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Department of Electronics & Communication Engineering

Project Phase-1 Rubrics for Group:

Sl.No	Criteria	1-2	3-4	5-6	7-8	9-10	CO
1.	Literature Survey **(10)**	One Literature	Two Literatures	Three Literatures	Four Literatures	Five Literatures	CO1
Sl.No	**Criteria**	**1-2**	**3-4**	**5**			**CO**
2.	Definition of Problem Statement **(05)**	Identified problem is not clear	Problem statement is clear, but not feasible for implementation	Problem statement is clear, can be implemented and tested			CO2
3.	Objectives of the Proposed Work **(05)**	Defined One or Two Objectives	Defined Three or Four Objectives	Defined maximum of Objectives			CO3
4.	Identification of Community that shall benefit with defined solution **(05)**	The defined solutions benefit the general community	Identified the community where the project cannot be directly used but the outcome of the project can be used as one of the parameter	Identified the community where the project can be directly used			CO2
5.	Environmental & Societal Impact **(05)**	The environment & societal impact is not clearly indicated	The impact of the outcome of the project on environment is indicated but the societal impact is not clearly indicated	The environment & societal impact is clearly indicated			CO2
6.	Identification of tools required for solution **(05)**	The tools required for the solution is not clearly identified	There is no justification for the tool / components being used	Clear Justification in selecting the tool / components being used is provided			CO3
Sl.No	**Criteria**	**1-3**	**4-6**	**7-9**	**10-12**	**13-15**	**CO**
7.	Project Report **(15)**	Not well organized, clear objectives and outcomes indicated, not as per the template given by the department and not submitted within the deadline	Not well organized, clear objectives and outcomes are not indicated, not as per the template given by the department	Not well organized, clear objectives and outcomes indicated, not as per the template given by the department	Well organized, clear objectives and outcomes indicated, not as per the template given by the department	Well organized, clear objectives and outcomes indicated, Report is as per the template	CO4

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Department of Electronics & Communication Engineering

Project Phase-1 Rubrics for Individual: Sem : 7

Sl.No.	Criteria	1-4	5-8	9-10	CO
1.	Oral presentation preparation **(10)**	Not as per uniform template given by the department	As per uniform template given by the department Does not seem to understand the topic very well and presentation flow is missing	Shows a deep understanding of the topic with excellent flow in the presentation	CO4
2.	Presentation skills **(10)**	Poor: The slides were syntactically not complete, used filler words, presentation material is not relevant, exceeded given time more than 15 minutes or Presentation is less than 10 minutes	Satisfactory: Most of the slides were syntactically not complete, used filler words, presentation material is not so relevant, exceeded given time by 12 – 15 minutes or finished before 12 - 15 minutes	Very Good: All the slides were syntactically complete, no use of filler words, presentation material is relevant, Kept up the given time 20 minutes	CO4
3.	Involvement and contribution in the team **(10)**	Does not involve in all the activities and there is no much contribution to the team	Involves in all the activities but does not contribute to the team	Involves in all the activities and contribute to the team	CO5
4.	Mentoring / Leading the team **(10)**	Does not cooperate in the team	Leads the team but lack in mentoring	Mentors and leads the team	CO5
5.	Ability to answer the queries **(10)**	Answered 25% of the queries	Answered 50% of the queries	Answered all queries	CO4

9.8.23

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Department of Electronics & Communication Engineering

Project Phase-2 Rubrics for Individual:

Sl.No.	Criteria	1-2	3-5	6-8	9-10	CO
1.	**Presentation (10)** 1. Preparation 2. Flow & Style 3. Confidence 4. Answering queries	Any 1 parameter is addressed	Any 2 parameters are addressed	Any 3 parameters are addressed	All the 4 parameters are addressed	CO4
2.	**Viva (10)** 1. Oral Communication 2. Interpretation of results 3. Q&A (Answering/Clarifying evaluator's queries). 4.Overall knowledge about the project	Any 1 parameter is addressed	Any 2 parameters are addressed	Any 3 parameters are addressed	All the 4 parameters are addressed	CO3
3.	**Professional Skills (10)** 1. Time Management & Adaptability 2. Project Planning & Management 3. Oral & Written Communication Skills 4. Concern about Society & Environment	Any 1 parameter is addressed	Any 2 parameters are addressed	Any 3 parameters are addressed	All the 4 parameters are addressed	CO4
4.	**Teamwork(10)** 1. Involvement 2. Coordination 3. Contribution 4. Overall performance	Any 1 parameter is addressed	Any 2 parameters are addressed	Any 3 parameters are addressed	All the 4 parameters are addressed	CO5
5.	**Leadership(10)** 1. Mentoring team members 2. Respecting the team members 3. Comprehension ability 4.Coordination	Any 1 parameter is addressed	Any 2 parameters are addressed	Any 3 parameters are addressed	All the 4 parameters are addressed	CO5

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Department of Electronics & Communication Engineering

Project Phase-2 Rubrics for Group: Sem : 8

Sl.No	Criteria	1	2	3	4	5	CO
1.	Literature Survey(5)	One Literature	Two Literatures	Three Literatures	Four Literatures	Five Literatures	CO1
Sl.No	**Criteria**	**1-3**	**4-5**	**6-8**	**9-10**		**CO**
2.	**Design (10)** 1. All the Specifications indicated 2. Selection of the tool / component 3. All the objectives are met 4. Algorithm / Circuit	Any 1 parameter is addressed	Any 2 parameters are addressed	Any 3 parameters are addressed	All the 4 parameters are addressed		CO2
Sl.No	**Criteria**	**1-4**	**5-7**	**8-10**			
3.	**Implementation(10)** 1. Simulation carried out 2. Implemented partially 3. Implemented completely	Any 1 parameter is addressed	Any 2 parameters are addressed	All parameters are addressed			CO2
Sl.No	**Criteria**	**1-2**	**3-4**	**5**			
4.	**Result Analysis(5)** 1. Results are partially obtained 2. Results are complete 3. Results are analyzed & inferences are drawn	Any 1 parameter is addressed	Any 2 parameters are addressed	All parameters are addressed			CO3
Sl.No	**Criteria**	**1-4**	**5-8**	**9-12**	**13-16**	**17-20**	**CO**
5.	**Project Report(20)** 1. Adherence to Template 2. Report in line with the content as suggested by the Coordinator 3. Organization of the Report 4. Grammar 5. documented using Latex documentation tool	Any 1 parameter is addressed	Any 2 parameters are addressed	Any 3 parameters are addressed	Any 4 parameters are addressed	All the 5 parameters are addressed	CO4

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Department of Electronics & Communication Engineering

Rubrics for Internship seminar

Student Name: Suhas N. S.	USN : 4JN18EC094	Date: 18/05/2022
Title : IoT based communication with both using multiple control system web development using Flask framework and pythonanywhere hosting platform		

Criteria		Grading Pattern (marks)				
Technical Skills (20 Marks)		1 to 5	6 to 10	11 to 15	16 to 20	Marks
1	Software Tools or hardware learnt	Criteria ONE is addressed	Criteria ONE & TWO are addressed	Criteria ONE to THREE are addressed	All the FOUR criteria are addressed	18
2	Design and development of project using Software/ Hardware / Model / Prototype					
3	Analysis of Results					
4	Inferences drawn					
Professional Skills (10 marks)		1 to 2	3 to 5	6 to 8	9 to 10	
1	Time Management & Adaptability	Criteria ONE is addressed	Criteria ONE & TWO are addressed	Criteria ONE to THREE are addressed	All the FOUR criteria are addressed	10
2	Interpersonal Skills					
3	Oral & Written Communication Skills					
4	Industry Etiquettes					
Presentation & Viva (10 marks)		1 to 2	3 to 5	6 to 8	9 to 10	
1	Preparation	Any 1 parameter is addressed	Any 2 parameters are addressed	Any 3 parameters are addressed	All the 4 parameters are addressed	9
2	Flow & Style					
3	Confidence					
4	Answering queries					
Report (10 marks)		1 to 2	3 to 5	6 to 8	9 to 10	
1	Adherence to Template	At least 1 parameters is addressed	At least 2 parameters are addressed	At least 3 parameters are addressed	All the 4 parameters are addressed	10
2	Report in line with the content of presentation					
3	Organization of the Report					
4	Grammar					
					Total Marks (Presentation +report)	47

	Name	Signature	Signature of HoD
Guide	Dr. S.V. Sathyanarayana	[signature] 18/5/22	[signature] 18/5/22
Evaluator	Sunil M.D.	[signature]	
Coordinator	Shwetha. B	[signature] 18/5/22	

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TECHNICAL SEMINAR RUBRICS

Name of the student :

Seminar Topic:

USN:

Category	Grading Pattern					Marks
Literature Survey (20 Marks)	**5 Marks**	**4 Marks**	**3 Marks**	**2 Marks**	**1 Mark**	
1. No. of papers referred	5 or more Papers	4 Papers	3 Papers	2 Papers	1 Paper	
2. Relevance	All 5 papers are relevant to chosen domain	All 4 papers are relevant to chosen domain	All 3 papers are relevant to chosen domain	All 2 papers are relevant to chosen domain	Paper is relevant to chosen domain	
3. Quality	At least 5 papers are from reputed journals	Atleast 4 are from reputed journals	At least 3 papers are from reputed journals	Atleast 2 papers are from reputed journals	Paper is from reputed journal	
4. Recency	At least 5 papers published in Past two years	Atleast 4 papers published in Past 3-4 years	At least 3 published in Past 5-6 Atleast 3 papers years	Atleast 2 papers published in Past 7-8 years	Paper published in Past more than 8 years	
Presentation (60 Marks)	**9 -10 Marks**	**7-8 Marks**	**5-6 Marks**	**3-4 Marks**	**1-2 Marks**	
Organization of presentation 1. Well structured 2. Formatting 3. Effective use of Text & Graphics	All the three parameters are addressed		At least two parameters are addressed		At least one	
Technical Content 1. Provides a thorough overview 2. In-depth explanations & justifications 3. Design / Calculations / Simulations / Algorithms 4. Research and analysis 5. Societal & Environmental concerns	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	
Presentation skills 1. Preparation 2. Communication 3. Confidence 4. Flow & style 5. Formal appearance	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	
Answering queries	Answered all queries	Answered most of the queries	Answered some of the queries	Answered very few queries	Attempted to answer	
Inferences/results & discussions 1. Inferences are drawn based on experiment/implementation by the student 2. Ability to comprehend / summarize the concepts 3. Exploring the future scope of the study	All the three parameters are addressed		At least two parameters are addressed		At least one	
Adherence to time(20 minutes)	kept up the given time	Exceeded given time by ± 5 mins	Exceeded given time by ±10 mins	Exceeded given time ± 15 mins		
Seminar Report(20 Marks) 1. Adherence to Template 2. Report in line with the content of presentation 3. Organization of the report 4. Grammar 5. Inclusion of Citations	All the 5 parameters are addressed	At least 4 parameters are addressed	At least 3 parameters are addressed	At least 2 parameters are addressed	At leastone parameter is addressed	

Abhijith. N
Asst. Prof.
Dept of E C E
JNNCE, Shivamogga

Professor & Head
Dept. of Electronics & Communication Engg.
JNN College of Engineering
SHIVAMOGGA-577 204.

Rubrics for Laboratory					
Criteria					
Observation and Record (10)	Observations and record are incomplete **(4-5 Marks)**	Observations and record are moderately complete but not regularly submitted **(6-7 Marks)**	Observations and record are moderately complete with regular submission **(7-8 Marks)**	Observations and record are thoroughly complete **(10 Marks)**	
Viva (4)	Not able to answer questions **(0 Marks)**	Attempt to answer at least some of the questions **(1- Mark)**	Able to answer at least some of the questions appropriately **(2-3 Marks)**	Able to answer most of the questions correctly **(4 Marks)**	
Conduction (10)	Lack of fundamental concept of the experiment **(0-1 Marks)**	Possess fundamentals but could not demonstrate the conduction procedure of the experiment. **(1-2 Marks)**	Demonstrate good fundamentals, conduction procedure but could not obtain the results **(3-5 Marks)**	Demonstrate good fundamentals, conduction procedure along with results **(6-8 Marks)**	Demonstrate good fundamentals, conduction procedure along with result analysis **(9-10 Marks)**

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Department of Electronics & Communication Engineering

LAB ASSESMENT SHEET

Lab Name:		**Lab Code:**	
Faculty I/C:		**Academic Year:**	
Student Name:		**Sem & Section:**	
USN:		**Max. Marks:**	

Sl. No.	Date	Expt. No.	Observation & Record (10M)	Viva (4M)	Conduction (10M)	Total (24M)	Signature
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
	AVERAGE						

Daily Evaluation (24M)	Lab Test(16M)		Total (40M)	Faculty Signature
	Writeup (8M)	Conduction (8M)		

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Department of Electronics & Telecommunication Engineering

Rubrics for Evaluation of Internship

Date:

Name of student		**USN**	

Criteria	**Grading Pattern (marks)**			**Marks awarded**
	1-3	**4-7**	**8-10**	
Literature Survey (10 marks)	One paper reviewed	Two papers reviewed	More than two papers reviewed	
Design & development (15 marks)	**1-5**	**6-10**	**11-15**	
1. Software Tools or hardware learnt 2. Design and development of project using Software/ Hardware / Model / Prototype 3. Implementation	Criteria ONE is addressed	Criteria ONE & TWO are addressed	All the THREE are addressed	
Analysis of results (10 marks)	**1-3**	**4-7**	**8-10**	
1. Partial results obtained 2. Complete results obtained 3. Analysis of results reported	Criteria ONE is addressed	Criteria ONE & TWO are addressed	All the THREE are addressed	
Professional Skills (5 marks)	**1**	**2-3**	**4-5**	
1. Time Management & Adaptability 2. Interpersonal Skills 3. Oral & Written Communication Skills 4. Industry Etiquettes	Criteria ONE & TWO are addressed	Criteria ONE, TWO & THREE are addressed	All the FOUR criteria are addressed	
Presentation & Viva (5 marks) 1. Preparation 2. Flow &Style 3. Confidence 4. Answering queries	Any 1 parameter is addressed	Any 2-3 parameters are addressed	All the FOUR parameters are addressed	
Report (5 marks) 1. Adherence to Template 2. Report in line with the content of presentation 3. Organization of the Report 4. Grammar	At least 1 parameters is addressed	At least 2-3 parameters are addressed	All the FOUR parameters are addressed	
Total marks				

Name of the guide: **Signature:**	**Signature of Coordinator**	**Signature of Head of dept.**

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Department of Electronics & Telecommunication Engineering

Rubrics for Evaluation of Internship

Date:

Name of student		**USN**	

Criteria	**Grading Pattern (marks)**			
	1-5	**6-10**	**11-15**	**16-20**
Technical Skills (20 marks) 1. Software Tools or hardware learnt 2. Design and development of project using Software/ Hardware / Model / Prototype 3. Analysis of Results 4. Inferences drawn	Criteria ONE is addressed	Criteria ONE & TWO are addressed	Criteria ONE to THREE are addressed	All the FOUR criteria are addressed
Professional Skills (10 marks)	**1-2**	**3-5**	**6-8**	**9-10**
1. Time Management & Adaptability 2. Interpersonal Skills 3. Oral & Written Communication Skills 4. Industry Etiquettes	Criteria ONE is addressed	Criteria ONE & TWO are addressed	Criteria ONE to THREE are addressed	All the FOUR criteria are addressed
Presentation & Viva (10) 1. Preparation 2. Flow & Style 3. Confidence 4. Answering queries	Any 1 parameter is addressed	Any 2 parameters are addressed	Any 3 parameters are addressed	All the 4 parameters are addressed
Report (10) 1. Adherence to Template 2. Report in line with the content of presentation 3. Organization of the Report 4. Grammar	At least 1 parameters is addressed	At least 2 parameters are addressed	At least 3 parameters are addressed	All the 4 parameters are addressed

Name of the guide: **Signature:**	**Signature of Coordinator:**	**Signature of Head of dept.**

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Dept. of Electronics & Telecommunication Engg. JNNCE, SHIMOGA

Department of Telecommunication Engineering

Rubrics for Internship Evaluation (CIE) 2019-20

Criteria	1-5	5-10	10-15	15-20
Quality of work (20)	Student is able to clearly articulate observations and thoughts about the professional aspects of the internship experience; how experience parallels program of study; ways the internship experience might have been improved; skills and knowledge acquired.	Student adapted easily to the work environment within the limits of his personal values.	The degree to which the student's work is thorough, accurate, and completed in a timely manner	Thoroughly and accurately performed all work requirements; submitted all work assignments on time.
Application / Relevance in current scenario (5)	The work is relevant to the current societal needs and the applications and can be extended as a prototype			
Learning Outcome of the Internship (5)	Was a self-starter; consistently sought new challenges and asked for additional work assignments; regularly approached and solved problems independently; frequently proposed innovative and creative ideas, solutions, and/or options			
Quality of Presentation (5)	Presentation clearly structured, concise and to-the-point.			
Ability to answer the queries (5)	Answering the questions to the point and completely - Demonstrate an outstanding knowledge of the material(s).			
Quality of Internship report (10)	Written report is error-free, logically presents design recommendations and analysis, is well-organized and easy to read.	adhered to the standard reporting template given by the department		

Dept. of Electronics & Telecommunication Engg. JNNCE, SHIMOGA

NATIONAL EDUCATION SOCIETY

JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING

DEPARTMENT OF TELECOMMUNICAITON ENGINEERING

8th Semester

INTERNSHIP EVALUATION RUBRICS (2018-19)

Department: Telecommunication Engineering				Course code: 15EC84
Title of Internship:				
Organization & Place of internship:				
Name of student:		USN:		Date:

Sl. No.	Parameters	Max. Marks	Marks Allotted
1.	Quality of work	20	
2.	Application / Relevance in current scenario	05	
3.	Learning Outcome of the Internship	05	
4.	Quality of Presentation	05	
5.	Ability to answer the queries	05	
6.	Quality of Internship report	10	
	Total	**50**	

		Name of Staff	Signature
Signature of HoD	1	____________________	__________
	2	____________________	__________

Evaluation Guidelines

1. Quality of the work is to be assessed based on the technical content of the report.
2. Learning outcome should be evaluated based on the presentation, knowledge gained by the student (which may be evaluated by asking various queries to test the knowledge) and the report.
3. Quality of report: Evaluated based on whether the student has adhered to the standard reporting template given by the respective department and flow of the report & quality of the language.

Dept. of Electronics & Engg. J.N.N.C.E. SHIMOGA

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TECHNICAL SEMINAR RUBRICS

Category	Grading Pattern					Marks
Literature Survey (20 Marks)	5 Marks	4 Marks	3 Marks	2 Marks	1 Mark	
1. No. of papers referred	5 or more Papers	4 Papers	3 Papers	2 Papers	1 Paper	
2. Relevance	All 5 papers are relevant to chosen domain	All 4 papers are relevant to chosen domain	All 3 papers are relevant to chosen domain	All 2 papers are relevant to chosen domain	Paper is relevant to chosen domain	
3. Quality	At least 5 papers are from reputed journals	At least 4 are from reputed journals	At least 3 papers are from reputed journals	At least 2 papers are from reputed journals	Paper is from reputed journal	
4. Recency	At least 5 papers published in Past two years	At least 4 papers published in Past 3-4 years	At least 3 published in Past 5-6 At least 3 papers years	At least 2 papers published in Past 7-8 years	Paper published in Past more than 8 years	
Presentation (60 Marks)	**9 -10 Marks**	**7-8 Marks**	**5-6 Marks**	**3-4 Marks**	**1-2 Marks**	
Organization of presentation 1. Well structured 2. Formatting 3. Effective use of Text & Graphics	All the three parameters are addressed		At least two parameters are addressed		At least one	
Technical Content 1. Provides a thorough overview 2. In depth explanations & justifications 3. Design / Calculations / Simulations / Algorithms 4. Research and analysis 5. Societal & Environmental concerns	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	
Presentation skills 1. Preparation 2. Communication 3. Confidence 4. Flow & style 5. Formal appearance	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	
Answering queries	Answered all queries	Answered most of the queries	Answered some of the queries	Answered very few queries	Attempted to answer	
Inferences/results & discussions 1. Inferences are drawn based on experiment/implementation by the student 2. Ability to comprehend / summarize the concepts 3. Exploring the future scope of the study	All the three parameters are addressed		At least two parameters are addressed		At least one	
Adherence to time (20 minutes)	Kept up the given time	Exceeded given time by ± 5 mins	Exceeded given time by ±10 mins	Exceeded given time ± 15 mins		
Seminar Report (20 Marks) 1. Adherence to Template 2. Report in line with the content of presentation 3. Organization of the report 4. Grammar 5. Inclusion of Citations	All the 5 parameters are addressed	At least 4 parameters are addressed	At least 3 parameters are addressed	At least 2 parameters are addressed	At least one parameter is addressed	

TECHNICAL SEMINAR RUBRICS

Category	Grading Pattern					Marks
Literature Survey (20 Marks)	**5 Marks**	**4 Marks**	**3 Marks**	**2 Marks**	**1 Mark**	
1. No. of papers referred	5 or more Papers	4 Papers	3 Papers	2 Papers	1 Paper	
2. Relevance	All 5 papers are relevant to chosen domain	All 4 papers are relevant to chosen domain	All 3 papers are relevant to chosen domain	All 2 papers are relevant to chosen domain	Paper is relevant to chosen domain	
3. Quality	At least 5 papers are from reputed journals	At least 4 are from reputed journals	At least 3 papers are from reputed journals	At least 2 papers are from reputed journals	Paper is from reputed journal	
4. Recency	At least 5 papers published in Past two years	At least 4 papers published in Past 3-4 years	At least 3 published in Past 5-6 At least 3 papers years	At least 2 papers published in Past 7-8 years	Paper published in Past more than 8 years	
Presentation (60 Marks)	**9 -10 Marks**	**7-8 Marks**	**5-6 Marks**	**3-4 Marks**	**1-2 Marks**	
Organization of presentation 1. Well structured 2. Formatting 3. Effective use of Text & Graphics	All the three parameters are addressed		At least two parameters are addressed		At least one	
Technical Content 1. Provides a thorough overview 2. In-depth explanations & justifications 3. Design / Calculations / Simulations / Algorithms 4. Research and analysis 5. Societal & Environmental concerns	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	
Presentation skills 1. Preparation 2. Communication 3. Confidence 4. Flow & style 5. Formal appearance	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	
Answering queries	Answered all queries	Answered most of the queries	Answered some of the queries	Answered very few queries	Attempted to answer	
Inferences/results & discussions 1. Inferences are drawn based on experiment/implementation by the student 2. Ability to comprehend / summarize the concepts 3. Exploring the future scope of the study	All the three parameters are addressed		At least two parameters are addressed		At least one	
Adherence to time (20 minutes)	kept up the given time	Exceeded given time by ± 5 mins	Exceeded given time by ±10 mins	Exceeded given time ± 15 mins		
Seminar Report (20 Marks) 1. Adherence to Template 2. Report in line with the content of presentation 3. Organization of the report 4. Grammar 5. Inclusion of Citations	All the 5 parameters are addressed	At least 4 parameters are addressed	At least 3 parameters are addressed	At least 2 parameters are addressed	At least one parameter is addressed	

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Technical Seminar Evaluation Rubrics (Course Code: 18TES84)

Name of the Student: Mohammed Afridi
USN: 4JN18TE021
Title: Categorizing Diseases from Leaf Images using a Hybrid Learning model
Batch: B7

Category	Grading Pattern (marks)					Marks Allotted
Literature Survey (20 Marks)	5	4	3	2	1	
a. No. of papers referred (5)	5 or more Papers	4 Papers	3 Papers	2 Papers	1 Paper	5
b. Relevance (papers are relevant to chosen domain) (5)	All 5 papers	All 4 papers	All 3 papers	All 2 papers	1 Paper	5
c. Quality (papers are from reputed journals) (5)	At least 5 papers	At least 4 papers	At least 3 papers	At least 2 papers	At least 1 Paper	5
d. Recency (5)	At least 5 papers published in Past 2 years	At least 4 papers published in Past 3-4 years	At least 3 papers published in Past 5-6	At least 2 papers published in Past 7-8 years	At least 1 Paper published in Past more than 8 years	5
Subtotal						20
Technical Content (30 marks)	25-30	19-24	13-18	7-12	1-6	
1. Provides a thorough overview 2. In-depth explanations and justifications 3. Design / Calculations / Simulations / Algorithms 4. Research and analysis 5. Answering queries	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	28
Inferences / Results & Discussions (20 marks)	14-20		8-13		1-7	
1. Inferences are drawn based on experiment/ implementation by the student 2. Ability to comprehend / summarize the concepts 3. Exploring the future scope of the study	All the three parameters are addressed		At least two parameters are addressed		At least one	18
Organization of presentation (10 Marks)	7-10		4-6		1-3	
a. Well structured b. Formatting c. Effective use of Text and Graphics	All the three parameters are addressed		At least two parameters are addressed		At least one	7
Presentation skills (10 marks)	9-10	7-8	5-6	3-4	1-2	
1. Preparation 2. Communication 3. Confidence 4. Flow & style 5. Adherence to time 25 mins (P) + 5 mins (Q/A) = 30 mins	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	8
Seminar Report (10 marks)	9-10	7-8	5-6	3-4	1-2	
1. Adherence to Template 2. Report in line with content of presentation 3. Organization of the report 4. Grammar 5. Inclusion of Citations	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	9
					Total marks	90

Name & Signature of staff:			Signature of Head of the Dept.	
	1.	Madhukar C.S [signature] 3/6/2022		
	2.	Benak Patel MP [signature] 3/6/22		

13 - Technical Seminar Rubrics. (13)

National Education Society (R.)

Department of Electronics & Telecommunication Engineering

JNN College of Engineering, Shivamogga

(Approved by AICTE, New Delhi, Certified by UGC 2f & 12B, Accredited by NAAC - 'B', UG programs CE,ME,EEE,ECE,CSE,ISE,TCE accredited by NBA:1.7.2019 to 30.6.2022, Recognized by Govt. of Karnataka and Affiliated to VTU, Belagavi)

INTERNAL QUALITY ASSURANCE CELL

Technical Seminar Evaluation Rubrics (Course Code: 18TES84)

Name of the Student: Manish. H.G
USN: 4JN18TE020
Title: Free Space optical Communication
Batch: B6

Category	Grading Pattern (marks)					Marks Allotted
Literature Survey (20 Marks)	5	4	3	2	1	
a. No. of papers referred (5)	5 or more Papers	4 Papers	3 Papers	2 Papers	1 Paper	4
b. Relevance (papers are relevant to chosen domain) (5)	All 5 papers	All 4 papers	All 3 papers	All 2 papers	1 Paper	4
c. Quality (papers are from reputed Journals) (5)	At least 5 papers	At least 4 papers	At least 3 papers	At least 2 papers	At least 1 Paper	4
d. Recency (5)	At least 5 papers published in Past 2 years	At least 4 papers published in Past 3-4 years	At least 3 papers published in Past 5-6	At least 2 papers published in Past 7-8 years	At least 1 Paper published in Past more than 8 years	4
Subtotal						16
Technical Content (30 marks)	25-30	19-24	13-18	7-12	1-6	
1. Provides a thorough overview 2. In-depth explanations and justifications 3. Design / Calculations / Simulations / Algorithms 4. Research and analysis 5. Answering queries	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	25
Inferences / Results & Discussions (20 marks)	14-20		8-13		1-7	
1. Inferences are drawn based on experiment/ implementation by the student 2. Ability to comprehend / summarize the concepts 3. Exploring the future scope of the study	All the three parameters are addressed		At least two parameters are addressed		At least one	16
Organization of presentation (10 Marks)	7-10		4-6		1-3	
a. Well structured b. Formatting c. Effective use of Text and Graphics	All the three parameters are addressed		At least two parameters are addressed		At least one	08
Presentation skills (10 marks)	9-10	7-8	5-6	3-4	1-2	
1. Preparation 2. Communication 3. Confidence 4. Flow & style 5. Adherence to time 25 mins (P) + 5 mins (Q/A) = 30 mins	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	09
Seminar Report (10 marks)	9-10	7-8	5-6	3-4	1-2	
1. Adherence to Template 2. Report in line with content of presentation 3. Organization of the report 4. Grammar 5. Inclusion of Citations	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	08
					Total marks	82

Name & Signature of staff:			Signature of Head of the Dept.	
	1.	MADHUKAR. CS [signature]		
	2.	ANAND RAJ S.N [signature] 02/06/2022		

Jawaharlal Nehru National College of Engineering, Shivamogga

Department of Telecommunication Engineering

8th Semester B.E

Technical Seminar (Course Code: 15ECS86) Evaluation Rubrics

Date:		Topic:	
Name of Student:			
USN:			

CATEGORY	Max. Marks	Grading pattern				Marks Allotted
		40 -30 Marks	29 - 20 Marks	19 -10 Marks	9 - 1 Marks	
Content	40	Shows a deep understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.	
		30 - 20 Marks	19 - 15 Marks	14 - 9 Marks	8 -1 Marks	
Presentation Skills	30	Very Good: All the slides were syntactically complete, No use of filler words, presentation material is relevant, Kept up the given time - 20 minutes	Good: Most of the slides were syntactically complete, Minimum use of filler words, presentation material is moderately relevant, exceeded given time by 5 - 10 minutes or finished before 5 - 10 minutes	Satisfactory: Most of the slides were syntactically not complete, used filler words, presentation material is not so relevant, exceeded given time by 10 - 15 minutes or finished before 10 - 15 minutes	Poor: The slides were syntactically not complete, used filler words, presentation material is not relevant, exceeded given time more than 15 minutes or Presentation is less than 10 minutes	
		10 - 8 Marks	7 - 5 Marks	4 - 3 Marks	2 -1 Marks	
Answering Queries	10	Very Goo d: Answered all queries	Good: Answered most of the queries	Satisfactory: Answered some of the queries	Poor: Answered very few queries	
Total Marks (Out of 80 Marks)						
Report compilation (Out of 20 Marks)						
Total Marks Awarded						

Name of the Evaluator:	
Signature:	

(B11)
19/4/22
3:00pm - 5:00pm.

