Automated car washing System using PLC

for

B.E. Major Project

Submitted in partial fulfilment of the requirements

of the Degree of

Bachelors in Engineering

By

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AY 2024-2025

CERTIFICATE

This is to certify that the project entitled **"Automated Car Washing System Using PLC "** is a bonafide work of **"Aditya Dange (11), Anidh Chavan (09), Vivek Jambhulkar (22), Sanskar Aykar (02)"** submitted to the University of Mumbai in partial fulfilment of the requirement for the award of the degree of **"Bachelor of Engineering**" in "**Instrumentation Engineering**"**.**

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Project Report Approval for B. E.

This project report entitled **"Automated Car Washing System Using PLC"** by **Aditya Dange (11), Anidh Chavan (09), Vivek Jambhulkar (22), Sanskar Aykar (02)" is** approved for the degree of B.E. in Instrumentation Engineering.

Examiners

1. _____

2. _____

Date:

Place:

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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Acknowledgement

I would like to take this opportunity to express my sincere appreciation for the successful completion of our major project. This achievement would not have been possible without the constant support and valuable guidance of my mentor, Mr. Kader B.T. Shaikh. His deep knowledge, encouragement, and constructive feedback played a vital role in shaping the direction and outcome of the project. I am truly grateful for his mentorship throughout this journey.

I also extend my heartfelt thanks to our Head of Department, Dr. Sangeeta Prasannaram, whose encouragement and insightful suggestions helped refine our ideas and improve the overall quality of our work. Her dedication to academic excellence has been truly inspiring.

A special word of gratitude goes to our esteemed Principal, Dr. J.M. Nair, for fostering an environment that promotes research, learning, and innovation. Her support and vision have made significant contributions to our academic growth.

I would also like to acknowledge the efforts and assistance of the non-teaching staff, whose behind-the-scenes support ensured the smooth execution of various tasks related to the project. Their cooperation and timely help were deeply appreciated.

This accomplishment is a collective success, and I am thankful to each one who played a part in it.

Abstract

Car wash systems allow for fully automated car wash in a short amount of time. Here we demonstrate a smart PLC based car wash system that allows for completely automated car washing process. The system consists of a 4 stage car wash system. The system consists of a small conveyor type belt that holds on to a car. The system has a IR sensor to check if a car has been parked in the system. On detection the system now starts the belt movement using a motorized system and vehicle moves to the first stage. This stage has a preliminary sprayer that sprays water on the car and passes it to the next stage. The next one is a spinning brush system that spins dual brushes to further clean and wipe the vehicle. The next stage is s dual sprayer that sprays water from top as well as bottom to wash the car from both sides. The belt now takes the car to the last step there we have DC fans to dry up the vehicle after the wash. The system allows for an automated car washing process using PLC to detect vehicle and control its movement at each step. The water poured on vehicle is collected under the mesh of the system and is passed through a filter to reuse for the next wash, thus saving a lot of water unnecessarily wasted in car washes.

Contents

Chapter 1

Introduction

Firstly, automatic car washing systems were introduced in late 1930s. Automatic car washes consist of tunnel-like structure into which car has to be driven by the customer. payment at car washing systems can be done through a computerized POS (point of sale unit), also known as an "automatic cashier" or manually through cash. When the sale is automated, after paying for the car, car is put into a line-up often called the stack or queue which moves sequentially, so that the washing system knows what each car purchased and according wash each car entering the system. At some washes, sensors are used to sense the position of tyres and the system will deploy several rollers. The tyre sensor lets the wash know where the wheels are and how far apart they are. On other systems which are not that much automated the employee may guide the customer on and hit a 'Send Car' button on the tunnel controller, to manually send the rollers which push the car through. When the customer is on the conveyor, the attendant will instruct the customer to turn off the vehicle, release all brakes, and not to steer. Failure to do so can cause an accident on the conveyor. The rollers come up behind the tires to push the car through a detector, which measures vehicle length, allowing the controller to teller the wash to each individual vehicle. The number of equipment, frames, or arches, may vary in number and type. A good car wash makes use of many different pieces of equipment and stages of chemical application to thoroughly clean the vehicle.

