AUTOMATIC CONTROLLING AND MONITORING DRAINAGE SYSTEM USING CX-PROGRAMMER AND TOUCHWIN XINJE DESIGNER

Ahmad Syazani bin Muda

Faculty of Electrical Engineering

University Technology MARA Malaysia

40450 Shah Alam,Selangor,Malaysia

Email: syazani.richm5@gmail.com

ABSTRACT This paper present the Intelligent Automatic Drainage Monitoring and Control system which relies on Programmable Logic Controller (PLC). This system is proposed to overcome real time problem. The concept is to replace the manual work of drainage gate system by automated system. With the continued expansion of industries and global warming that caused unexpected rainstorm or flash flood, the increasing problem of drainage system must be urgently resolve. PLC is the major controlling unit and the drainage level is monitored by the sensor used. For the Intelligent Automatic Drainage System, level sensor are used to monitor the drainage water level an dc motor (24V) as the actuator for the gate system. The software that is used in this project is OMRON CX-Designer and OMRON CX-Programmer. These software are need to be integrated and linked with each other to develop sophisticated and user friendly system. Ladder diagram program used as the language to control the whole system.

I. INTRODUCTION

Drainage is defined as the infrastructure for drying the land from the excess and unutilized water, rainwater and waste water. The type of drainage channel can be natural or constructed channel. In an urban area, drainage channel built to control the movement of the water or surface of water due to rain, waste water, so it does not disturb the activities of certain place at certain country also the country's facilities and property in community[1].

Efficient drainage system should be monitored in order to maintain it proper function. In fact, not all area in the country have drainage monitoring team especially in rural area. Its lead to irregular monitoring of the drainage system and malfunction system. The irregular and malfunction of drainage system has contributed to clogging of the drainage that imply to the situation which trigger flooding or flash flood in the neighbourhood. Manual monitoring requires high number of man power with high quality of skill which is lead to inefficient system[8]. These weaknesses lead to the slow handling for drainage system.

Intelligent Automatic Drainage system is a modern technology of system that consisted of level sensor to detect the flowing water. This sensor detects the level of water accordingly the water gate will turn on or open up when the level sensor detect the water at the fix level. Each node of drainage system involves one or more sensor and actuator.

In urban area, drainage system has an important rule in the prevention of flood danger. Many research have be done on the drainage system. This paper will discuss on the design of automatic monitor and controlling drainage system to monitor and control conditions at some point in drainage by level sensors.

i. PROBLEM STATEMENT

Passing through this 21st century, technologies become wider each day. From a very simplest thing to a complex thing people are able to invent their ideas to improve our technology. Technology can ease human work load and at the same time can be a life saver. Automatic drainage system is one of the technology that had been widely used and need to be improved time by time.

The implementation of automatic control and monitoring system in the drainage system operation provides accuracy, time saving, man power saving and also can contributes to life

saving. Monitoring system is essential to automatic system to ensure the automation of drainage system provides such benefits. The monitoring and control system in this project provides identification of early warning of failure system or technical problem on the drainage system which can affect the whole system. To design a automatic monitoring and control is the main purpose of this project. By using CX- Programmer and the ladder diagram as the language to control the system which is can be programmed in the CX- Programmer.

ii. OBJECTIVE

The aim of this project is to design an intelligent automatic drainage system that can improve the water flow in any place in the country.

The main objectives of this study is to

1. To design an automatic drainage system control by using OMRON CX-Programmer
2. To stimulate the monitoring of intelligent automatic monitoring and control drainage system in Touchwin Xinje Designer
3. To integrate the ladder diagram with HMI Touch Screen

iii. SCOPE OF PROJECT

Two main focus of this project is to control and monitor of the drainage system. For the control part, it can be either automatically and manually control. Where the automatically control is based on the sensor use , when the sensor detect the water level in the drainage the gate system will automatically widely open to make sure the water flow efficiently. As the manually control, authorities can manually open the gate system when water level reach the emergency or danger level.

As the monitoring part, it will monitoring the water level, the flow of the water in the drainage system and also to provide identification of failure system in the drainage system. The monitoring system is based on the system that will be design using Touchwin Xinje Designer.