National Education Society (R.)

Jawaharlal Nehru National College of Engineering, Shivamogga

(Approved by AICTE, New Delhi, Certified by UGC 2f & 12B, Accredited by NAAC –'B', UG program accredited by NBA Recognized by Govt. of Karnataka and Affiliated to VTU, Belagavi)

INTERNAL QUALITY ASSURANCE CELL

TECHNICAL SEMINAR RUBRICS

Name of the student : Madhura B.N USN: 4JN18EC045

Seminar Topic: "Conversion of Sign language into text"

Category	Grading Pattern					Marks
Literature Survey (20 Marks)	**5 Marks**	**4 Marks**	**3 Marks**	**2 Marks**	**1 Mark**	20
1. No. of papers referred	5 or more Papers	4 Papers	3 Papers	2 Papers	1 Paper	
2. Relevance	All 5 papers are relevant to chosen domain	All 4 papers are relevant to chosen domain	All 3 papers are relevant to chosen domain	All 2 papers are relevant to chosen domain	Paper is relevant to chosen domain	
3. Quality	At least 5 papers are from reputed journals	Atleast 4 are from reputed journals	At least 3 papers are from reputed journals	Atleast 2 papers are from reputed journals	Paper is from reputed journal	
4. Recency	At least 5 papers published in Past two years	Atleast 4 papers published in Past 3-4 years	At least 3 published in Past 5-6 Atleast 3 papers years	Atleast 2 papers published in Past 7-8 years	Paper published in Past more than 8 years	
Presentation (60 Marks)	**9 -10 Marks**	**7-8 Marks**	**5-6 Marks**	**3-4 Marks**	**1-2 Marks**	
Organization of presentation 1. Well structured 2. Formatting 3. Effective use of Text & Graphics	All the three parameters are addressed ✓		At least two parameters are addressed		At least one	7
Technical Content 1. Provides a thorough overview 2. In-depth explanations & justifications 3. Design / Calculations / Simulations / Algorithms 4. Research and analysis 5. Societal & Environmental concerns	All the 5 parameters are addressed ✓	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	9
Presentation skills 1. Preparation 2. Communication 3. Confidence 4. Flow & style 5. Formal appearance	All the 5 parameters are addressed ✓	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	9
Answering queries	Answered all queries ✓	Answered most of the queries	Answered some of the queries	Answered very few queries	Attempted to answer	9
Inferences/results & discussions 1. Inferences are drawn based on experiment/implementation by the student 2. Ability to comprehend / summarize the concepts 3. Exploring the future scope of the study	All the three parameters are addressed ✓		At least two parameters are addressed		At least one	9
Adherence to time(20 minutes)	kept up the given time ✓	Exceeded given time by ± 5 mins	Exceeded given time by ±10 mins	Exceeded given time ± 15 mins		10
Seminar Report(20 Marks) 1. Adherence to Template 2. Report in line with the content of presentation 3. Organization of the report 4. Grammar 5. Inclusion of Citations	All the 5 parameters are addressed ✓	At least 4 parameters are addressed	At least 3 parameters are addressed	At least 2 parameters are addressed	At leastone parameter is addressed	20

SM - [signature] SB - [signature] 19/4/22

Department of Electronics and Communication Engg. J.N.N. College of Engineering SHIVAMOGGA [stamp, signature]

93/100

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J.N.N College of Engineering, Shivamogga
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for period 1.7.2019 to 30.6.2022,
Recognized by Govt. of Karnataka and Affiliated to VTU, Belagavi)

Department of Electronics and Communication Engineering

Seminar Evaluation Sheet

USN: 4JN18EC045			**Name:** MADHURA B N	
Sem: 8			**Section:** A	
Guide:SMITHA S M				
Title: Conversion of sign language into text				
Sl. No	Parameter	Guide Marks (Max:80)	Coordinator Marks (Max: 20)	Total Marks (Max: 100)
Rubrics				
1	Technical Content	7.2	1.8	9
2	Presentation skills	7.2	1.8	9
3	Organization of presentation	5.6	1.4	7
4	Literature survey	16	4	20
5	Answering Queries	7.2	1.8	9
6	Inferences/ Results and discussions	7.2	1.8	9
7	Adherence to time	8	2	10
8	Seminar report	16	4	20
	Total	74.4	18.6	93

Signature of Guide

Signature of Seminar Coordinators

Signature of HOD

Head of the Department
Electronics and Communication Engineering
J N N College of Engineering
SHIMOGA-577 204

B28	4JN18EC112	Vidyashree R	Magic Medical Mirror			**EC104**
	4JN18EC065	Rachana R Hathwar	Security System			
B31	4JN18EC022	Chethan V	3nm GAA Tech	21/4/22	3:00 pm to 5:00pm	PSC, ABN **EC101**
	4JN18EC055	Nikhil Anand	Bluetooth			

Technical Seminar Co-ordinators: Abhijith N, Prashanth G S

Head of the Department
Electronics and Communication
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Dept. of Electronics & Communication Engg.
JNNCE
SHIVAMOGGA-

B20	4JN18EC086	Shwetha R	IoT Wearable Sensor and Deep Learning: An Integrated Approach for Personalized Human Activity Recognition in a Smart Home Environment	20/4/22	3:00 pm to 5:00pm	BSU, PGS **EC104**
	4JN18EC069	Ranjitha P	E-textiles (Electronic textiles)			
	4JN18EC074	Samiksha HR	Real-time detection of apple leaf diseases using a deep learning approach based on improved CNN			
	4JN18EC072	Sahana B N	A robust image copy detection method using machine learning			
B8	4JN18EC070	Ravi Kumar G K	plant leaf disease detection using a hybrid learning model	21/4/22	9:00am to 11:00am	KVD, SSM, ABN **EC101**
	4JN18EC106	Ujwal G	Research on Fire Detection and Image Information Processing System Based on Image Processing			
	4JN18EC122	Santhosh M S	Nutrient deficiency detection in maize (Zea mays L.) leaves using image processing			
	4JN18EC124	Adithya T R	End-to-End Learnt Image Compression via Non-Local Attention Optimization and Improved Context Modeling			
B13	4JN18EC034	Hemanth L	DETECTION AND DIAGNOSIS OF GLAUCOMA FROM RETINAL IMAGE USING IMAGE PROCESSING	21/4/22	9:00am to 11:00am	TSH, Dr.PKS, PGS **EC104**
	4JN18EC060	Pramod R	Deep Learning-Based Object Detection Improvement for Tomato Disease			
	4JN18EC013	Areeb Ur Rahaman	Face Recognition based Attendance System using Haar Cascade			
	4JN19EC401	Aftab Husen H L	On Road Animal Detection.			
B32	4JN18EC426	Sunil Kumara D T	Automatic rail crossing alarming system	21/4/22	11:15am to 1:15pm	AKJ, ABN **EC101**
	4JN17EC033	Kiran Kumar K S	"RFID Based Smart Bus"			
	4JN18EC420	Shambhu Nadager	High-Speed Broadband Communication System for Moving Trains using Free Space Optics			
	4JN18EC104	Twinkle Srusti J K	Visible Light Communication (VLC)	21/4/22	11:15am to 1:15pm	RBS, PGS
	4JN18EC062	Priya KS	IoT Based Real-Time Soil Nutrients Detection			

	4JN18EC082	Shashank K S	Fatigue driving detection.			
	4JN18EC078	Santosh	Specular Reflection Image Enhancement			
B15	4JN19EC412	Wilson Dsouza	Wireless charging for vehicles using receiver coils	20/4/22	9:00am to 11:00am	AKJ, TSH, ABN **EC101**
	4JN19EC406	Kiran Kumar R	Biometric System.			
	4jn19ec400	Adarsha D M	Wireless charging			
	4JN18EC066	Rajat Kumar	Wireless LAN			
B35	4jn14ec009	Ankith G.M.	Smart dust	20/4/22	9:00am to 11:00am	SSM, PGS **EC104**
	4JN16EC114	VARUN N	6G Network Access and Edge-Assisted Congestion Rule Mechanism using Software-Defined Networking			
	4jn15ec104	Punith S	VLC			
B6	4JN19EC409	Preethi K S	Design, Development and Evaluation of an Intelligent Animal Repelling System for Crop Protection embedded Edge-AI	20/4/22	11:15am to 1:15pm	SBN, ABN, SS **EC101**
	4JN19EC407	Pallavi N S	On underwater wireless sensor networks routing protocols			
	4JN19EC404	Anusha G	Optoelectronic and Nano sensors Detection Systems			
	4JN19EC408	Pooja A P	Color Image Enhancement of Acute Leukemia Cells in Blood Microscopic Image for Leukemia Detection Sample			
B33	4JN17EC012	Apeksha C S	Attribute-based encryption for secure access to cloud based EHR systems	20/4/22	11:15am to 1:15pm	KVD, PGS **EC104**
	4JN17EC048	Monika K P	URBAN UNDERGROUND INFRASTRUCTURE MONITORING IoT: THE PATH LOSS ANALYSIS			
	4JN16EC045	Manjunath v banger	Steganography scheme on JPEG compressed cover image with high embedding capacity			
B24	4jn18ec077	Sanjay kb	Forest monitoring system for early fire detection based on Convolutional neural network and UAV imagery	20/4/22	3:00 pm to 5:00pm	SHR, SM, ABN **EC101**
	4JN18EC117	Vishruth V Belagavi	Artificial Intelligence for the Metaverse: A Survey			
	4JN18EC118	Vivek H B	Real-time Traffic Jam Detection and Congestion Reduction Using Streaming Graph Analytics			
	4JN18EC105	Uday S	Image classification with ML			

Communication Engi...

B22	4JN18EC098	Sumanth Shanbog HR	Real-Time Embedded sEMG analysis using Neural Networks for Gesture Recognition	19/4/22	9:00am to 11:00am	PSC, PKN, PGS **EC104**
	4JN18EC119	Yashas Vinay	Nuclear Fusion 101			
	4JN18EC081	Shashank G S	From Algorithms to Devices: Enabling Machine Learning through Ultra-Low-Power VLSI Mixed-Signal Array Processing			
B16	4JN18EC016	Bhargavi G N	Block chain for Industry	19/4/22	11:15am to 1:15pm	SMD, ABN, ABP **EC101**
	4JN18EC006	Aishwarya s	A Deep Cascade of Convolutional Neural Networks for Dynamic MR Image Reconstruction			
	4JN18EC019	Bhoomika BC	Light Fidelity (Li-Fi) Technology: Will It Be an Eco-friendly for Monitoring the Covid-19 Patients in Hospital.			
	4JN18EC115	Vinusha K	Energy harvesting technologies for wireless sensor networks			
B26	4JN19EC405	Apoorva A Jain	Concept of convolutional neural network using deep learning approach	19/4/22	11:15am to 1:15pm	SK, RBS, PGS **EC104**
	4JN19EC402	Anujna BN	Automatic Segmentation of MR Brain Images with a Convolutional Neural Network			
	4jn18ec095	Suma Manjunath Anvekar	Survey of Convolutional Neural Networks			
	4JN18EC083	Shilpa S	Complex - valued Neural Networks with Non - parametric Activation Functions			
B11	4JN18EC054	Neha S Bharadwaj	Hand gesture recognition using convolution neural network	19/4/22	3:00 pm to 5:00pm	SM,SB, ABN **EC101**
	4JN18EC050	Mounya S.M	Robust Handwriting Recognition with Limited and Noisy Data			
	4JN18EC045	Madhura B N	Conversion of sign language into text			
	4JN18EC008	Akshatha R Kunte	Languge Recognition System			
B27	4JN18EC084	Shiva Kumar M	Deep Learning-Based Smart IoT Health System for Blindness Detection Using Retina Images	19/4/22	3:00 pm to 5:00pm	SS, BSU,PGS **EC104**
	4JN18EC107	Ullas R K	Malicious Insider Attack Detection in IoTs Using Data Analytics			

B5	4JN18EC121	Gagana H M	Access Control System Based on Face Recognition	18/4/22	11:15am to 1:15pm	SK, TSH,PGS **EC104**
	4JN18EC026	Deepak B N	Li-fi Technology and its Application			
	4jn19ec403	Anusha B V	Smart Attendance Management System Based on Face Recognition Using CNN			
	4JN18EC039	Kavana M	A Study on Digital Image Forgery Techniques and its Detection			
B12	4JN18EC049	Mohammed Shahid	Visual Speech Recognition using Convolutional Neural Network	18/4/22	3:00 pm to 5:00pm	SM, PKN,ABN **EC101**
	4JN18EC048	Mohammed Saqib	Detection of Glaucoma in Retinal Image using various Image Processing Techniques			
	4JN18EC002	Adarsh Prabhakar	Scene Recognition Method by Bag of Objects Based on Object Detector			
	4JN18EC046	Manoj Kumar KP	A Semi-Supervised Multi-Task Learning Approach for Predicting Short-Term Kidney Disease Evolution			
B25	4JN18EC096	Suman S	Fast chain	18/4/22	3:00 pm to 5:00pm	Dr. SVS, SS, PGS **EC104**
	4JN18EC111	Vidyarani S H	A Novel Improvement With an Effective Expansion to Enhance the MD5 Hash Function for Verification of a Secure E-Document. (RAINBOW TABLE - CRYPTOGRAPHY)			
	4JN18EC064	Priyanka P S	IoT-Assisted ECG Monitoring Framework with Secure Data Transmission for Health Care Applications			
	4JN18EC094	Suhas N S	Steganography.			
B10	4JN18EC027	Dilip M	An Overview of Internet of Things (IoT) and Data Analytics in Agriculture: Benefits and Challenges	19/4/22	9:00am to 11:00am	SHR, AKJ,ABN **EC101**
	4JN18EC028	Gagan H U	5G for Vehicular Use Cases: Analysis of Technical Requirements, Value Propositions and Outlook			
	4JN18EC061	Pratheek K Y	Design of Intelligent Vehicle Based on Dynamic Wireless Charging			
	4JN18EC043	Kumar V B	Deep Learning-Based Object Detection Improvement for Tomato Disease			
	4JN18EC085	Shripada Adiga	6G Wireless Communications: Vision and Potential Techniques			

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Department of Electronics and Communication Engineering
Technical Seminar Presentation Schedule

Academic Year-2021-22 From 18/4/22 to 21/4/22

Batch No.	USN	Name	Seminar Title	Date	Time	Evaluators
B19	4JN18EC075	Sanath N	Security in cloud computing	18/4/22	9:00 am to 11:00am	SSM, ABN, BSU **EC101**
	4JN18EC093	Sudhanva H G	Sub-10 nm Nanogap Arrays for the Next Generation Electronics			
	4JN18EC071	S Bharat	Flexible Textile Antenna Design with Transparent Conductive Fabric Integrated in OLED for WiMAX Wireless Communication Systems			
	4JN18EC116	Vishnu C R	Hybrid Energy Storage System for Electric Vehicles			
B18	4JN18EC088	SINCHANA S R	Unmanned Aerial Vehicles	18/4/22	9:00am to 11:00am	SB, PGS,SHR **EC104**
	4JN18EC091	Spoorthi T S	Hand-Written Character Identification from an Image by using Digital Image Processing			
	4JN18EC092	Spoorthy	Internet of things for high-speed railways			
	4JN18EC090	Soukya B V	Statistical Region Merging			
B2	4JN18EC025	Deeksha TJ	Forest fire detection using image processing	18/4/22	11:15am to 1:15pm	ABP,SBN, ABN **EC101**
	4JN18EC004	Adithi.S.R	Underground Infrastructure Water Supply Monitoring using IOT			
	4JN18EC024	Chitrashree	Decentralized E-Voting Portal Using Blockchain			
	4JN18EC033	Harshitha. M. D	Blockchain Enabled Smart Contracts			

B9	4JN18EC012	Anushree N R	Deep Learning Based Detection and Correction of Cardiac MR Motion Artefacts During Reconstruction for High-Quality Segmentation	13/4/22	11:15am to 1:15pm	SS, ABN, SB **EC101**
	4JN18EC036	Inchara V Shetty	Long Short-Term Memory Recurrent Neural Network for Automatic Speech Recognition			
	4JN18EC063	Priya K V	Large area free positioning wireless power transfer to movable receivers			
	4JN18EC068	Raksha S G	Color Correction Based on CFA and enhancement based on retinex with dense pixels for underwater images			
B30	4JN18EC073	Sahana SK	Color balance and fusion for underwater image enhancement	13/4/22	11:15am to 1:15pm	SK, PGS, SBN **EC104**
	4JN18EC076	Sanidhya.G.M	Back propagation network			
	4JN18EC123	Shruthi M	CNN Architecture- LeNet, AlexNet, ZFnet			
	4JN18EC101	Swathi. S	CNN architecture-VGG net, Resnet, Google net			
B34	4jn16ec087	Shridhara.S	Artificial Intelligence Aided Automated Design for Reliability of Power Electronic Systems	13/4/22	3:00 pm to 5:00pm	ABN, KVD **EC101**
	4JN16EC102	Taniya Shaikh	Low-cost flip chip stack for Partitioning Processing and Memory			
	4JN18EC411	Navyasri S R	Face recognition in the scene of wearing a mask			
B14	4JN18EC052	Nathaniel Santhosh	Zigbee Based Wearable Remote Healthcare Monitoring System for Elderly Patients	13/4/22	3:00 pm to 5:00pm	PGS, TSH **EC104**
	4JN18EC047	Mohammed Junaid A	IoT for next generation smart system 5g-IOT			
	4JN18EC031	Gautham S G	A Hybrid Artificial Intelligence and Internet of Things Model for Generation of Renewable Resource of Energy.			
	4JN18EC020	Charan Gadade M	Low-cost sensor with IOT LoRa WAN connectivity and machine learning based calibration for air pollution monitoring			

Note: Technical Seminar for Remaining Batches will be scheduled from 18/4/2022.

Technical Seminar Co-ordinators: Abhijith N, Prashanth G S

			Problems Through Predictive Analysis of ECG Signals			
	4JN18EC023	Chinmay G P	Automated health Monitoring.			
B23	4JN18EC113	Vikram G V	Automatic Fall Risk Detection Based on Imbalanced Data	12/4/22	11:15am to 1:15pm	SB, PGS, SHR **EC104**
	4JN18EC053	Naveen C J	3D Holographic and Interactive Artificial Intelligence System			
	4JN18EC097	Sumanth. K	Development and experiment of Novel Deep Sea-Resident ROV			
	4JN18EC099	Sumukh B G	Wireless power Transmission for IoT			
B4	4JN18EC044	Likitha K P	Li-Fi the Next Generation of Wireless Communication	12/4/22	3:00 pm to 5:00pm	ABN, AKJ **EC101**
	4JN18EC058	Pavana P Kulal	Unmanned aerial vehicle with underlaid Device to Device communications: performance and tradeoffs			
	4JN18EC056	Nikhitha Yadav N	Artificial immune wireless intelligent sensor and actuator network			
	4JN18EC011	Anagha B R	Fog Computing: A New Era of Cloud Computing			
B29	4JN18EC108	Umm E Hani	Li fi technology	12/4/22	3:00 pm to 5:00pm	PGS, Dr. PKS **EC104**
	4JN18EC102	Tanuja V	Cloud computing technology: Improving small business performance using the Internet			
	4JN18EC103	Thejaswini D	5G Technology			
	4JN18EC100	Sushma P	Automobile blackbox System.			
B7	4JN18EC010	Amoghavarsha S G	Touch Sensing for a Projected Screen Using Slope Disparity Gating	13/4/22	9:00am to 11:00am	PSC, ABN, SMD **EC101**
	4JN18EC057	Niranjana Jois H C	Halide Perovskite and Its Application in Solar Cells			
	4JN18EC041	Kiran C N	High efficiency WLANs			
B21	4JN18EC080	Shamantha B R	An Edge Intelligent transport system based on Deep Learning to monitor traffic flow	13/4/22	9:00am to 11:00am	PKN, PGS, SM **EC104**
	4JN18EC015	Bhanupriya R	Ambulatory Maternal and Fetal Monitoring			
	4JN18EC087	Siddarth M Muchadi	"A Seed Planting Robot with 2 control Variables"			
	4JN18EC110	Varun M	Liver cancer detection using hybridized convolutional Neural Network based on deep learning framework			

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Department of Electronics and Communication Engineering
Technical Seminar Presentation Schedule

Academic Year-2021-22

Batch No.	USN	Name	Seminar Title	Date	Time	Evaluators
B1	4JN18EC030	Ganesh G Shet	Haptic Interfaces for Virtual Reality	12/4/22	9:00 am to 11:00am	RBS, KVD, ABN **EC101**
	4JN18EC029	Ganashree K G	The extended reality in IoT			
	4JN18EC001	Abhishek A K	IP (ARP) Spoofing Detection and Prevention Techniques using Protocols"			
	4JN18EC017	Bhargavi S G	Analysis of the NTRU Post-Quantum Cryptographic Scheme in Constrained IoT Edge Devices			
B17	4JN19EC410	Swathi R	IoT based Automated Aquaponics system	12/4/22	9:00am to 11:00am	Dr. PKS, PSC, PGS **EC104**
	4JN18EC089	Sneha KS	IoT-based soil-less farming (using water)			
	4JN19EC411	Varshitha S	Smart and sustainable home aquaponics system with feature-rich IoT mobile application			
	4JN18EC125	Navya v shet	Automatic control and management system for hydroponics cultivation			
B3	4JN18EC021	Chethan R	Wearable Sensing and Telehealth Technology with Potential Applications in the Coronavirus Pandemic	12/4/22	11:15am to 1:15pm	ABP, ABN **EC101**
	4JN18EC014	Arjun Kamath	IoT-assisted ECG monitoring framework with secure data transmission for health care applications			
	4JN18EC009	Amith N	Smart Heart Monitoring: Early Prediction of Heart			

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Dear Students,
PFA for the preparation of Technical Seminar PPT and Report.
Need to be prepared only after getting approval from the guide.

Abhijith N
Asst.Prof
Dept. of Electronics and Communication Engineering
J.N.N College of Engineering
Shimoga-577204
Ph.No-9620852497

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Dear Students,

Upload the Technical Seminar details in the attached google form, only after getting approval from the respective Project guide.

This has to be completed as soon as possible because the technical seminar is scheduled from 12th April 2022.

Link to upload the detailes- https://forms.gle/ASxCcc7kNdUGHXcQA

For any queries regarding the technical seminar, contact the respective Co-ordinators:

'A' Section - Mr. Abhijith N

'B' section - Mr. Prashanth G S

Abhijith N
Asst.Prof
Dept. of Electronics and Communication Engineering
J.N.N College of Engineering
Shimoga-577204
Ph.No-9620852497

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Dear all,

We hereby bring to your notice that, since there is a technical seminar (18ECS84 and 17ECS86 for 100 marks) in the 8th semester, it is planned to schedule the Technical Seminar from 12th April 2022. With respect to this, the students are hereby informed to discuss and decide the title of the paper with the Project guide. After approval from the project guide, students need to submit the approved hard copies of the papers to the respective Technical seminar Coordinators.

.

The following guidelines should be followed while selecting the seminar topic.

1. The paper should be chosen from a referred journal viz., IEEE, Elsevier and Springer
2. The paper should be the latest and the date of publication should be from 2019 onwards.
3. The topic should be purely technical.

The topic review process is scheduled from 10.03.2022 to 23.03.2022 and the seminar presentation schedule will be intimated later.

Evaluation Rubrics are attached herewith for your reference, based on which the technical seminar marks will be evaluated.

For any queries regarding the technical seminar, contact the respective Co-ordinators:

'A' Section - Mr. Abhijith N
'B' section - Mr. Prashanth G S

Head of the Department
Electronics and Communication
J.N.N. College of Engineering
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Dept. of Electronics & Communication Engg. JNNCE SHIVAMOGGA-204

2021- 2022

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TECHNICAL SEMINAR RUBRICS

Name of the student : USN:

Seminar Topic:

Category	Grading Pattern					Marks
Literature Survey (20 Marks)	**5 Marks**	**4 Marks**	**3 Marks**	**2 Marks**	**1 Mark**	
1. No. of papers referred	5 or more Papers	4 Papers	3 Papers	2 Papers	1 Paper	
2. Relevance	All 5 papers are relevant to chosen domain	All 4 papers are relevant to chosen domain	All 3 papers are relevant to chosen domain	All 2 papers are relevant to chosen domain	Paper is relevant to chosen domain	
3. Quality	At least 5 papers are from reputed journals	Atleast 4 are from reputed journals	At least 3 papers are from reputed journals	Atleast 2 papers are from reputed journals	Paper is from reputed journal	
4. Recency	At least 5 papers published in Past two years	Atleast 4 papers published in Past 3-4 years	At least 3 published in Past 5-6 Atleast 3 papers years	Atleast 2 papers published in Past 7-8 years	Paper published in Past more than 8 years	
Presentation (60 Marks)	**9 -10 Marks**	**7-8 Marks**	**5-6 Marks**	**3-4 Marks**	**1-2 Marks**	
Organization of presentation 1. Well structured 2. Formatting 3. Effective use of Text & Graphics	All the three parameters are addressed		At least two parameters are addressed		At least one	
Technical Content 1. Provides a thorough overview 2. In-depth explanations & justifications 3. Design / Calculations / Simulations / Algorithms 4. Research and analysis 5. Societal & Environmental concerns	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	
Presentation skills 1. Preparation 2. Communication 3. Confidence 4. Flow & style 5. Formal appearance	All the 5 parameters are addressed	Any 4 parameters are addressed	Any 3 parameters are addressed	Any 2 parameters are addressed	Any one parameter is addressed	
Answering queries	Answered all queries	Answered most of the queries	Answered some of the queries	Answered very few queries	Attempted to answer	
Inferences/results & discussions 1. Inferences are drawn based on experiment/implementation by the student 2. Ability to comprehend / summarize the concepts 3. Exploring the future scope of the study	All the three parameters are addressed		At least two parameters are addressed		At least one	
Adherence to time(20 minutes)	kept up the given time	Exceeded given time by ± 5 mins	Exceeded given time by ±10 mins	Exceeded given time ± 15 mins		
Seminar Report(20 Marks) 1. Adherence to Template 2. Report in line with the content of presentation 3. Organization of the report 4. Grammar 5. Inclusion of Citations	All the 5 parameters are addressed	At least 4 parameters are addressed	At least 3 parameters are addressed	At least 2 parameters are addressed	At leastone parameter is addressed	

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Electronics and Communication
J.N.N. College of Engineering
SHIMOGA-577 204.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belagavi, Karnataka - 590 018.

