Carwash machine using PLC

رسالة تقدم بها كل من :

حسنين اكرم علي

ثامر ماهر عبد القادر

زين العابدين خالد ناصر

عباس جبارحنو

حسين صالح هادي

صدرالدين عبد الهادي

إبراهيم الخليل حسين

مقدم الى

مجلس قسم الكهرباء / المعهد التقني / كوت

وهي جزء من متطلبات نيل شهادة الدبلوم في قسم تقنيات الكهرباء

اشراف الأستاذ :

الأستاذ علي حسنين

بسم الله الرحمن الرحيم

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا ۖ إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ

صدق الله العلي العظيم

الإهداء

إلى من وضع المولى - سبحانه وتعالى - الجنة تحت قدميها، ووقَّرها في كتابه العزيز...

(أمي الحبيبة).

إلى خالد الذكر، الذي وفاته المنيَّة منذ عام، وكان خير مثال لرب الأسرة،

والذي لم يتهاون يوم في توفير سبيل الخير والسعادة لي..

(أبي المُوقَّر).

إلى من أعتمد عليه في كل كبيرة وصغيرة..

(أخي المُحترم).

إلى أصدقائي ومعارفي الذين أُجلُّهم وأحترمهم..

إلى أساتذتي في المعهد ....

أُهدي لكم بحثي في.....

شكر وتقدير

أول مشكور هو الله عز وجل، ثم والداي على كل مجهوداتهم منذ ولادتي إلى هذه اللحظات، أنتم كل شيء أحبكم في الله أشد الحب.

يسرني أن أوجه شكري لكل من نصحني أو أرشدني أو وجهني أو ساهم معي في إعداد هذا البحث بإيصالي للمراجع والمصادر المطلوبة في أي مرحلة من مراحله، وأشكر على وجه الخصوص استاذي الفاضل الدكتور (رعد فرهود)(والأستاذ علي حسنين) على مساندتي وإرشادي بالنصح والتصحيح وعلى اختيار العنوان والموضوع، كما أن شكري موجه لإدارة المعهد التقني / كوت لتوفير أفضل بيئة لتدريس العلوم (الكهربائية) في أفضل الأحوال التي تلائم طلبة العلم.

Abstract

Automation has become a basic requirement in this developing world. Today in this present era, automation helps us to save time, expense as well as manpower. It is significant to have a smooth and effective system to sustain the cleanliness of the vehicle. The automatic vehicle washing machine concentrates on the car washer system using PLC. The automatic vehicle washer system has three capital processes namely washing, cleansing, and drying. Hence the external of the vehicle will be washed by detecting the vehicle on a conveyor belt and further controlled by PLC. An automatic vehicle washer is served with the usage of a conveyor belt which carries the vehicle. Proximity sensors are used for detecting the vehicle, which is placed in their positions according to the functioning of the washer. As soon as the vehicle is sensed, the functioning of the conveyor assembly invokes. With the predefined time delay, the conveyor gets suspend. Vehicle washer technique is the combination of different functions that performs scattering the solution of detergent water, then cleaning with normal water and finally wiping the wetness using cotton brushes. Vehicle washing can be done where vehicles are parked for a long time and washing cars can be done easily like fuel filling stations, supermarkets, hospitals, government buildings, railway stations and can also be widely used in service stations and manufacturing units. The type of PLC used in the design is LSIS G7M-DR20U.

1.1: Introduction

The vehicle washing system is the simple technique of preventive maintenance or to keep the exterior of the vehicle clean. To prevent rust, oxidation, and reduce the occurrence of fine scratches, the exterior of a vehicle must be kept clean. This system helps clean the vehicle automatically with the help of a Programmable Logic Controller (PLC). This process is done in two steps namely washing and cleaning. Washing also involves three processes where the clean water is sprayed over the vehicle initially then the detergent water is sprayed and again, the normal water is sprayed. This is then followed by cleaning. In the cleaning process,

the wetness in the vehicle is wiped using cotton brushesPLC is a specialized computer for control and operation of a process that functions using a programmable memory to store many instructions and execute functions including timing, counting, on/off control, etc. In existing systems, many electromechanical relays are used which was replaced by PLC, where the information of completion and emergency is informed efficiently. In automatic vehicle washing machine using PLC, the ladder logic is developed according to the functioning of the washer using timer delays. The manual way of car washing required plenty of time and also needs more water. This can be avoided using this automatic vehicle washing system where a vehicle can be washed in lesser time with less consumption of water. Also, they can be set up in some places like residential, departmental stores, etc., where the vehicles are parked for a long period and cleaning can be done there. This can also be widely used in manufacturing units.