II. LITERATURE REVIEW

In past year of reliable automatic drainage system in this country, operator would like to be able to operate the automatic drainage system automatically via telephone or internet or any other source. The operator should receives the signal by the same communication method that the drainage system open successfully, or a warning signal of a failure open due to a jammed gate, or something else that requires their attention[3]. A power backup system or manual operation of the gates is required is case of power failure.

There are mainly example of method which had been use if drainage system:

1. Conventional drainage system using manual gate
2. Automatic drainage system based on rain sensor
3. Control and cleaning drainage system based on water level sensor
4. Smart drainage system using IOT
5. Automatic drainage cleaner and monitoring (raspberry pai)
6. Drainage Automation system (DAS) using android for mobile Phone

Automatic system of the drainage connected to electronics devices in order to control and monitoring the drainage system. The components of the automatic system include:

1. Sensor as the feedback element that will sensing the input of parameters
2. Transmitter for transmitting the raw signal in electrical form.
3. Control system which include PLC, ARDUINO and DCS&PID controller
4. Output devices such as actuators ,drives , control valve and indication lamp

III. METHODOLOGY

The experimental approach towards accomplishing this project will be explained in a sequential and logical order in this section. The next section of this chapter will be discussion on the flow chart and its element. Figure 1 shows the flowchart for the whole project designed. It focused on the implementation and simulation of the monitoring system includes the development of PLC ladder diagram programming using CX-Programmer and the HMI design using Touchwin xinje Designer.

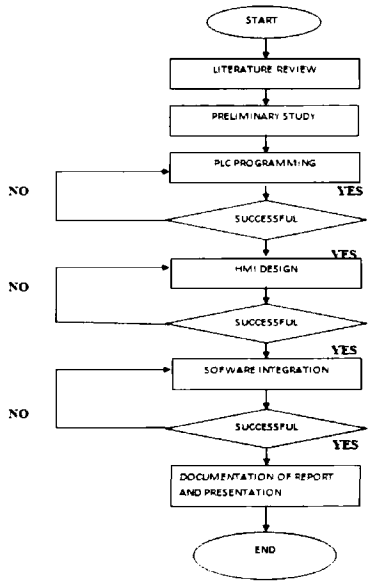

Figure 1: Flow chart of the project

A. Literature Review

The first step to begin this final year project is to conduct a literature review. The PLC ladder diagram programming based on the previous project that is utterly alike are referred for references . the PLC program and programming that focuses on automatic drainage system have been studied and the positive and negative point from the previous project had been measured. The information obtain will be used in order to make improvement to the next project. The previous research are based on the journal, research , book or manual. Apart from that, information that obtain from the internet also can be used.

B. Preliminary Study

Preliminary study are focuses on the understanding of the PLC ladder diagram programming using CX-Programmer and on the HMI design using Touchwin Xinje Designer. Several knowledge discoveries have been made such as the behaviour of the timer and counter function in OMRON software and the effectiveness latching techniques. The ladder diagram programming will be based on the real operation of an automatic drainage system. Preliminary study also includes the familiarization to the OMRON CX-Programmer and Touchwin Xinje Designer.

i. CX-Programmer

CX-Programmer is a type of programming software that is suited for every one of Omron's PLC series. This software is completely integrated inside the CX-One software suite. CX-Programmer also contains a broad variety of features that can speed up the users' PLC program development. CX-Programmer used for creating, testing and maintenance of the program (ladder logic diagram)[6]. Its facilitates for the support of PLC device and address information to communicate with OMRON PLCs or their supported network types. CX-Programmer runs in a Microsoft windows operating system. It features are easily achieve position control, easy connection, multiples of inputs and output can be used and high program readability

ii. Touchwin Xinje Designer

Touchwin Xinje Designer is a data visualization tool for OMRON PLCs. The software is efficiency creates screen and aids in project debugging. It also capable of sharing tag information with CX-Programmer that need to be shorten the development time and provide valuable information in testing and troubleshooting. The software consisted of four main panels which are project workspace, property list, output windows and edit screen. Project workspace used to design and manage the project. The entire project structure can be examining thoroughly make it easier to troubleshoot the error. The project work space also, display screen, alarms and other common setting. Property list allows functional object setting to be managed without having to open the dialog box which is easier method to create and edit the object. Touchwin Xinje Designer can be used to simulate the project in the test mode without connecting them to PLC[5].