A project report on

"Autonomous 3-D Mapping and Navigating Droid"

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

in

Electronics and Communication Engineering

by

Shashank G S USN:4JN18EC081
Shripada Adiga USN:4JN18EC085
Sumanth Shanbog H R USN:4JN18EC098
Yashas Vinay USN:4JN18EC119

Under the guidance of
Mrs. Prema K N, M.Tech
Assistant Professor,
Dept. of ECE,
JNNCE-577 204.

Department of Electronics and Communication Engineering
JNN College of Engineering, Shimoga - 577 204.

July 2022

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July 2022

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belagavi-590 018.

JNN College of Engineering

Department of Electronics and Communication Engineering

Shimoga-577 204.

CERTIFICATE

This is to certify that the project work entitled **"Autonomous 3-D Mapping and Navigating Droid"** is carried out by **Shashank G S (4JN18EC081), Shripada Adiga (4JN18EC085), Sumanth Shanbog H R (4JN18EC098), Yashas Vinay (4JN18EC119)** , the bonafide students of JNN College of Engineering, Shimoga in partial fulfillment for the award of "Bachelor of Engineering" in department of "Electronics and Communication Engineering" of the Visvesvaraya Technological University, Belagavi, during the year 2021-2022. It is certified that all the corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said degree.

Signature of the Guide
Mrs. Prema K N
Assistant Professor,
Dept. of ECE,
JNNCE, Shimoga.

Signature of the HOD
Dr. S.V. Sathyanarayana
Professor & HoD
Dept. of ECE,
JNNCE, Shimoga.

Principal
Jawaharlal Nehru New
College of Engineering (JNNCE)
Shivamogga

Signature of the Principal
Dr. K Nagendra Prasad
Principal
JNNCE, Shimoga.

External Viva

Name of the examiner	Signature with date
1. Sheela S	22/7/22
2. Harish T.S	22/7/22

ABSTRACT

The purpose of this work is to develop a mobile bot for remote monitoring of different environments via an IoT-enabled live video feed in addition to tracking various sensor signals and 3D mapping the surrounding environment and navigating in it autonomously.

The Two wheeled bot, mounted with wide-angle wireless cameras, can freely move around in its environment, based on a path planned out of a 3D-point map, and in the process shall provide live video footage to a computer, along with monitoring various physical parameters via different sensors embedded onto its controller. Thus the act of surveillance can be achieved.

Further enhancement of the project is possible by considering a virtual reality headset using which the user could be provided with an immersive rendering of the environment to be monitored, along with upgrading the bots control to be done by hand gestures, thereby easing machine-human interaction

Keywords: IoT,3D mapping,3D-point map,surveillance,cameras;

ACKNOWLEDGEMENTS

We consider it as a great privilege to express my gratitude and respect to all those who guided and inspired me in the completion of this seminar. It is difficult for us to express our sense of gratitude and appreciation for the help we have received in this endeavor. Our effort here is a feeble attempt to do so.

First of all, we acknowledge for the provision of the required infrastructure by my esteemed institute **J N N College of Engineering**, Shivamogga and D**epartment of Electronics and Communication Engineering**.

I thank to **Dr. K Nagendra Prasad**, Principal, JNNCE, Shivamogga for giving facilities to undertake Project work.

We would like to thank **Dr. S V Sathyanarayana**, our head of the department who stood as a guiding spirit and lending guidance to achieve the aim with added zeal.

We thank seminar coordinator Associate Professor **Dr. Pramod Kumar S** for his valuable suggestions and treasured assistance throughout the preparation of the seminar.

Our special thanks to **Asst Prof. Mrs. Prema K N**, my project guide for providing all the inputs and corrections needed for the preparation of the report.

Lastly, We are thankful to our classmates, teaching and non-teaching staff and everyone who has helped me directly or indirectly for the successful completion of the seminar.

Contents

List of Figures

Chapter 1

Preamble

1.1 Introduction

Technology has led to tremendous change in the robotics and automation field which ranges in all kinds of areas. Security and surveillance are an integral part of our daily activities. The process of surveillance, in general, is not just limited to security purposes but involves continuous systematic supervision of a particular environment and everything else part of it. A robot is an automated electronic machine that can perform, any number of times, a given set of tasks and can thus replace human work. Surveillance involves risk or irreplaceable damage when in adverse environments. With its added advantage of high accuracy, high speed, and the ease with which they can be maintained, robots become the ideal choice for such jobs. Surveillance is not limited to just security, it can be used for real-time monitoring of industrial environments, disaster relief management, etc. One of the more recent uses of such bots was in looking after Covid patients and preventing unauthorized entries into a ward. Moreover, such bots can also be used to survey construction sites remotely and rectify errors or keep track of developments at ease. By changing the upgrade tree of such bots their usage in monitoring varies and can also be utilized for containing explosions and blasts. The two-wheeled bot, mounted with wide-angle wired cameras, can freely move around in its environment, based on a path planned out of a 3D-point map, and in the process shall provide live video footage to a computer, along with monitoring various physical parameters via different sensors embedded onto its controller, thus, performing surveillance. Data from the subsidiary sensors can be collected and the same can be transmitted to the ground station or server. The visual data collected via the camera is transmitted to the user, wireless, present in the ground station. The user also would be able to direct the movements of the robot in the ground station which is the transmitter section for the control of the bot.

1.2 Aim of the project

The aim of this project is to develop an Autonomous 3-D Mapping and Navigating Droid.

1.3 Objectives of the project

The Objectives are:.

1. To implement an embedded sensor module on the wheeled bot and thereby monitoring various physicalparameters
2. To Achieve SLAM (simultaneous localization and mapping) using ORB-SLAM2 (real-time Slam library) package and training the system using Jetson Nano
3. To Adopt an Collision detection and avoidance Algorithm to move around

1.4 Methodology

This project is divided into two major modules, the sensor embedded module and camera embedded module. Sensor embedded module consists of two different sensors and NodeMCU. It works on the principle of the internet of things (IoT). Two different have been used, DHT11 humidity and temperature sensor alongside an MQ-2 gas sensor which will collect data on humidity, temperature and gas in the immediate environment and transmit to the NodeMCU. The NodeMCU then transmits the data to a ground station via the internet where it facilitates the user to access the data. Camera embedded module consists of a Jetson Nano compute unit as the main controller and RealSense D415 depth camera to capture the footage along with a Sony IMX219 sensor. The mapping and localization of the bot to give it a sense of awareness of its surroundings is achieved using a technique known as Simultaneous Localization and Mapping or SLAM for short. With the visual feed from RealSense D415 depth camera, building a map of an environment and localizing the bot at the same time is performed using ORB-SLAM2. The navigation of the bot is based on Collision detection and avoidance using an appropriate learning method which utilizes a secondary camera. Integrating these two modules will result in the formation of Autonomous 3D Mapping and navigating Droid.

1.5 Scope of the project

The project serves a purpose of mapping the environment or places which are not accessible or not safe for human locomotion. Surveillance of such places would be one of the main applications of this project. Surveillance is the process of gathering the information. And different ways to gather information from the areas have been there in the past. Although these systems have given good results, there are less systems which map and 3D models the whole environment. Our bot's main motive lies in the fact to map the surrounding area. This ability to make the map of the surroundings forms the basis for security application. The bot is internet enabled making it suitable for the application of IoT. It can be used for dynamic supervision. This bot can be utilized in the remote monitoring of high risk/hazardous industrial environments. Direct human intervention to such places like the radioactive sites will cause adverse effects to the human itself. Embedding the bot with required appropriate sensors gives it an upper hand in the remote analysis. This bot can be used to surevy construction sites remotely and help rectify any build errors encountered. Further, this bot can be used to monitor a supposed threat in a surrounding or be of help during rescue ops in case of a natural/man-made disaster. In case of natural calamities the data other than just the image like temperature and humidity from such places can be collected and sent to the ground station.

1.6 Limitations

The bot cannot be able to transmit the data to the ground station without the help of the internet. Even though the bot is having 3 degree of freedom, the camera is mounted on top so the whole body has to rotate completely to have a 360 degree view. We are not using any internal sensors and if we have to detect any damage or any sort of problem at the surveillance place, the user has to monitor it continuously without fail. These bots are more reliable for large scale industries.

1.7 Organization of the project

This report is organized into four chapters.

1. Chapter 1 includes the introduction aim and objectives of the project.
2. Chapter 2 includes the theoretical concepts related to the project.
3. Chapter 3 includes the design and implementation of Autonomous 3D mapping and navigating droid.
4. Chapter 4 includes the results obtained and discussion
5. Chapter 5 includes the conclusion and future scope of the implemented methods.

Chapter 2

Theoretical Background

A total of 8 papers were studied in detail and a summarized version of each is presented in this section which consists of authors modeling of SLAM problem, IoT frameworks etc., their approach to solving SLAM challenges, comparisons and benchmarks set

2.1 ORB-SLAM2 An Open-Source SLAM System for Monocular, Stereo and RGB-D Cameras.

Author: Raúl Mur-Artal and Juan D.Tardós, 2017

Simultaneous Localization and Mapping (SLAM) has been a hot research topic in the last two decades in the Computer Vision and Robotics communities, and has recently attracted the attention of high-technological companies. SLAM techniques build a map of an unknown environment and localize the sensor in the map with a strong focus on real-time operation. Among the different sensor modalities, cameras are cheap and provide rich information of the environment that allows for robust and accurate place recognition. Therefore Visual SLAM solutions, where the main sensor is a camera, are of major interest nowadays. Place recognition is a key module of a SLAM system to close loops (i.e. detect when the sensor returns to a mapped area and correct the accumulated error in exploration) and to relocalize the camera after a tracking failure, due to occlusion or aggressive motion, or at system re-initialization.

Visual SLAM can be performed by using just a monocular camera, which is the cheapest and smallest sensor setup. However as depth is not observable from just one camera, the scale of the map and estimated trajectory is unknown. In addition the system bootstrapping require multi-view or filtering techniques to produce an initial map as it cannot be triangulated from the very first frame. Last but not least, monocular SLAM suffers from scale drift and may fail if performing pure rotations in exploration.

By using a stereo or an RGB-D camera all these issues are solved and allows for the most reliable Visual SLAM solutions. In this paper authors build on their monocular ORB-SLAM and propose ORB-SLAM2 with the following contributions:

Figure 2.1: **Stereo case**

1. The first open-source1 SLAM system for monocular, stereo and RGB-D cameras, including loop closing, relocalization and map reuse
2. The RGB-D results show that by using Bundle Adjustment (BA) they've achieved more accuracy than state-of-the art methods based on ICP or photometric and depth error minimization
3. By using close and far stereo points and monocular observations the stereo results are more accurate than the state-of-the-art direct stereo SLAM
4. A lightweight localization mode that can effectively reuse the map with mapping disabled

The stereo case in 2.1 shows the final trajectory and sparse reconstruction of the sequence 00 from the KITTI dataset. This is an urban sequence with multiple loop closures that ORB-SLAM2 was able to successfully detect. The RGB-D case in figure 3.1(b) shows the keyframe poses estimated in sequence fr1 room from the TUM RGB-D Dataset, and a dense pointcloud, rendered by backprojecting sensor depth maps from the estimated keyframe poses. This SLAM does not perform any fusion like KinectFusion or similar, but the good definition indicates the accuracy of the keyframe poses.

A general overview of the ORB-SLAM2 system is shown in 2.3. The system has three main parallel threads:

Figure 2.2: **RGB-D case**

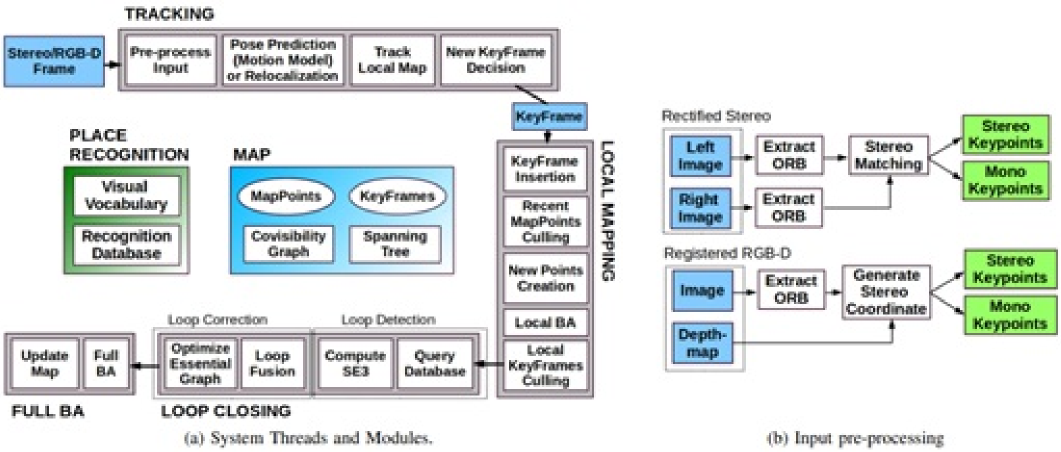


Figure 2.3: **Overview of ORB-SLAM2**

1. The tracking to localize the camera with every frame by finding feature matches to the local map and minimizing the reprojection error applying motion-only BA

2. The local mapping to manage the local map and optimize it, performing local BA

3. The loop closing to detect large loops and correct the accumulated drift by performing a pose-graph optimization. This thread launches a fourth thread to perform full BA after the pose-graph optimization, to compute the optimal structure and motion solution[1]

2.2 Bags of Binary Words For Fast Place Recognition in Image Sequences

Author: Dorian Gálvez-López, Juan D.Tardós, 2012

One of the most significant requirements for long-term visual SLAM (Simultaneous Localization and Mapping) is robust place recognition. After an exploratory period, when areas non-observed for long are re-observed, standard matching algorithms fail. When they are robustly detected, loop closures provide correct data association to obtain consistent maps. The same methods used for loop detection can be used for robot relocation after track lost, due for example to sudden motions, severe occlusions or motion blur. For small environments, map-to-image methods achieve nice performance, but for large environments, image-to-image (or appearance-based) methods such as FAB-MAP scale better. The basic technique consists in building a database from the images collected online by the robot, so that the most similar one can be retrieved when a new image is acquired. If they are similar enough, a loop closure is detected. In recent years, many algorithms that exploit this idea have appeared, basing the image matching on comparing them as numerical vectors in the bag-of-words space. Bags of words result in very effective and quick image matchers, but they are not a perfect solution for closing loops, due mainly to perceptual aliasing. For this reason, a verification step is performed later by checking the matching images to be geometrically consistent, requiring feature correspondences. The bottleneck of the loop closure algorithms is usually the extraction of features, which is around ten times more expensive in computation cycles than the rest of steps. This may cause SLAM algorithms to run in two decoupled threads: one to perform the main SLAM functionality, and the other just to detect loop closures.

In this paper, authors present a novel algorithm to detect loops and establishing point correspondences between images in real time, with a conventional CPU and a single camera. The approach is based on bag of words and geometrical check, with several important novelties that make it much faster than current approaches. The main speed improvement comes from the use of a slightly modified version of the BRIEF descriptor with FAST keypoints. The BRIEF descriptor is a binary vector where each bit is the result of an intensity comparison between a given pair of pixels around the keypoint. Although BRIEF descriptors are hardly invariant to scale and rotation, the experiments show that they are very robust for loop closing with planar camera motions, the usual case in mobile robotics, offering a good compromise between distinctiveness and computation time. Also introduced is a bag of words (figure 3.3) that dis-

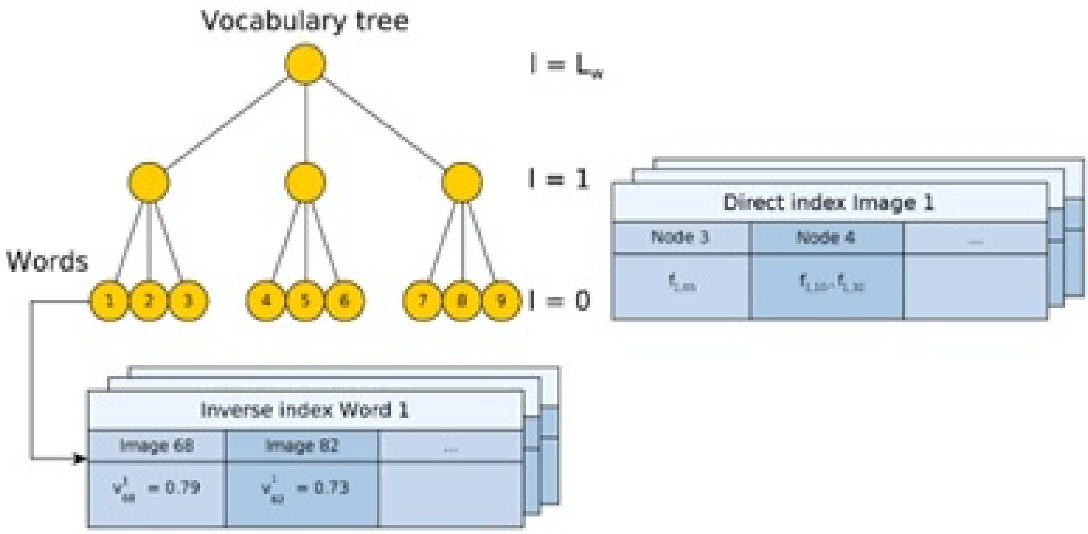


Figure 2.4: **Bag of Words – Vocabulary tree**

cretizes a binary space, and augment it with a direct index, in addition to the usual inverse index - the first time a binary vocabulary– vocabulary words are the leaf nodes of the tree– is used for loop detection. The inverse index stores the weight of the words in the images in which they appear and is used for fast retrieval of images potentially similar to a given one. A novel use of the direct index which stores the features of the images and their associated nodes at a certain level of the vocabulary tree, to efficiently obtain point correspondences between images, speeding up the geometrical check during the loop verification is also explained.

The complete loop detection algorithm– to decide that a loop has been closed, verification the temporal consistency of the image matches obtained is done. One of the novelties in this paper is a technique to prevent images collected in the same place from competing among them when the database is queried. It is achieved by grouping together those images that depict the same place during the matching.

Authors also present comparisons as shown in 2.5 between the effectiveness of BRIEF and two versions of SURF features, the descriptor most used for loop closing.

Authors also analyze the performance of the temporal and geometrical consistency tests for loop verification. Finally presented are the results achieved by this technique after evaluating it in five public datasets with 0.7–4 Km long trajectories. It is demonstrated that the algorithm can run the whole loop detection procedure, including the feature extraction, in 52ms in 26300 images (22ms on average), outperforming previous techniques by more than one order of magnitude.[2]

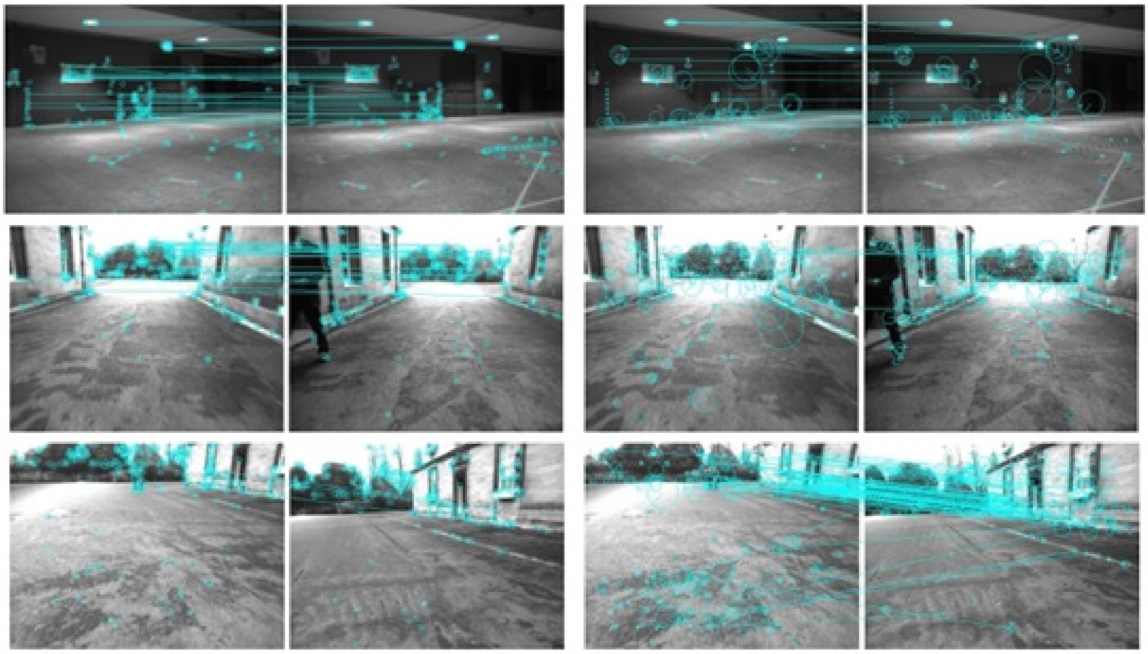


Figure 2.5: **Examples of words matched by using BRIEF (pair on the left) and SURF64 descriptors (pair on the right)**

2.3 Surveillance Robot Using Raspberry Pi and IoT

Author: Harshitha R, Muhammad Hameem Safwat Hussain, 2018

Traditionally, surveillance systems are installed in every security critical areas. These systems generally consist of high quality cameras, multiple computers for monitoring, servers for storing these videos and many security personnel for monitoring these videos. When considered as a whole, these systems can yield great complexities while installing as well as for their maintenance. The CCTV camera feeds are only visible in certain locations and they also have limited range within which these can be viewed. Above all these, the cost of implementations of these systems is so high that they cannot be installed in every household. The traditional systems require continuous monitoring by some dedicated personnel which is not possible in every household. Hiring an unknown person to do so will also raise privacy issues. The CCTV cameras installed these days also have limited vision because they're stationary modules. If an intruder moves away from the field of view of a CCTV camera, it cannot follow or track his motions.

The solution to all the above issues is to have a surveillance robot which can monitor the areas where it's installed and send notifications to the owner when an intrusion happens. It also allows the user to login to the Raspberry Pi's webcam from any remote location and view live feed of whatever is happening in his premises, as demonstrated in 2.6 in support with dynamics.

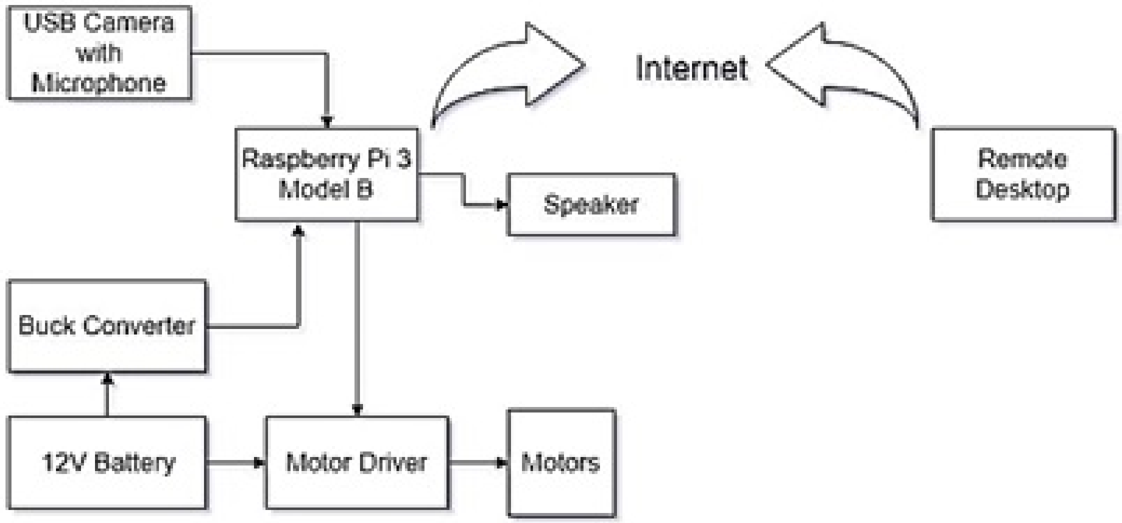


Figure 2.6: **Block Diagram of Proposed System**

The other advantage of using a microprocessor like Raspberry Pi is that it can be made into a very handy device. This ensures that we can install this system in any position and in any part of the house. The camera mounted on the robot can also be turned in any required direction, in contrast to the stationary one built in the PC. The power consumption is also very less comparatively. Since the Raspberry Pi runs on 5V DC, it can be easily powered from a power bank. That helps us achieve an uninterrupted power supply for the system as a low power consumption rate.

The cost effectiveness and remote control features of the robot allow it to be used easily by every user.[3]

2.4 Design and Control of a Four-wheeled Omnidirectional Mobile Robot with steerable Omnidirectional Wheels

Author: Jae-Bok Song and Kyung-Seok Byun, 2004

The authors of the paper talk about different types of Omni-direction wheels such as universal wheels, ball wheels and even offset wheels. A discussion on the types of bases i.e. the no.of wheels in a configuration that a system should be designed on is considered. For example having three wheels in a triangular arrangement will lead to problems when moving up ramps, so it would be better to go with a 4-wheeled arrangement and so on. The paper also looks to detail a Variable Footprint mechanism that could adjust wheel arrangements on the fly or the use of CVT (continuously variable transmission) to improve motor driving capability instead of adjusting wheels is also discussed. This particular paper deals with an omnidirectional robot having omnidirectional wheels drive by a CVT. The robot has 3 Degrees of Freedom (3DOF) in Motion and 1DOF in steering. The paper goes into great detail as to the structure of omnidirectional wheel placement and variable wheel placement. Some things to note with regards to the velocity calculation of the wheels is the fact that the velocity is only calculated in the current active direction of the wheel's motion. The active component is directed along the axis of the roller in contact with the ground while the passive one is perpendicular to the roller axis. Omnidirectional wheels are fixed relative to the robot body and do not rotate for steering as the steering can be done by a combination of wheel velocities. The authors from here go in to a lot of detail to explain the different turning mechanisms that can be implemented using omnidirectional wheels. The fact the they can have 4DOF allows the wheels to be placed in such a manner that they can rotate in almost in any direction inducing the movement of the bot in the necessary direction. The authors also explain an Omni-directional system with offset wheels. Offset wheels are also called Variable Footprint mechanism wheels. The variable footprint is achieved by having two beams rotate a pivot point with ball wheels and motors attached to the ends of the beams. Thai whole mechanism is considered to have 1DOF. The offset can be changed based on the angle needed by the bot to turn, this allows for motion in all direction but a lot of complexity is added to the overall system. Motor selection is a key part of the process and the authors have a detailed this by looking at some specific motor parameters. Torque of the motor is a of importance and this cannot be achieved through high speed alone. So the selection of motors capable of CVT for example would enable good torque even at lower speeds. If a small motor were to be used, then a transmission would need to be created that is capable of CVT where the gear ratios adjusted to enable good torque delivery..

The main experiment consisted of designing and implementing an omnidirectional bot using these findings. A bot with dimension of 500mm with a heigh of 420mm was designed by the authors. The module used 4 wheels with a synchronous steering mechanism implying that the bot is using CVT in an offset arrangement.