1.2: Tools used in this project

1. PLC
2. Photo Sensor
3. Push-Button Switches
4. Conveyor Belt
5. Contactors
   - DC Motor
6. Relays
7. Water Pump
8. Water Tank

1.2.1: PLC

A Programmable Logic Controller, or PLC for short, is simply a special computer device used for industrial control systems. They are used in many industries such as oil refineries, manufacturing lines, conveyor systems, and wherever there is a need to control devices the PLC provides a flexible way to " soft wire" the components together.

The basic units have many input and output pins, a CPU (a computer processor Unit) that is dedicated to run one program that monitors a series of different inputs and logically manipulates the outputs for the desired control and memory (RAM and ROM) for stores status information for input and output devices, along with values for timers, counters, and internal devices. PLCs require a Programming device to upload data onto the CPU like a computer. They are meant to be very flexible in how they can be Programmed while also providing the advantages of high reliability(no Program crashes or mechanical failures), compact and economical over traditional control systems.

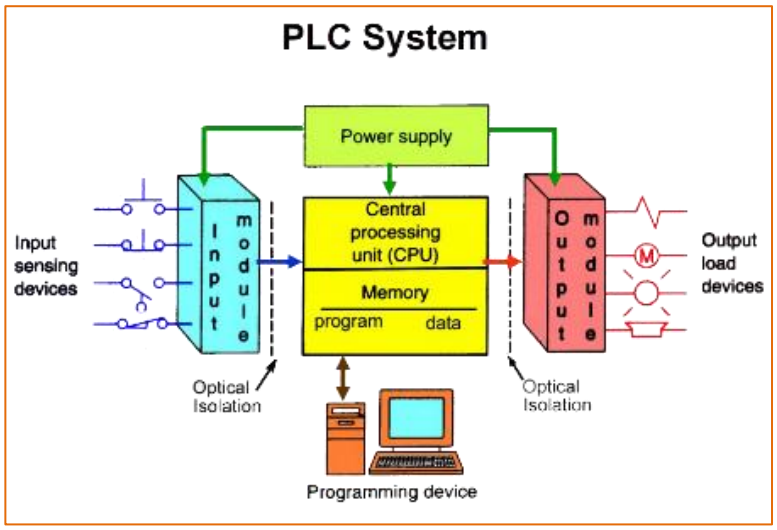

Fig. 1: PLC System

➢ Principle Of Operation

The operation of the programmable controller is relatively simple. The system is physically connected to the field device that is encountered in the machine or that is used in the control of a process. These field devices may be discrete or analog input/output devices such as limit switch pressure transducers, push buttons, motor starters, solenoids……etc.

The I/O interfaces provide the connection between the CPU and information providers (input) and controllable device (output). During it is an operation, the CPU completes three processes

- It reads or accepts, the input data from the field devices via the input interfaces.
- It executes or performs, the control program stored in the memory system
- It writes, or updates, the output devices via the output interfaces

This process is known as scanning, Figure below illustrates a graphic representation of the scan

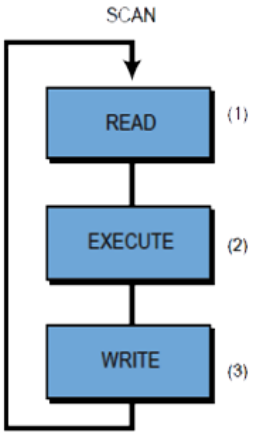

Illustration of a scan

➢ PLCs versus Other Types Of Controls

The industrial control system or ICS comprises of different types of control systems that are currently in operation in various industries. These control systems include PLC, SCADA and DCS, and various others.