C. PLC Programming

OMRON CX-Programmer is used to create and compile the PLC ladder diagram for this project. The ladder diagram consist of 6 inputs, 17 rungs, 6 output, 3 timers 5 memories and 2 counter. The compilation of these functions enable the fully control for the automatic drainage system that had been designed.

D. HMI Design

The design of the complete simulation of the controlling and monitoring automatic drainage system which is also the HMI of the system is constructed by using OMRON Touchwin Xinje Designer. There are two main automatic gates for operation of water flow in the drainage and an automatic drainage cleaner with cleaner motor for the cleaning operation in the drainage. The layout of the HMI is designed to be user friendly and easy to be handled by the operator. Figure 2 shows the HMI design for controlling and monitoring the automatic drainage system for this project. The function of timer and counter had been added in the HMI design.

Function of the timer is to show the time

left for the gate to be closed after the sensor stop detecting the parameters and the function of the counter is to count the complete cycle (open and off) the main gate for the maintenance purpose. The flow of water level can be seen by the colour of led that act as the indicator of on and off. Green colour of led showed that the main gate is closed and the water level below the dangerous level. The red colour of led showed that the gate were opening and the motor for the gate is active. The change of led colour from green to red showed that the water level is surpassed the dangerous level. The gate will keep open as long as the sensor detect the water level sensor is above the dangerous level.

The timer will start to be actived if the sensor stop working or stop detecting the water level. The main gate will keep open for one hour after the sensor stop detecting for a better efficient system and the timer can be seen on the monitoring board. The right side of the screen is the main panel which consist the main component which control the whole program. It consists of START, STOP. TIMER, COUNTER, RESET and STOP button. Figure 2 shows the HMI design for the project

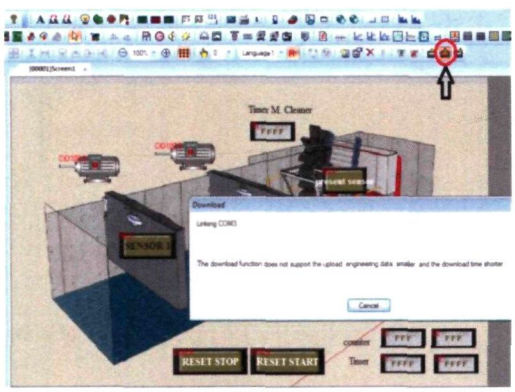

Figure 2: HMI Design for the controlling and monitoring automatic drainage system

E. Software Integration

OMRON CX-Programmer will have to be link to the OMRON Touchwin Xinje Designer to complete this step. The programming functions in the CX-Programmer are link to the objects in the Touchwin Xinje Designer through the certain addresses. The simulation of the control of the program can be done by selecting the test mode button in tools panel on the task bar of Touchwin Xinje Designer

F. *Documentation and Presentation*

Documentation is important in this study, the knowledge in this paper maybe used as the reference foe the next generation. It is requirement of this course to complete the technical paper and thesis report. A final presentation is compulsory for this project. This document needs to follow the specific format to comply the standard required for this course. This documentation also may be used for the future research and development.

IV. RESULT AND DISCUSSION

A. Simulation of the system

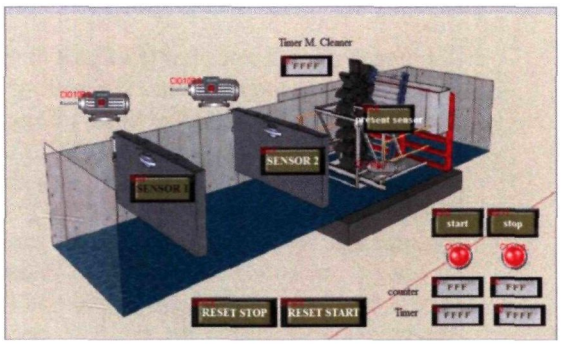

Figure 3: Full HMI simulation design

Figure 3 shows the complete HMI simulation design that had be designed in the OMRON Touchwin Xinje. Step for the simulation:

