

Programmable Logic Controller based Automatic Car Washing System

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Abstract - Technology is best interconnecting channel in each part of world with the means of transportation or communication or business which led to a highly increase in the number of cars. Time consumption is essential for cleaning these vehicles or cars etc. Time management is directly proportional to reduction of cost for maintenance. The automatic way is used for man to perform tasks at higher speed. Automatic car washing system is very common in developed countries. It consists of large machines with automated brushes controlled by programmable logic controller (PLC). Automatic car washing system is fully automated with different stages of washing, foaming, brushing, washing, drying. This system has used various components such as PLC MITSUBISHI (FX 2N-25MR), conveyor belt, sensors, dc motors, brushes and dry fans. These components are controlled by programmable logic controller (PLC). In this system, ladder diagram is written for using PLC.

Indexed Terms - DC motors, Ladder Diagram, Programmable Logic Controller (PLC), Sensors

I. INTRODUCTION

In today's modern industrial environment, the surface of a vehicle is subjected to daily abuse. Automatic car washing techniques vary amongst individual car owners. Automatic car washing is an essential function of preventive maintenance. There are many types of car washes like manual car wash where the vehicle is washed by employees, self-services car wash where the customer has to perform the washing and chemical car washes which use chemicals to wash and polishing the car surface and etc. In all automobile Industries manual car washing need more labor to carry out work which effects in time consumption and also the results may or may not be satisfactory to the customer that depends. So as to overcome these issues, automatic car washing can be done automatically using Programmable Logic Controllers (PLC).

The main objectives of this paper are to study the function of the PLC, the programming language for PLC to control the system and the operation of automation car washing machine. And then, there are five programming language for PLC.

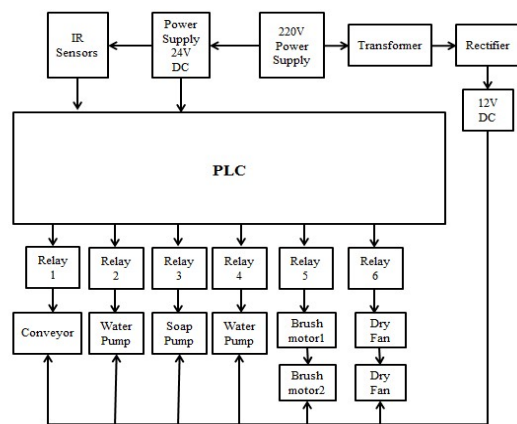


Fig. 1: Block Diagram of PLC based Automatic Car Washing System

II. AUTOMATIC CAR WASHING SYSTEM

With the modern convenience of automatic car washes, it may be difficult to remember that the industry was not always so high-tech. Though, other commercial car washes came before it, the first semi-automatic car wash in the United States made its debut in 1946, and from there, the industry has grown in both size and sophistication. The start of the history of car washing dated back into 1914. The first semi-automatic car wash was active for the first time in Detroit, Michigan using automatic pulley systems and manual brushing. Many things had occurred within 1955 regarding car washing history. In 1957, he formed the Hanna Enterprises and eventually reached about 31 car washes in America. In 1959, Hanna operated his wash rack until he made the first mechanized car washing system. As the news spread throughout the city, so did his business. In 1960s, Hanna Enterprises had established itself as the main

source innovator and the manufacturer of car washing equipment and materials. Over time, Hanna had made several machines that will be the first to do the main requirements over car washing, this includes the Wrap-Around Brush, Roller-on-demand Conveyor belt, soft cloth friction washing, several ways to wash the tires, and a recirculating water system. With that said, Hanna Enterprises have become the largest vehicle washing equipment manufacturer. In the 1970s it was a difficult time for the car washing industry, as the result of the gasoline prices increasing rapidly.

III. HARDWARE IMPLEMENTATION

Fig. 2 shows the overall circuit diagram of the purposed system. The Programmable Logic Controller (PLC) is the main part of the system. In this system, PLC (MITSUBISHI) is used to control the function of automatic car washing system. It has input 10 pins and output 14 pins.