➢ PLC Advantages

- Flexibility: One single Programmable Logic Controller can easily run many machines.
- Correcting Errors: In the old days, with wired relay-type panels, any program alterations required time for the rewiring of panels and devices. With PLC control any change in circuit design or sequence is as simple as retyping the logic. Correcting errors in PLC is extremely short and cost-effective.
- Space Efficient: Today's Programmable Logic Control memory is getting bigger and bigger this means that we can generate more and more contacts, coils, timers, sequencers, counters, and so on. We can

have thousands of contact timers and counters in a single PLC. Imagine what it would be like to have so many things in one panel.

- Low Cost: Prices of Programmable Logic Controllers vary from a few hundred to few thousand. This is nothing compared to the prices of the contact and coils and timers that you would pay to match the same things. Add to that the installation cost, the shipping cost, and so on.
- Testing: A Programmable Logic Control program can be tested and evaluated in a lab. The program can be tested, validated, and corrected saving very valuable time.
- Visual observation: When running a PLC program a visual operation can be seen on the screen. Hence troubleshooting a circuit is quick, easy, and simple [2].

➢ PLC Disadvantages

- Because it is a new technology, that should require training.
- Some applications that perform a single function, is not efficient in the use of PLC.
- Limited usage environments, high temperatures, and harsh vibrations can disrupt electronic equipment on the PLC.
- Need extra security equipment such as real.
- PLC is not considered necessary when applied to industrial systems that do not need to change the wiring [3].

The next flow chart explains the project sequence:

