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PLC Dependent Smart and Automatic Car Washing System and Water Recycling

Rajesh Kumar[1,*], Jay Bahadur Singh[2], Beauty Maurya[2], Raj Kumar Prasad[2], Rajneesh Yadav[2], Ramanand Yadav[2]

Abstract

The world's finest communication, transportation, and commerce channels are all connected by technology, which has resulted in a sharp rise in the number of cars. Cleaning these autos or cars, etc., requires a lot of time. The lowering of maintenance costs is directly correlated with effective time management. Man uses the automated method to complete jobs more quickly. Autonomous vehicle washing systems are widely prevalent in industrialized nations. It is made up of sizable devices with automated brushes that are managed by PLCs (programmable logic controllers). A completely automated car wash system includes multiple steps of cleaning, foaming, brushing, and drying. Several parts have been employed in this system, including a conveyor belt, brushes, dc motors, sensors, conveyor belt PLC DELTA (DVP 14SS2. These elements are managed by a PLC, or programmable logic controller. Ladder diagrams are written in this system to be used with PLCs. The need for sustainable and effective systems is greater than ever in an era of growing automation and environmental awareness. A smart, automated car wash system with integrated water recycling, operated by a Programmable Logic Controller (PLC), offers a solution aimed at enhancing both sustainability and convenience in car washing. By combining automation with water-saving techniques, the system ensures effective car cleaning with minimal environmental impact. This article discusses the architecture and operational components of the PLC-based system, as well as the importance of water recycling in promoting environmental sustainability.

Keywords: Sensors, programmable logic controller (PLC), ladder diagram, and DC motors

INTRODUCTION

In the late 1930s, automatic car washes first became available. Customers (or attendants) drive into tunnel-like structures that house automatic carwashes. Customers of some car-wash use computerized point-of-sale units, or "automatic cashiers", to make payments. The wash is input by the mechanism of the PLU automatically into a tunnel controller or a master computer. When a sale is completed automatically, the vehicle is placed in a queue or stack after payment. The wash is aware of what each car bought since the stack moves in a sequential manner. Upon reaching the tunnel entrance, a customer is typically assisted by an attendant in boarding the conveyor or track. When two tires cross a tire sensor during a wash, the system will send multiple rollers. The tire sensor provides the wash with information about the location and spacing of the wheels. With alternative systems, the staff member could lead the client through and manually activate the rollers that propel the vehicle through by pressing a "Send Car" button on the tunnel controller. The attendant will give the

***Author for Correspondence**
Rajesh Kumar
E-mail: rajeshrrsimt16@gmail.com

[1]Assistant Professor, Department of Electrical Engineering, Bansal Institute of Engineering and Technology, Lucknow, Uttar Pradesh, India
[2]Student, Department of Electrical Engineering, Bansal Institute of Engineering and Technology, Lucknow, Uttar Pradesh, India

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customer instructions to put the car in neutral, release all brakes, and not to steer while they are on the conveyor. Failing to do so could lead to an accident involving a conveyor.

The car is pushed through a detector that measures vehicle length as the rollers approach behind the tires, enabling the controller to customize the wash for each unique vehicle. The number and kind of arches that make up the equipment frame vary. To completely clean the car, a quality car wash uses a variety of tools and steps in the chemical application process. The conveyor is also visible. Pre-soaking solutions are typically sprayed through specific arches to begin the car wash's cleaning process. If this is not done, it could lead to a lower pH (mild acid) followed by a higher pH (mild alkali), or the sequence may be reversed, according to the chemical suppliers and formula employed. The seasonal dirt and film on vehicles, the outside temperature, and other variables will also affect the chemical formulas and concentrations. Chemical application and dilution are effective when used in conjunction with removal systems that use friction, high pressure water, or a combination of the two. Despite their industrial strength, chemicals are not used in hazardous concentrations because car washes are made to protect components of vehicles. The next item the customer comes across are tire and wheel nozzles, also known as CTAs (Chemical Tire Applicators) in the industry. These will use specific formulations that clean the wheel surface of brake dust and tires. The following arch is frequently a wraparound, which is typically composed of closed cell. After cleaning the sides, these wraparounds should rub against the front bumper and then travel across the back of the car, washing the back, including the area where the license plate is. There might be a tire brush that cleans the wheels and tires after the initial wraps or entrance wraps. This low component is frequently found above wheels or under a matter (the hanging ribbon, which resembles moving curtains of cloth from side to front or back to side). Moreover, a rocker panel might exist.

