

## TABLE OF CONTENTS

	<b>PAGE</b>
<b>Lembar Pengesahan .....</b>	<b>i</b>
<b>Halaman Pernyataan Orisinalitas.....</b>	<b>ii</b>
<b>Abstrak .....</b>	<b>iii</b>
<b>Abstract .....</b>	<b>iv</b>
<b>Preface .....</b>	<b>v</b>
<b>Acknowledgements .....</b>	<b>vi</b>
<b>Table of Contents.....</b>	<b>vii</b>
<b>List of Figures .....</b>	<b>xi</b>
<b>List of Tables.....</b>	<b>xiii</b>
<b>List of Abbreviations .....</b>	<b>xiv</b>
<b>List of Terminologies.....</b>	<b>xv</b>

### CHAPTER I INTRODUCTION

1.1	Background.....	1
1.2	Problem Statement.....	2
1.3	Purpose .....	2
1.4	Scope of Problems .....	2
1.5	Research Methodology .....	3
1.6	Writing Systematics.....	4

### CHAPTER II THEORY

2.1	Wireless Sensor Network .....	5
	2.1.1 General Concepts.....	5
	2.1.2 Architcture and Key Components of WSN .....	6
	2.1.3 WSN Topology Network.....	7
	2.1.4 Examples of WSN Applications.....	8

2.2	IEEE 802.15.4 Protocol .....	9
	2.2.1 IEEE 802.15.4 Protocol Standard .....	9
	2.2.2 IEEE 802.15.4 Network Layer .....	11
	2.2.2.1. Physical Layer .....	11
	2.2.2.2. Medium Access Control Layer .....	12
	2.2.2.3. Security .....	12
2.3	RF XBee Modules .....	12
	2.3.1 General Concepts .....	12
	2.3.2 RF XB24-AWI-001 Specification .....	14
	2.3.3. XCTU .....	15
2.4	RSSI .....	16
2.5	Sensors .....	18
	2.5.1 General Concepts .....	18
	2.5.2 Bipolar NPN Phototransistor .....	18
	2.5.3 Infrared LED .....	19
2.6	Microcontroller .....	21
	2.6.1 General Concepts .....	21
	2.6.2 Arduino Microcontroller .....	23
	2.6.3 Arduino IDE .....	24
2.7	Lithium Polymer Battery .....	25
2.8	Turbidity .....	26
	2.8.1 Water .....	26
	2.8.2 Turbidity Phenomena on Liquid Substances .....	26
	2.8.3 Optical Phenomena of Light Scattering by Particles On Liquid Substances .....	29
	2.8.3.1. Electromagnetic Waves .....	30
	2.8.3.2. Rayleigh and Mie Scattering .....	31
	2.8.4 Turbidimeter Work Mechanism .....	32
2.9	Technique of Turbidity Measurement .....	33

2.9.1 Measurement .....	33
2.9.2 Standard Method of Turbidity Measurement .....	34
2.9.2.1. USEPA 180.1 Standard Method .....	34
2.9.2.2. ISO 7027 Standard Method .....	35
2.9.3 Standard Liquid for Measuring Turbidity .....	35
<b>CHAPTER III SYSTEM DESIGN AND IMPLEMENTATION</b>	
3.1 WSN System Design .....	37
3.1.1 Technical Specifications .....	37
3.1.2 System Model .....	43
3.1.3 RF Modules Configuration .....	44
3.1.4 End Node Sensor Module Design .....	45
3.1.5. Microcontroller Minimum System Design .....	46
3.2 Making of Standard Liquid for Turbidity Measurement ...	46
3.3 Making of Processing and GUI Monitoring Program .....	48
<b>CHAPTER IV EXPERIMENT RESULTS AND ANALYSIS</b>	
4.1 Experiment Scenarios .....	55
4.2 Result and Analysis of Turbidity Measurement .....	55
4.3 Result and Analysis of RF Module Performance .....	58
<b>CHAPTER V SUMMARIES AND FURTHER RECOMMENDATIONS</b>	
5.1 Summaries .....	62
5.2 Recommendations .....	63
REFERENCES .....	xvi

## **APPENDIX**

### Appendix A

Documentation of Experiments Data Results.....A-1

### Appendix B

Result of Liquid Turbidity Measurement By Bandung Institute of  
Technology Water Testing Lab .....A-3

### Appendix C

Arduino End Node, Coordinator and Monitoring Program's Source  
Code.....A-4

### Appendix D

Datasheets Documentation .....A-15