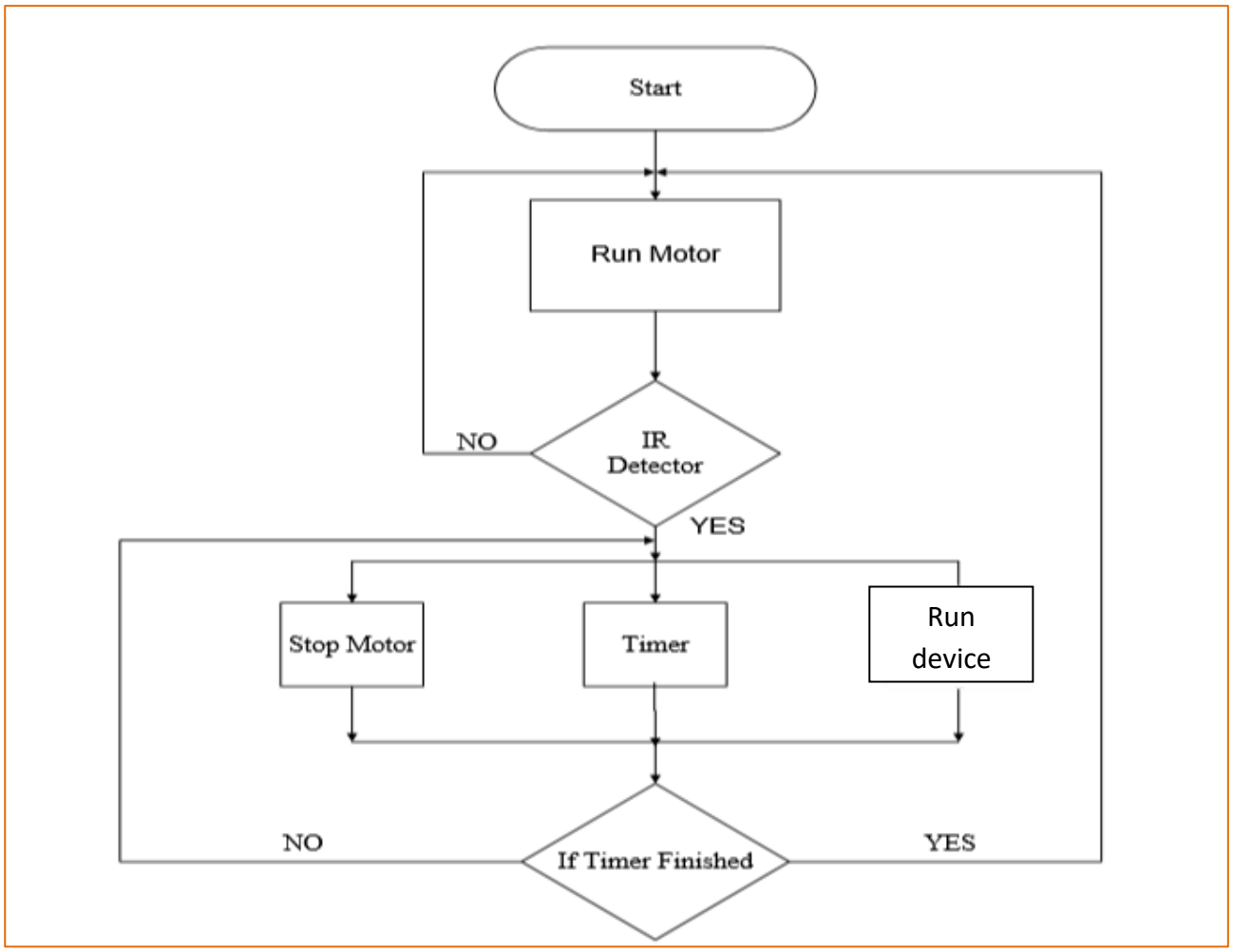

Fig. 2: flow chart of the project

➢ PLC Programming Language

- (LD) Ladder Diagram
- (LI) List Instruction
- (SFC) Sequential Function Chart

This project will be talking about LD only, because it is the language that we used to program the PLC unit, by using GMWIN Software.

➢ Ladder Diagram

Ladder logic was originally a written method to document the design and construction of relay racks as used in manufacturing and process control. Each device in the relay rack would be represented by a symbol on the ladder diagram with connections between those devices shown. Besides, other items external to the relay rack such as pumps, heaters, and so forth would also be shown on the ladder diagram.

Ladder logic has evolved into a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware. Ladder logic is used to develop software for programmable logic controllers (PLCs) used in industrial control applications. The name is based on the observation that programs in this language resemble ladders, with two vertical rails and a series of horizontal rungs between them.

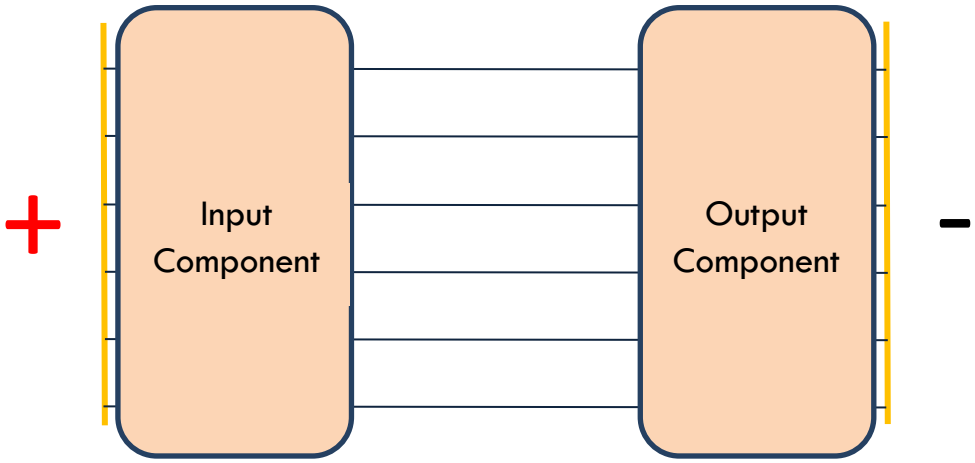

Fig. 3: LD

1.2.2: Photo Sensor

The photoelectric sensor is a device used to detect the absence or The presence of an object depending on the photoelectric phenomena. The sensor is widely used in industrial applications. The sensor has three different types: they show a beam sensor), a reflective sensor, and a proximity sensor.

The source is a stand-alone photoelectric sensor based on optical-electronic circuits where only energy is required. The sensor makes its modification, demodulation, amplification, and output switching. Some independent sensors provide options such as timers or built-in counters. With tremendous technological advances, photoelectric sensors have become smaller. Remote sensing sensors consist of special circuits for power input, amplification, and output switching. The smaller the control panel, the smaller the sensor.