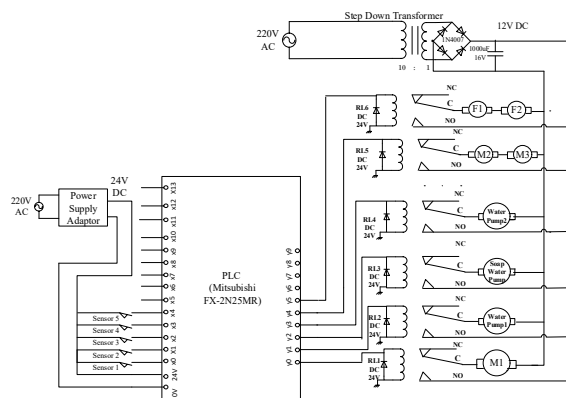


Fig. 2: Overall Circuit Diagram of PLC based Automatic Car Washing System

The step down transformer is used to get 24V supply AC from 220AC supply voltage. The rectifier is used to connect 24V AC supply to 24V DC supply and 12V DC power supply for motors. X0, X1, X2, X3 and X4 are connected for IR sensors. The output of the PLC Y0 is connected to conveyor motor. The output Y1 pin of relay is connected with the water pump motor 1 and the output Y2 of relay is connected to supply pin of soap water pump. The output Y3 is connected to two DC motors for brush and they are paralleled. Then the output Y4 of relay is connected with the water pump motor 2. The output Y5 of relay is connected to two dry fans and they are paralleled.

A. Operation of PLC based Automatic Car Washing System:

Conveyor is used for shifting the car through various stages of washing. We use DC motors for driving the conveyor belt via pulley and for driving brushes. When conveyor's components are in good condition and well aligned, it will operate properly. When car comes on conveyor, switch open and conveyor starts moving with the help of motor, it will reach to the next section (Pre-Wash Section). As the car reaches in pre-wash section, sensor 1 detects the car and water falls on the car by opening water sprinkle and after 10sec, sprinkle will close automatically. Conveyor is moving to the next section. As the car reach in soap water wash section, sensor 2 detects the car and soap water falls on the car by opening water sprinkle. After 10sec, sprinkle will close automatically and conveyor is driving to the next section (Brush). As the reaches to the next section, sensor 3 detects the car and two brushes start brushing the car for 10sec. Conveyor is moving until to the next section (Final wash) and sensor 4 detects the car and sprinkle get open for 10 sec. and get closed. Conveyor is moving to the next section (Drying). As the car reaches to the next section, sensor 5 detects the car dry fan start dry for 10 sec. and stop. Two fans are used for drying the car. After drying stage completion conveyor is moving to the exit gate and stop. Again conveyor starts moving for the next car until it will reach to the next section. The gate is opened to ready for the next car.

B. System Flowchart of PLC based Automatic Car Washing System:

Fig. 3 shows the system flow chart of the PLC based automatic car washing system. Initially, the conveyor is driven. When sensor 1 detects the car, conveyor will stop and water pump motor 1 will run for 10 seconds. After 10 seconds, conveyor drives to the next section. When sensor 2 detects the car, conveyor will stop and soap water pump motor runs for 10 seconds. After 10 seconds, conveyor drives to the next section.