Most of the experiments conducted were translational motion related. The robot was able to faithfully trace the reference input with the exact steering angl necessary and velocity. Incase of a circular trajectory both translation and rotational motion are necessary which means there is motion in the x and z direction. From plots it is clear that the bot is able to trace it relatively will but there are a few glitches that the bot runs into, but given that the authors were testing a

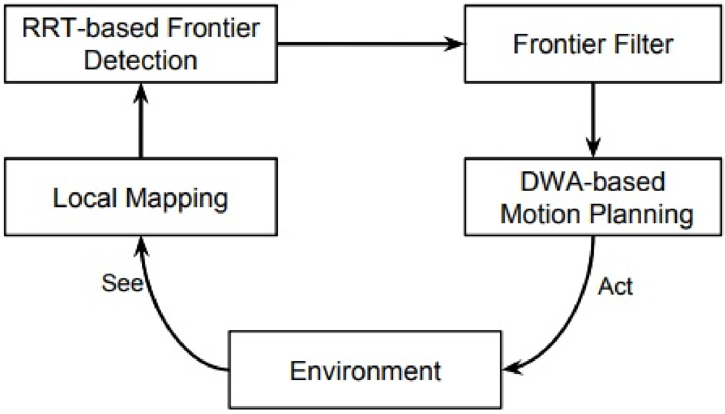


Figure 2.7: **Block Diagram of Proposed System**

prototype there is plenty of room for improvement.[4]

2.5 Mobile Robot Exploration Based on Rapidly-exploring Random Trees and Dynamic Window Approach

Author: Taiping Zeng, Bailu Si, 2019

Mobile robot exploration is essential for autonomous mobile robots safely and efficiently operating in many challenging application scenarios such as transportation, inspection, surveillance and search and rescue ops. The main issue as highlighted by this paper when it comes to exploration using Rapidly-exploring Random Trees is the fact that as the random tree grows, mobile robots with limited computing resources will be unable to handle the search and computation of probabilities over large areas. The author has proposed a new technique for the purpose of exploration by incorporating a sparse, relatively small-size point cloud map. The RRT-algorithm is made to run on this unordered sparse point map to detect frontier points and traversible paths.

The main mapping module shown in figure 3.7 consists of the local mapping module, the RRT-based frontier detection module, a filter model and a Dynamic Window Approach (DWA) based motion planning module. The local mapping module as shown in figure 3.8 only maps the nearby environment of the robot. The point clouds obtained from the local mapping module are down-sampled to sparse point clouds. By using odometry information, the movement from previous time step to current time step can be calculated. This is used to transform the coordinate of the previous local map to the current coordinate of the robot. The next module is the RRT-based frontier detection which aims to find the frontier points and traversable paths on

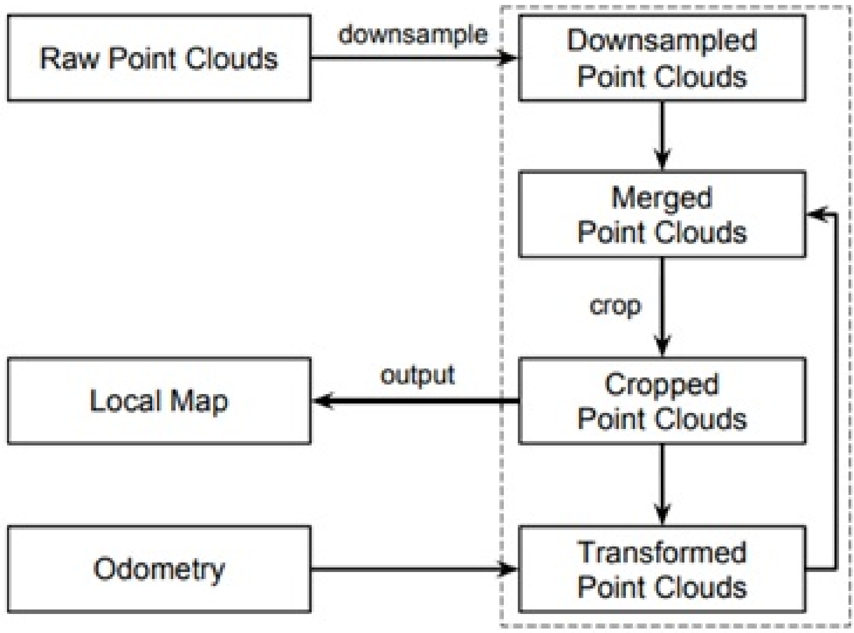


Figure 2.8: **Local mapping module**

the local point map. In a method similar to the paper where randomized trees are used to search for unknown locations from the nearest randomly generated point from the point cloud map is used. The module has a steer function that generates the nearest point from the vertex, this is then followed by an obstacle checking function which checks for obstacles near Xnearest and finally a Point cloud check function is used to check if the new point is close to the local point map.

Frontier filter module is used to reduce the number of frontier points which are extremely close to each other. It receives frontier points in a clustered manner. The desired frontier point of each cluster is at the centre of each of the clusters. After selecting the central points the other frontier points are deleted and the coordinates of the remaining points relative to the robot's current location would be the selection criteria akin to a navigation cost.

Finally the DWA module is used. The inputs to the module are the robot pose, the frontier point and the robot kinematics which contains values of translation and rotational velocities as well as acceleration of the bot, DWA uses there inputs to calculate a valid velocity search space and select an optimal velocity for the mobile robot. The DWA module is continuously updated with pose, obstacles detected and son to keep altering the speed of the bot and ensuring a safe path is traversed.

The software was implemented in Robot Operating System (ROS). This made it easy to create modules for each of the functions such as DWA, frontier filtering and local mapping. These were made into ROS nodes that would publish and subscribe to common ROS topics to

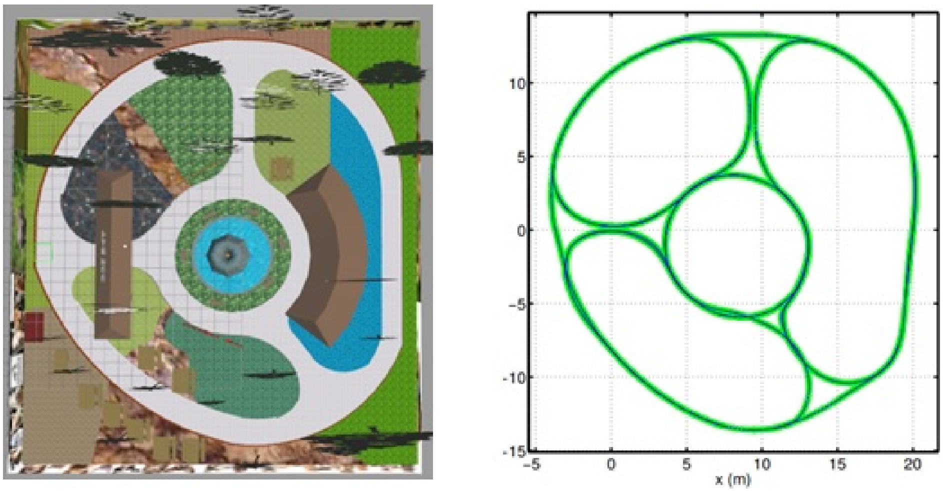


Figure 2.9: **Simulation Results**

ensure that information is passed around the system for the functioning of the bot.

The author performed a simulation of the bot in an environment called the zoo as shown in 2.9 and the findings that were reported show that the topological map generated by the simulation as shown in 2.9; has small deviations from the ground truth map but these uncertainties can be accounted for in odometry as there is some amount of uncertainty involved.

The conclusions drawn by the author showcase a system that generated a semi-metric topological map in an explored environment. Compared to the ground truth the map captures the overall layout of the road in the simulation environment. The RRT algorithm online computes good exploration paths and was able to find desired frontier points and help the robot avoid obstacles.[5]

2.6 Autonomous Robotic Exploration Based on Multiple Rapidly-exploring Randomized Trees

Author:Hassan Umari and Shayok Mukhopadhyay, 2017

Efficient robotic navigation requires a predefined map. Various autonomous exploration strategies do exist which direct robots towards unexplored regions or frontiers. Frontiers are boundaries that separate known space from unknown space. Usually frontier detection utilizes image processing tools such as edge detection which limits it to two dimensional exploration. The authors have devised a new exploration strategy based on the use of Rapidly-exploring Random Trees (RRT) as the RRT algorithm is biased towards unexplored regions. RRT is a path planning algorithm that samples space using randomly generated points. The random points are used to extend edges in a tree-like structure which consists of nodes and edges. The main

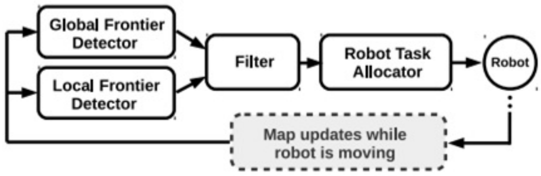


Figure 2.10: **Overall schematic**

issue with RRT is the inefficiency it can develop due to the possibility of overlapping occurring i.e. previously explored areas of the map are revisited. This is where the work of the authors comes to the fore. Instead of the robot being made to follow a growing RRT-tree physically in space, the tree is used in the search for frontier points and this search runs independently of robot movement. The detected points from the search are filtered and queued to be assigned to the robot. When the point is assigned the robot moves towards the point and the onboard sensors of the robot such as cameras help scan the area and add the region to the map. The overall exploration strategy is split into three modules; RRT-based frontier module, the filter module and the task allocator module. By splitting the exploration module, the task allocation module variables and parameters can be changed without it affecting the frontier detection modules and vice-versa. Additionally, multiple frontier detection modules can be run simultaneously if needed as shown in figure 3.10. The Frontier detection module is split into the local frontier module and the global frontier module. The basic principle driving the implementation is as follows; the map is represented as an occupancy grid and as the RRT tree grows a point is reached, that point is considered the frontier point. In the occupancy grid, the unknown region carries a cell value of -1, so by reading the cell value the cell can be classified either as unknown, free or occupied. Local Frontier detection works by generating a random vertex in the vicinity of the robot and then computing the next nearest point which then activates the robot's movement till a new point is reached or generated. If the new point is part of an unknown region it is marked as a frontier point and the generated tree is deleted. This tree deletion is the main difference between local frontier detection and standard RRT algorithms which is what global frontier detection is as it extends to all parts of the occupancy grid.

The next important part of the exploration module is the filter module. The filter module stores multiple points that form clusters and deletes all but the central points of the clusters to reduce the number of frontier points to optimize the process and improve information gathering efficiency. The final module is the task allocator module. This works by calculating the parameters such as Navigation cost; this specifies the distance to the frontier point; the information gain, this is calculated by trying to identify the area of the unknown region by counting the

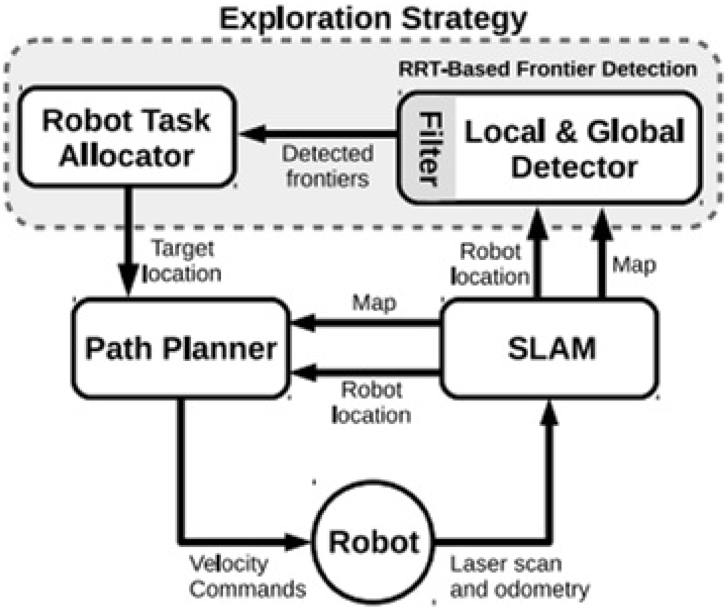


Figure 2.11: **Implementation**

number of unknown cells surrounding a frontier point within a user-defined radius. The final parameter is called revenue which is an amalgamation of the information gain and cost.

The final implementation is done in ROS as shown in figure 3.11 by developing a SLAM model. The g-mapping package in ROS is used to generate the map and localize the bot. The local and global frontier detection modules are programmed as ROS nodes in C++ and publish frontier points to a common ROS topic. The filter subscribes to the topic and publishes filtered frontier points back. Finally the task allocator node subscribes to the publishing node and queues the points for exploration.[6]

2.7 MonoRec: Semi-Supervised Dense Reconstruction in Dynamic Environments from a Single Moving Camera

Author:Felix Wimbauer, Nan Yang, Lukas von Stumberg, Niclas Zeller, Daniel Cremers, Technical University of Munich, Artisense, 2021

MonoRec is a semi-supervised monocular dense reconstruction architecture that predicts depth maps from a single moving camera in dynamic environments. It is based on a multi-view stereo setting which encodes the information of multiple consecutive images in a cost volume. To deal with dynamic objects in the scene a Mask Module that predicts moving object masks by leveraging photometric inconsistencies encoded in the cost volumes. To obtain a 3D view of any given static or dynamic environment in itself is a key challenge in robotics. To generate such an understanding multiple sensors such as LiDARs, RADARs, multi-camera systems are used which increases the overall complexity and the cost of mapping systems. To alleviate the problem there have been two approaches taken to perform 3D reconstruction using a single moving camera. These two methods are Multi-View stereo methods that have made improvements through the use of convolutional neural networks (CNNs). The other method is monocular depth prediction that relies purely on deep learning. Both these systems have specific advantages as MVS is good at stationary environment reconstruction while Monocular Depth prediction is thought to be good at reconstructing moving objects as predictions are based on individual images.

The authors propose a method to combine both forms of single camera 3D reconstruction techniques into MonoRec. This led to the creation of a MaskModule and a DepthModule where the MaskModule is able to identify moving pixels and down weights corresponding voxels in the same cost volume, thereby reducing artefact effects on moving objects. This allows the prediction of moving object masks that improves depth accuracy and allows for the elimination of noise in 3D reconstruction. DepthModule predicts a depth map from the masked cost volume. The MaskModule is setup to use a specific set of cost volumes which encode geometric priors. However due to various surface types that exist, simple geometric prior analysis will not be able to classify all Masks, to enhance the process a ResNet-18 pre-trained model is leveraged. This model is used to encode semantic priors into geometric priors. The features from different cost-volumes are aggregated using max-pooling and then passed through the decoder. DepthModule predicts a dense pixel-wise inverse depth map. It uses the cost volume as is since multi-frame cost volumes in general lead to higher depth accuracy and robustness against photometric noise. To eliminate any wrong depth predictions for moving objects, pixel-wise multiplication between the mask of the object and cost volume is performed for every depth step. A U-net architecture is used to get the depth outputs from the decoder. The authors have then detailed a set of refinements made to the algorithm to improve the performance of the system. The system was tested using the KITTI dataset where it outperformed many existing techniques such as Colmap, MonoDepth2 and PackNet which used LiDAR, DeepMVS and so on. After these studies were concluded the authors have conducted ablation studies to determine which components affected the method's performance.

The authors concluded that by utilizing Structural similarity Index measure instead of Sum of absolute differences as the photometric measurement to construct the cost volumes; dealing with dynamic objects using the MaskModule to predict moving object masks and the Depth-

Module to predict depths, the system is able to achieve a highly accurate depths for static and dynamic objects. [7]

2.8 Training End-to End steering of a self-balancing Mobile Robot based on RGB-D Image and Deep ConvNet

Chih-Hung G. Li, Long-Ping Zhou, 2020

In an attempt to build a self-balancing robot mobile robot, en end-to-end autonomous system was proposed by the authors based on RGB-D imaging and deep learning A deep convolutional neural network was trained to provided steering commands for direction control, with the key change to the system being the annotating of depth images with steering angles. An RGB-D camera is installed on the self-balancing system and is placed 1 feet above the ground and is used to continuously monitor the environment in front of it. Along with the RGB-D camera, three rotary encoders are used, two at the wheels and one at the steering. An initial run of the bot is done manually annotating various steering angles in the depth images taken. A deep CNN is then used to train the image input for a corresponding angle output for steering. In this particular setup the camera used is a RealSense D415 which is the main sensor even for our project hence our search for past projects utilizing such technology. The resolution chosen for the output is 640*480. Next, given that it is a self-balancing vehicle, changes in the centre of gravity and the direction of the Centre of gravity make the vehicle accelerate in the direction to balance itself. Along with ths angular input module for steering is also activated. The main process is the task formulation which is the vision-guided navigation. This can be divided in to cornering, path adjustment and obstacle avoidance. Each task can be trained separately and can be custom built for a specific navigation task. The CNN used tries to cover a depth range between 0 to 20 m. The main experiment was run on corridor cornering and path adjustment. The training was done by first annotating angles by using a human operator operato the vehicle by manually turning corners and the path training was done by depicting arrows to be the direction in which the robot should move and using the human operator initially to follow the arrows. A performance analysis was initially conducted on the CNNs capabilities with regards to cornering and an accuracy of 97 percent was recorded but an overall system accuracy of only 35 percent was recorded. It was a similar situation even in the path adjustment experiment as only a 23 percent overall accuracy was obtained. The authors have narrowed down the problem to be with regards to underestimation of weights and significance of handlebar angles which failed to correctly estimate the heading direction of the robot. This can be improved however by changing CNNs to better accommodate the underestimation or by updating the weight associated with the handlebar angles.[8]

Chapter 3

Design and Implementation

3.1 Introduction

The autonomous droid is so designed to have mainly 2 frameworks. The NodeMCU is connected to sensors which collect the data from the external environment. The Data collected is then transmitted to the ground station via the internet. This part of the project serves the purpose of sending the crucial information to the ground station which is used for the profiling of the environment. With the visual feed from RealSense D415 depth camera, building a map of an environment and localizing the bot at the same time using ORB-SLAM2 and navigation is achieved using Collision detection and avoidance.

3.2 Circuit Description

Jetson Nano is a small, powerful computer for embedded applications and AI IoT that delivers the power of modern AI. NVIDIA® Jetson Nano™ Developer Kit is a small, powerful computer that can run multiple neural networks in parallel for applications like image classification, object detection, segmentation, and speech processing. All in an easy-to-use platform that runs in as little as 5 watts.

Figure 3.1: **Jetson Nano**

The robot's locomotion is achieved by connecting it to wheels. To run the robot, we require motors. The motors used in this project are 60 rpm BO motors which have ample torque to carry the whole weight of all the components that are mounted on the robot. We used 2 motors and wheels to build a 2 wheeled robot which provides stability and proper control of the robot's movements.

Figure 3.2: **BO Motor**

The motor driver contains the H-bridge connection required for bi-directional control of the motor. This is essential for the robot to achieve all directions of locomotion, namely, forward, backward, left and right.The power source for the motors is a 12V battery which is supplied appropriately to the motors using the motor driver. The motor driver is controlled using the actuating signals from the microprocessor. The motor driver we plan to use in this project is the L298N. It is a dual motor controller, meaning it can control two motors at the same time. For controlling 4 motors, we need to connect two motors in parallel to the same slot. It can provide up to 2 amperes per channel and it is an inexpensive module to use. This board also features an onboard 12v to 5v regulator, IC 7805, which can be used to power up any board which requires it.

Figure 3.3: **Motor Driver**

In case of the power supply a Lipo battery suffices the project requirements. The main advantages of LiPo battery cells are that they have about four times the energy density of nickel cadmium or nickel metal hydride batteries. LiPo batteries are very lightweight and pliable, and can be made to almost any size or shape.

Figure 3.4: **Lipo battery**

MQ2 is one of the commonly used gas sensors in MQ sensor series. It is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as Chemiresistors as the detection is based upon change of resistance of the sensing material when the Gas comes in contact with the material. Using a simple voltage divider network, concentrations of gas can be detected.

Figure 3.5: **MQ-2 Gas Sensor**

The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data.

The Intel RealSense D415 has a standard field of view well suited for high accuracy applications such as 3D scanning. With a rolling shutter on the depth sensor, the D415 offers our highest depth quality per degree. When accuracy is the most important factor for your solution, the D415 is the perfect choice. The D415 has a tightly focused field of view, which offers higher quality depth per degree. Featuring an integrated RGB sensor, the D415 is perfect for facial authentication, 3D scanning or volumetric capture.

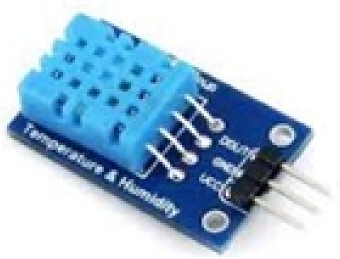


Figure 3.6: **DHT 11 Sensor**

Figure 3.7: **Intel RealSense Camera**

Ubuntu 18.04 LTS is a complete Linux operating system, freely available with both community and professional support. The ORB-SLAM2, required for the SLAM library, is tested on the Ubuntu platform. Also ROS Melodic, an optional way to train a SLAM system, is compatible with Ubuntu 18.04. Thus Ubuntu on a powerful on-bot controller, say Jetson Nano shall be used.

Figure 3.8: **Ubuntu**

Python Interpreter is an interpreted, object-oriented, high-level programming language with dynamic semantics. Its high-level built-in data structures, combined with dynamic typing and dynamic binding, make it very attractive for Rapid Application Development, as well as for use as a scripting or glue language to connect existingcomponents together. The processing of live feed from RGB-D cameras is intended to be done with a python script.

OpenCV (Open Source Computer Vision Library) is an open source, real-time, optimised computer vision and machine learning software library.ORB-SLAM2 library uses OpenCV to manipulate images and features.

Figure 3.9: **Python**

Figure 3.10: **Open CV2**

ROS is an open-source, meta-operating system for your robot. It provides the services you would expect from an operating system, including hardware abstraction, low-level device control, implementation of commonly-used functionality, message-passing between processes, and package management. TheORB-SLAM2 library can be implemented to process the live input of a monocular, stereo, or RGB-D camera using ROS nodes. Arduino IDE Software

Figure 3.11: **Robotic Operating system**

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards Arduino IDE is the software we are using in our project. The Arduino Integrated Development Environment or Arduino Software(IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. Various tools used in Arduino IDE are as follows: Verify Checks the code for errors compiling it. Upload Compiles your code and uploads it to the configured board. See uploading below for details. New Creates a new sketch. Open presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content. Save saves your sketch. Serial Monitor Opens the serial monitor. Intel

Figure 3.12: **Arduino IDE**

RealSense SDK 2.0 It is a cross-platform library for Intel RealSense depth cameras (D400 ,L500 series and the SR300) and the T265 tracking camera. The SDK allows depth and color streaming and provides intrinsic and extrinsic calibration information. The library also offers synthetic streams (point cloud, depth aligned to color, and vice-versa), and built-in support for record and playback of streaming sessions. The v2 Pi NoIR has a Sony IMX219 8-megapixel

Figure 3.13: **Intel RealSense**

sensor (compared to the 5-megapixel OmniVision OV5647 sensor of the original camera).

The Pi NoIR gives you everything the regular Camera Module offers, with one difference: it does not employ an infrared filter. (NoIR = No Infrared filter.) This means that pictures you take by daylight will look decidedly curious, but it gives you the ability to see in the dark with infrared lighting.

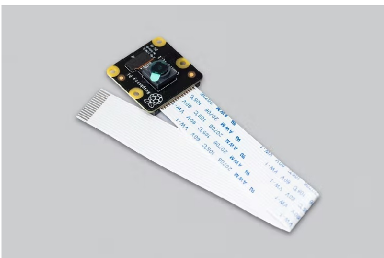


Figure 3.14: **Raspberry Pi Camera Module 2 NoIR**

3.3 Implementation

3.3.1 SLAM implementation

Robots too need help from maps, just like the rest of us, to go around. GPS isn't sufficiently accurate enough outdoors because precision within a few inches is required to move about safely. Instead they rely on what's known as simultaneous localization and mapping, or SLAM, to discover and map their surroundings. Using this map they plan a path and navigate autonomously.

SLAM is the computational problem of constructing or updating a map of an unknown environment while simultaneously keeping track of an agent's location within it. This initially appears to be a chicken-and-egg problem, but there are several algorithms known for solving it, at least approximately, intractable time for certain environments. 3.15 shows a point cloud map of a desk built using this approach Broadly speaking, there are two types of technology compo-

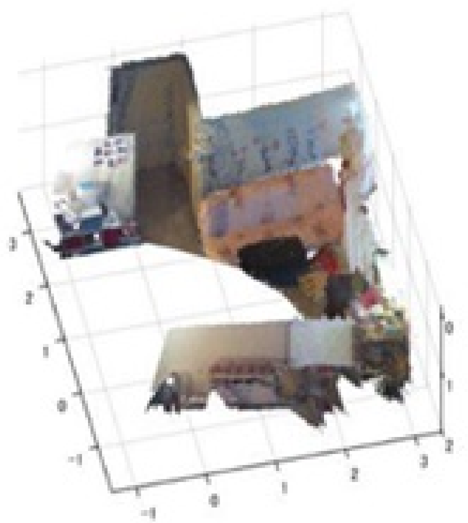


Figure 3.15: **Point cloud map of a desk in a room obtained by implementing SLAM**

nents used to achieve SLAM. The first type is sensor signal processing, including the front-end processing, which is largely dependent on the sensors used. The second type is pose-graph optimization, including the back-end processing, which is sensor-agnostic. Visual SLAM (or vSLAM) uses images acquired from cameras and other image sensors. Visual SLAM can use simple cameras (wide angle, fish-eye, and spherical cameras), compound eye cameras (stereo and multi cameras), and RGB-D cameras (depth and ToF cameras).

Depth cameras are cameras which can see not only the 2D details of a scene but can calculate how far away from the camera every pixel is. Stereoscopic cameras like Intel's RealSense D400 series take two images from the two sensors on the camera, which have slightly different points of view and compare them. The shift between the same points in both images can be used to determine depth. We decided to go with RealSense D415 based on preliminary background analysis against other stereo cameras, because D415 is based on RealSense D415 vision module which means the imagers, emitters, and RGB are on one compute board, or stiffener, making calibration much easier. Real Sense D415 has an approximately 65° field of view (FOV), a rolling shutter, has two-megapixel images, uses a vision processor to provide RGB-D data over USB 3.1, and has a maximum depth resolution of 1280 x 720.

Visual SLAM algorithms can be broadly classified into two categories. Sparse methods match feature points of images and use algorithms such as PTAM and ORB-SLAM. Dense methods use the overall brightness of images and use algorithms such as DTAM, LSD-SLAM, DSO, and SVO. ORB-SLAM (GPLv3 licensed) is a versatile and accurate SLAM solution for Monocular, Stereo and RGB-D cameras. It is able to compute in real-time the camera trajectory and a sparse 3D reconstruction of the scene in a wide variety of environments, ranging from small hand-held sequences of a desk to a car driven around several city blocks. It is able to close large loops and perform global relocalisation in real-time and from wide baselines. It includes an automatic and robust initialization from planar and non-planar scenes. Figure 2.5 shows the demo of ORB-SLAM2 for RGB-D cameras.

Figure 3.16: **shows the demo of ORB-SLAM2 for RGB-D cameras**

ORB-SLAM2 provides a GUI to change between a SLAM Mode and Localization Mode: SLAM Mode: This is the default mode. The system runs in parallel three threads: Tracking, Local Mapping and Loop Closing. The system localizes the camera, builds a new map and tries to close loops. Localization Mode: This mode can be used when you have a good map of your working area. In this mode the Local Mapping and Loop Closing are deactivated. The system localizes the camera in the map (which is no longer updated), using relocalization if needed.