AUTOMATIC CAR WASHING SYSTEM

With the contemporary ease of an automated vehicle washes, it might be hard to recall that the sector was not always so advanced. Still, the sector has grown in scale and sophistication since 1946, when the first semi-automatic car wash opened for business in the United States. Commercial car washes came before it. 1914 marked the beginning of the history of car washing. In Detroit, Michigan, the first semi-automatic car wash opened its doors, utilizing manual brushing in addition to automatic pulley systems. In the history of car washes, a lot had happened in 1955. Dan Hanna established Hanna Enterprises in 1957, and over time, the company operated about car washes across America. His business expanded along with the news across the city. Hanna Enterprises had made a name for itself as the primary innovator and producer of car wash supplies and equipment in the 1960s. Hanna has developed several machines over time that will be the first to perform the primary car washing tasks. These devices include a recirculating water system, a wrap-around brush, a roller-on-demand conveyor belt, soft cloth friction washing and various tire washing techniques. Having said that, Hanna Enterprises is now the biggest producer of car wash supplies. The rapidly rising cost of gasoline made the 1970s a challenging period for the car wash industry. The central component of the system is the PLC, or programmable logic controller. The automatic car wash system is operated by means of a Mitsubishi PLC system. It has 14 output pins and 10 input pins. The 220 V supply voltage is converted to a 24 V supply of AC using a step-down transformer. The rectifier is used to link a 24-V AC source to a 24-V DC supply.

Motor power supply: For IR sensors, X0, X1, X2, X3, and X4 are connected to 12 VDC supply. The conveyor motor is connected to the PLC Y0's output. Relay's output pins Y1 and Y2 are connected to the water pump motor and supply pin, respectively, of the soap water pump. Two parallel DC motors for the brush are connected to the output Y3. Next, the water pump motor 2 is connected to the relay's output Y4. Two dry fans are connected to the relay's output Y5A.

How the PLC-based Automatic Car Washing System Works

The car is moved through different phases of cleaning. DC motors are used to drive brushes and the conveyor belt through pulleys. A conveyor system functions correctly when its parts are in good shape and are aligned. The conveyor will proceed to the next section (the Pre-Wash Section) once the car is

positioned on it, with the switch opened and the conveyor moving with the assistance of a motor. Sensor 1 detects the vehicle as soon as it enters the pre-wash area, activating the water sprinkler to spray water on the vehicle. Sprinkler will automatically close in 10 sec. Conveyor is proceeding to the following segment. Sensor 2 detects the car as it approaches the soap water wash section and opens the water spray to let soapy water fall on the car. The sprinkler will automatically shut off after 10 sec, and the conveyor will move on to the next section (the brush). Two brushes begin cleaning the car for 10 sec as soon as sensor 3 recognizes the vehicle as it reaches the next section. Conveyor continues to move until it reaches the Final Wash section, at which point sensor 4 detects the car and opens the sprinkler for 10 sec, and shuts down. Conveyor is proceeding to the following segment (Drying). As the vehicle approaches the following segment, then the car's dry fan starts, it stops after 10 sec according to sensor 5. The car is dried using two fans. Following the completion of the drying stage, the conveyor moves to the exit gate and stops. The conveyor begins to move once more for the subsequent car until it reaches the next section. To make room for the following car, the gate is opened.

Flow Chart for an Automatic Car Wash System Powered by a PLC

The flow chart for the PLC-based system is shown in Figure 1. Automatic vehicle cleaning system: First, the conveyor is driven. When sensor 1 detects a car, the conveyor will halt and water pump motor 1 will run for 10 sec. After 10 sec, the conveyor advances to the next area. When sensor 2 detects a car, the conveyor will cease operating and the soap water pump motor will run for 10 sec. After 10 sec, the conveyor advances to the next area.