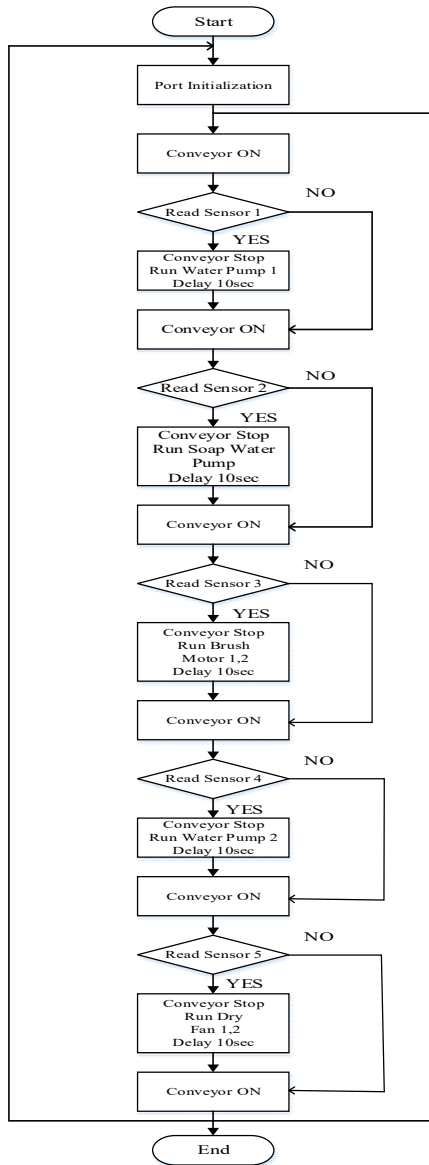


Fig.3: System Flowchart of the PLC based Automatic Car Washing System

When sensor 3 detects the car, conveyor will stop and brush motor 1 and 2 run for 10 seconds. After 10 seconds, conveyor drives to the next section. When sensor 4 read the car, conveyor will stop and water pump motor 2 run for 10 seconds. After 10 seconds, conveyor drives to the next section. When sensor 5 read the car, conveyor will stop and dry fan 1 and 2 run for 10 seconds. After 10 seconds, conveyor drives to the exit gate. Finally, the system flow chart of the PLC based automatic car washing system will be finished.

C. Operation of the Ladder Diagram:

Fig. 4 shows the overall ladder diagram of PLC based automatic car washing system. When the power supply is on, the X000 is operated and the output is Y000 that means conveyor motor is start driving. After the X001(sensor 1) is on, Y000 will stop and T0 is operated for a period of 10 seconds. The output is Y001 that means the water pump motor 1. After the X002 (sensor 2) is on, Y000 will stop and T1 is operated for a period of 10 seconds. The output is Y002 that means the soap water pump motor. After the X003 (sensor 3) is on, Y000 will stop and T2 is operated for a period of 10 seconds. The output is Y003 that means the brush motor. After X004 (sensor 4) is on, Y000 will stop and T3 is operated for a period of 10 seconds. The output is Y004 that means the water pump motor 2. After the X005 (sensor 5) is on, Y000 will stop and T4 is operated for a period of 10 seconds. The output is Y005 that means the dry fan motor.

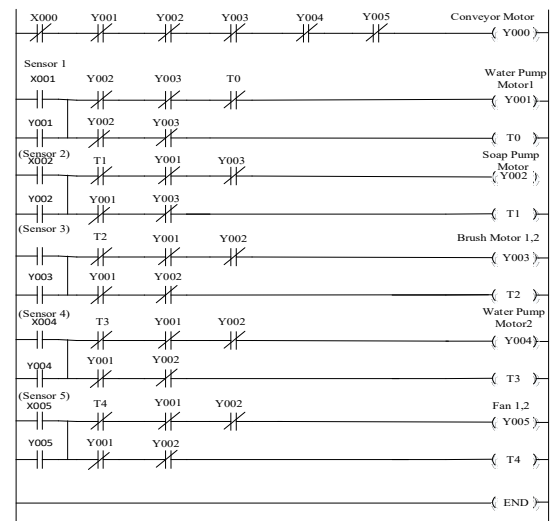


Fig. 4: Overall Ladder Diagram of PLC based Automatic Car Washing System

IV. SIMULATION OF THE SYSTEM

The ladder diagram of the PLC (MITSUBISHI FX-2N-25MR) is started to simulation in Fig. 5.