Figure 2.6 shows the ORB-SLAM2 viewer. We decided to go with RGB-D-ORB-SLAM due to the advantages it offers against other algorithms. We shall run the SLAM system in the TUM dataset as RGB-D SLAM using data provided by Intel's RealSense Camera. Processing the live feed from an RGB-D camera shall either be with a python/C++ script or by running a ROS stereo node. This processing shall be on the NVIDIA Jetson Nano 7.2.3

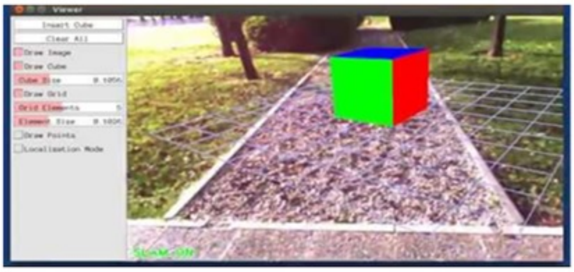


Figure 3.17: **An ORB-SLAM2 API interface**

3.3.2 Navigation Part

SLAM stands for Simultaneous Localization and Mapping. The idea behind using this system is to create a fully autonomous system capable of mapping its surroundings and knowing its own location. The sse ORB-SLAM2 was intended for the following reasons:

1. It works in real time and can be run on standard CPUs.

2. It has slightly more accuracy than RTABMAP

RealSense D415 camera in conjunction with the ORB-SLAM2 package in ROS Melodic will be used to perform SLAM. The system configuration will be as follows:

1. Jetson Nano 4GB

2. RealSense D415

3. RPi cam V2

4. SD Card 32GB to start of with

5. Ubuntu 18.04.5 LTS

6. ROS Melodic install

ORB-SLAM2 works on the principle of Loop Closure detection. Loop closure detection is the process of detecting whether an agent has returned to a previously visited location. Next comes the localization. This is achieved by using the formula below:
Where fx is the horizontal focal length, b is the baseline and d is the depth value.

$$u_R = u_L - \frac{f_x * b}{d}$$

These parameters are used to get a virtual right coordinate.To run the above package on the Jetson development board we will write a script that allows us to call only specific ROS publishing nodes from the ORB-SLAM2 package such as the point Cloud and localization topics. Up to this point, the entire system will remain static and only the camera will be moved to generate small maps and to test the speed of processing on the development board. To test SLAM in a mobile environment we plan on building a rover that combines the SLAM package with Move-base. The idea of an autonomously navigating bot hinges on the fact that it is able to detect or find places which it previously hasn't been to. This can be done by implementing Rapidly Exploring Random Trees. Using the ROS package rrt-exploration we can detect frontier points by subscribing to the topic 'frontiers', values can be published to move-base-node to drive the bot's wheels. As this is happening, the map of the surroundings is created by ORB-SLAM2. By setting a threshold in the topic that publishes distances to objects by publishing the value of the depth node to move-base, we can control the motion of the bot to avoid collisions. The final objective is collision avoidance. There is a split the SLAM and collision avoidance due to the fact that the overall processing will be slow when performing SLAM thus slowing down the bot. So, purposefully there is a separate system based on a single Raspberry Pi camera with a Field of View of 105 degrees to enable the bot to avoid collisions.

Frist the datasets are created, where two states are considered. The first state is considered to be "free"; in this state, there are no objects in the vicinity of the camera, picture below. The next state we consider is the blocked state. This will be considered as follows: The picture below illustrates an example of the camera on the bot observing a "blocked" state. Once these states have been identified. A model is built using ResNet-18 which is part of the TensorFlow library made available by google. By identifying when the path is blocked and when it is open, we can generate values that correspond to the distance to the object in view as a probability. If say the probability of the bot being blocked is greater than 50 percent, then we move the bot away from the object and continue.

Figure 3.18: **Free State**

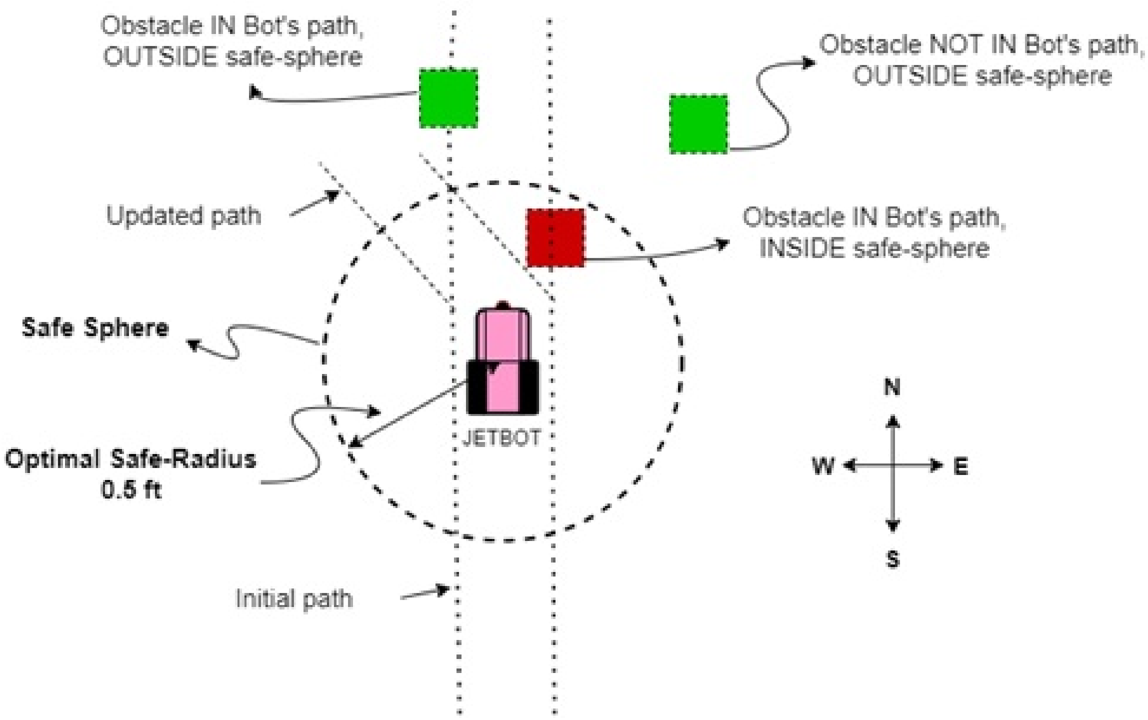


Figure 3.19: **Safe zone for the Bot to operate in**

Figure 3.20: **Blocked state**

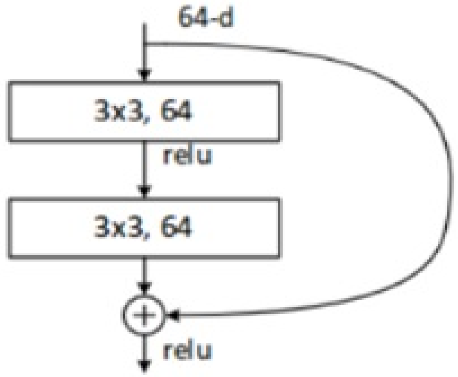


Figure 3.21: **ResNet block of 2 and 3 layers respectively**

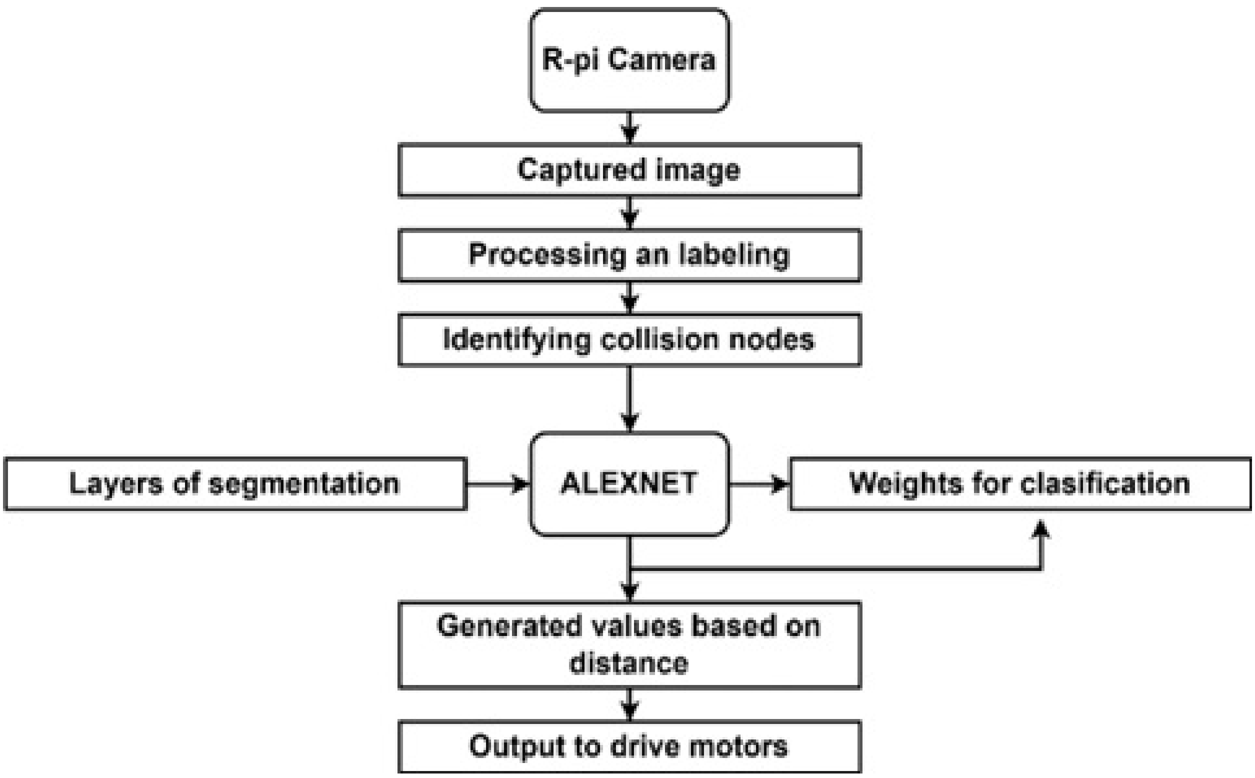


Figure 3.22: **The Process for collision avoidance**

3.3.3 Work flow of sensor embedded module

The NodeMCU is the secondary brain to which sensors whose purpose is to collect the environmental data like temperature, humidity, etc.and sends it to the user via the internet.

1. All sensors and Node MCU were integrated and created a PCB board
2. Database was created using mySQL in myphpadmin
3. Website was hosted in 000webhost server(open-source version)currently using 2 php les to host the website

Two sensors namely MQ2 and DHT11 sensors are connected to the Node MCU.They collect the data from the surrounding environment and gives it to the Node MCU.Later the collected data are stored in mySQL database. Then those datas are published in the hosted website.Code flow of the Node MCU is given below.

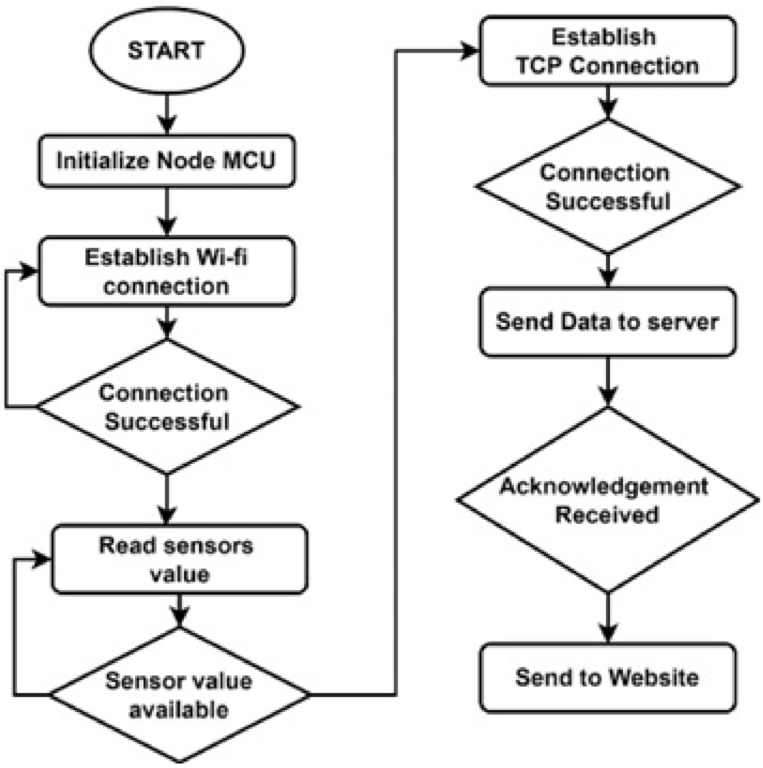


Figure 3.23: **Code flow sensor embedded module**

Chapter 4

Results and Discussions

We ran this project initially on ORB-SLAM2 but ended up running into many problems mainly with regards to rendering and loop closure detection due to compatibility issues with dependencies, specifically DBoW2 and Eigen3. Due to these issues, we switched to using RTABMAP, which stands for Real Time Appearance Based Mapping and utilizes Loop Closure detection to perform localization. Below are images that we obtained from the onboard camera upon performing Loop Closure. detection successfully.

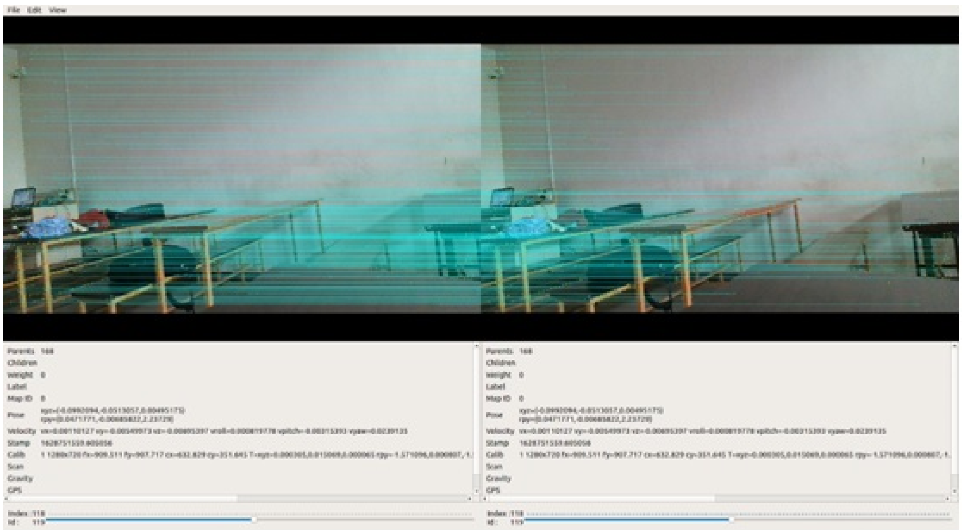


Figure 4.1: **Loops detected and closed using RealSense D415 on a Jetson Nano**

We were able to generate a complete map of the surrounding sand localize the camera when attached to the Jetson running ROS as showcased below.

Using the D415 in tandem with the Sony IMX219 sensor that is integrated in the raspberry pi camera module, we were able to generate 3D maps and perform SLAM as shown in the below image where a 3D point map of the environment that the bot was navigating in was generated.

We were able to successfully generate voxel maps of the environment and achieved SLAM as show in the below images of the RTABMAP GUI:

We also successfully managed to generate outputs at the collision avoidance stack which we used instead of move-base stack in ROS and got the following outputs when in free state.

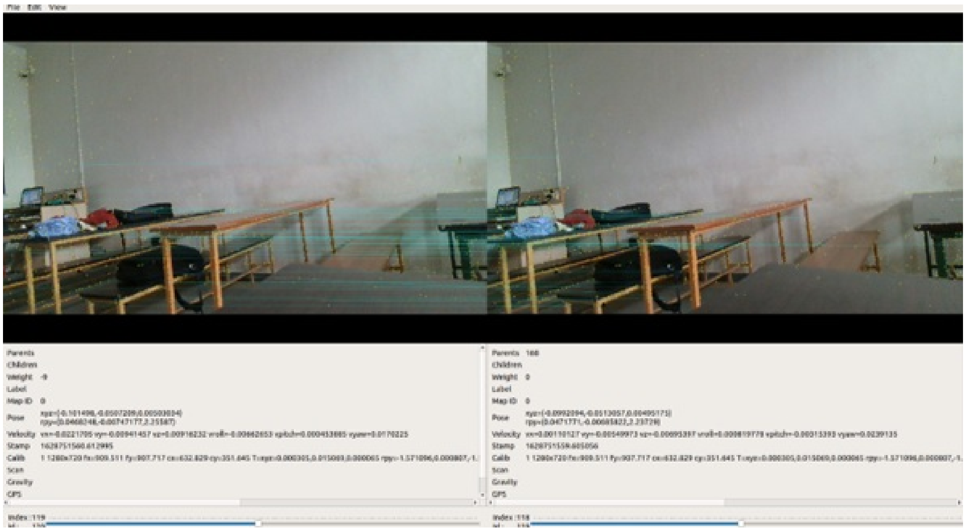


Figure 4.2: **Slight difference in the number of loops detected as the camera has fewer features to identify and close loops**

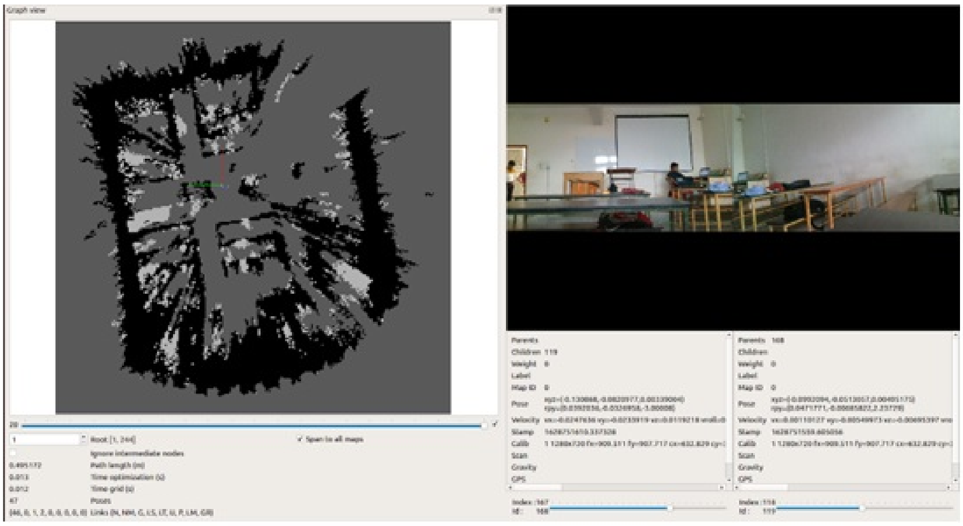


Figure 4.3: **Map of the surroundings with position localized**

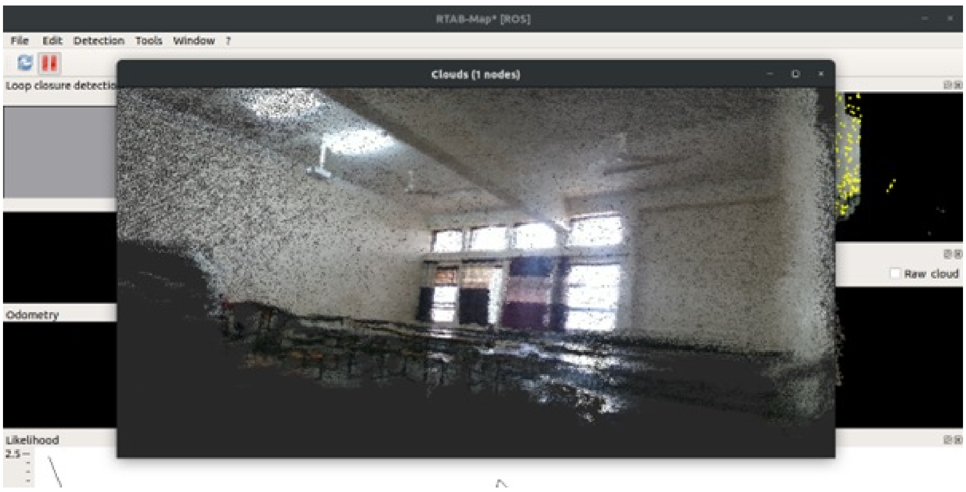


Figure 4.4: **3D point map of the environment generated by the bot**

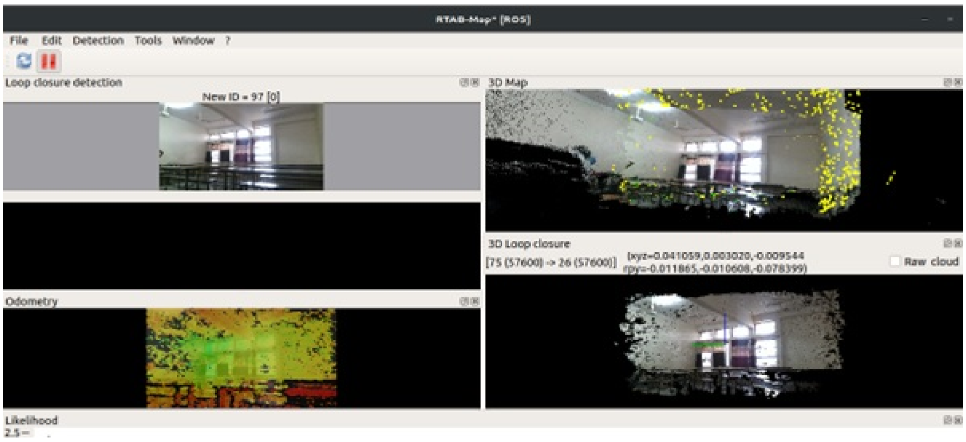


Figure 4.5: **SLAM in progress with 3D point cloud, loop closure detection and visual odometry values being compared to achieve loop closure**

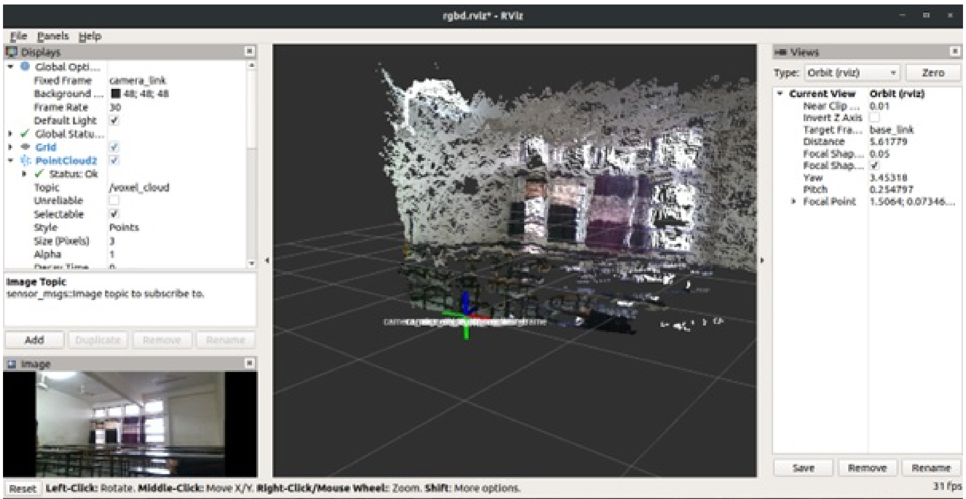


Figure 4.6: **Voxel Cloud rendering using Rviz from a subscribed topic in the RTABMAP nod**

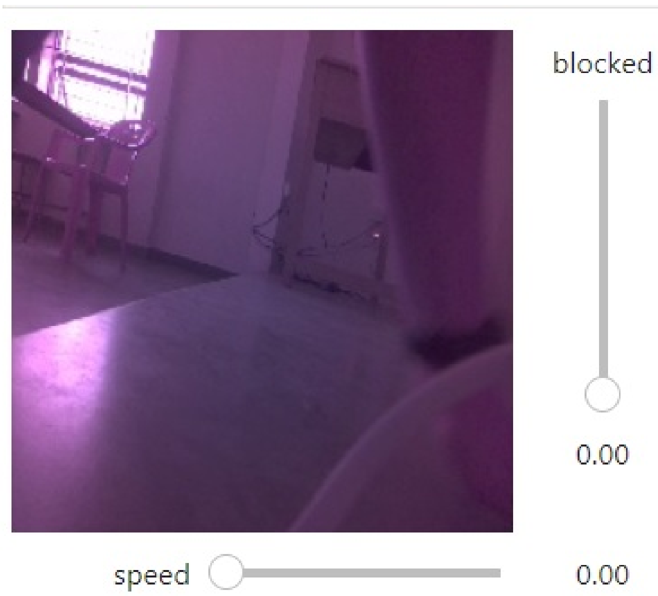
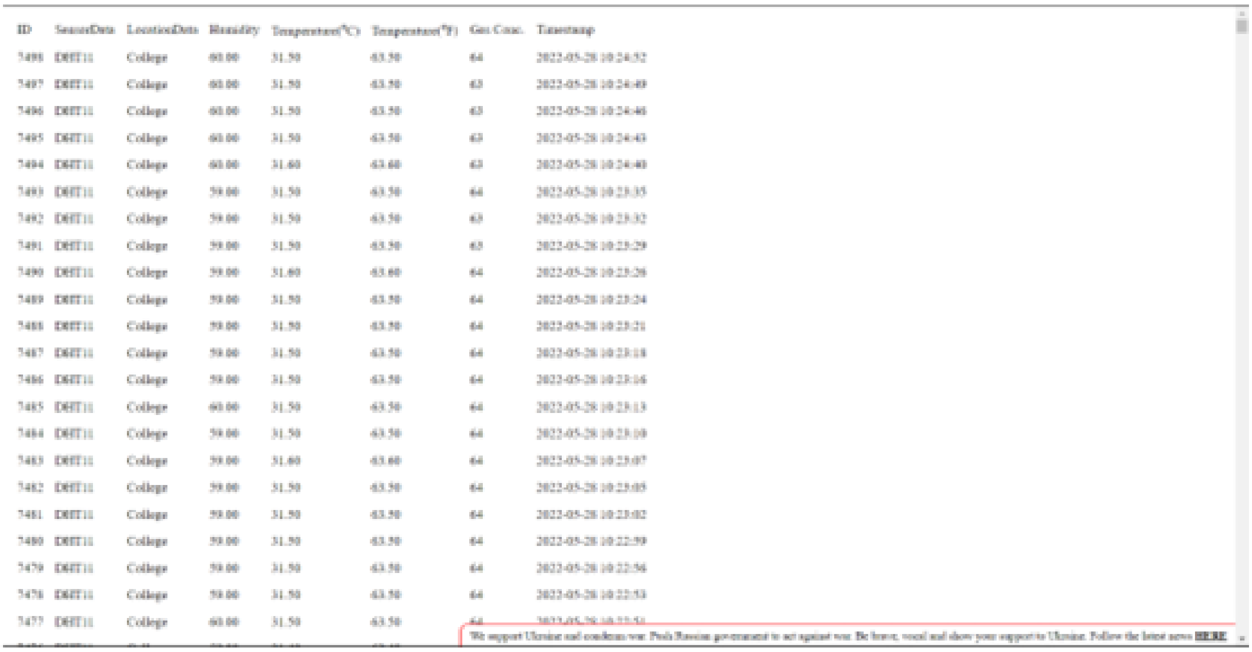


Figure 4.7: **Initialized camera**

Finally, our embedded system for environment monitoring was able to generate good readings using the MQ2 gas sensor and the DHT11 humidity sensor. We were able to integrate all of these systems onto a single bot and generate a live data feed along with the location of the bot using the internet.