Optical beam sensor application from a receiver inside the transmitter's line of sight. An object is detected when the beam of light is blocked. • The reflective sensor in which the transmitter and receiver are replaced by a reflector, does the same job as the receiver and transmitter, the presence of an object is detected when the light beam is blocked. Proximity sensor Unlike the previous two sensors, the presence of the object is detected when the transmitter sees the transmitter rather than blocking the beam

Photoelectric Sensors detect objects, changes in surface conditions, and other items through a variety of optical properties.
A Photoelectric Sensor consists primarily of an Emitter for emitted light and Receiver for receiving light. When emitted light is interrupted or reflected by the sensing object, it changes the amount of light that arrives at the Receiver. The Receiver detects this change and converts it to an electrical output. The light source for the majority of Photoelectric Sensors infrared or visible light (generally red, or green/blue for identifying colors).

- Specifications:

Operating Range	*50-300mm*
Input voltage	*10-35V*
Output	*PNP: NO/NC* *NPN: NO/NC*
Maximum rating	*200mA*
Output diameter	*M-18, M-20, flat*

Table No.1. Specification of Proximity Sensor

➢ Features

- Space-saving
- Wiring only on one side
- Object with fluctuating position detectable
- Wide sensing area
- No beam alignment needed

Fig. 4: Photo Sensor

1.2.3: Push-Button Switch

A type of switch usually in the form of a push-button that is only engaged while it is being depressed, as opposed to a typical "on/off" switch, which latches in its set position. Momentary switches may be normally open or normally closed. A normally open switch doesn't make contact until and unless it is held down. A normally closed switch is always making contact until the button is pushed. Most electronic keyboard sustain pedals use momentary switches. Unfortunately, most manufacturers never agreed on a standard for normally open or normally closed so your Yamaha switch may not work with your Korg keyboard, and vice versa. (This is less of an issue these days as most synths automatically set themselves for the type of switch connected upon power-up.)

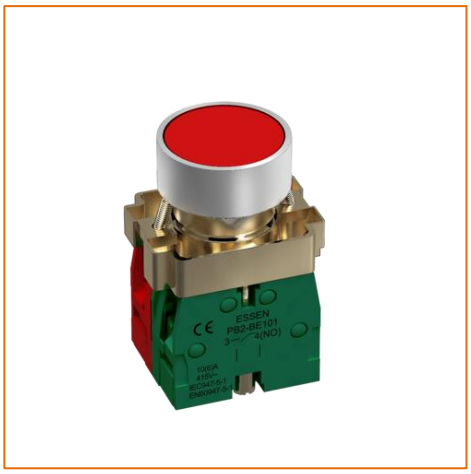

Fig. 5: Push-Button switch

1.2.4: Conveyor belt

A conveyor belt is one of many types of conveyor systems. The belt is a loop of flexible material as shown in Figure 6 (a) used to mechanically link two or more rotating shafts, most often parallel. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley.

Fig. 6:Conveyor belt

The conveyor belt runs by using DC Motor, so we must learn what is dc motor :

- DC motor

The DC motor used is a DC geared type motor whose shaft is interconnected with the shaft of the roller. This motor has an input voltage of 12v with an input current of 600mA to 14A. Its no-load speed is 50 RPM. The reason for selecting this motor is to achieve high torque at a constant speed. It has a torque of 70kgcm which provides a sufficient amount of torque for our load. The motor comes with a metal gearbox and centered shaft. The shaft is loaded with bearing for wear resistance. The reason for choosing such a high torque is having such heavy rollers used on either side of the hardware which is mounted with a conveyor belt.

Fig.7: 12V DC geared Motor

1.2.5: Contactors

It is an electromagnetic device used to separate and connect electrical or control circuits. The circuit breaker is activated with a current of current and a difference of voltage smaller than the electrical current to be controlled. The connector comes in several shapes, sizes and capacities depending on the nature of use. Unlike the circuit breaker, the conductor is not intended to be used to protect the circuits from short-circuit currents. It is used in controlling electric motors, lighting, heating, capacitors, and others .