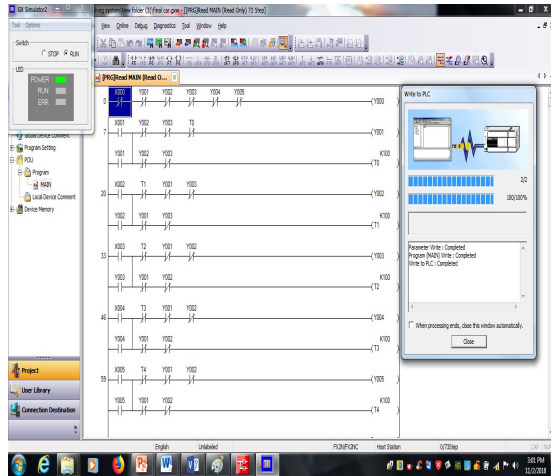


Fig. 5: Start Simulation

In the ladder diagram, X000, Y001, Y002, Y003, Y004 and Y005 are used as normally closed contact (NC). Therefore, the power supply is on, the output Y000 is activate. The output Y000 represents the conveyor motor.

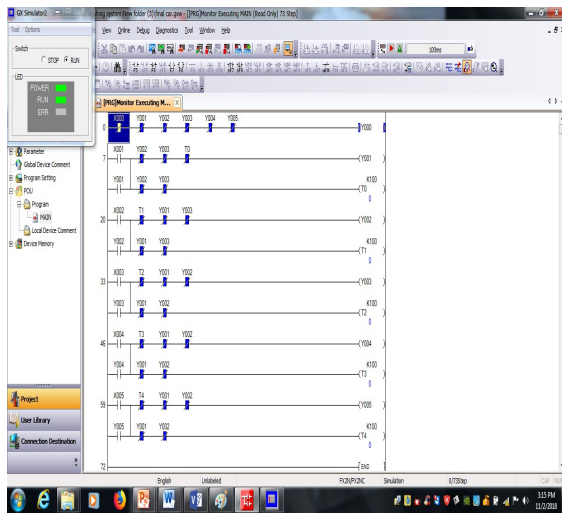


Fig. 6: Running Program for Conveyor Motor

In network 2, the X001 is used as normally open contact (NO) and represents the sensor 1 . When the car reaches in front of sensor 1, the X001 represents on state and the output Y001 and Timer T0 activate for 10 seconds. The output Y001 represents the water pump motor 1 in washing section. After 10 seconds, the output Y001 is off state and the output Y000 is on state again.

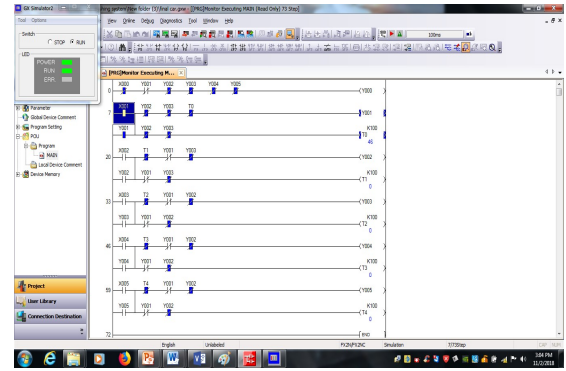


Fig. 7: Running Program for Water Pump Motor

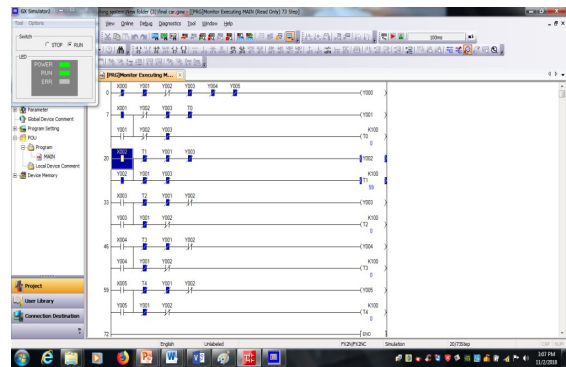


Fig. 8: Running Program for Soap Water Pump Motor

In network 3, the X002 is used as normally open contact (NO) and represents the sensor 2 . When the car reaches in front of sensor 2, the X002 represents on state and the output Y002 and Timer T1 activate for 10 seconds. The output Y002 represents the soap water pump in washing section. After 10 seconds, the output Y002 is off state and the output Y000 is on state again.