ID	SensorData	LocationData	Humidity	Temperature(°C)	Temperature(°F)	Gas Conc.	Timestamp
7498	DHT11	College	60.00	31.50	63.50	64	2022-05-28 10:24:52
7497	DHT11	College	60.00	31.50	63.50	63	2022-05-28 10:24:49
7496	DHT11	College	60.00	31.50	63.50	63	2022-05-28 10:24:46
7495	DHT11	College	60.00	31.50	63.50	63	2022-05-28 10:24:43
7494	DHT11	College	60.00	31.60	63.60	63	2022-05-28 10:24:40
7493	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:23:35
7492	DHT11	College	59.00	31.50	63.50	63	2022-05-28 10:23:32
7491	DHT11	College	59.00	31.50	63.50	63	2022-05-28 10:23:29
7490	DHT11	College	59.00	31.60	63.60	64	2022-05-28 10:23:26
7489	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:23:24
7488	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:23:21
7487	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:23:18
7486	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:23:16
7485	DHT11	College	60.00	31.50	63.50	64	2022-05-28 10:23:13
7484	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:23:10
7483	DHT11	College	59.00	31.60	63.60	64	2022-05-28 10:23:07
7482	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:23:05
7481	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:23:02
7480	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:22:59
7479	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:22:56
7478	DHT11	College	59.00	31.50	63.50	64	2022-05-28 10:22:53
7477	DHT11	College	60.00	31.50	63.50	64	2022-05-28 10:22:51

We support Ukraine and condemn war. Push Russian government to act against war. Be brave, vocal and show your support to Ukraine. Follow the latest news HERE

Figure 4.8: **An image of live data(temperateness and humidity) from bot sensors**

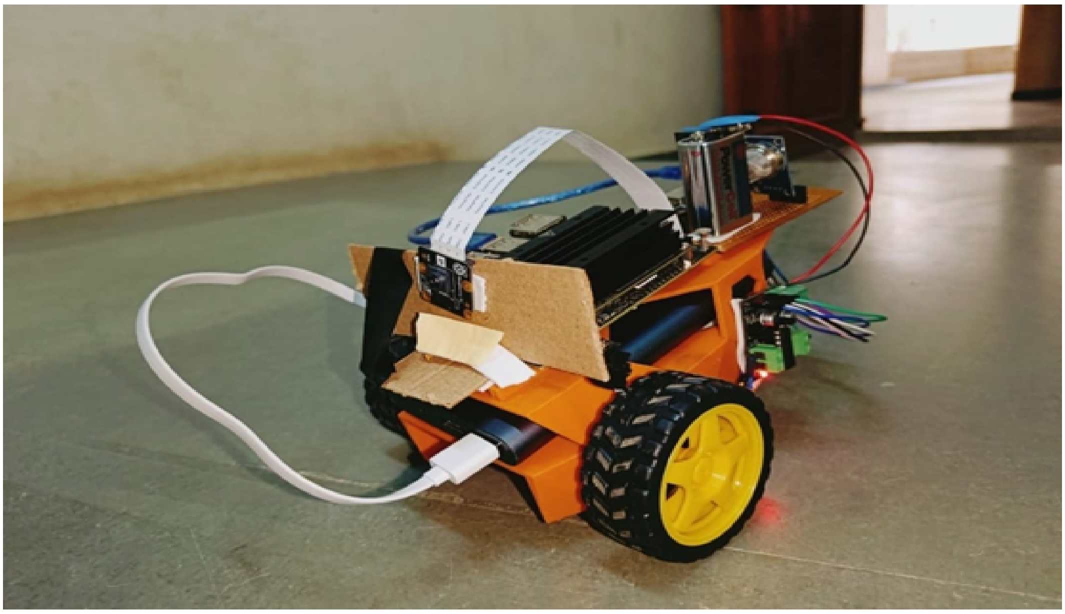


Figure 4.9: **Final prototype of our project**

Chapter 5

Conclusion and future work

The project serves the purpose of mapping the environments which are not accessible or not safe for humans. Surveillance of such places would be one of the main applications of this project. Surveillance is the process of gathering the information. Although these systems have been available for a while, there are few systems out there which can map and create 3D models of the whole environment. Our bot's main motive lies in the fact to map the surrounding area. This ability to make the map of the surroundings forms the basis for security application. The bot is internet enabled making it suitable for the application of IoT. It can be used for dynamic supervision. This bot can be utilized in the remote monitoring of high risk/hazardous industrial environments. Direct human intervention to such places like the radioactive sites will cause adverse effects to the human itself. Embedding the bot with required appropriate sensors gives it an upper hand in the remote analysis. This bot can be used to surevy construction sites remotely and help rectify any build errors encountered. This bot is a technology demonstration in trying to reduce the computing necessary to run SLAM algorithms and to help push mapping technology towards smaller devices that can be utilized in all sorts of environments from sewers to water pipes, aerial navigation to navigation underwater.

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Chapter 6

Reference papers

Paper1:ORB-SLAM2 An Open-Source SLAM System for Monocular, Stereo and RGB-D Cameras.

This article has been accepted for inclusion in a future issue of this journal. Content is final as presented, with the exception of pagination.

IEEE TRANSACTIONS ON ROBOTICS 1

Short Papers

ORB-SLAM2: An Open-Source SLAM System for Monocular, Stereo, and RGB-D Cameras

Raúl Mur-Artal and Juan D. Tardós

***Abstract*—We present ORB-SLAM2, a complete simultaneous localization and mapping (SLAM) system for monocular, stereo and RGB-D cameras, including map reuse, loop closing, and relocalization capabilities. The system works in real time on standard central processing units in a wide variety of environments from small hand-held indoors sequences, to drones flying in industrial environments and cars driving around a city. Our back-end, based on bundle adjustment with monocular and stereo observations, allows for accurate trajectory estimation with metric scale. Our system includes a lightweight localization mode that leverages visual odometry tracks for unmapped regions and matches with map points that allow for zero-drift localization. The evaluation on 29 popular public sequences shows that our method achieves state-of-the-art accuracy, being in most cases the most accurate SLAM solution. We publish the source code, not only for the benefit of the SLAM community, but with the aim of being an out-of-the-box SLAM solution for researchers in other fields.**

***Index Terms*—Localization, mapping, RGB-D, simultaneous localization and mapping (SLAM), stereo.**

I. Introduction

Simultaneous localization and mapping (SLAM) has been a hot research topic in the last two decades in the computer vision and robotics communities, and has recently attracted the attention of high-technological companies. SLAM techniques build a map of an unknown environment and localize the sensor in the map with a strong focus on real-time operation. Among the different sensor modalities, cameras are cheap and provide rich information of the environment that allows for robust and accurate place recognition. Therefore, visual SLAM solutions, in which the main sensor is a camera, are of major interest. Place recognition is a key module of a SLAM system to close loops (i.e., detect when the sensor returns to a mapped area and correct the accumulated error in exploration) and to relocalize the camera after a tracking failure, due to occlusion or aggressive motion, or at system reinitialization.

Visual SLAM can be performed by using just a monocular camera, which is the cheapest and smallest sensor setup. However, as depth is not observable from just one camera, the scale of the map and estimated trajectory is unknown. In addition, the system bootstrapping require multiview or filtering techniques to produce an initial map as it cannot be triangulated from the very first frame. Last but not least, monocular SLAM suffers from scale drift and may fail if performing pure rotations in exploration. By using a stereo or an RGB-D camera, all these issues are solved and allow for the most reliable visual SLAM solutions.

In this paper, we build on our monocular ORB-SLAM [1] and propose ORB-SLAM2 with the following contributions:

1) the first open-source[1] SLAM system for monocular, stereo, and RGB-D cameras, including loop closing, relocalization, and map reuse;
2) our RGB-D results show that by using bundle adjustment (BA), we achieve more accuracy than state-of-the-art methods based on iterative closest point (ICP) or photometric and depth error minimization;
3) by using close and far stereo points and monocular observations, our stereo results are more accurate than the state-of-the-art direct stereo SLAM;
4) a lightweight localization mode that can effectively reuse the map with mapping disabled.

Fig. 1 shows examples of ORB-SLAM2 output from stereo and RGB-D inputs. The stereo case shows the final trajectory and sparse reconstruction of the sequence 00 from the KITTI dataset [2]. This is an urban sequence with multiple loop closures that ORB-SLAM2 was able to successfully detect. The RGB-D case shows the keyframe poses estimated in sequence fr1_room from the TUM RGB-D Dataset [3], and a dense pointcloud, rendered by backprojecting sensor depth maps from the estimated keyframe poses. Note that our SLAM does not perform any fusion like KinectFusion [4] or similar, but the good definition indicates the accuracy of the keyframe poses. More examples are shown on the attached video.

In the rest of this paper, we discuss related work in Section II, we describe our system in Section III, then present the evaluation results in Section IV, and end with the conclusion in Section V.

II. Related Work

In this section, we discuss related work on stereo and RGB-D SLAM. Our discussion, as well as the evaluation in Section IV is focused only on SLAM approaches.

A. Stereo SLAM

A remarkable early stereo SLAM system was the work of Paz *et al.* [5]. Based on conditionally independent divide and conquer extended-

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R. Mur-Artal was with the Instituto de Investigación en Ingeniería de Aragón (I3A), Universidad de Zaragoza, 50018 Zaragoza, Spain, until January 2017. He is currently with Oculus Research, Redmond, WA 98052 USA (e-mail: raul.murartal@oculus.com).

J. D. Tardós is with the Instituto de Investigación en Ingeniería de Aragón (I3A), Universidad de Zaragoza, 50018 Zaragoza, Spain (e-mail: tardos@unizar.es).

Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/TRO.2017.2705103

[1]https://github.com/raulmur/ORB_SLAM2

Bags of BinaryWords For Fast Place Recognition in Image Sequences

$(y_1 DM)_j = 1$ if $j = (m+1)^2$, and $(y_1 DM)_j = 0$ otherwise. Let $(y_2)_j = 1$ if $j = m+1$, and $(y_2)_j = 0$ otherwise. The statement follows from Motzkin's Theorem since $y_1 DM - y_2 N = 0$. ■

Proof of Theorem 3.1: Let $V_{\min} = \emptyset$, $V = V_{\max}$, and $|V| = n = m+1$. Let δ^* be the vector of waiting intervals and arrival times defined in Trajectory 1. Note that the specification of the robots initial positions implies the specification of the arrival times $\mathcal{A}_{\min}$. Suppose that δ^* is not an optimal solution to the optimization problem A4, and let δ be a minimizer of A4. Then, $\|b + DM\delta\|_\infty < \|b + DM\delta^*\|_\infty$. It can be verified that the entries of $b + DM\delta^*$ indexed by $V_{\max}$ are all equal to each other. In addition, $b + DM\delta \succeq 0$, $b + DM\delta^* \succeq 0$. Hence

$$DM(\delta - \delta^*) \prec 0. \quad \text{(A5)}$$

Notice that, since $\delta_1^i(k)^* = 0$ and $\delta_1^i(k) \geq 0$ due to the constraint in A4, it follows that $\delta_1^i(k) - \delta_1^i(k)^* \geq 0$. Because of Lemma 6.2, the inequalities A5 with the constraint $\delta_1^i(k) - \delta_1^i(k)^* \geq 0$ are infeasible. Due to convexity, we conclude that δ^* is a global minimizer of A4 with $V_{\min} = \emptyset$.

Let $V_{\min} \neq \emptyset$, and observe that, because of Lemma 2.2, the weighted refresh time for the set of viewpoints $V_{\max} \cup V_{\min}$ cannot be smaller than the weighted refresh time for the set of viewpoints $V_{\max}$. Then, the vector δ^* that is defined in Trajectory 1 is a global minimizer of the optimization problem A4.

We now characterize the performance of Trajectory 1. Notice that $x_i(t) = x_{i+1}(t + \frac{\mathrm{RT}_\mathrm{T}^*}{\phi_1})$. Hence, the viewpoint v_α is not visited for an interval of length $\frac{\mathrm{RT}_\mathrm{T}^*}{\phi_1} - \delta_\alpha$, where δ_α is the waiting interval at the viewpoint v_α. We have

$$\frac{\mathrm{RT}_\mathrm{T}^*}{\phi_1} - \delta_\alpha = \frac{\mathrm{RT}_\mathrm{T}^*}{\phi_1} - \frac{\mathrm{RT}_\mathrm{T}^*(\phi_\alpha - \phi_1)}{\phi_\alpha \phi_1} = \frac{\mathrm{RT}_\mathrm{T}^*}{\phi_\alpha}.$$

From (1), we have $\mathrm{RT}(X) = \max_\alpha \phi_\alpha \frac{\mathrm{RT}_\mathrm{T}^*}{\phi_\alpha} = \mathrm{RT}_\mathrm{T}^*$. Note that

$$\frac{\Delta_1^m(1)}{\phi_1} = L + \mathcal{A}_{\min}(1) + \sum_{\alpha=1}^{n} \delta_\alpha^1(1) - \mathcal{A}_{\min}(m) - \delta_1^m(1)$$

where $\Delta_1^m(1) = \mathrm{RT}_\mathrm{T}^*$, $\delta_1^m(1) = 0$, and

$$\mathcal{A}_{\min}(1) - \mathcal{A}_{\min}(m) = -(m-1)\mathrm{RT}_\mathrm{T}^*/\phi_1$$

$$\sum_{\alpha=1}^{n} \delta_\alpha^1(1) = m\mathrm{RT}_\mathrm{T}^*/\phi_1 - \sum_{\phi \in \Phi_{\max}} \mathrm{RT}_\mathrm{T}^* \phi^{-1}.$$

Hence, $\mathrm{RT}_\mathrm{T}^* = \frac{L}{\sum_{\phi \in \Phi_{\max}} \phi^{-1}}$. Finally, for the Equal-Time-Spacing trajectory, it holds $\mathrm{RT}_1 = \mathrm{RT}_2 = \mathrm{RT}_\mathrm{T}^* = \mathrm{RT}(X)$. ■

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Bags of Binary Words for Fast Place Recognition in Image Sequences

Dorian Gálvez-López and Juan D. Tardós

***Abstract*—We propose a novel method for visual place recognition using bag of words obtained from accelerated segment test (FAST)+BRIEF features. For the first time, we build a vocabulary tree that discretizes a binary descriptor space and use the tree to speed up correspondences for geometrical verification. We present competitive results with no false positives in very different datasets, using exactly the same vocabulary and settings. The whole technique, including feature extraction, requires 22 ms/frame in a sequence with 26 300 images that is one order of magnitude faster than previous approaches.**

***Index Terms*—Bag of binary words, computer vision, place recognition, simultaneous localization and mapping (SLAM).**

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The authors are with the Instituto de Investigación en Ingeniería de Aragón, Universidad de Zaragoza, 50018 Zaragoza, Spain (e-mail: dorian@unizar.es; tardos@unizar.es).

Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

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Paper3:Surveillance Robot Using Raspberry Pi and IoT

2018 International Conference on Design Innovations for 3Cs Compute Communicate Control

Surveillance Robot using Raspberry Pi and IoT

Harshitha R
Assistant Professor, MVJ College of Engineering
Bangalore, India
Email: harshitha.r@mvjce.edu.in

Muhammad Hameem Safwat Hussain
Electronics and Communication Engineering
MVJ College of Engineering, Bangalore, India
Email: safwatchamp@gmail.com

Abstract— remote surveillance and monitoring of our homes has seen a growing need in emerging times. By means of this paper, we put forward a surveillance robot which can be integrated into any kind of household. The base controller of the bot will be the powerful Raspberry Pi 3 Model B. A webcam attached to the Pi monitors the area and sends a notification when any trespassing or obtrusion is detected. The camera also possesses face recognition algorithm which will possess the ability to identify the person responsible for the motion triggering. If it is an authorized personnel, the on board voice assistant will start talking with the person. The notification will be sent only when it's an unauthorized personnel and will contain pictures clicked of the trespasser and also activate live streaming of the webcam feed. The live streaming ability of the Pi allows the camera feed to be analyzed from any location using internet. With such a system, every user will feel more sheltered while they're not at their place of residence or when they've left their children and old ones alone at home.

Keywords-surveillance, Raspberry Pi 3 Model B, webcam, live stream

I. INTRODUCTION

Traditionally, surveillance systems are installed in every security critical areas. These systems generally consist of high quality cameras, multiple computers for monitoring, servers for storing these videos and many security personnel for monitoring these videos. When considered as a whole, these systems can yield great complexities while installing as well as for their maintenance. The CCTV camera feeds are only visible in certain locations and they also have limited range within which these can be viewed. Above all these, the cost of implementations of these systems is so high that they cannot be installed in every household. .

The traditional systems require continuous monitoring by some dedicated personnel which is not possible in every household. Hiring an unknown person to do so will also raise privacy issues. The CCTV cameras installed these days also have limited vision because they're stationary modules. If an intruder moves away from the field of view of a CCTV camera, it cannot follow or track his motions. The solution to all the above issues is to have a surveillance robot which can monitor the areas where it's installed and send notifications to the owner when an intrusion happens. It also allows the user to login to the Raspberry Pi's webcam from any remote location and view live feed of whatever is happening in his premises. The cost effectiveness and remote control features of the robot allow it to be used easily by every user.

II. RELATED WORK

Several projects and systems have been introduced in developing a robust home security system. With a common motto, they've developed systems using varying processors and features.

In [1], the author discusses a system developed for remote surveillance of homes using an Arduino, IP cam and Team Viewer to monitor the system. A DTMF controlled remote is used to switch on the PC, camera and robot. Once the mobile phone is called and specific set of keys are pressed, corresponding relay switches activate all the components required in the remote surveillance. Then to login to the remote PC, it uses a VNC server and the Windows app built on the PC. The app then sends respective signals to the mobile robot using RF technology. Looking at it from a broader prospective, we use GSM technology to activate the system, Internet to gain access of the remote PC and RF technology to control the robot. The lag between each system has not been considered in the system, which is a very crucial factor. When experimented with a similar setup, the response time between pressing the button on the Windows app and the robot's movement can extend up to even a minute or more. The RF technology used to control the robot requires line of sight communication between the transmitter and receiver module. It also has limited range and cannot be used in long halls. The robot cannot be controlled from another room either. The advantage of using Raspberry Pi 3 Model B is that it has on-board Wi-Fi, allowing it to connect to the home's router. This allows easy movement in every nook and corner of the house without any hassle. The lag is also only dependent on the internet speed, which can be easily upgraded.

The paper in [2] describes a system for smart surveillance of homes using a PC with on-board camera. The image processing algorithm uses background subtraction to detect motion by fixing certain threshold above which it decides that intrusion is detected. It also uses Gaussian blur to smoothen the high frequency noise which may occur while capturing the images using different conditions. Once motion is detected, the Arduino which has a buzzer connected to it. As soon as motion is detected, the buzzer goes on. Simultaneously, the camera clicks pictures and uploads it to the Dropbox. The obvious drawback of this system is that it doesn't send any notifications to the user regarding the intrusion. Uploading the images to Dropbox is a good idea for remote access but not for instant notifications. Moreover, using a PC's camera for motion detection makes it a very bulky system. It cannot be moved around or controlled from a remote location. The another

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Paper4: Design and Control of a Four-wheeled Omnidirectional Mobile Robot with steerable Omnidirectional Wheels

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Design and Control of an Omnidirectional Mobile Robot with Steerable Omnidirectional Wheels

Jae-Bok Song*, Kyung-Seok Byun**
*Korea University, ** Mokpo National University
Republic of Korea

1. Introduction

Applications of wheeled mobile robots have recently extended to service robots for the handicapped or the aged and industrial mobile robots working in various environments. The most popular wheeled mobile robots are equipped with two independent driving wheels. Since these robots possess 2 degrees-of-freedom (DOFs), they can rotate about any point, but cannot perform holonomic motion including sideways motion. To overcome this type of motion limitation, omnidirectional mobile robots (OMRs) were proposed. They can move in an arbitrary direction without changing the direction of the wheels, because they can achieve 3 DOF motion on a 2-dimensional plane. Various types of omnidirectional mobile robots have been proposed so far; universal wheels (Blumrich, 1974) (Ilou, 1975), ball wheels (West & Asada, 1997), off-centered wheels (Wada & Mory, 1996) are popular among them.

The omnidirectional mobile robots using omnidirectional wheels composed of passive rollers or balls usually have 3 or 4 wheels. The three-wheeled omnidirectional mobile robots are capable of achieving 3 DOF motions by driving 3 independent actuators (Carlisle, 1983) (Pin & Killough, 1999), but they may have stability problem due to the triangular contact area with the ground, especially when traveling on a ramp with the high center of gravity owing to the payload they carry. It is desirable, therefore, that four-wheeled vehicles be used when stability is of great concern (Muir & Neuman, 1987). However, independent drive of four wheels creates one extra DOF. To cope with such a redundancy problem, the mechanism capable of driving four omnidirectional wheels using three actuators was suggested (Asama et al., 1995).

Another approach to a redundant DOF is to devise some mechanism which uses this redundancy to change wheel arrangements (Wada & Asada, 1999) (Tahboub & Asada, 2000). It is called a variable footprint mechanism (VFM). Since the relationship between the robot velocity and the wheel velocities depends on wheel arrangement, varying wheel arrangement can function as a transmission. Furthermore, it can be considered as a continuously-variable transmission (CVT), because the robot velocity can change continuously by adjustment of wheel arrangements without employing a gear train. The CVT is useful to most mobile robots which have electric motors as actuators and a battery as a power source. Energy efficiency is of great importance in mobile robots because it is directly related to the operating time without

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Paper5: Design and Control of a Four-wheeled Omnidirectional Mobile Robot with steerable Omnidirectional Wheels

2019 5th International Conference on Control, Automation and Robotics

Mobile Robot Exploration Based on Rapidly-exploring Random Trees and Dynamic Window Approach

Taiping Zeng[1,2,3,4], Bailu Si[4]
[1]State Key Laboratory of Robotics, Shenyang Institute of Automation,
Chinese Academy of Sciences, Shenyang 110016, China
[2]Institutes for Robotics and Intelligent Manufacturing,
Chinese Academy of Sciences, Shenyang 110016, China
[3]University of Chinese Academy of Sciences, Beijing 100049, China
[4]School of Systems Science, Beijing Normal University, Beijing 100049, China
e-mail:zengtaiping.ac@gmail.com, bailusi@bnu.edu.cn

***Abstract*— Exploration is a critical function for autonomous mobile robots. Traditionally, the entire map has to be processed to extract frontiers and perform path planning. However, as the robot explores the environment, the map grows over time, and increasing computational resources are required, especially for large-scale environments. Moreover, only a few methods focus on the exploration on point cloud maps. Here, I present a new practical method to autonomous mobile robot exploration based on a sparse, relatively small-size point cloud local map, which combines Rapidly-exploring Random Tree (RRT) and dynamic window approach (DWA) algorithm together. The local map is built from the consecutive inputs of raw point clouds using an inexpensive 3D sensor, i.e. Kinect V2. Frontiers are effectively detected and local path planning is performed by RRT algorithm directly on unordered point cloud local maps. Motion planning is performed online by DWA to avoid obstacles and direct a nonholonomic mobile robot towards frontiers separating known environments from unknown environments. Embedded with simultaneous localization and mapping (SLAM) system of my previous research, the performance of the proposed method is evaluated in a large-scale customized virtual environment with a size of $33 \times 29 \times 6$m using Gazebo as the robotic simulator. The results suggest that the proposed algorithm can accurately direct the nonholonomic mobile robot to unexplored environments in real time. Also, it successfully helps build a coherent semi-metric topological map. The proposed algorithm shows great efficient performance and is suitable for both static and dynamic environments. Combination of RRT and DWA algorithm on point clouds, as a general approach, can be extended to generic 3D nonplanar physical environments. Videos of the experiments can be found at https://youtu.be/0i766fhs9Ds.**

Keywords-mobile robots; autonomous exploration; pointclouds; motion planning; rapidly-exploring random tree; dynamicwindow approach

I. Introduction

Mobile robot exploration is essential for autonomous mobile robots safely and efficiently operating in many challenging application scenarios, such as transportation, inspection, surveillance, and search and rescue. The main goal of mobile robot exploration is to answer the question of choosing where a robot should go next, and select appropriate control actions to reach the next desired position. It leads to increase the knowledge of the robot by visiting unknown or uncertain environments [1].

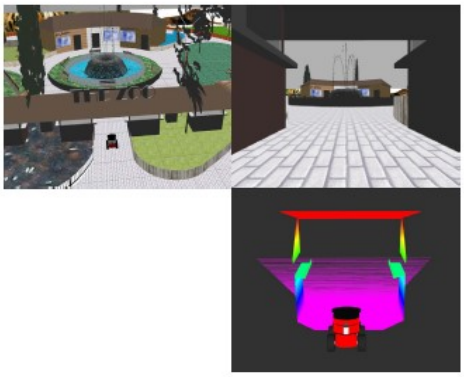

Figure 1.An instant at the beginning of the simulation experiment. The top left image depicts the robot, i.e. Pioneer 3-AT, at the gate. The top right shows what the robot sees. The bottom left image is the top-down shot of the simulation environment. Point clouds are presented on the bottom right corner, when the robot sees the environment through Kinect V2.

Although many works have been proposed to solve the indoor exploration problem using laser scanner and deal with navigation problem on point cloud maps, only a few methods focus on the exploration on point cloud maps. An online computed random tree is applied to find the best branch and make micro aerial vehicle (MAV) follow the first edge of this branch to explore unmapped space for 3D environments [2]. A point cloud map of environment is built from stereo cameras on the MAV. The algorithm is tested in two simulation scenarios, the apartment setup and the bridge model. It is also evaluated in a closed room with a size of $9 \times 7 \times 2m$. However, the online random tree still needs to search the whole 3D occupancy map. As the map grows, the MAV with limited resources will be unaffordable. Also, it is only evaluated in a closed room in the physical environment.

In this work, I present a new practical method to au-

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Paper6: Autonomous Robotic Exploration Based on Multiple Rapidlyexploring Randomized Trees

Autonomous Robotic Exploration Based on Multiple Rapidly-exploring Randomized Trees

Hassan Umari[1] and Shayok Mukhopadhyay[2]

Abstract— **Efficient robotic navigation requires a predefined map. Various autonomous exploration strategies exist, which direct robots to unexplored space by detecting frontiers. Frontiers are boundaries separating known space form unknown space. Usually frontier detection utilizes image processing tools like edge detection, thus limiting it to two dimensional (2D) exploration. This paper presents a new exploration strategy based on the use of multiple Rapidly-exploring Random Trees (RRTs). The RRT algorithm is chosen because, it is biased towards unexplored regions. Also, using RRT provides a general approach which can be extended to higher dimensional spaces. The proposed strategy is implemented and tested using the Robot Operating System (ROS) framework. Additionally this work uses local and global trees for detecting frontier points, which enables efficient robotic exploration. Current efforts are limited to the single robot case. Extension to multi-agent systems and three-dimensional (3D) space is left for future effort.**

I. INTRODUCTION

The main goal of an autonomous robotic exploration algorithm is to direct robots to unknown space, thus expanding the known and explored portion of a map which is being created as a robot moves. Frontier based exploration strategies [1], [2], [3] which are usually used for robotic exploration, direct robots to frontier edges. Frontier edges are lines that separate known space form unknown space in an occupancy grid map. Once a frontier edge is detected, a point on the detected edge, which is normally the centroid, is assigned to a robot for exploration. In order to extract frontier edges, the entire map has to be processed, and as the map expands, processing it will consume more and more computational resources [4]. This has led to research on efficient detection of frontier edges [4], [5].

The second branch of exploration strategies deploy randomized search techniques such as the simple random walker, and the Sensor-based Random Tree (SRT) [6], [7], which is a variation of RRT [8]. RRT is a path planning algorithm that samples space using randomly generated points. Random points are used to extend edges in a tree-like structure, which consists of nodes and edges. One possible mode of RRT based exploration is to make robots follow the above mentioned tree structure as the tree structure grows [9].

RRT is heavily biased towards unexplored and unvisited regions. In addition, RRT provides completeness [8], which ensures complete map coverage. Due to these properties, RRT has gained interest in exploration. However, making robots use RRT can be inefficient because of the possibility that robots may try to revisit map areas that are already explored (i.e. '*overlapping*' may occur). This is because branches can grow from random points at different time-steps. To avoid this, SRT was used in [5]. SRT grows one branch at time, a robot follows this branch in space until the branch can no longer extend due to the existence of a physical obstacle to robot motion. However, this approach of SRT doesn't necessarily reduce overlapping either. If a branch is not able to extend, the robot has to go back and track previous positions in an attempt to find a position in space, where a new branch can extend from. This process is known as backtracking, and is a major source for overlapping. As a result, researchers proposed solutions to reduce backtracking [10], [11].

This paper presents a new strategy for detecting frontier points using RRT. The robot is not made to follow a growing RRT-tree physically in space. Instead, the tree is used in the search for frontier points, and this search runs independently from robot movement. The detected points are filtered and queued to be assigned to a robot. When a point is assigned to a robot for exploration, the robot moves towards the assigned point. During this process, sensors onboard the robot (e.g. laser scanner) scan and explore neighboring areas within the sensor range. An additional novelty of this work is the use of multiple independently growing trees for speeding up the search for frontier points.

The exploration strategy is presently implemented on a single robot using ROS framework. However, it can be extended to multiple robots and to 3D space. The exploration strategy is tested in presence of other commonly used navigation components, in particular, the simultaneous localization and mapping (SLAM) module [12], [13] and the path planner module. The good performance of exploration seen in this work provides encouragement for using RRT based exploration approaches for fast path planning and exploration in higher dimensional spaces, because this can help extend the work in [14], [15] for computing invariant sets of N-dimensional systems via efficient RRT based approaches.

