Automatic Car Washing System using PLC

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Abstract. Automated car washing systems are widely adopted for their ability to clean vehicles quickly and effectively, without requiring human intervention. However, traditional systems often rely on hardwired circuits and microcontrollers to control washing sequences. While effective, these systems are difficult to modify, as any changes require extensive reworking of the hardware. They also feature complex logical architectures that limit diagnostic capabilities, making troubleshooting more challenging and reducing monitoring efficiency. Our project addresses these limitations by utilizing programmable logic controllers (PLCs) to enhance the car washing process. Unlike conventional systems, a PLC-based approach is highly flexible, allowing the washing sequence to be easily reprogrammed or adjusted to accommodate different cleaning needs or vehicle types. Furthermore, PLC technology supports advanced diagnostic functions, enabling faster troubleshooting and efficient monitoring. This modernized approach not only simplifies maintenance but also results in long-term cost savings, enhancing the system's reliability and adaptability.

Keywords: Online method of teaching, Remote access of machines, Q03UDE Logic Controller, GOT Men Machine Interface, Virtual environment.

1 Introduction

The development of additional car washing systems that are automatic has been fast growing resulting from the development of urbanization and also car ownership. This is so, as it is efficient and causes convenience to the vehicle owners who need a wash without getting their hands wet. However, almost all of the normal automated car washing systems used circuits, sensors and microcontrollers that were connected through fixed wires for control of the washing process. Nevertheless, such arrangements are more or less formal, and are also integrated in such a way that does not allow easy changes. New change and extension to the system means radical modification of the hardware that hinders the system from fully realizing its potential for responding to the irregular evolution of requirements and improvements. This has become a problem for detecting faults and rectifying them since designs of traditional systems offer no provision for fault diagnosis. Maintenance issues are created by aspects such as immutability and inadequate diagnosis that deteriorate service delivery and customer satisfaction due to increased unproductive time and repair costs. Thus, the lack of sophisticated systems is the reason why creation the new Programmable Logic Controller (PLC) based car washing system

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is required. Washing systems could be controlled, and this included the inclusion of sophisticated diagnostics that could be housed in PLCs and this form of washing depended on an individual and a vehicle's washing cycle. This support modern sustainable car wash method which is different from the conventional fully automated car wash system making it more reliable, flexible and economical to current boring car wash business.

2 Block Diagram

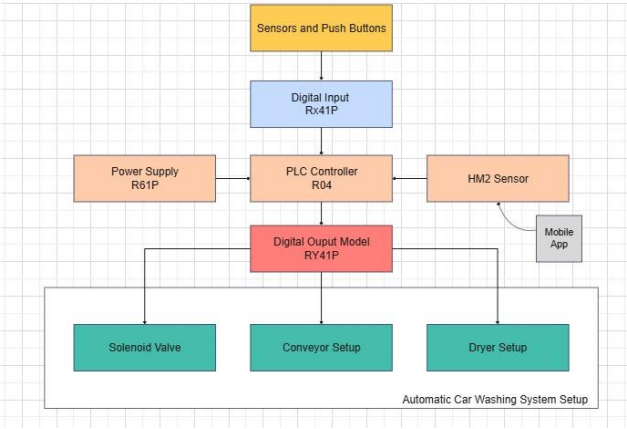

Fig. 1. Block diagram of Automatic car washing system.

The provided block diagram depicts the setup for an Automatic Car Washing System. This system integrates sensors, a modular controller, and automated outputs to operate solenoid valves, conveyor setups, and dryer units. The sensors and push buttons are connected via a digital input module (Rx41P) to the PLC controller (R04), which is powered by a power supply unit (R61P). Output control is managed through the digital output module (RY41P). Fig. 1 shows the Block diagram of Automatic car washing system.

Additionally, the HM2 sensor interacts with a mobile app for remote monitoring or control. The GUI screen (Graphical User Interface) and SCADA systems allow for real-time operation and visualization. Programs are developed in ladder logic and are mapped to the I/O addresses for seamless operation [5]-[7].

3 Circuit Diagram

Digital inputs and outputs are connected to the PLC's DI/DO ports, allowing control of components like brushes, fans, pumps, and motors. These I/Os are configured and programmed using GX WORKS 2 software [4]. Fig. 2 shows the circuit diagram.

