

## LIST OF FIGURES

Figure II. 1 Basic Elements of Automation System (Groover, 2001).....	9
Figure II. 2 Close Loop System (Groover, 2001) .....	10
Figure II. 3 Open Loop System (Groover, 2001).....	10
Figure II. 4 Automation System Components (Groover, 2001).....	11
Figure II. 5 PLC Component (Groover, 2001).....	13
Figure II. 6 (a) PLC <i>Compact</i> and (b) PLC <i>Modular</i> Siemens S7-1200 .....	15
Figure II. 7 Architecture of SCADA System (Wicaksono, 2012) .....	17
Figure II. 8 Flow to Determine Water Treatment Plant.....	21
Figure III. 1 Conceptual Model.....	26
Figure III. 2 Problem Solving Systematics .....	28
Figure IV. 1 Process Flow of Existing Water Treatment and Distribution.....	36
Figure IV. 2 P&ID of A-E Buildings .....	37
Figure IV. 3 P&ID of F and 1-12 Buildings .....	39
Figure IV. 4 Design of Water Treatment Plant .....	49
Figure IV. 5 Design of Filtration Plant (a) Side View and (b) Top View.....	56
Figure IV. 6 Master Plan of Water Distribution .....	58
Figure IV. 7 Flowchart of Proposed Water Treatment Scenario .....	59
Figure IV. 8 Flowchart of Water Sucking Scenario.....	60
Figure IV. 9 Flowchart of Pumps Switch Scenario.....	61
Figure IV. 10 Flowchart of Proposed Water Treatment System.....	63
Figure IV. 11 Flowchart of Proposed Distribution .....	64
Figure IV. 12 Flowchart of Alarm System.....	65
Figure IV. 13 Structure of Human Machine Interface .....	69
Figure IV. 14 Display of Login Window .....	70
Figure IV. 15 Display of Water Treatment Window .....	70
Figure IV. 16 Display of Distribution Window 1 and Distribution Window 2 ....	71
Figure IV. 17 Display of Database Window .....	71
Figure IV. 18 Display of Setting Window .....	72
Figure IV. 19 Add PortCpS7 Object.....	73
Figure IV. 20 Determine the Port.....	73
Figure IV. 21 Determine Address. ....	74

Figure IV. 22 Device Group Determination .....	74
Figure IV. 23 Creating a Connection to SQL .....	75
Figure IV. 24 Creating a database.....	75
Figure IV. 25 Creating a table.....	76
Figure IV. 26 Determine the contents of the table.....	76
Figure V. 1 Program of System to Start.....	82
Figure V. 2 Program of Auto/Manual System .....	83
Figure V. 3 Program of Emergency Button .....	83
Figure V. 4 Scenario to Manage the Pump .....	84
Figure V. 5 Program to Add PAC.....	84
Figure V. 6 Program of PAC Tub .....	84
Figure V. 7 Program of Coagulation.....	85
Figure V. 8 Program of Flocculation Tube 1 .....	85
Figure V. 9 Program of Mud Removal 1 .....	86
Figure V. 10 Program of Backwash Process.....	86
Figure V. 11 Program for Disinfection .....	87
Figure V. 12 Program to Start the Distribution System.....	88
Figure V. 13 Program of Water Distribution .....	88
Figure V. 14 Program for Error Alarm .....	89
Figure V. 15 Login window of HMI.....	90
Figure V. 16 Water Treatment Window of HMI .....	91
Figure V. 17 Distribution 1 Window of HMI .....	91
Figure V. 18 Distribution 2 Window of HMI .....	92
Figure V. 19 Database Window of HMI.....	92
Figure V. 20 Setting Window of HMI .....	93