This paper is organized as follows. Section II provides necessary terminology used in the description of the proposed exploration strategy. Section III introduces the exploration strategy and its components. Section IV discusses strategy implementation. Section V, shows the simulation and experimental setup. Finally, simulation and experimental results are shown in Section VI, and the paper is concluded in Section

[1]Hassan Umari is a graduate (M.Sc.) student in the Mechatronics Engineering program, American University of Sharjah, 26666 Sharjah, UAE b00062945@aus.edu

[2]Shayok Mukhopadhyay is an assistant professor of Electrical Engineering, American University of Sharjah, 26666 Sharjah, UAE smukhopadhyay@aus.edu

Paper7: MonoRec: Semi-Supervised Dense Reconstruction in Dynamic Environments from a Single Moving Camera

MonoRec: Semi-Supervised Dense Reconstruction in Dynamic Environments from a Single Moving Camera

Felix Wimbauer[1,⋆] Nan Yang[1,2,⋆] Lukas von Stumberg[1] Niclas Zeller[1,2] Daniel Cremers[1,2]
[1] Technical University of Munich, [2] Artisense
{wimbauer, yangn, stumberg, zellern, cremers}@in.tum.de

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Abstract

In this paper, we propose MonoRec, a semi-supervised monocular dense reconstruction architecture that predicts depth maps from a single moving camera in dynamic environments. MonoRec is based on a multi-view stereo setting which encodes the information of multiple consecutive images in a cost volume. To deal with dynamic objects in the scene, we introduce a MaskModule that predicts moving object masks by leveraging the photometric inconsistencies encoded in the cost volumes. Unlike other multi-view stereo methods, MonoRec is able to reconstruct both static and moving objects by leveraging the predicted masks. Furthermore, we present a novel multi-stage training scheme with a semi-supervised loss formulation that does not require LiDAR depth values. We carefully evaluate MonoRec on the KITTI dataset and show that it achieves state-of-the-art performance compared to both multi-view and single-view methods. With the model trained on KITTI, we furthermore demonstrate that MonoRec is able to generalize well to both the Oxford RobotCar dataset and the more challenging TUM-Mono dataset recorded by a handheld camera. Code and related materials are available at https://vision.in.tum.de/research/monorec.

Figure 1: MonoRec can deliver high-quality dense reconstruction from a single moving camera. The figure shows an example of a large-scale outdoor point cloud reconstruction (KITTI Odometry sequence 07) by simply accumulating predicted depth maps. Please refer to our project page for the video of the entire reconstruction of the sequence.

1. Introduction

1.1. Real-world Scene Capture from Video

Obtaining a 3D understanding of the entire static and dynamic environment can be seen as one of the key-challenges in robotics, AR/VR, and autonomous driving. State of today, this is achieved based on the fusion of multiple sensor sources (incl. cameras, LiDARs, RADARs and IMUs). This guarantees dense coverage of the vehicle's surroundings and accurate ego-motion estimation. However, driven by the high cost as well as the challenge to maintain cross-calibration of such a complex sensor suite, there is an increasing demand of reducing the total number of sensors. Over the past years, researchers have therefore put a lot of effort into solving the problem of perception with only a single monocular camera. Considering recent achievements in monocular visual odometry (VO) [8, 59, 52], with respect to ego-motion estimation, this was certainly successful. Nevertheless, reliable dense 3D mapping of the static environment and moving objects is still an open research topic.

To tackle the problem of dense 3D reconstruction based on a single moving camera, there are basically two paral-

⋆ Indicates equal contribution.

Paper8 :Training End-to End steering of a self-balancing Mobile Robot based on RGB-D Image and Deep ConvNet

2020 IEEE/ASME International Conference on
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(Virtual Conference), July 6-9, 2020

Training End-to-End Steering of a Self-Balancing Mobile Robot Based on RGB-D Image and Deep ConvNet

Chih-Hung G. Li, Member, IEEE, and Long-Ping Zhou

Abstract—**In an attempt to build a self-balancing mobile robot, an end-to-end autonomous steering system was proposed based on RGB-D deep learning. An RGB-D camera is installed on the mobile robot to capture real-time depth images of the front environment. By annotating the depth images with the steering angles, a deep convolutional neural network was trained to provide end-to-end steering commands for direction control. The self-balancing mobile robot was built on a commercial self-balancing mobile platform; a data collection scooter was built on the same mobile platform and operated by a human rider to reflect the social-aware behavior. Two types of navigation tasks – corridor cornering and path adjustment were devised and tested. A preliminary performance study was also reported.**

I. Introduction

A mobile service robot navigates its work environment and provides services such as delivery, surveillance, tour-guiding, object-handling, etc. We built a mobile robot on a commercialized self-balancing two-wheeled scooter – Ninebot Mini Pro, which will be referred to as J4.α in this article. To devise the navigation system of J4.α, we divide the system into two parts, a localization module through visual place recognition and a self-driving module through visual direction control. The localization module was reported in [1]; in this paper, we report the self-driving module developed for J4.α. Specifically, a deep learning scheme was adopted to train the robot to properly react to the depth images acquired in real time and control the handlebar for proper steering. When J4.α navigates along indoor corridors, the self-driving system guides the robot through the path without bumping into the wall. Along with the localization module, J4.α can thus perform autonomous navigation from one location to a designated location according to the topological nodal structure depicted in [1].

An RGB-D camera is installed in front of J4.α, 29 cm from the ground, and is used to continuously inspect the environment in front. The depth information of various corridor scenes in relation to a human rider's response is collected to form the training set for the control model that determines the handlebar angle. The relatively vacant environments allow us to focus on the static objects and neglect the passing pedestrians. To collect the training images, a self-balancing scooter of the same kind was modified to install the RGB-D camera and three rotary encoders that monitor the handlebar angle and the rotation of the two wheels. As the human rider rides the vehicle along indoor corridors, the depth images are recorded along with the rider's control actions. We then annotate the depth images with the corresponding handlebar angles. A deep convolutional neural network (ConvNet) is used to train the image input for the angle output end-to-end. As shown in Figure 1, during operation, the robot acquires real-time depth information by the RGB-D camera, the on-board PC executes the ConvNet calculation and outputs the detection result, and the handlebar angle is driven accordingly by a stepper motor. The main contributions of this work are three folds. First, an end-to-end deep learning visual steering strategy was proposed for a self-balancing mobile robot. Secondly, the deep learning scheme allows the system to imitate a human rider's social-aware reactions in indoor corridor environments. Thirdly, we demonstrate the scheme on two types of navigation tasks; preliminary performance study was also reported.

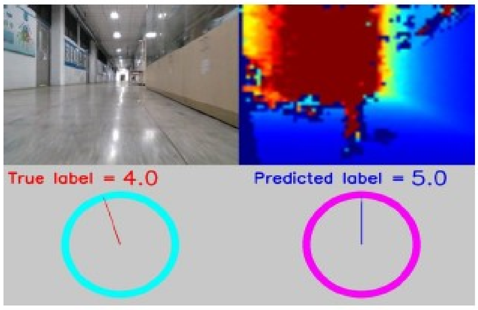

Fig. 1 The proposed end-to-end steering system for a self-balancing mobile robot receives RGB-D inputs of the front view and predicts handlebar angle by a deep ConvNet.

II. Related Work

A. RGB-D Vision

RGB-D cameras capture RGB images along with per-pixel depth information. Applications of the RGB-D camera for detection of the depth information around the robot have been reported previously. Researchers used RGB-D vision for provision of depth information of the targeted objects [2] to perform automated manipulator tasks such as object grasping [3] and clothes handling [4]. Henry et al. [5] introduced RGB-D Mapping, which utilizes RGB-D cameras to generate dense 3-D models of indoor environments. They have concluded

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Chih-Hung G. Li and Long-Ping Zhou are with the Graduate Institute of Manufacturing Technology, National Taipei University of Technology, Taipei, 10608 Taiwan ROC (e-mail: cL4e@ ntut.edu.tw).

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Chapter 7

Appendix-B

Arduino code for bot navigation part:

```
// arduino = serial.Serial(port='COMx', baudrate=9600)
// arduino.write()
// arduino.close()

#define a1 4
#define a2 5
#define b1 6
#define b2 7
#define s1 9
#define s2 10
int cmd = 0;

void setup() {
        Serial.begin(9600);
        pinMode(a1, OUTPUT);
        pinMode(a2, OUTPUT);
        pinMode(b1, OUTPUT);
        pinMode(b2, OUTPUT);
  pinMode(s1, OUTPUT);
  pinMode(s2, OUTPUT);

}

void loop() {
        analogWrite(s1,255);
  analogWrite(s2,255);
```

```
        if (Serial.available() > 0){
                cmd = Serial.read();
                Serial.println(cmd);
                if (cmd == 'S') stop();
                else if (cmd == 'F') {forward(); digitalWrite(13, HIGH)
                else if (cmd == 'B') {backward(); digitalWrite(13, LOW)
                else if (cmd == 'R') right();
                else if (cmd == 'L') left();
        }
}

void stop(){
        digitalWrite(a1, LOW);
        digitalWrite(a2, LOW);
        digitalWrite(b1, LOW);
        digitalWrite(b2, LOW);
}

void forward(){
        digitalWrite(a1, HIGH);
        digitalWrite(a2, LOW);
        digitalWrite(b1, HIGH);
        digitalWrite(b2, LOW);
}
void backward(){
        digitalWrite(a1, LOW);
        digitalWrite(a2, HIGH);
        digitalWrite(b1, LOW);
        digitalWrite(b2, HIGH);
}
void right(){
        digitalWrite(a1, HIGH);
        digitalWrite(a2, LOW);
```

```
        digitalWrite(b1, LOW);
        digitalWrite(b2, LOW);
}
void left(){
  digitalWrite(a1, LOW);
  digitalWrite(a2, LOW);
  digitalWrite(b1, HIGH);
  digitalWrite(b2, LOW);
}
```

Arduino code for interfacing DHT11 temperature sensor and MQ2 gas sensor:

```
#include <ESP8266HTTPClient.h>
#include <ESP8266WiFi.h>
#include <WiFiClient.h>
#include "DHT.h"
#define DHTTYPE DHT11
WiFiClient client;
#define dht_dpin 0
DHT dht(dht_dpin, DHTTYPE);
const char* ssid = "GSS";
const char* password = "shreyags";

const char* serverName =
 "http://b-22.000webhostapp.com//post-data.php";

String apiKeyValue = "*456789#";

String sensorName = "DHT11";
String sensorLocation = "College";

void setup()
{
  Serial.begin(115200);
  dht.begin();
```

```
  WiFi.begin(ssid, password);
  Serial.println("Connecting to the Wifi Network");
  while(WiFi.status() != WL_CONNECTED)
  {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.print("WiFi is Connected at this IP Address : ");
  Serial.println(WiFi.localIP());
}
void loop()
{
  float hum = dht.readHumidity();
  float temp = dht.readTemperature();
  float Ftemp= (9/5)*temp + 32;
  Serial.print("Humidity:- ");
  Serial.println(hum);

  Serial.print("Temperature:- ");
  Serial.println(temp);
  Serial.print("Temperature in Farenheit:- ");
  Serial.println(Ftemp);
  if(WiFi.status()== WL_CONNECTED)
  {
  HTTPClient http;
  http.begin(client,serverName);
  http.addHeader("Content-Type", "application/x-www-form-urlencoded");

  String httpRequestData =
  "api_key=" + apiKeyValue +
  "&SensorData=" + sensorName
   + "&LocationData=" + sensorLocation
```

```
    + "&value1=" + hum + "&value2=" + temp +
    "&value3=" + Ftemp + "";

    Serial.print("httpRequestData: ");
    Serial.println(httpRequestData);

    int httpResponseCode = http.POST(httpRequestData);

    if (httpResponseCode>0)
    {
      Serial.print("HTTP Response code: ");
      Serial.println(httpResponseCode);
    }
    else
    {
      Serial.print("Error code: ");
      Serial.println(httpResponseCode);
    }
    http.end();
  }
  else
  {
    Serial.println("WiFi Disconnected");
  }
  delay(1000);
}
```

code related to web hosting:

index.php

```
<!DOCTYPE html>
<html>
<header>
<script>
setTimeout(function(){
   window.location.reload(1);
}, 1500);
</script>
     </header>
<body>

<?php



$servername = "localhost";
$dbname = "id18873149_esp_data";
$username = "id18873149_espht1";
$password = "Bcpk@>&&kr78^8Oz";




$conn = new mysqli($servername, $username, $password, $dbname);
if ($conn->connect_error) {
     die("Connection failed: " . $conn->connect_error);
}

$sql = "SELECT id, SensorData, LocationData, value1, value2, value3, va

echo '<table cellspacing="5" cellpadding="5">
       <tr>
          <td>ID</td>
```

```
        <td>SensorData</td>
        <td>LocationData</td>
        <td>Humidity</td>
        <td>Temperature(<sup>o</sup>C)</td>
        <td>Temperature(<sup>o</sup>F)</td>
        <td>Gas Conc.</td>
        <td>Timestamp</td>
      </tr>';

if ($result = $conn->query($sql)) {
    while ($row = $result->fetch_assoc()) {
        $row_id = $row["id"];
        $row_SensorData = $row["SensorData"];
        $row_LocationData = $row["LocationData"];
        $row_value1 = $row["value1"];
        $row_value2 = $row["value2"];
        $row_value3 = $row["value3"];
        $row_value4 = $row["value4"];
        $row_reading_time = $row["reading_time"];


        echo '<tr>
                <td>' . $row_id . '</td>
                <td>' . $row_SensorData . '</td>
                <td>' . $row_LocationData . '</td>
                <td>' . $row_value1 . '</td>
                <td>' . $row_value2 . '</td>
                <td>' . $row_value3 . '</td>
                <td>' . $row_value4 . '</td>
                <td>' . $row_reading_time . '</td>
              </tr>';
    }
    $result->free();
```

```
}

$conn->close();
?>
</table>


</body>
</html>
```

post-data.php

```
<?php
$servername = "localhost";
$dbname = "id18873149_esp_data";
$username = "id18873149_espht1";
$password = "Bcpk@>&&kr78^8Oz";

$api_key_value = "*456789#";
$api_key= $SensorData = $LocationData = $value1
 = $value2 = $value3 = $value4 ="";

if ($_SERVER["REQUEST_METHOD"] == "POST") {
    $api_key = test_input($_POST["api_key"]);
    if($api_key == $api_key_value) {
        $SensorData = test_input($_POST["SensorData"]);
        $LocationData = test_input($_POST["LocationData"]);
        $value1 = test_input($_POST["value1"]);
        $value2 = test_input($_POST["value2"]);
        $value3 = test_input($_POST["value3"]);
        $value4 = test_input($_POST["value4"]);

        $conn = new mysqli($servername, $username, $password, $dbname);
        if ($conn->connect_error) {
            die("Connection failed: " . $conn->connect_error);
        }

        $sql = "INSERT INTO ESPData
        (SensorData, LocationData, value1,
         value2, value3, value4)
        VALUES ('" . $SensorData . "'
        , '" . $LocationData . "',
        '" . $value1 . "', '" . $value2 .
         "', '" . $value3 . "', '" . $value4 . "')";
```

```
        if ($conn->query($sql) === TRUE) {
            echo "New record created successfully";
        }
        else {
            echo "Error: " . $sql . "<br>" . $conn->error;
        }

        $conn->close();
    }
    else {
        echo "Wrong API Key";
    }

}
else {
    echo "No data posted HTTP POST.";
}

function test_input($data) {
    $data = trim($data);
    $data = stripslashes($data);
    $data = htmlspecialchars($data);
    return $data;
}
```

SQL command for creating database

```
CREATE TABLE ESPData(
    id INT(6) UNSIGNED AUTO_INCREMENT PRIMARY KEY,
    SensorData VARCHAR(30) NOT NULL,
    LocationData VARCHAR(30) NOT NULL,
    value1 VARCHAR(10),
    value2 VARCHAR(10),
    value3 VARCHAR(10),
    reading_time TIMESTAMP DEFAULT
     CURRENT_TIMESTAMP ON UPDATE CURRENT_TIMESTAMP
)
```

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Carried out by Shashank G S - 4JN18EC081, Shripada Adiga - 4JN18EC085

Yashas Vinay - 4JN18EC119, Sumanth Shanbog H R - 4JN18EC098 under the guidance of

Mrs. Prema K N, Asst.Professor, Dept. of Electronics and Communication Engineering

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SPS	Title : Low Cost Hearing Aid Team Members : Jagrathi J Nayak,Gautham Shankar N Institution : Vivekananda College of Engineering and Technology Puttur	Title : A Novel Technique todetect the Muscle Disorder Team Members : M.Ganga Bhavani, N.Mythreyi, K.RavindraReddy, M.Rakesh Institution : Sai Vidya Institute Of Technology
IAS	Title : Eco Friendly Charcoal BriquetteTeam Members : CHANDANRAJ N G, SNEHA K S, AMOGH M Institution : JNNCE	Title : Low Cost SmartSpirometer Team Members : SANIHA, ADITHYA SUBRAHMANYA SHARMA P, ASHLESH S, MIDHUN MOHANAN Institution : AJ INSTITUTE OF ENGINEERING AND TECHNOLOGY
RAS	Title : Autonomous 3−D Mapping andNavigating Droid Team Members : Shripada Adiga, Shashank G S, Yashas Vinay, Siddharth M,V N Gokul Krishna Institution : JNN College of Engineering	Title : Design and development ofAutonomous VTOL for medicine deliveries in hilly areas Team Members : Jeevan K, SohanM Rai, Pranav Sathish, V Mukesh Kumar, Chandra Singh Institution : Sahyadri College of Engineering and Management

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belagavi,Karnataka - 590 018

A Internship on Report on

"Embedded systems and IoT"

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

in

Electronics and Communication Engineering

by

SANIDHYA G M   USN:4JN18EC076

Under the Guidance of

Sumathi K M.Tech.,Ph.D.

Assistant Professor,

Dept. of ECE,

JNNCE-577 204.

Department of Electronics and Communication Engineering

JNN College of Engineering, Shimoga - 577 204.

Internship Carried out in

TECH AMPLITUDE

Shimoga-577 201

July 2022

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belagavi-590 018.

JNN College of Engineering

Department of Electronics and Communication Engineering

Shimoga-577 204.

CERTIFICATE

This is to certify that the internship entitled **"Embedded systems and IoT"** is carried out at Tech Amplitude Pvt. Ltd, Shivamogga, submitted by **Sanidhya(4JN18EC076)** , the bonafide student of JNN College of Engineering, Shimoga in partial fulfillment for the award of "Bachelor of Engineering" in department of "Electronics and Communication Engineering" of the Visvesvaraya Technological University, Belagavi, during the year 2021-2022. It is certified that all the corrections/suggestions indicated for internal assessment have been incorporated. The internship report has been approved as it satisfies the academic requirements in respect of internship prescribed for the said degree.

Signature of the Guide
Sumathi K
Assistant Professor,
Dept. of ECE,
JNNCE, Shimoga.

Signature of the Coordinator
Shewtha B
Assistant Professor
Dept. of ECE,
JNNCE, Shimoga.

Signature of the HoD
Dr. S.V. Sathyanarayana
Professor & HoD
Dept. of ECE, JNNCE, Shimoga.

External Viva

Name of the examiner

1.

2.

Signature with date

ABSTRACT

I am submitting this report on a major project I have worked on and completed , which is GSM based Dam monitoring system. An autonomous flood gate system has been proposed and developed in this project that will be able to open and close gates automatically. This system is capable of sensing drain water and tidal water, it controls the pump to irrigate excessive water and DC motors are also used to control the movement of dam gates. In this project by using Microcontroller to control all the operations regarding the level of water in the dam is done. Arduino UNO used as a controller, it controls the level of Water in dam and sends message to the user through GSM Technology. By using this project, we can avoid wastage of water and can reduce the man power for continuous monitoring the water level in the dams.

ACKNOWLEDGEMENTS

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of the people who made it possible whose constant guidance and encouragement crowned the efforts with success.

I thank to **Dr. K Nagendra Prasad, Principal,** JNNCE, Shivamogga for providing excellent academic climate.

I thank to **Dr. Manjunatha P**, Dean Academics, JNNCE, Shivamogga for giving facilities to undertake internship work. I would wish to express my gratitude to our guide **Dr. S.V Sathyanarayana**, Head of Department, Electronics and Communication Engineering for providing the good working environment and for his constant support and encouragement.

It gives me great pleasure in placing on record a deep sense of gratitude to our internship coordinator, **Shwetha B**, Assistant Professor, Department of Electronics and Communication Engineering for their expert guidance, initiative and encouragement that led me through the presentation.

I also thank **Tech Amplitude** and my guide **Mr. Mohammed Umer Shah** for providing me an opportunity to work in the company and complete the internship program.

And lastly, I would hereby acknowledge and thank my parents who have been a source of inspiration and also instrumental in the successful completion of internship.

Sanidhya G M

4JN18EC076

Contents

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Chapter 1

COMPANY PROFILE

TECH AMPLITUDE was formed by professionals with formal qualifications and industrial experience in the field of embedded systems, real-time software and process control.

Services offered: Embedded Development: Commercial and Educational projects on IoT and Robotics. Training, Mentorship and Internships on mentioned domains.

Software Development:

- Development related to commercially used software such as billing, human resource management, inventory management.
- Development of web applications and designing of web pages for small scale and largescale businesses.
- Trainings internship in the field of web development, machine learning, python and other programming languages.

Chapter 2

AIM OF THE INTERNSHIP UNDERTAKEN

The aim of the internship is to gain knowledge on Embedded systems IoT and apply the knowledge and skills acquired on real world projects such as Bluetooth control robot using Arduino with obstacle detection, Underground cable fund detection using Bluetooth, Arduino based LPG leakage detector with buzzer indication, IoT based Home Automation, IoT based Agricultural robot and many more.

Worked on a major project named GSM based Dam monitoring system. Dams have been used in many purposes since long time by mankind. Power has been generated through flow of water in dam and the water stored in dam for a whole year has been used for irrigation and drinking purposes. This project is based on automating the dam functions based on controlling the various parameters such as level and flow of water with real time implementation of gate control using Arduino.

Chapter 3

INTRODUCTION

Dams are the major sources of water supply to cities, they also play a vital role in flood control and can assist river navigation. Most of the dams are built to serve more than one purpose and their benefits are manifold. Generally, the dams are monitored through traditional surveillance techniques and the water management except the monitoring of level of water in some of the dams which is automatized.

The global system for mobile communication (GSM) is used worldwide for continuous monitoring, controlling and alerting of dam water level. This advance technology uses short message services (SMS) to directly control and monitor the opening and closing of the shutter in dam. Through the SMS this system alerts the people staying nearby places about the rise in water level. Temperature sensor, sense the changes in atmospheric temperature and take up appropriate measure like relieving the excess water in dam for irrigation purpose in seasons. This project gives a detailed model of the system which senses the changes like temperature and water level difference using sensors, and overflow detection using GSM technology.

Chapter 4

THEORETICAL BACKGROUND

In this chapter Theoretical background of Embedded system, Microcontroller, GSM Technology and sensors is discussed.

4.1 Embedded system

An Embedded System is an integrated system which is formed as a combination of computer hardware and software for a specific function. This is the system which works independently or attached to a larger system to work on few specific functions. It can also work without human intervention or with a little human intervention.

4.1.1 Characteristics of Embedded system

a. Performs specific tasks: It performs some specific function or tasks.

b. Low cost: Its price is not expensive.

c. Time specific: It performs the task within certain amount of time.

d. Low Power: It doesnâĂŹt need more power to operate.

e. High Efficiency: Its efficiency level is high.

f. Minimal User Interface: It requires less User Interface and easy to use.

g. Less Human intervention: It requires no human intervention or very less human intervention.

h. Highly stable: The system will not change frequently by maintaining stability.

i. High Reliability: The system is highly reliable which performs the task consistently well.

4.1.2 Top Embedded Programming Languages

Embedded systems can be programmed using different programming languages like Embedded C, Embedded C++, Embedded Java, Embedded Python. However, it entirely depends on the developer to use which programming language for the development of the embedded system.

4.2 Microcontroller

A microcontroller is a small and low-cost microcomputer, which is designed to perform the specific tasks of embedded systems like displaying microwave's information, receiving remote signals, etc. The general microcontroller consists of the processor, the memory (RAM, ROM, EPROM), Serial ports, peripherals (timers, counters), etc.

Arduino Board The ARDUINO is a low-power, high-performance CMOS 8-bit Arduino microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using AtmelâĂŹs high-density non-volatile memory technology and is compatible with the industrystandard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel ARDUINO is a powerful Arduino microcontroller which provides a highly-flexible and costeffective solution to many embedded control applications. Figure 1 shows the Arduino Board

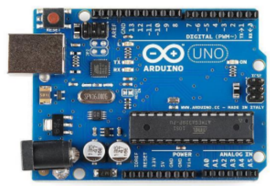

Figure 4.1: Arduino Board

The ARDUINO provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. The on-chip Flash allows the program memory to be reprogrammed in system or by a conventional non-volatile memory programmer

4.3 GSM Technology

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz. The GSM specifications define the functions and interface requirements in detail but do not address the hardware. The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS). Figure 2 shows the basic GSM Network elements.

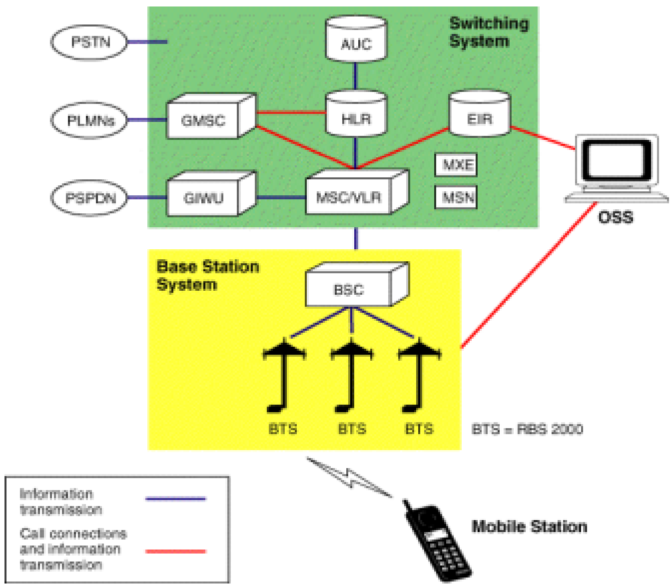

Figure 4.2: GSM network

GSM Modem

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves

4.4 Sensors

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing

4.4.1 Characteristics of Sensors

A good sensor should have following characteristics **i.High Sensitivity:** Sensitivity indicates how much the output of the device changes with unit change in input (quantity to be measured). **ii.Linearity:** The output should change linearly with the input. **iii. High Resolution:** Resolution is the smallest change in the input that the device can detect. **iv.Less Noise and Disturbance. v.Less power consumption.**

4.4.2 Classification of Sensors

a.Active Sensor: This sensor requires an external source of power (excitation voltage) that provides the majority of the output power of the signal.

b.Passive Sensor: The output power is almost entirely provided by the measured signal without an excitation voltage

Chapter 5

DETAILS OF THE WORK CARRIED OUT

In this chapter details of the work carried out during project preparation which includes details of software tools used, system design and Implementation, working and result obtained is discussed.

5.1 Details of Software tools used

a.Embedded C Programming Embedded C is one of the most popular and most commonly used Programming Languages in the development of Embedded Systems. It is perhaps the most popular languages among Embedded Programmers for programming Embedded Systems. There are many popular programming languages like Assembly, BASIC, C++, Python etc. that are often used for developing Embedded Systems but Embedded C remains popular due to its efficiency, less development time and portability.

b.Arduino IDE Compiler The Arduino IDE is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring project. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. This IDE comes with a C/C++ library called "Wiring", which makes many common input/output operations much easier. Arduino programs are written in C/C++

5.2 System design and Implementation

Figure 3 shows the block diagram of the GSM based Dam monitoring system. It shows overall view of the system. Arduino uno is employed as the processor with 9V AC power supply. Water level sensor used to detect water level as well as DC motor along with gear rack system is implemented in the system to open or closed gates. A level sensor to identify the water level of a dam and that should be giving information to the corresponding authority people by using a GSM modem.