The contact switch is an essential component of control circuits in general, and the high-power motor and lighting circuits in particular. It is a primary pole capable of withstanding a high current that is controlled by the control coil in which a small current pass through, and thus it is possible to control high currents by low currents, The switch is provided with many auxiliary poles which are two types

- Normally open .
- Normally closed .

The first type (N / O) is in the normal position open as long as there is no electrical signal in the key coil, and then the main poles are also open, then automatically it switches to the closed position as soon as it is

The key file is electrified, and vice versa in the case of the second type (N / C). The primary use of these auxiliary poles is in light-current control circuits, where the status of the base electrodes carrying the main current can be monitored by following the auxiliary state of the auxiliary poles

Fig. 8: Contactor

1.2.6: Relays

Relay is an electrical switch that opens and closes a circuit called a power circuit under the control of another circuit called a control circuit, so it performs the function of electrical insulation or what is known as galvanic insulation between the two circuits. The relay is dependent on a magnetic coil that attracts moving contacts (switches) to separate or reach the current. The relay is initially composed of an electromagnet and applies force to the moving contacts while feeding. The electromagnet is fed, as needed, with either very low tension (48v, 24v, 12v or less) continuous or alternating, or with low tension (400v, 230v).

The relay can have one or several switches that are either normally closed or normally open and these switches are designed taking into account the maximum current value required as well as the maximum potential difference they must bear. Because it contains kinematic parts, the relay takes a period to open and close the cutter. A relay can be single-stabilized or dual-stabilized.

The primary function of the relay is to separate the control circuits from the power circuits, for example, to drive a high current or tension from a relatively weak control signal.

In many applications, the relay provides for worker safety and device safety. Relays can also be used to design logical functions as in early computers.

Fig. 9: Relay

1.2.7: Water Pump

The net weight of the pump is 150 gm. Its dimensions of inlet and outlet are 15 mm O. D. and 5 mm O. D. Its working voltage is 12 V DC and the working current is 0.1 – 0.5 A. Its lift is 130 cm at 12 V DC and the flow rate is 300L/H.

In this project, the water pump is submerged in the reservoir from where the water will be pumped up to the main tank if it gets empty.

Fig. 10: 12V DC submersible water pump

1.2.8: Water Tank

The function of the water tank is to store the water which is to be filled in the water bottle via solenoid valve whenever required. The water tank contains a float switch which is normally used to determine the level of water and whenever the water level in the tank falls it is restored by the water stored into the reservoir with the help of the pump through a narrow pipe that is connected with the tank.

2.1: The Practical and Programming Circuit

In this chapter, the Practical and Programming Circuit for this project will be shown

- The Ladder Diagram circuit

This circuit must be drawn in the GMWIN program and upload into PLC unit by data cable