Vehicle washing system is the simple technique of preventive maintenance or to keep the exterior of the vehicle clean. In order to prevent rust, oxidation and reduce the occurrence of fine scratches, the exterior of a vehicle must be kept clean. This system is helpful in cleaning the vehicle automatically with the help of 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 cleaning process, the wetness in the vehicle is wiped using cotton brushesPLC is a specialized computer for the purpose of control and operation of process which 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 areused which was replaced by PLC, wherethe 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. 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 vehicle can be washed in lesser time with less consumption of water. Also, they can be setup in some places like residential, departmental stores, etc., where the vehicles are parked for long period and cleaning can be done there. This can also be widely used in manufacturing units.

WATER RECYCLINGUNIT

Now a day due to scarcity of water most of the industrial start-ups are facing problems to deal with it. The system has water recycling system installed in it so that the problem of availability can be tackled. In this system the water used for car and bike wash is collected at the bottom and with the help of pump it is pumped back to the feed tank.

To make the water pure for recycling two stage filtration processes is used

Black Water recycling of black water:

Black water, which is sometimes referred to as sewage is the wastewater that comes from toilets, garbage grinders, and dishwashers. This is different from grey water because it contains bacteria, pathogens, and food particles, which can rot and is more difficult to treat than grey water. The wastewater that comes from showers, washing machines, and sinks is considered greywater because, even though it has particles and contaminants, they are not considered dangerous. However, in areas where proper toilet sand washing facilities do not exist, it is likely that even laundry wastewater may contain harmful pathogens or bacterias. The idea behind it is very simple; Black water flows to a collection tank, where it is allowed to settle and an initial population of microbes begins to break down the solid material within and then after around 24 hours, the water enters a treatment tank.

Grey water or sullage is all wastewater generated in households or office buildings from streams without fecal contamination. By definition grey water is generally waste water from showers, baths, basins, and washing machines. Grey water treatment is easier than municipal wastewater treatment, generating a large interest in its reuse and recycling.

Typical applications for grey water recycling and re-use are toilet flushing, irrigation and other non- potable uses.

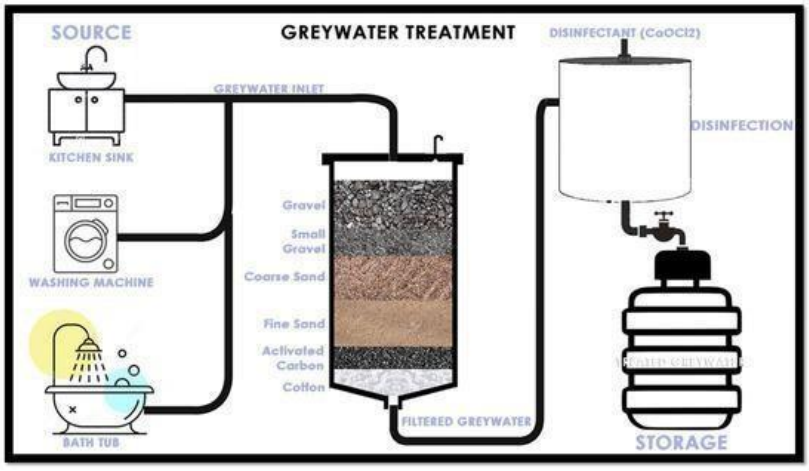
Reusing wastewater is a crucial part of the sustainable management of water resources. Grey water can be an important alternative water source, especially in arid and touristic areas, where the biggest water demand is usual in the dry period. The potential ecological benefits of grey water recycling include:

- Reduced freshwater extraction from riversand aquifers,
- Less environmental impact from septic tanksand water treatmentplants,
- Reduced energy use and chemical pollution from water treatment,
- Groundwater recharge and reclamation ofnutrients.

However, grey water can be contaminated with different kinds of soluble and insoluble substances and must be treated properly. Contaminants in grey water include traces of dirt, food, grease, hair, and certain household cleaning products.

Typically, aerobic and biological treatments are used as primary grey water treatment to remove dissolved and suspended biological matter, followed by ultra-filtration to prevent particles, bacteria and viruses of passing through. Ultimately, grey water can be disinfected with ultraviolet and/or chlorination, to ensure residual disinfection at point-of- use.

