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Automation of Watering Systems in Gardens Using Programmable Logic Controller (PLC)

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Abstract

The background of this research is based on automation, where automation is a technology used to carry out work processes or procedures without human assistance. In the current era of the industrial revolution 4.0, manual activities that use human labor are starting to decrease and are replaced by automated systems and tools in order to streamline and effectively operate a field of work. Programmable Logic Controller (PLC) can be defined as a microcomputer-based controller that uses programmed in-memory instructions to apply logic, sequencing, timing, counting and arithmetic functions via digital or analog input/output (I/O) modules, to control the machine and process. This PLC is commonly used in the industrial world as a tool for automation of production machines. Automation of the watering system in the garden aims to water the garden without using human labor. The research stage begins with literature study and field observation activities followed by the design of ladder diagrams on PLCs. The PLC ladder diagram simulation that was then implemented in the field has been carried out and the automation of this garden watering system can run well with a shorter watering time (15 min) and less water consumption (27.4 lt) and can operate without human intervention..

Keywords: Automation, Programmable Logic Controller, System Watering, Garden

1. INTRODUCTION

A park is a piece of land open with an area inside it planted with trees, shrubs, bushes, and grass that can be combined with creations from other materials [1]. The origin of the meaning of the word garden can be traced back to the Hebrew gan, which means to protect; indirectly stating the fenced land, and eden or eden, which means pleasure or joy [2]. So in English, the word "garden" has a combination of both words, which means a fenced plot of land used for pleasure. Gardens are grouped into three categories based on the nature of their ownership [3], namely:

1. Public parks (general), namely, a garden that can be used by the public.
2. a public park that is owned by personal and can be used by the public or can be used in a way together.
3. A private garden that is a park owned by a person who cannot publicly accessible.

In the general public, park personnel are in the environment, domiciled/residing in someone's area with limited so watering plants in the garden is done manually, remembering the area from the park.

Several matter need be noticed For guard plants, such as determination right time For do watering and how much Lots required water content plant For developing, but If Still done manually upgrade possibility the occurrence error, due to man No Can determine level drought soil and temperature air in a way objective, thing This can result bad If plant too dry or damp [4]. Tendency for water in a way sporadic often happens by citizens busy urban areas. Lack of available time to pay attention and care plant pushes the need for watering in an automatic way.

Automation is a technology used to carry out a process or procedure without human help [5]. PLC here acts as an automation device related to watering plants in the garden, where watering plants can be done automatically without human intervention [6][7]. Watering seed plants can be done in an automatic way with utilise development and progress technology computers that are already very forward, one of which is by utilizing PLC (*Programmable Logic Controller*). PLC is a system controller that can be programmed to control and regulate the watering process of seed plants that can be set up in accordance with water needs for each stage of seed growth until they become plant adults [8]. The watering system, which is still manual, can be made more effective and efficient in its operation by automatically using the PLC. The research aims to generate PLC programs along with their implementation in the system watering park so that it can automate watering plants without the involvement power man. The determining factor for the failure of a plant is that almost 80% is influenced by the technique or method of watering the wrong plant. This is caused by the technique of watering being done manually, so that not all plants get an even water intake, to avoid plants becoming withered. Other factors that cause failure growth plant to fail are humidity land [8].

A plant is a creature that needs water to develop its life. There are Lots of factors that can influence plant development, such as temperature, humidity, land, up to intensity of light. The need for sufficient water is also an important factor for plants in photosynthesis. If things the not fulfilled, then the plant can wither and die [8]. On the basis of said, it was made A device with a system that can nurse plants in an automatic way which can replace the role plant owner in nursing the plants. There are several factors that influence the speed and quality of growth. Factors that influence every plant in a different way [9]. The parameters in question are intensity of light, humidity of air, humidity of soil, and soil pH [10]. The water content in the soil is an important matter to pay attention to in the field of agriculture. This relates directly to the results of the harvest production plants. Humidity land is an agent that can carry and move nutrients as well as compounds on the ground for a fertile plant. Trend For water in a way, sporadic often happens by citizens busy urban areas. Lack of available time to pay attention and care plant pushes the need for watering in an automatic way. At the moment, watering seeds is still done by manpower man so that needs a long time and effort [11].

2. RESEARCH METHODS

Automation system watering the garden based on this PLC involves 2 main steps, as shown in the flow *diagram* in Figure 2.2. First step is a study process of literature and observation field, where in this process done studies regarding park layout and systems watering that have been done are and running. The second step is designing programs on PLC and the systems of the water park based on information obtained from the first step. PLC programming using *ladder diagram*. A *ladder diagram* that has been created in PLC is simulated using *PLC simulation software*. The simulation results have been correctly implemented on the system watering, and then done observation was conducted on the related performance system watering and program on the PLC. This is feedback for the repair *ladder diagram* and also related *hardware* with the automated watering park.