LITERATURE REVIEW

It could be hard to recall that the car wash industry was not always as advanced technologically, given the convenience of automatic car washes in the present era [1]. The first semi-automatic vehicle wash opened in the United States in 1946, though there had been commercial car washes before it. Since then, the sector has expanded in terms of both size and sophistication. 1914 marked the beginning of the history of automobile washing [2]. In Detroit, Michigan, the first semi-automated car wash opened its doors, employing hand brushing and automatic pulley systems. In the history of vehicle washes, a lot had happened in 1955 [3]. The Delta DVP series PLC is employed in the washing machine control system by various nations and their predecessors [4]. Unfortunately, this method necessitates a lot of pumping and discharging as well as numerous cable connections, which are expensive and cumbersome. The middle valve must be opened and closed frequently in the human lab. The operation will take too long, and a significant number of human resources will be wasted [5]. As a result, we suggest a control system made up of Delta PLC 14SS2 via the network connector [6]. Additionally, add four solenoid valves to the drainage systems of the two sewage tanks, and add one solenoid valve (for a total of two) to each of the original two venting valves. The ten solenoid valves are Delta Sewerage purification control systems and have been fully designed possible to accomplish the goal of automatically extracting and purifying sewage [7]. The washing machine's function buttons are located on the operation panel. The detection signals include the ability to detect the position of different nozzles, the blowing device, the washing machine's body, the position of each motor's defect, and the detection of overload and defects in individual motors. This detection signal is linked to the DELTA DVP 14SS2 input, which serves as the detection device's opening point [8]. The condition of the various indicators on the DVP14SS2's input can be used to determine the fault site if there is a problem with the working portion, which is highly helpful for any subsequent repair or maintenance effort [9]. A DC solenoid valve that regulates the vehicle and the water supply and demand, an AC contactor operated by a motor, and a light-emitting diode that the panel indicates comprise the PLC's output load [10].

BLOCK DIAGRAM OF PROPOSED CAR WASH SYSTEM

These Automatic Car wash Equipment can easily wash from 30 to 120 cars per hour depending upon the length of the conveyor. High-performance car wash conveyors built using cutting edge technology make your car wash a robust one, and give you years and years of service. Block diagram of the proposed car wash system is shown in Figure 1.

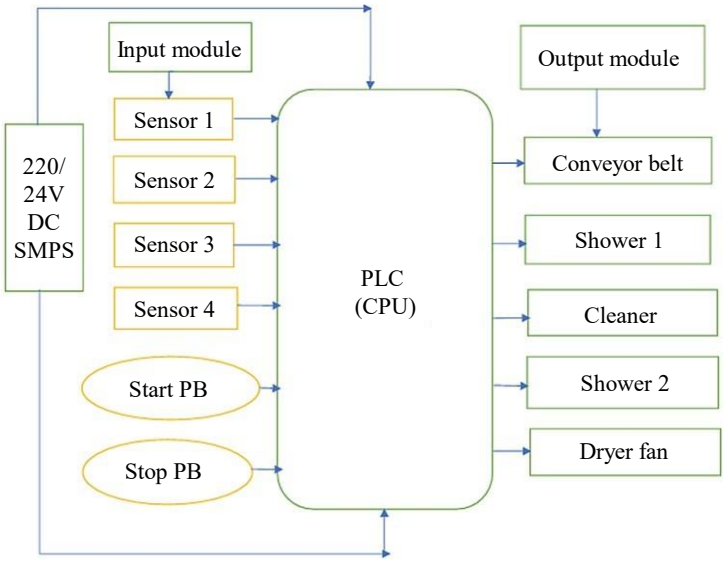

Figure 1. Block diagram of proposed car wash system.

PLC-INSIDE AUTOMATIC CAR CLEANING FACTOR

The term "programmable controller" is often used to refer to PLCs (Programmable Logic Controllers). It is an operational, digital industrial computer. A PLC may first appear to be confined to a black box with wires receiving signals and different lines transmitting signals. One such invention is the DVP series from the House of Delta PLC. From the simplest logic controller to the potent ISP Shoft in programming software, which are high performance integrated controllers, these Programmable Logic Controllers (PLC) from Delta provide a broad range of selection options. Delta also provides the PC-based automation management platform for programs with greater requirements on data storage and quicker communication with embedded applications, such as GUI. Regardless of the specifications, one can combine one or more DVP controllers in a flexible way to create the ideal solution.

Power Supply

Electricity is the lifeblood of any system, and it is provided by the power supply. Three specific voltage supplies, such as 5, 12, and 24 V SMPS, are needed for automatic vehicle wash systems. First, a 5-V supply is needed for the relay and sensor. A 12-V power supply is then needed for the relay and DC motors, which are driving the conveyor belt assembly, the shower, the cleaning brushes, the solenoid valve, and the small pipes that spray water from the bottom to clean the car's underside. Power supply is shown in Figure 2.

PLC relays and system switches are run by a 24-V switched mode power supply (SMPS) as shown in Figure 3. A switched-mode power supply (SMPS) is an electronic power supply that incorporates a switching regulator to enable efficient electrical power conversion. Like other suppliers, an SMPS transforms voltage and current while delivering power to DC loads through a DC or AC source.