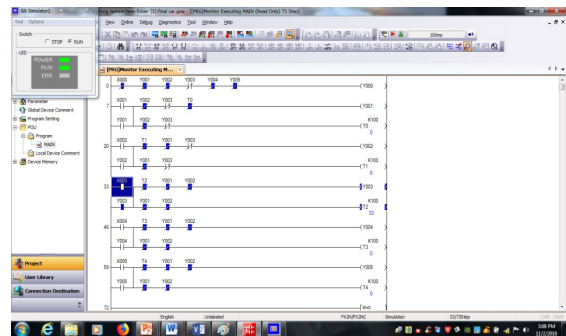


Fig. 9: Running Program for Brush Motors

In network 4, the X003 is used as normally open contact (NO) and represents the sensor 3 . When the car reaches in front of sensor 3, the X003 represents on state and the output Y003 and Timer T2 activate for 10 seconds. The output Y003 represents the brush motor in brushing section. After 10 seconds, the output Y003 is off state and the output Y000 is on state again.

In network 5, the X004 is used as normally open contact (NO) and represents the sensor 4. When the car reaches in front of sensor 4, the X004 represents on state and the output Y004 and Timer T3 activate for 10 seconds. The output Y004 represents the water pump motor 2 in washing section. After 10 seconds, the output Y004 is off state and the output Y000 is on state again.

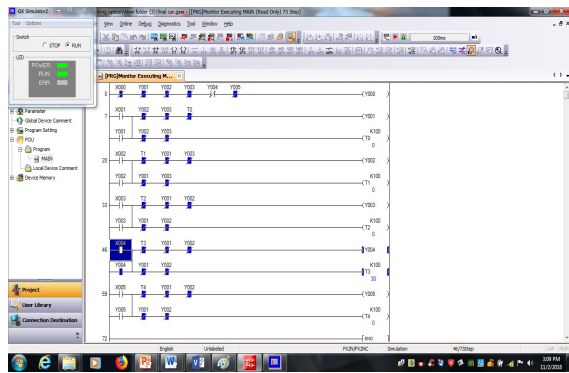


Fig. 10: Running Program for Water Pump Motor 2

In network 6, the X005 is used as normally open contact (NO) and represents the sensor 5. When the car reaches in front of sensor 5, the X005 represents on state and the output Y005 and Timer T4 activate for 10 seconds. The output Y005 represents the dry fan in drying section. After 10 seconds, the output Y005 is off state and the output Y000 is on state again.

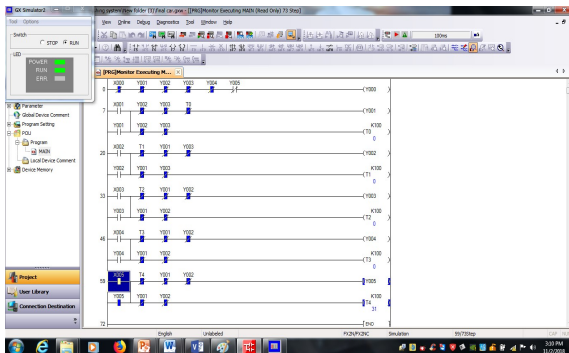


Fig. 11: Running Program for Dry Fans

The whole process is completed after five steps. And then, the system is continuous the operation of the next process.