PLC is used in research. This is the Zelio Logic PLC - 12 IO - 24 V SR2B121BD as shown in Figure 2.1. below this. Where is this PLC that has 4 *inputs* and 4 *outputs* and works on a 24V voltage?



Figure 2.1. PLC Zelio Logic SR2B121BD



Figure 2.2. Flow Diagram Study

Garden layout looks as shown in Figure 2.3, where the park consists of 3 locations, that is, Park A (red), Park B (blue), and Park C (green). Watering has been done there, and running has been done manually with use hose from the water source at source 1. This manual watering uses a hose with a discharge of 6.67 liters/minute, requiring time watering for 30 minutes, so that uses 200 liters of water.

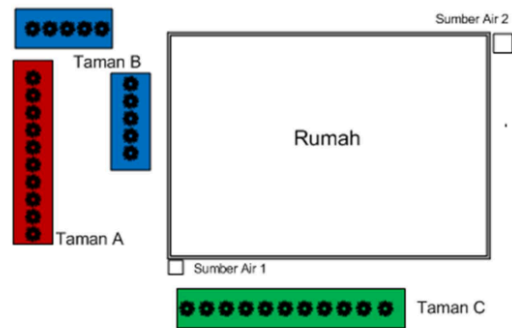


Figure 2.3. Garden layout

3. RESULTS AND DISCUSSION

3.1. PLC ladder diagram program creation and simulation

PLC programming begins with making a *ladder diagram* and doing program ¹simulation on *Zelio Soft 2 software*, using software *Zelio PLC default software*.

Ladder diagram clock consists of H1 for the main valve solenoid (Q1 output); H2, H3, and H4 for the park solenoid A (Q2 output); H5 and H6 for park B solenoid (Q3 output); H7 and H8 for park C solenoid (Q4 output). In the watering clock settings on this PLC, set up one watering in the afternoon starting at 16.48 – 17.11 WIB. The ON / OFF *sequence of the solenoid* is as shown in Table 3.1 below. This

Table 3.1 *Solenoid On-Off Sequence*

Clock		Main Valve	Solenoid Taman A			Solenoid Taman B			Solenoid Taman C	
		Q1	Q2			Q3			Q4	
jam	mnt	H1	H2	H3	H4	H5	H6	H7	H8	
16	48									
16	49									
16	50									
16	51									
16	52									
16	53									
16	54									
16	55									
16	56									
16	57									
16	58									
16	59									
17	00									
17	01									
17	02									
17	03									
17	04									
17	05									
17	06									
17	07									
17	08									
17	09									
17	10									
17	11									

In the table *sequence on-off* solenoid above, the cell colored green means start ON, and the cell colored red means start OFF. Colored cells orange show watering pressure full on each solenoid for 5 minutes. This sequence is done with at first opening all solenoids, then turning on the *main valve* and pump, and so on, solenoids closed stepwise start from park solenoid C, then park solenoid B, so park solenoid A gets pressure full. For watering for 5 minutes, shown in the cell colored orange. Opening and closing in a way that gradually on each of these solenoids, as shown, For arrange increase water pressure on each solenoid can work.

The *ladder diagrams* for each output (Q1, Q2, Q3, and Q4) are shown in Figures 3.1, 3.2, and 3.3 below. This :