1. When system off, all the input and output are off
2. When the START button is pressed:
- Green light LED power indicator is turn on to show the gate is off
- Red light LED power indicator turn on to show the is on (emergency)
3. When the first water level sensor detect the parameter or the set point (water level)
- Motor gate 1 will turn on to open the gate 1
- LED 1 turn to red as indicator that the gate is active (emergency)
4. When first water level sensor stop detecting (low water level) :
- Timer 1 turn on for 1 hours
- LED turn to green as the gate closing and not active
- Counter 1 decrease from the set point after the timer stop (after one complete open and closed gate)
5. When the second water level sensor detect the parameters or the set point (water level) :
- motor gate 2 will turn on to open the gate
- LED 2 turns to red as the gate is opening and active (emergency).
6. When second water level sensor stop detecting (low water level) :
- Timer 2 turn on for 1 hours
- LED 2 turn to green as the gate closing and not active
- Counter 2 decrease from the set point after the timer stop (after one complete open and closed gate)

7. When the present sensor detect rubbish or waste material in drainage approaching :
- Cleaner motor will turn on and move the conveyor.
8. Present sensor stop detecting :
- Timer 3 will turn on for 30 minutes for cleaning process
- Motor cleaner stop after timer stop

B. PLC Ladder Diagram

The programming of the PLC ladder diagram of the system begins with the programming START and STOP button which is the main switch in the system. It is essential to both main switch for the simulation of the project. Figure 4 show the ladder diagram that had been written for the START and STOP button. The use of the memory also one of the important component in this ladder diagram. Memory used in the ladder diagram for the latching purpose in order to make the system continuously turn on with need to press it various time. Safety features used in this ladder diagram. As shown in the Figure 4, M1 will be off as the STOP button press and all the system will shut down as the M1 is connected to the normally open (NO) condition in all rung.

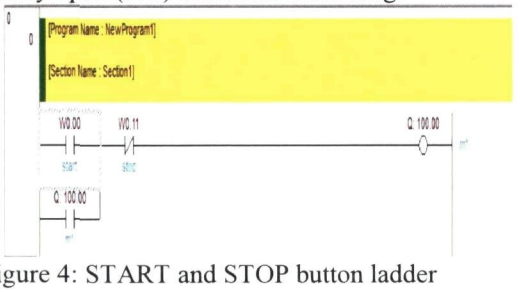

Figure 4: START and STOP button ladder diagram

The rung 1 and 2 represent the ladder diagram for the first indicator led that need to be declared in the CX-Programmer. The colour for the first LED is green. This indicator is used in order to alarm the user that the gate 1 is in the normal condition or in closed condition. Figure 5 show the ladder diagram for the rung 1. Figure 6 shows the ladder diagram for the next LED indicator for gate 1. The colour of the LED is red that which is shown when the gate is in the active condition or emergency condition. The gate in the active state will be raise up from the normal level to high level until the water can pass through based on the input parameter. The rung is connected to the normally open (NO) switch by M1 from the first run where the switch START and STOP button located.

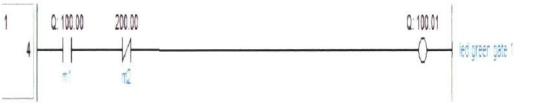

Figure 5: Green LED indicator for passive gate 1

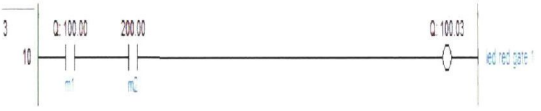

Figure 6: Red LED indicator for active gate 1

Rung 2 and 4 represent the ladder diagram for LED indicator for the second gate in the CX-Programmer that had been declared by the user. The colour for the first LED is green. This indicator is used in order to alarm the user that the gate 2 is in the normal condition or in closed condition. Figure 7 shows the ladder diagram for the passive gate 2. Figure 8 shows the ladder diagram for the next LED indicator for gate 2. The colour of the LED is red that which is shown when the gate is in the active condition or emergency condition. The gate in the active state will be raise up from the normal level to high level as long as the sensor detecting the water level is above the set point. The rung is connected to the normally open (NO) by M1 from the first run where the switch START and STOP button located.