Figure 2. Power supply. **Figure 3.** PLC relays.

Switch

An electrically operated switch is a hand-off. Many transfers use an electromagnet to operate a switch mechanically, but other working standards like legitimate state transfers, for example, are also employed in a similar manner. Materials that are heavy or significant are transported using transfers. Transport frameworks provide efficient and quick conveyance of goods for remote classification. With the eight 5 V relays and the related switching and isolating components, the eight-channel relay module facilitates simple interfacing with a microcontroller or sensor using the fewest possible parts and connections. Two relays share each of the eight terminal blocks, which have six terminals apiece. Because the terminals are screw type, connecting to mains wire is simple and interchangeable. Switch is shown in Figure 4.

Conveyor Belt

Thes transfers materials from one location to the next. Applications where large or bulky materials need to be transported benefit greatly from the use of transport. Transport frameworks allow for the efficient and quick movement of a variety of goods. Conveyor belts are employed in this project to reach cars at various stages of cleaning. A conveyor belt is a belt that has been looped and is wound around one or more pulleys for driving. The conveyor belt is supported by rollers or a metal plate bed and is driven by an electric motor. There is an idler pulley that is not driven and a driving pulley that drives a conveyor belt. Conveyor belt is shown in Figure 5.

Pump

Pumps move fluid by creating a pressure difference between the device's inlet and outlet. The pump's moving parts, such as the impeller, piston, or vane, push air out of the way, creating a partial vacuum as shown in Figure 6. Depending on the kind of pump, more air or water is subsequently pumped into the vacuum. The pump's prime mover, such as an electric motor or turbine, converts energy into kinetic energy, which is then converted into pressure energy for the fluid being pumped. The impeller and volute or diffuser are the two main parts of the pump that cause these energy changes.

Figure 4. Switch.

Figure 5. Conveyor belt.

Figure 6. Pump.

Proximity Sensor

An apparatus that can identify the presence of adjacent items without making physical contact is called a proximity sensor. In order to detect changes in the electromagnetic field or returning signal, proximity sensors frequently emit an electromagnetic field or beam of electromagnetic radiation. There are three main types of proximity sensors: capacitive, ultrasonic, and inductive. Each has specific characteristics and is best suited to different applications. Proximity sensor is shown in Figure 7.

DC Motor

A DC series compound motor is suitable for conveyor systems because it offers constant speed and high starting torque. DC motors have a variety of voltages, with 12 and 24 V being the most common. They also have the following benefits for belt conveyors:

Solid Shaft 24 V 10 rpm High Torque Self-locking Strong Wheel Turbine Worm Reduction motors are Low-speed DC motors with worm metal gearboxes for high torque with permanent magnet motors known for delivering high power compact. These motors are ideal for applications requiring motor speed adjustment and reversing capabilities. It is a straightforward DC motor with a metal gearbox to drive the motor shaft, making it an electric motor with mechanical commutation that runs on a DC source. Johnson Geared Motors are renowned for their enormous torque-speed characteristic and small size. DC motor is shown in Figure 8.

Water Recycling

The term water polishing can refer to any process that removes small (usually microscopic) particulate material or removes very low concentrations of dissolved material from water. The process and its meaning vary from setting to setting: a manufacturer of aquarium filters may claim that its filters perform water polishing by capturing “micro particles” within nylon or polyester pads, just as a chemical engineer can use the term to refer to the removal of magnetic resins from a solution by passing the solution over a bed of magnetic particulate. In this sense, water polishing is simply another term for whole house water filtration systems. Polishing is also done on a large scale in water reclamation plants. Water recycling is shown in Figure 9.

WORKING OF CAR WASH SYSTEM

The car entry sensor triggers the process and turns the conveyor belt ON to move the car. The soapy water sprinkler turns ON when the stage 1 sensor detects the car and does the process for a certain time. The brusher turns ON when stage 2 sensors detect the car and do the process for a certain time. The clean water sprinkler turns ON when stage 3 sensors detect the car and do the process for a certain time. The dryer turns ON when stage 4 sensors detect the car and do the process for a certain time. The car exit sensor triggers the conveyor motor to turn off. Transport is utilized for drifting the car through distinct phases of wash. We utilize 10 rpm DC motors for driving the conveyor through PVC pipes and gears for driving brushes. When conveyor`s portion is in strong condition and very much adjusted, it will work legitimately. Latching rung to operate the system through Master Start and Stop PB. The car entry sensor triggers the memory bit which will turn on the conveyor motor. ON/OFF operation of conveyer motor is happening in this rung using various conditions like Sensor input and timer done output. When the car reaches stage 1 sensor conveyor motor should stop and the water sprinkler should

Figure 7. Proximity sensor.