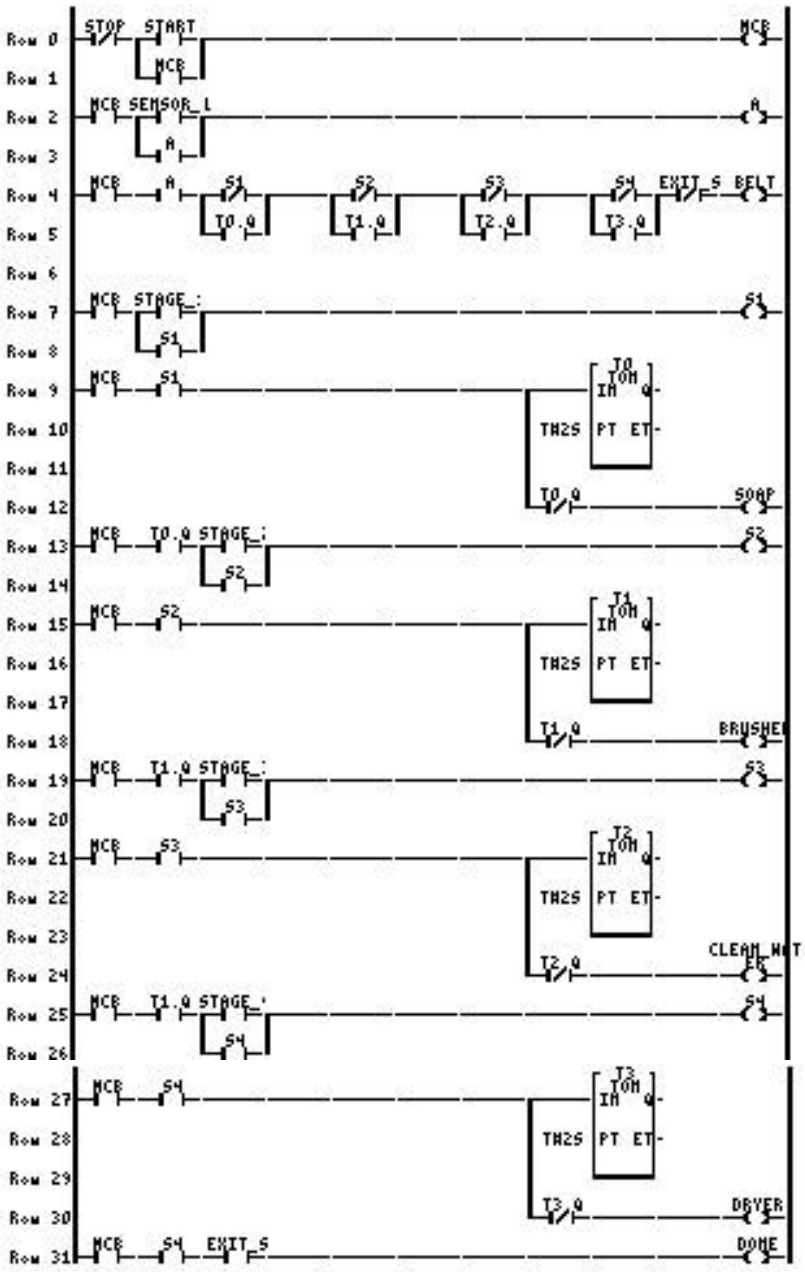

Fig. 11: Programming LD

- Program Explanation:

The ladder logic of Automatic Car Washing Process using PLC Ladder Diagram explanation as follows :

- Row 0, Row 1: Latching rung to operate the system through Master Start and Stop PB.
- Row 2, Row 3: Car entry sensor triggers the memory bit which will turn on conveyor motor.
- Row 4, Row 5: ON/OFF operation of conveyor motor is happening in this rung using various conditions like Sensor input and timer did output.
- Row 6 – Row 12: When the car reached stage 1 sensor conveyor motor should stop and water sprinkler should ON for 10 sec. At the end of the water sprinkler timer, Conveyor will again ON because of the parallel contact in Row 2,3.
- Row 13 – Row 19: When the car reached stage 2 sensor conveyor motor should stop and brusher should ON for 10 sec. At the end of the brushing process, Conveyor will again ON because of the parallel contact in Row 2,3.
- Row 19 – Row 25: When the car reached stage 3 sensor conveyor motor should stop and water sprinkler should ON for 10 sec. At the end of the water sprinkler timer, Conveyor will again ON because of the parallel contact in Row 2,3.
- Row 25 – Row 30: When the car reached stage 4 sensor conveyor motor should stop and water sprinkler should ON for 10 sec. At the end of the water sprinkler timer, Conveyor will again ON because of the parallel contact in Row 2,3.
- Row 31: When the car reached the exit , the car exit sensor will trigger the car wash done indication lamp

The variable table for the address of memory allocations and the variable name is shown in table 2 :