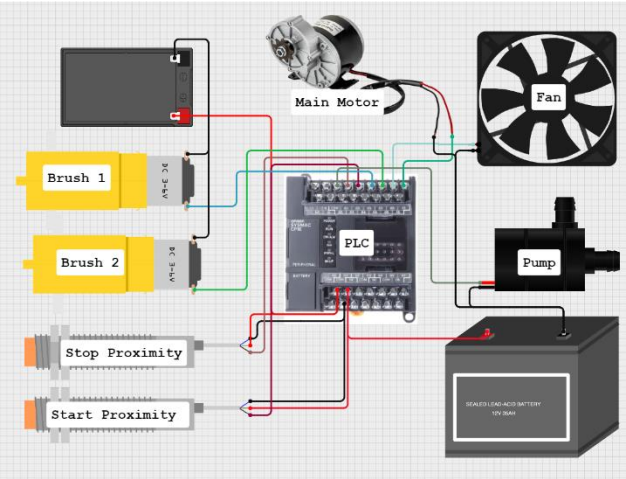

Fig. 2. circuit diagram.

The proximity sensors (Start and Stop) provide input signals to initiate or halt operations, while the brushes, pump, fan, and motor are controlled as outputs. A sealed lead-acid battery (12V 3AH) powers the system. Analog modules, if applicable, would be linked to buffer memory and data registers for handling real-time parameters [8]-[10]

4 Process

Fig. 3. Car Washing Process Diagram.

4.1 Washing

The washing process begins when the Start Proximity Sensor signals the PLC, activating the pump to spray water uniformly over the vehicle. The water flow is maintained for a predefined duration, ensuring thorough wetting of the surface. Fig. 3 shows the Car Washing Process Diagram.

The operation is controlled via GX WORKS 2 software, with the pump's timing and flow rate optimized for effective washing. The process halts automatically once the timer elapses or the Stop Proximity Sensor is triggered, signalling the completion of the washing phase [11]-[13]. Fig. 4 shows the Car Washing.

Fig. 4. Car Washing.

4.2 Cleaning

The cleaning process starts immediately after the washing phase. The PLC activates Brush 1 and Brush 2, which rotate in opposite directions to scrub the vehicle's surface effectively. The brushes are powered by DC motors, ensuring consistent cleaning pressure across all surfaces.

The cleaning duration is preprogrammed in GX WORKS 2 software, with sensors monitoring the process to prevent over-scrubbing or damage. Once the cleaning cycle is complete, the brushes automatically stop, transitioning the system to the next phase [14]-[16]. Fig. 5 shows the Car cleaning.

Fig. 5. Car cleaning.

4.3 Drying

The drying process is initiated after the cleaning phase. The PLC activates the fan and main motor to blow air over the vehicle's surface, effectively removing water droplets. The fan operates at a high speed to ensure quick and thorough drying.

The duration of the drying process is preconfigured in GX WORKS 2 software, with safety interlocks ensuring no overlap with previous stages. Once the drying timer concludes, the fan and motor shut off automatically, marking the end of the drying phase [17]-[19].

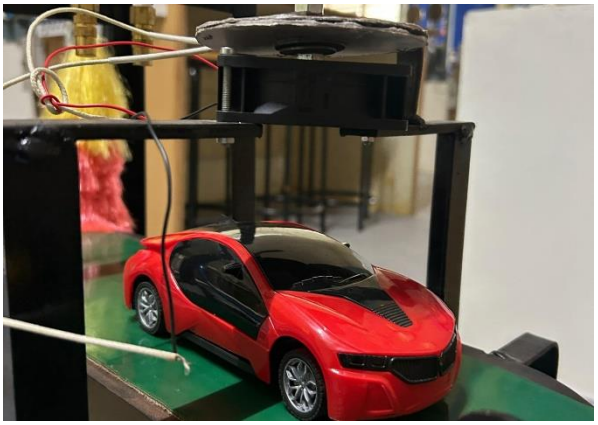

Fig. 6. Car cleaning.

5 Simulation

The simulation for the Washing Phase is shown in Fig 7. In this phase, the ladder logic program in GX WORKS 2 activates the pump when the Start Proximity Sensor is triggered. Timer T1 is used to maintain water flow for a set duration, ensuring uniform coverage of the vehicle. Once the timer elapses or the Stop Proximity Sensor is triggered, the pump deactivates, signalling the end of the washing phase. This process ensures efficient water usage and effective cleaning before moving to the next phase [20]-[22].