Figure 8. DC motor.

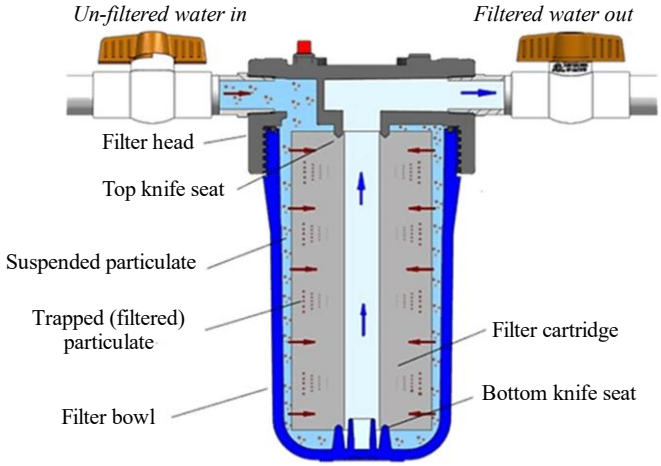

Figure 9. Water recycling.

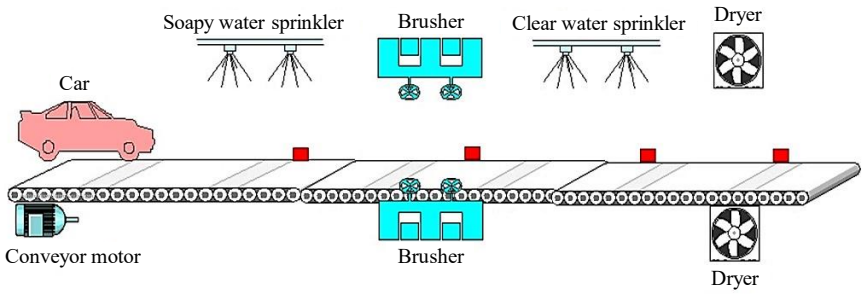

Figure 10. Working of car wash system.

be ON for 10 sec. At the end of the water sprinkler timer, Conveyer will again be ON because of the parallel contact. When the car reaches stage 2 sensor conveyor motor should stop and the brusher should ON for 10 sec. Working of car wash system is shown in Figure 10.

Conveyer will once more be ON following the brushing procedure due to the parallel contact. The water sprinkler should be turned on for 10 sec and the conveyor motor should stop when the automobile reaches stage 3 of the sensor. Conveyer will once more be ON due to the parallel contact at the conclusion of the water sprinkler timer. The water sprinkler should be turned on for 10 sec and the conveyor motor should stop when the automobile reaches stage 4 of the sensor. Conveyer will once more be ON due to the parallel contact at the conclusion of the water sprinkler timer. The car wash done indicator lamp will turn on when the automobile has reached the exit thanks to the car exit sensor [11].

CONCLUSION

After working on the automated vehicle wash system, this system can conclude that this kind of automation is highly advantageous, saving operation time and reducing the need for human labour, thereby increasing system economy. Such automated solutions will become more and more in demand in the future. The primary component utilized in this study to regulate the system's cleaning components is the DELTA PLC 14SS2. Understanding the purpose of each PLC pin is essential. PLCs are more capable than other integrated circuits in a wide range of functions. There are numerous programming languages available for this PLC. The most practical programming language for PLCs is ladder diagram language. In this work, the PLC is programmed using a ladder diagram. The system that has been constructed is a PLC controller, which needs to be accurate, quick, and small. It is possible that this system lacks the features and dependability of the original blueprints. It is merely being developed to make sure the idea is workable and not unfeasible, and that it can be applied more effectively and on a far bigger scale. Coin or token systems and interior washing are two applications for the automatic

washing system. Additionally, a counter that allows for the counting of the number of cars washed can be implemented using this method.

Acknowledgment

A PLC-based automatic car wash system uses a programmable logic controller (PLC) to control the various components of the car washing system, including the water pump, conveyor belt, and brushes. The PLC receives inputs from sensors that detect the position and size of the car, and based on these inputs, it controls the various components of the system. A water recycling car wash system uses a filter net to separate dirt from used water in order to allow recycling of the system by pumping it back into the system. This system can save a lot of water that is unnecessarily wasted in car washes.

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