Name	Var. Kind	Allocation	Used	Data Type	Initial value	Comments
A	VAR	<Auto>	*	BOOL		
BELT	VAR	%QX0.0.0	*	BOOL		
BRUSHER	VAR	%QX0.0.2	*	BOOL		
CLEAN_WATER	VAR	%QX0.0.3	*	BOOL		
DONE	VAR	<Auto>	*	BOOL		
DRYER	VAR	%QX0.0.4	*	BOOL		
EXIT_S	VAR	%IX0.0.7	*	BOOL		
MCB	VAR	<Auto>	*	BOOL		
S1	VAR	<Auto>	*	BOOL		
S2	VAR	<Auto>	*	BOOL		
S3	VAR	<Auto>	*	BOOL		
S4	VAR	<Auto>	*	BOOL		
SENSOR_1	VAR	%IX0.0.2	*	BOOL		
SOAP	VAR	%QX0.0.1	*	BOOL		
STAGE_1	VAR	%IX0.0.3	*	BOOL		
STAGE_2	VAR	%IX0.0.4	*	BOOL		
STAGE_3	VAR	%IX0.0.5	*	BOOL		
STAGE_4	VAR	%IX0.0.6	*	BOOL		
START	VAR	%IX0.0.1	*	BOOL		
STOP	VAR	%IX0.0.0	*	BOOL		
T0	VAR	<Auto>	*	FB Instance		
T1	VAR	<Auto>	*	FB Instance		
T2	VAR	<Auto>	*	FB Instance		
T3	VAR	<Auto>	*	FB Instance		

Table 2: Variable Table

- Practical Circuit

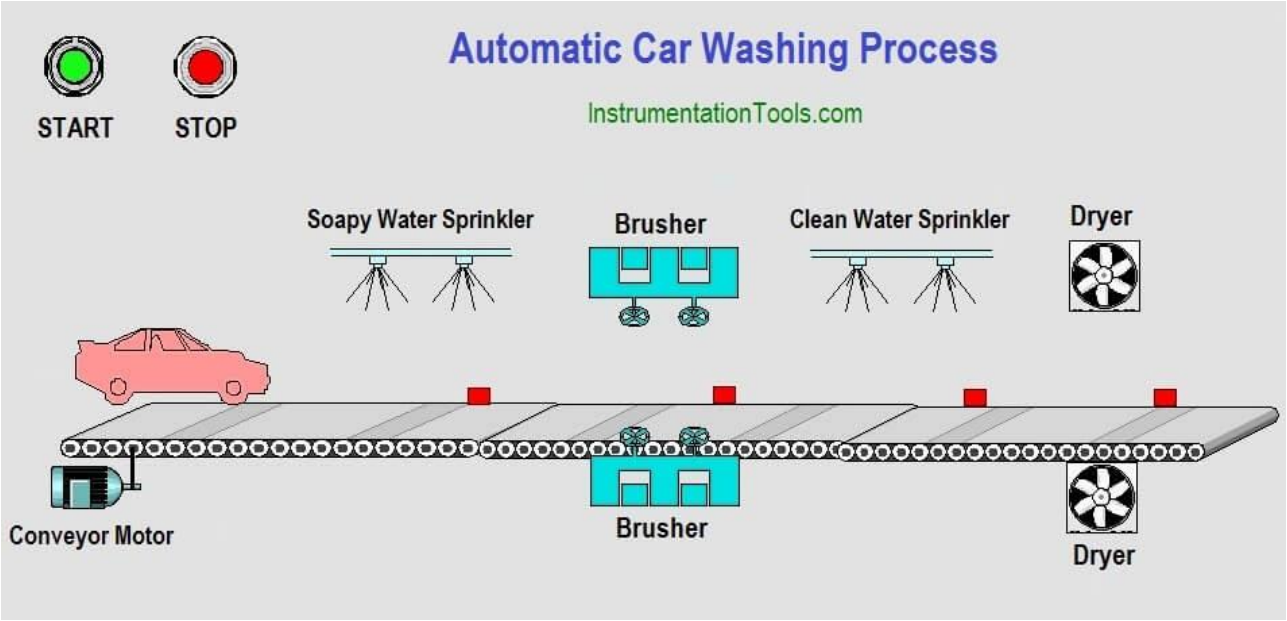

Fig. 12: Simulation of project

The figure above shows the final shape of the project which consents of five photosensors, two push-button, belt, water pump or valve, water tank, dryer, brushers, and lamp.

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[1] . Control of mechatronic system .Davide Borghi , cesare fantuzzi,2012.

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