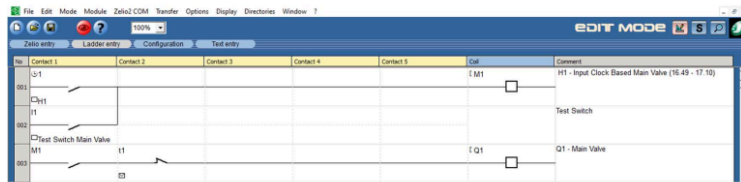


Figure 3.1 *Ladder Diagram of Main Valve*

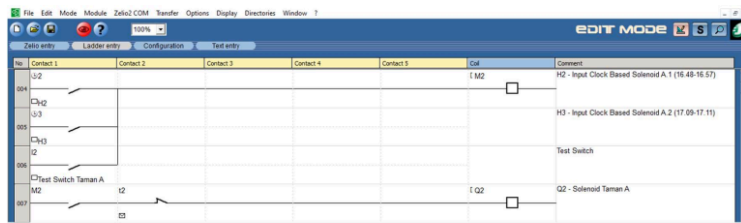


Figure 3.2 Ladder Diagram Solenoid Park A

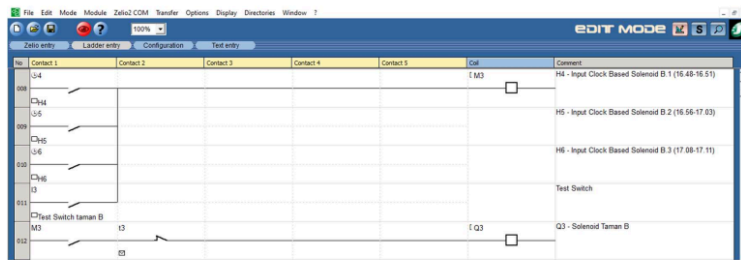


Figure 3.3 Ladder Diagram of Garden Solenoid B

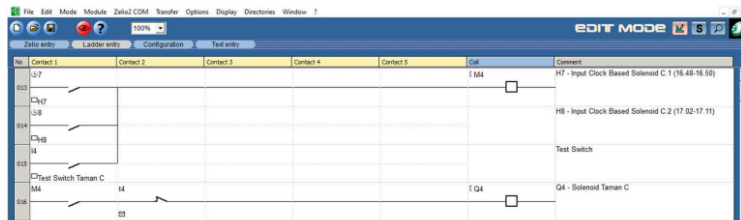


Figure 3.4 Ladder Diagram of Garden Solenoid C

3.2. Irrigation Line Installation and PLC Implementation

Related to noise generated by the pump watering, as well as the convenience and availability of water sources and resources, electricity is used. For this study, a number of adjustments were made as shown in Figures 3.5, 3.6, 3.7, and 3.8.

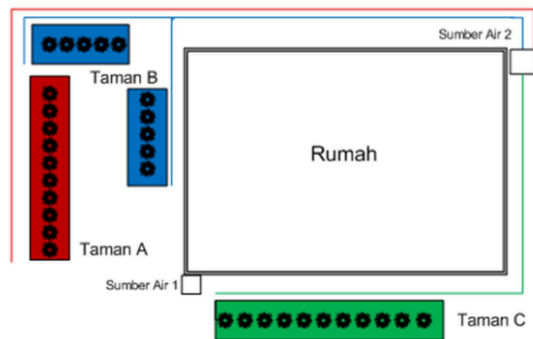


Figure 3.5 Garden Irrigation Line Installation



Figure 3.6 Garden watering line A



Figure 3.7 Garden watering line B



Figure 3.8 Irrigation lines, Park C

For PLC installation, the main valve and garden solenoid are shown in Figures 3.9, 3.10, and 3.11 below.



Figure 3.9 PLC Installation, Figure 3.10 PLC Installation, main valve



Figure 3.11 Garden solenoid installation

Manual watering is done overall, needing 30 minutes time In parks A, B, and C, 10 minutes are allocated for watering, with a discharge of 6.67 lt / minute, consuming water within 30 minutes, watering as much as 200 lt. Automation system watering park PLC based using track system watering that can walk in a way automatically without a power operator with allocation time at parks A, B, and C, 5 minutes time watering pressure full. Total water consumption at the time watering pressure full Park A at a discharge of 1.67 lt / minute, as much as 8.3 lt. Total water consumption at the time, watering pressure full Park B with a discharge of 2 liters/minute, as much as 10 liters. Total water consumption at the time watering pressure full Park C with a discharge of 1.82 lt / minute, as much as 9.1 lt of water. Total water usage at the time watering pressure full as full as 27.4 lt. Total consumption time, watering pressure full on system PLC based, requires 50% of the total time, manual watering with total water consumption is 13.7% of the total water consumption for manual watering. The system watering park uses PLC to do watering faster with less water consumption A little and can operate without manual intervention.

4. CONCLUSION

1. An automation system for watering a park can be used using ⁶ *Programmable Logic Control (PLC)* with an arranged *Clock (H1, H2, H3, H4, H5, H6, H7, and H8)* on the PLC ladder diagram.
2. Parameters required to be noticed in the automated system watering park using PLC in the study. This is a watering duration setting based on arrangement time watering (clock-based), where time watering under pressure full set at 5 minutes.
3. Settings time *clock (H)* adjusted with time for manual watering in a day. In this study, the *clock (H)* is set to do watering as many as 1 time in a day, namely in the afternoon, adjusting the time of manual watering.

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4. Parks A, B, and C have different *ladder diagrams*. Based on the arrangement, open or close the solenoid of each park. Duration watering under pressure, full set at 5 minutes. Duration: This can be modified and adjusted according to needs in the field.
5. Implementation *ladder diagram* PLC in the automation system watering park. This walk with Good has with duration of watering more shorter (total 15 minutes at a time), with full watering pressure, and uses little water use little (27.4 liters).

SUGGESTION

Need existence study more carry on related water and humidity sufficiency soil on plants in park the relationship with duration and frequency watering, and the number of PLC inputs and outputs required if there is Addition of input in the form of sensors and output in the form of solenoids for track watering new on the system watering This.

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