

## TABLE OF CONTENT

APPROVAL PAGE .....	ii
DECLARATION .....	iii
PREFACE .....	iv
TABLE OF CONTENTS .....	vi
LIST OF FIGURES.....	viii
LIST OF TABLES.....	x
LIST OF EQUATIONS.....	xi
ABSTARCT .....	xii
INTISARI .....	xiii
CHAPTER I INTRODUCTION .....	1
1.1. Background .....	1
1.2. Problem Statement .....	3
1.3. Scope of Problems .....	3
1.4. Research Objectives .....	4
1.5. Research Benefits .....	4
CHAPTER II LITERATURE REVIEW .....	5
CHAPTER III THEORETICAL BASIS .....	13
3.1. LORA Telemetry .....	13
3.2. Communication Parameters .....	14
3.3. ESP-WROOM-32.....	16
3.4. Signal Distribution of an Antenna .....	17
3.5. Smith Chart.....	19
3.6. Power Module and its influence on RF Communication .....	21
CHAPTER IV RESEARCH METHODOLOGY .....	23
4.1. Work Procedures and Data Collection.....	23
4.2. Tools and Material .....	23
4.3. System Design .....	25
4.3.1 System Architectural Design .....	25
4.3.2 Hardware Design .....	28
4.3.3 Antenna Design.....	32
4.3.4 Firmware design .....	32
4.3.5 Data Handling and Communication .....	35

4.3.6 Data Visualization Design.....	40
4.4. System Test.....	41
CHAPTER V IMPLEMENTATION.....	43
5.1. System Setup and Assembly.....	43
5.1.1 Hardware Integration .....	43
5.1.2 Firmware Deployment .....	44
5.2. LORA Configuration .....	50
5.3. Data Handling.....	51
5.3.1 Data Collection .....	51
5.3.2 Data Formatting and Data Storage.....	52
5.3.3 Data Transmission.....	52
5.3.4 Visualization .....	53
5.4. Antenna Parameter .....	54
5.5. Testing Implementation .....	54
5.5.1 Testing Scenarios .....	54
5.5.2 Metrics Measurement .....	57
CHAPTER VI RESULT AND DISCUSSION.....	59
6.1. Antenna Parameter .....	59
6.1.1 Rubber Duck 3 dBi .....	59
6.1.2 Rubber Duck 5 dBi .....	60
6.1.3 Rubber Duck 8 dBi .....	61
6.2. Data Collected .....	63
6.2.2 Line of Sight and Path Loss Comparison: GSP UGM vs. Calder Park .....	67
6.3. Performance Trends: Distance vs. Success Rate .....	69
6.4. Performance Trends: Distance vs. Corrupted Packets.....	71
6.5. Performance Trends: Distance vs. Transmission Time .....	73
CHAPTER VII CONCLUSION .....	77
7.1. Conclusion.....	77
7.2. Final Remarks.....	77
BIBLIOGRAPHY .....	79