Figure 7: Green LED indicator for passive gate 2

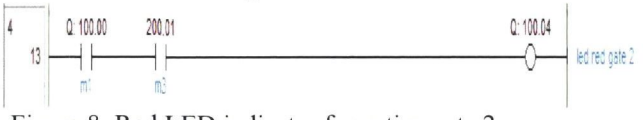

Figure 8: Red LED indicator for active gate 2

The used of the timer is really important to hold and execute the function in the PLC Programming. Utilization of the function of the timer to delay one output and for the ext output is necessary for the programming the gate of the drainage system. There are 3 timers used in this ladder diagram. The timers will be turn on after the sensor stop detecting the water level higher than the set point. As long as the senor detecting the parameter, the timer will be off. Figure 9, 10, 11 shows the ladder diagram for the each of the timer declaration in the CX-Programmer.

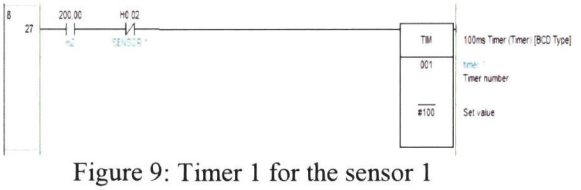

Figure 9: Timer 1 for the sensor 1

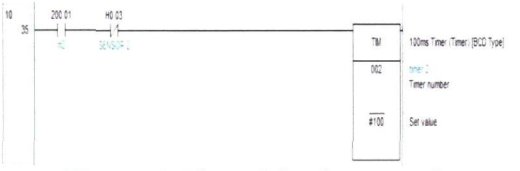

Figure 10: Timer 2 for the sensor 2

Figure 11: Timer 3 for the present sensor

In the ladder diagram, counter function is used to count up and count down until it reaches a limit. The type of counter that used in the ladder diagram is reversible counter or also known as UP-DOWN counter. The input is the sensor 1 for the gate 1 and sensor 2 for the gate 2. The counter will triggered after the timer stop running after the sensor stop detecting the water level. The counter will set to the 10 counter and will be decreased after one complete cycle open and off of the gate. When the timer stop running, the gate will be lower down to the original position and the cycle will be complete. After 10 complete cycles ON and OFF of the gate, the counter will turn to zero and ready for the maintenance, the counter is he reset by the STOP button to back to the original value 10. Figure 12 and 13 shows the ladder diagram for the counter 1 and counter 2.

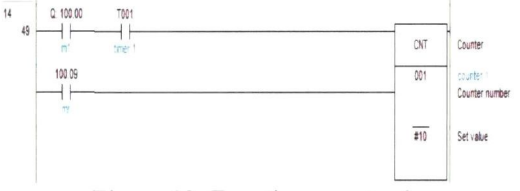

Figure 12: Function counter 1

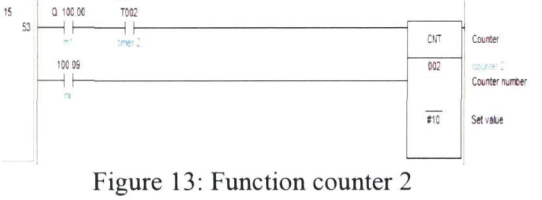

Figure 13: Function counter 2

CONCLUSION

System that is been developed or design by using OMRON CX-One positively give much more advantages in monitoring and controlling the automatic drainage system. The ladder diagram programmed for this project successfully created and constructed by using CX-Programmer which is the software provided easy interface, friendly language, multi-programmable PLC language and unlimited number of rung which make this software very suitable in developing this project. For the monitoring panel or the HMI for monitoring the automatic drainage system is successfully designed by using Touchwin Xinje Designer. Touchwin Xinje Designer provides many elements that are very useful to create monitoring panel that easy to interface with the CX-Programmer. With simple and friendly user component in the Touchwin Xinje Designer, the drainage operator or the skipper can easily master the control panel on the touch win panel which consist the gate diagram, water level sensor, timer and operation monitoring system. The HMI design simulate perfectly according to the ladder diagram that had been created by using the CX-Programmer. The ladder diagram is successfully integrated with all the objects used in the Touchwin Xinje Design. The monitoring of automatic system itself has advantages over the conventional control which is more sophisticated, time consuming, and require high number of power to operate the drainage system. The objectives for the whole project was successfully achieved.

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