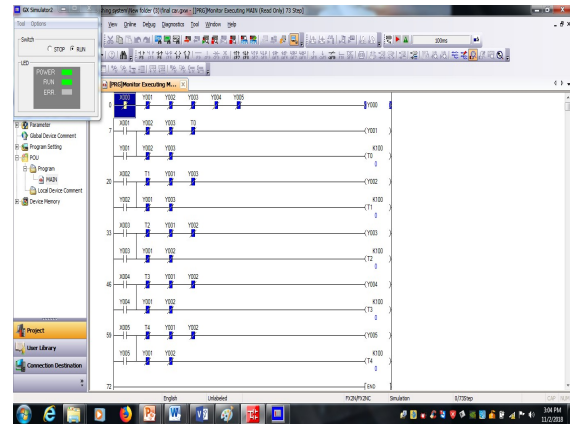


Fig. 12: Simulation of Overall Ladder Diagram of PLC based Automatic Car Washing System

V. TESTS AND RESULTS

When the switch of PLC is ON, conveyor motor will be driven to carry the car to the water section. Fig. 13 shows the testing conveyor motor.



Fig. 13: Testing Conveyor Motor



Fig. 14: Testing Water Pump Motor

Fig. 14 shows washing the car with water. When car reaches in front of the sensor 1, sensor 1 detects the car and conveyor will stop. Water pump motor 1 will operate and water sprinkle will open 10 seconds. After 10 seconds, sprinkle will close automatically and conveyor is driving to the next section.



Fig. 15: Testing Soap Water Pump Motor

Fig. 15 shows washing the car with soap water. When car reaches soap wash section, sensor 2 detects the car and conveyor will stop. Soap water pump motor will operate and water sprinkle will open 10 seconds. After 10 seconds, sprinkle will close automatically and conveyor is driving to the next section (Brush).

Fig. 16 shows car brushing with brushes. When car reaches brush section, sensor 3 detects the car and conveyor will stop. Brush motor 1 and 2 are operated 10 seconds. After 10 seconds, conveyor drives to the next section.



Fig. 16: Testing Brush Motors

Fig. 17 shows car washing with water again. When car reaches final wash section, sensor 4 detects the car and conveyor will stop. Water pump will operate and water sprinkle will open. After 10 seconds, sprinkle will close automatically and conveyor is driving to the next section.

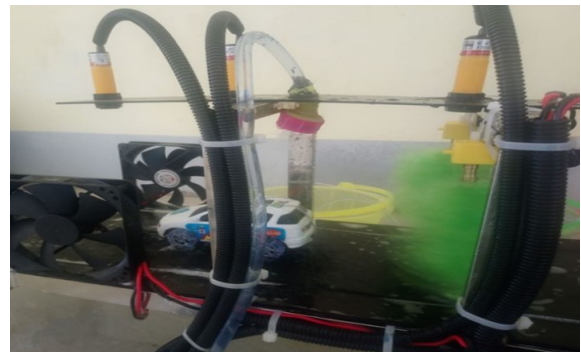


Fig. 17 Testing Water Pump Motors

Fig. 18 shows drying the car with dry fans. When car reaches dry section, sensor 5 detects the car and dry fans will operate. Start drying for 10 seconds. After 10 seconds conveyor is driving to the exit gate.



Fig. 18: Testing Dry Fans

VI. CONCLUSION

After working on the automatic car wash system, this system can come to conclusion that such automation system is quite beneficial and saving time of operation and also man power is reduced, improving the economy of the system. In the future, such type of automated systems will have more demanded. In this paper, MITSUBISHI (FX 2N-25MR) PLC is used as the main component to control the washing parts of the system. It is necessary to know the function of each pin of PLC. PLC can perform many functions higher than the other integrated circuit. This PLC has many programming languages that can be accessed. Ladder diagram language is the most usable programming language for PLC. In this paper, Ladder diagram is used to program the PLC. The system that has built is a working on PLC controller, which should be compact, fast and accurate. This system may not have the features and reliability of the original designs. It is only being developed to ensure that the design is feasible, not impractical and can be implemented on a much larger scale in a more efficient way. The automatic washing system can be used in interior wash, and coin or token system. Also this system can implement a counter which will be allowing the number of cars washed to be counted.

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