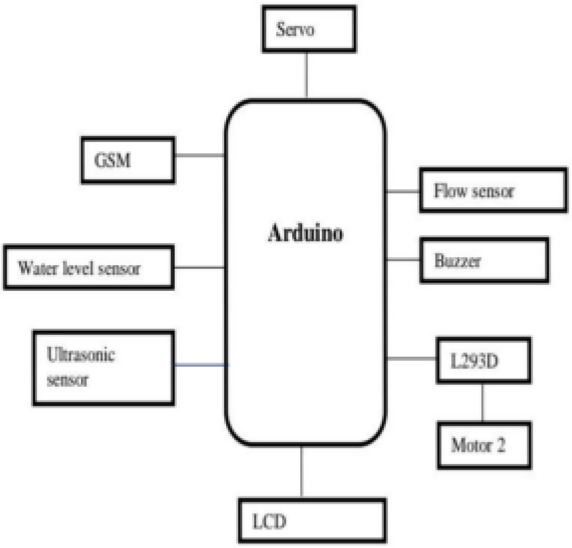

Figure 5.1: Arduino Board

The basic operation of control unit is the controlling water pump by Arduino which is programmed by particular program. Water pump are connected with an output pin of Arduino via a relay circuit which is connected with a transistor. A water level sensor will monitor the level of the liquid. Depending on the need, it can be configured to perform a variety of functions for different situations. They could be used to provide feedback on water level, they can be used to control circuits that operate different components and they can be used to send an alarm signal and given information via GSM.

5.3 Working

Initially the level of water data is got using sensors. The sensors are interfaced with a micro controller which transfers the data to a local base station using far field/near field communication. In this stage dealing with transferring the data at shorter distances is done i.e., at a local base station. The distance might range from few hundred meters to one or two kilometres. The short data transfer modules like Bluetooth are interfaced with the Arduino and used to transfer the data. In this stage by working on transferring the data to long distances of order of several hundred kilometres. These helps in gathering the data from all the nodes to a central base station which in turn reads the data and send the commands based on it.

The proposed idea has been implemented using short range communication sensors and Arduino micro controller. The first stage of the implementation which involves determining the level of water using water level sensors. The water level sensor is mounted on the top of a water container which determines the distance between the top of the container and the surface of the water. If the distance goes below a certain point, it indicates that the water level in the container has exceeded optimum level.

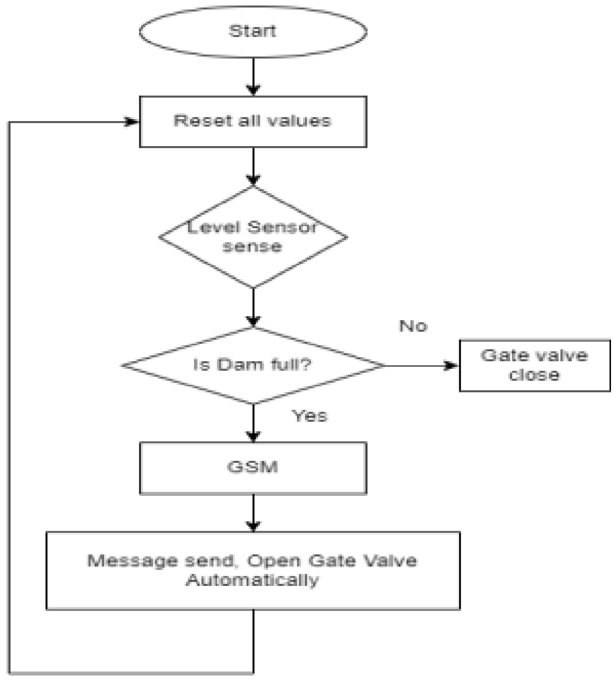

Figure 5.2: flow chart

Figure 4 shows the flowchart of the proposed system. The starting conditions all the values are reset. The water level sensor is to sense the water level in the dam. If the dam is not to be filled, the gate valve remains in closed position. Otherwise, if the dam water level increases beyond the limit, signal will be sent to GSM. The message was sent to the person and gate valves will opens automatically. After that process it again reset the values and repeats the process.

5.4 Output obtained

figure 5.3 shows the Dam monitoring system model. This proposed automated mechanism of water level monitor, control and alerting system using GSM in dams and irrigation system is based on season change which reduces the wastage, ensure efficient use of available water resources and generates more precise and accurate results. There is no requirement of human laborers for monitoring the level of water. By increasing the number of level sensors the dam gated can be opened or closed whenever necessary knowing the accurate level of water

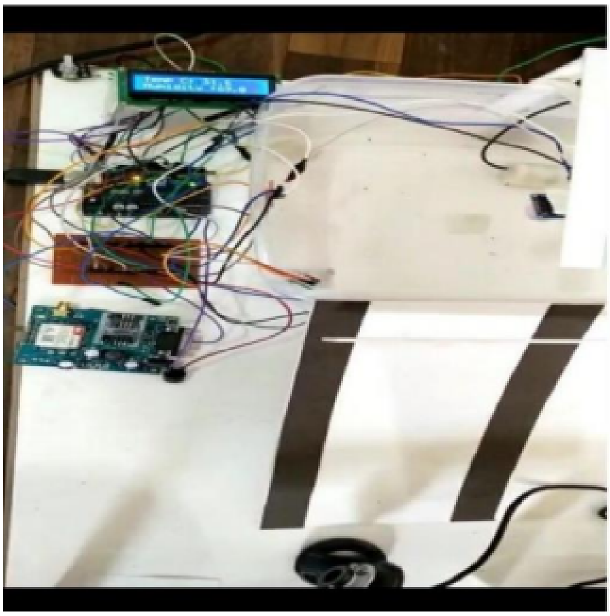

Figure 5.3: output obtained

Chapter 6

CONCLUDING REMARKS

This internship provided me an opportunity to gain valuable experience in career field. It's a great way to gain specific skills and knowledge as well as make contacts and build confidence. This program helped me to gain technical knowledge on Embedded systems, Embedded C, Protocols, various sensors and hardware. Initially I learnt basic knowledge about Embedded system and done some minor projects related to Embedded systems which covered how to write programming in Embedded C and to interface different microcontrollers with various hardware. These are the challenges I have faced which helped me to improve my technical knowledge in this internship which shows manual work that takes more time than the proposed work. My biggest challenge was to work independently. I had to make self-decisions which gave me strength to think independently. This sense of independence is the biggest source of my worry, yet it is the most exciting part of being able to work. I have earned a better outlook on how to work in an organization

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MEHRAN MAJEED
Co-Founder

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Belagavi

Technical Seminar Report

"BLOCKCHAIN ENABLED SMART CONTRACTS"

Technical Seminar Report
submitted to Visvesvaraya Technological University in partial fulfillment for the completion of Technical Seminar in 8th semester B.E. Electronics & Communication Engineering

Submitted By,

HARSHITHA M D
4JN18EC033

Department of Electronics & Communication Engineering
Jawaharlal Nehru National College of Engineering, Shivamogga-577204

May 2022

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Department of Electronics & Communication Engineering

Certificate

This is to certify that the Technical Seminar entitled

"BLOCKCHAIN ENABLED SMART CONTRACT"
is presented by

Harshitha M D *4JN18EC033*

In partial fulfillment of the award of the degree of Bachelor of Engineering in Electronics & Communication Engineering of Visvesvaraya Technological University, Belagavi, during the year 2022. It is certified that all corrections/suggestions indicated during internal assessment have been approved as it satisfies the academic requirements in respect of the Technical Seminar report.

(Mr Ajay Bethur P)
Asst.Professor, Guide

(Mr Abhijith N)
Asst.Professor, Coordinator

Dr. S V Sathyanarayana
HOD, ECE Dept.

Name and signature of Evaluator with date

1. Ajay Betur P
2. Abhijith N
3.
4.

Contents

Table Of Figures

Acknowledgement

I consider it as a great privilege to express my gratitude and respect to all those who guided and inspired me in completion of this seminar. It is difficult for me to express my sense of gratitude and appreciation for the help I have received in this endeavor. My effort here is a feeble attempt to do so.

First of all, I acknowledge for the provision of the required infrastructure by my esteemed institute **J N N College of Engineering, Shivamogga** and **Department of Electronics and Communication Engineering.**

I would like to thank our head of the department **Dr. S V Sathyanarayana.,** who stood as a guiding spirit and lending guidance to achieve the aim with added zeal.

I thank the seminar coordinator **Prof. Mr Abhijith N** for her valuable suggestions and treasured assistance throughout the preparation of the seminar.

My special thanks **Prof. Mr Ajay Betur P,** my project guide for providing all the inputs and corrections needed for preparation of report.

Lastly, I am thankful to my classmates, teaching and non-teaching staff and everyone who have helped me directly or indirectly for the successful completion of the seminar.

HARSHITHA M D

USN: 4JN18EC033

Abstract

In recent years, the rapid development of cryptocurrencies and their underlying blockchain technology have been evolving without central authorities. Smart contracts can find a wide spectrum of potential application scenarios in the digital economy and intelligent industries. A systematic and comprehensive overview of blockchain-enabled smart contracts has been proposed here. The operating mechanism and mainstream platforms of blockchain-enabled smart contracts, have been introduced and several application scenarios have been presented. The application and use of smart contracts in organizations require a holistic overview. This overview helps to understand the current adoption of this technology and also deduces factors that are inhibiting its use in the modern organization. Smart contracts are executed on a blockchain system if specified conditions are met, without the need of a trusted third party. Blockchains and smart contracts have received increasing and booming attention in recent years, also in academic circles

1. Introduction

The term "smart contract" was first coined in mid 1990s by computer scientist and cryptographer Szabo. However, the idea of smart contracts did not see the light till the emergence of blockchain technology. Smart contracts can be defined as the computer protocols that digitally facilitate, verify, and enforce the contracts made between two or more parties on blockchain. It is worth noting that Bitcoin is widely recognized as the first cryptocurrency that support basic smart contracts. Ethereum is the first public blockchain platform that supports advanced and customized smart contracts with the help of Turing-complete virtual machine called Ethereum virtual machine (EVM). A smart contract is a computer program consists of a set of rules run on the blockchain With the rise of blockchain technology in the last decade which shows it has many application areas. The integration of blockchain technology and smart contract give lots of flexibility to develop and design as well as implement some of the real world problems in less cost and time without involves of traditional third party based system.

Blockchain-enabled smart contracts are computer programs that are consistently executed by a network of mutually distrusting nodes, without the arbitration of a trusted authority [4]. Smart contracts provide organizations the possibility to collaborate and execute self-enforcing contract clauses in a blockchain network without the involvement of a third-party. While smart contracts provide new options for organizations and several studies have been carried out on how smart contracts can be applied to solve several issues affecting modern organizations, little is known about the adoption of smart contracts in organizations.

2. Literature Survey

2.1 Paper[1]

- Bhabendu Kumar Mohanta,Soumyashree S Panda and Debasish Jena"An Overview of Smart Contract and Use cases in Blockchain Technology"2019 IEEE International conference paper

This paper explains,a smart contract as "a set of promises, specified in digital form, including protocols within which the parties perform on these promises. , the idea of smart contracts did not see the light till the emergence of blockchain technology, in which the public and append-only distributed ledger technology (DLT) and the consensus mechanism make it possible to implement smart contract in its true sense. As smart contracts are typically deployed on and secured by blockchain, they have some unique characteristics. First, the program code of a smart contract will be recorded and verified on blockchain, thus making the contract tamper-resistant. Second, the execution of a smart contract is enforced among anonymous, trustless individual nodes without centralized control, and coordination of third-party authorities. Third, a smart contract, like an intelligent agent, might have its own cryptocurrencies or other digital assets, and transfer them when predefined conditions are triggered

2.1 Paper [2]

- Bhabendu Kumar Mohanta,Soumyashree S Panda and Debasish Jena"An Overview of Smart Contract and Use cases in Blockchain Technology"2019 IEEE International conference paper.

This paper explains the various components and working principle of smart contract. A smart contract is pieces of a program executed in blockchain system that uses consensus protocol to run a sequence of events. The importance of smart contract is it gives peer to peer transaction and database can be maintained publicly in a secure way in a trustful environment. A smart contract is a set of programs which are self-verifying ,self-executing and tamper resistant. Smart contract with the integration of blockchain technology capable of doing a task in real time with low cost and provide a greater degree of security

2.2 Paper [3]

- Chibuzor Udokwu, Aleksandr Kormiltsyn, Kondwani Thangalimodzi, Alex Norta "The State Of The Art For Blockchain Enabled -Smart contract Applications In The Organization"2019 IEEE Conference Paper.

This paper, identify properties of smart-contract applications in different domains of modern organizations. The blockchain is a distributed ledger that allows participants to write and update records on the ledger. The top application areas of smart contracts - finance, healthcare etc. Smart contract projects are developed using Ethereum and Hyperledger fabric blockchains. Hyperledger fabric is part of the blockchain tools developed in the open source Hyperledger project. IBM is a leading contributor to the Hyperledger fabric project, and also a leading service provider for organizations adopting blockchain projects This study provides a systematic review of previous studies comprising of frameworks, methods, working prototypes and simulations that demonstrate the application of smart contracts in organizations. Understanding the current state and usage of smart-contract technology in an organization is a focal point of this paper.

2.3 Paper [4]

- Yuechen Tao,Cong Wang "On Sharding Open Blockchains With Smart Contracts"2020 IEEE 36th International Conference On Data Engineering(ICDE)

This paper proposes and analyzes a new distributed and dynamic sharding system to substantially improve the throughput of blockchain systems based on smart contracts. This introduces how to divide transactions and miners into different shards in a distributed fashion, and then introduce how users and miners work in our sharding system. When a miner receives a transaction, that first figures out whether the sender of that transaction is only involved in the current shard This reduce the communication cost and improve security. This paper, involves completely distributed sharding system that not only eliminates crossshard communication, but also eliminates the need for new consensus protocols during the transaction validation process.

2.4 Paper [5]

- Amjad Aldweesh , Aad van Moorsel "Blockchain-based Smart Contracts: A Systematic Mapping Study of Academic Research" 2019 IEEE International Conference On Cloud Computing, Bigdata And Blockchain(ICCBB)

The aim of this paper is to identify and to classify all research that has been conducted on smart contract technology. Smart contracts can be developed and deployed in different blockchain platforms e.g. Ethereum and hyperledger fabric. The heart of Ethereum is the Ethereum virtual machine, which executes smart contracts. The source code of a smart contract is compiled into a bytecode form which can be interpreted by the Ethereum virtual machine. Hyperledger fabric consists of the code that is deployed and executed on the blockchain, the state database (key/value store) .

3. Theoretical Background And Methodology

3.1.1 Blockchain

Blockchain is a continuously growing list of records, called blocks, which are linked and secured using cryptography. Blockchain adopts the P2P protocol that can tolerate single point of failure. By design, blockchain has such characteristics as decentralization, integrity, and auditability. In addition, based on different levels of access permission, blockchains can be divided into two types:

1. Public Blockchain 2. Private Blockchain

Public Blockchain : A public blockchain is readable and writeable for everyone in the world. This type is popular for cryptocurrencies.

Private Blockchain : A private blockchain sets restrictions on who can read or interact with the blockchain. Private blockchains are also known as being permissioned, where access can be granted to specific nodes that may interact with the blockchain

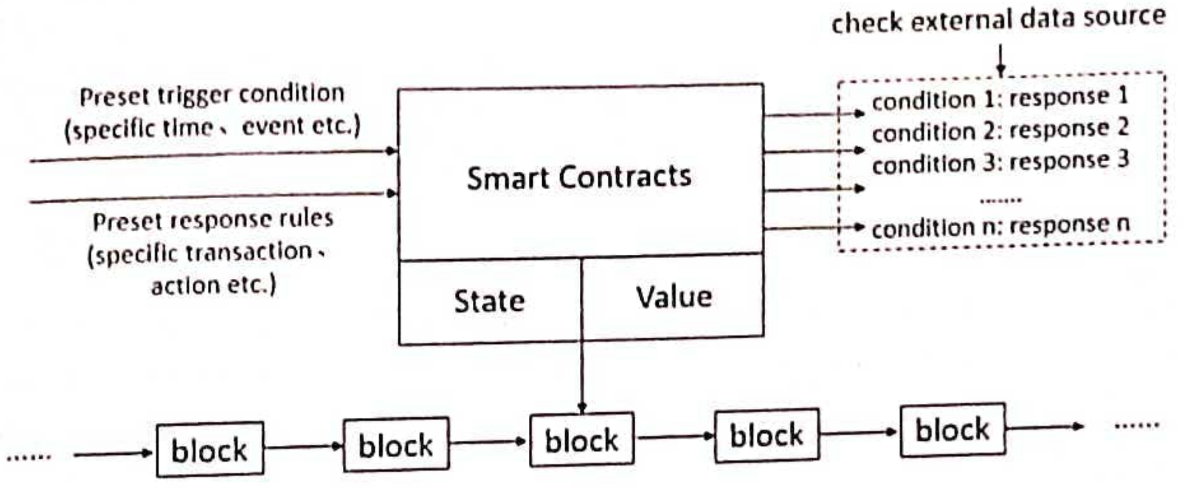

figure 1 Overview Of Smart Contract

3.1.2 Ethereum

Ethereum is currently the most widely used smart contracts development platform that can be viewed as a transaction-based state machine. Ethereum introduces the concept of accounts. There are two types of accounts: 1) externally owned accounts (EOAs) 2) contract accounts Users can only initiate a transaction through an EOA. The transaction can include binary data (payload) and Ether.

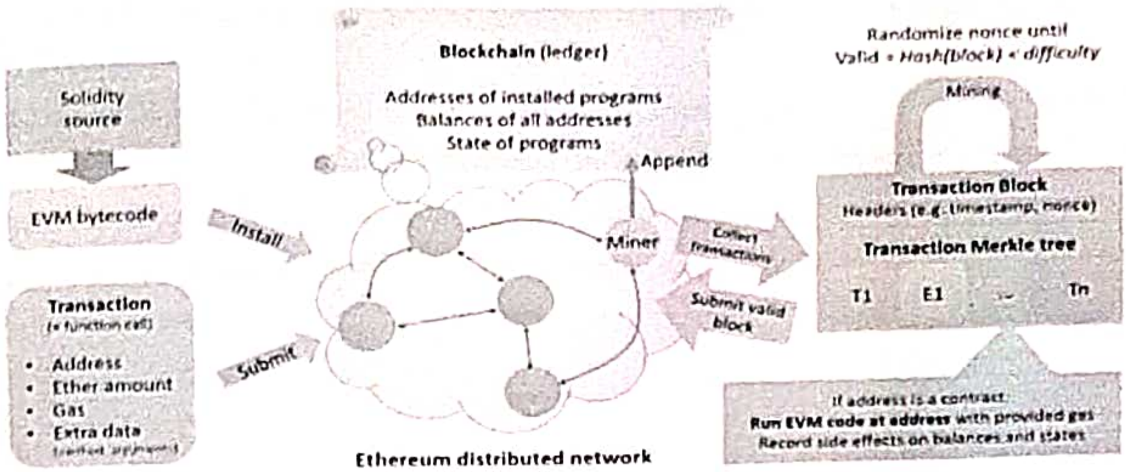

figure 2 Workflow In Ethereum Network

3.1.3 Hyperledger fabric

Hyperledger Fabric is a blockchain framework implementation and one of the Hyperledger projects was hosted by The Linux Foundation. The transaction workflow of Hyperledger Fabric consists of three phases as follows:

1. Proposal 2. Packaging 3. Validation

Proposal : The proposal is a request to invoke a chaincode function so that data can be read and/or written to the ledger. The transaction results include a response value, read set, and write set. The transaction results include a response value, read set, and write set.

Packaging : The application verifies the endorsers signatures and checks if the proposal responses are the same. Then, the application submits the transaction to ordering service to update the ledger. The orderer sorts the transactions it received from the network, and packages batches of transactions into a block that ready for distribution back to all peers connected to it.

Validation : The peers connected to the orderer validate every transaction within the block to ensure that it has been consistently endorsed by required organizations according to the endorsement policy. It is worth noting that this phase does not require the running of chaincode—this is only done in proposal phase. After validation, each peer appends the block to the chain, and the ledger is updated.

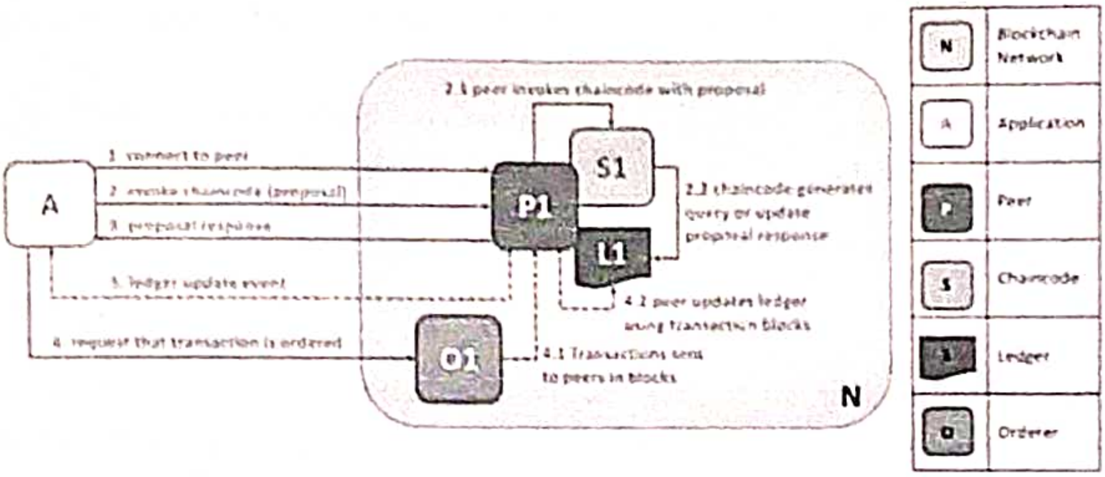

figure 3 Transaction Workflow Of Hyperledger Fabric

3.2 Applications Scenarios Of Smart Contract

1. Finance

Blockchain and smart contracts enable increased visibility and trust across the participants while bring huge savings in infrastructures, transactions, and administrative costs. There are several typical applications of smart contracts in finance.

a. Securities
b. Insurances
c. Trade Finance

2. Management

Blockchain-enabled smart contracts can provide appropriate and transparent accountability in terms of roles, responsibilities, and decision processes in management. Some use cases follow.

a. Digital properties and rights management
b. Organizational management
c. E-Government

3. Energy

Blockchain technology can be used to build distributed energy system and deploy energy supply and trading smart contracts. Energy is a consortium blockchain platform that creates localized energy marketplaces for transacting energy across existing grid infrastructures. The Sun Exchange is a blockchain enabled marketplace that enables its members to purchase and then lease solar cells.

4. Results And Discussions

With the increasing popularization and deepened applications of blockchain technology, emerging smart contracts have become a hot research topic in both academic and industrial communities. The decentralization, enforceability, and verifiability characteristics of smart contracts enable contract terms to be executed between untrusted parties without the involvement of a trusted authority or a central server. Block chain enabled Smart contracts are expected to revolutionize many traditional industries, such as financial, management, IoT, Energy sector etc. smart contracts tools that can aid during the process of developing smart contracts, identify security issues, or provide confidentiality for smart contract information.

5. Summary

The proposed methodology present a comprehensive overview of smart contracts, including the operational mechanism, mainstream platforms, and application scenarios. Blockchains provides secure, tamper-proof, distributed architecture platform for peer to peer transaction in a trustful environment. The integration of blockchain and smart contract can be more powerful. Blockchains provides secure, tamper-proof, distributed architecture platform for peer to peer transaction in a trustful environment. Smart contracts provide automatic, deterministic program unit to process various modules in a certain way and trigger the corresponding events. Different application areas are considered as the use case of smart contract. smart contracts tools that can aid during the process of developing smart contracts, identify security issues, or provide confidentiality for smart contract information.

References

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Blockchain-Enabled Smart Contracts: Architecture, Applications, and Future Trends

Shuai Wang, Liwei Ouyang, Yong Yuan, *Senior Member, IEEE*, Xiaochun Ni, Xuan Han, and Fei-Yue Wang, *Fellow, IEEE*

***Abstract*—In recent years, the rapid development of cryptocurrencies and their underlying blockchain technology has revived Szabo's original idea of smart contracts, i.e., computer protocols that are designed to automatically facilitate, verify, and enforce the negotiation and implementation of digital contracts without central authorities. Smart contracts can find a wide spectrum of potential application scenarios in the digital economy and intelligent industries, including financial services, management, healthcare, and Internet of Things, among others, and also have been integrated into the mainstream blockchain-based development platforms, such as Ethereum and Hyperledger. However, smart contracts are still far from mature, and major technical challenges such as security and privacy issues are still awaiting further research efforts. For instance, the most notorious case might be "The DAO Attack" in June 2016, which led to more than $50 million Ether transferred into an adversary's account. In this paper, we strive to present a systematic and comprehensive overview of blockchain-enabled smart contracts, aiming at stimulating further research toward this emerging research area. We first introduced the operating mechanism and mainstream platforms of blockchain-enabled smart contracts, and proposed a research framework for smart contracts based on a novel six-layer architecture. Second, both the technical and legal challenges, as well as the recent research progresses, are listed. Third, we presented several typical application scenarios. Toward the end, we discussed the future development trends of smart contracts. This paper is aimed at providing helpful guidance and reference for future research efforts.**

***Index Terms*—Blockchain, parallel blockchain, six-layer architecture, smart contracts.**

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S. Wang and L. Ouyang are with the State Key Laboratory for Management and Control of Complex Systems, Institute of Automation, Chinese Academy of Sciences, Beijing 100190, China, and also with the University of Chinese Academy of Sciences, Beijing 100049, China (e-mail: wangshuai2015@ia.ac.cn; ouyangliwei2018@ia.ac.cn).

Y. Yuan, X. Ni, and X. Han are with the State Key Laboratory for Management and Control of Complex Systems, Institute of Automation, Chinese Academy of Sciences, Beijing 100190, China, and also with the Parallel Blockchain Technology Innovation Center, Qingdao Academy of Intelligent Industries, Qingdao 266109, China (e-mail: yong.yuan@ia.ac.cn; xiaochun.ni@ia.ac.cn; xuan.han@ia.ac.cn).

F.-Y. Wang is with the State Key Laboratory for Management and Control of Complex Systems, Institute of Automation, Chinese Academy of Sciences, Beijing 100190, China, also with the Parallel Blockchain Technology Innovation Center, Qingdao Academy of Intelligent Industries, Qingdao 266109, China, and also with the Research Center of Military Computational Experiments and Parallel Systems, National University of Defense Technology, Changsha 410073, China (e-mail: feiyue.wang@ia.ac.cn).

Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

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I. Introduction

THE TERM "smart contract" was first coined in mid-1990s by computer scientist and cryptographer Szabo, who defined a smart contract as "a set of promises, specified in digital form, including protocols within which the parties perform on these promises [1]." In his famous example, Szabo analogized smart contracts to vending machines: machines take in coins, and via a simple mechanism (e.g., finite automata), dispense change and product according to the displayed price. Smart contracts go beyond the vending machine by proposing to embed contracts in all sorts of properties by digital means [2]. Szabo also expected that through clear logic, verification and enforcement of cryptographic protocols, smart contracts could be far more functional than their inanimate paper-based ancestors. However, the idea of smart contracts did not see the light till the emergence of blockchain technology, in which the public and append-only distributed ledger technology (DLT) and the consensus mechanism make it possible to implement smart contract in its true sense.

Generally speaking, smart contracts can be defined as the computer protocols that digitally facilitate, verify, and enforce the contracts made between two or more parties on blockchain. As smart contracts are typically deployed on and secured by blockchain, they have some unique characteristics. First, the program code of a smart contract will be recorded and verified on blockchain, thus making the contract tamper-resistant. Second, the execution of a smart contract is enforced among anonymous, trustless individual nodes without centralized control, and coordination of third-party authorities. Third, a smart contract, like an intelligent agent, might have its own cryptocurrencies or other digital assets, and transfer them when predefined conditions are triggered [3].

It is worth noting that Bitcoin[1] is widely recognized as the first cryptocurrency that support basic smart contracts, in the sense that its transactions will be validated only if certain conditions are satisfied. However, designing smart contract with complex logic is not possible due to the limitations of Bitcoin scripting language that only features some basic arithmetic, logical, and crypto operations.

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