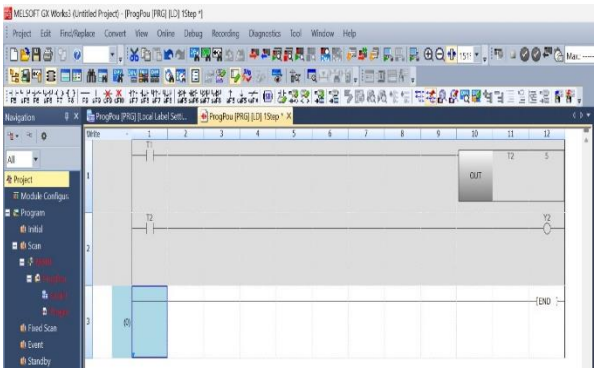

Fig .7. Washing Simulation.

Fig 8 illustrates the Cleaning Phase, where ladder logic controls Brush 1 and Brush 2. After receiving input from the washing phase, the PLC energizes the brushes' motors. Timers T2 and T3 ensure the brushes operate for a specific duration, providing consistent cleaning. Interlocks are implemented to avoid overlapping operations between the washing and cleaning phases, ensuring smooth transition and effective cleaning without interference [23]-[25].

The Drying Phase simulation, shown in Fig 9, activates the fan and main motor after the cleaning process ends. Timer T4 controls the fan's operation for efficient drying within a specified time. Sensors provide feedback, confirming the drying process's completion before transitioning to standby mode, ensuring no unnecessary energy consumption and preparing the system for the next operation [26]-[28].

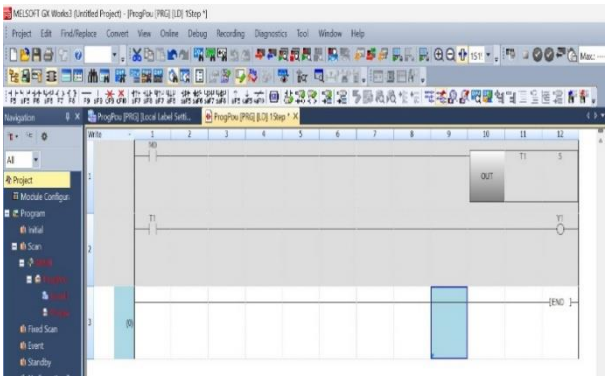

Fig. 8. Cleaning Simulation.

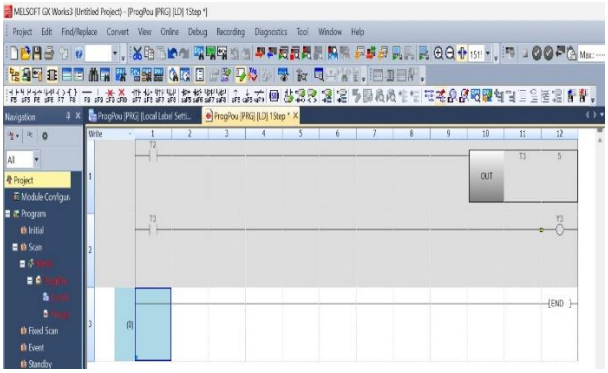

Fig. 9. Drying Simulation.

6 Results

The implementation of the PLC-based automated car washing system was completed using GX Works 2 for ladder logic programming and simulation. The system successfully automates key processes such as washing, cleaning, and drying, ensuring a streamlined, efficient, and fault-

tolerant operation. The developed system is cost-effective, reducing labour costs and ensuring a faster car wash process. Additionally, the use of sophisticated diagnostics and fault detection improves system reliability and reduces maintenance costs. After deployment, the system will contribute to time-saving and environmental sustainability by eliminating manual intervention and optimizing energy consumption.

By leveraging PLCs, GX Works, and advanced sensors, the system delivers consistent performance while reducing resource wastage and operational downtime. This ensures enhanced efficiency, customer satisfaction, and scalability for varying operational demands, reinforcing its role as a transformative solution in automated car washing processes [29]-[31].

7 Conclusion

This PLC-based automated car washing system prototype offers an efficient and high-quality solution for cleaning cars. It reduces the need for manual labour, saving both time and costs while ensuring minimal human intervention. The system is designed to wash multiple cars simultaneously, enhancing productivity in environments with high demand. Furthermore, it operates in an environmentally friendly manner, contributing to sustainability goals by eliminating pollution. Its user-friendly design and automated functionality ensure consistent results while minimizing maintenance efforts. This prototype promises to improve car washing efficiency, reduce operational expenses, and promote eco-friendly practices.

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