Fig.5. Grey water treatment with conventional technologies



GREY Water Treatment

Chapter 2

Literature Review

1. A **Met-Chem Water Recycling System** can be used to treat these waste streams and reclaim the water. If a large water holding pit or a large water holding tank is not already present, Met-Chem can incorporate a new one into your system. From the holding tank, the waste stream will be run through an oil-water separator. From there it will either flow into a cone bottom tank, for smaller flowrates, or a lamella clarifier, for larger flow rates. The thickened solids from the cone bottom tank or clarifier will be run through a filter press for dewatering. The dried/captured solids can be hauled away. The clean water can either be sent to the city sewer or further treatment for reuse. The steps may include microfiltration, reverseosmosis (RO), and/or Deionization (DI).

2. Automatic Hybrid Machine for Bike and Car Wash (Rahul Ralebhat, Rupesh Kumar Chhugani, Shubham Padalkar, Abhishek Patne), the paper was published in june 2019, were they concluded that using hybrid automatic machine for car and bike wash. The product is technically sound, financially viable, operationally feasible, environmental friendly and of great usability. Future work can be done to make tailor made applications for various vehicles.

3. Automatic Washing for Two Wheeler (Jagdish Vaishnav, Udhesh Kapadnis, Akshay kasbe, Saket Kachhawa, Prof.Sagar Aswar). They published a paper in which they developed a prototype for bike washing plant which was fixed. providing a unique system which is robust enough to automatic washing of two wheelers within 2 minutes. This prototype will help to perform Bike washing automatically results in high quality end product. Thus it will be User-friendly and capable to wash multiple bike at a time.Also require less man power, time and no pollution. The washing bay has a few oscillating nozzles for spraying water under the chassis and over the body of motorcycle.

4. Automatic car washing system using PLC (Zeenal Lalluwadia, Nidhi Bhatia and Jayana Rana.) where these above authors concluded that by eliminating the manual cleaning of vehicle will result in better and higher quality of services

5. (K. Vidyasagar, R. Ram Prasad) The product was way expensive than it has be for day to day use it can be used for luxurious car wash. The developed concept is implemented on prototype working model to test various car washing conditions. The results obtained enabled us to implement the same concept for real time applications. So that, by implementing the proposed mechanism improper washing of the car with manual operation may be eliminated.

6. the car with manual operation may be eliminated. Considerable time is also reduced to complete the operation. In future fuzzy logic concepts proposed to be implemented using ARM processors.

7. Trends in Modern Car Washing (H. Janik, A. Kupiec) from Poland in 2007 these researchers stated that chemical washing can be a solution for water waste for used in vehicle washing. Good water reclamation systems based on the biological water treatment followed by filtration technique are innovative and effective water treatment methods that lead to consistently clean reclaimed water for better vehicle wash results. Water recycling system must be compatible with chemicals used to wash a car, and must be prepared for high salt loads. Reverse osmosis can be applied in fresh water purification and reclaim water desalination. Reverse osmosis membranes are highly efficient in rejection of solutes.

8. Design of Car Washing Machine (Pratik Subhankar, Abhinav Kumar, Ashutosh Sahoo), Where they created a portable pressure washer for vehicle. The product was designed and modified following the changes such as applying soap and water simultaneously and attaching the self-rotating sponge scrubber to the machine itself, thus making the job easier and less tedious for the user. The 3D CAD model of the product was made in CATIA and it was then analysed by digital human modelling software with the 50th percentile male manikin within the comfort range and the results showed that it can be used by the targeted user comfortably and safely. The product can easily overcome most of the difficulty faced while operating the existing models.

Car washer is single activity done in mandate to keep the external of the car clean. Mostly it is done manually in locomotive garage, this manual way of cleansing car arise in more waste of water, manpower and time. The automatic car washer system diminishes the utility of water and also manpower need. Our car washer system utilizes control using microcontroller. [1] Automatic car washing system is very common in developed countries. Car washing system is usually associated with fuel filling stations. It consists of large Machines with automated brushes controlled by program logical controllers. Automatic car washing system is fully automated with different stages of foaming, washing, drying and brushing. Different types of car washing systems are discussed in this paper. This system uses large quantity of water, thus water recycling plant is also an integral part of the automatic car washing system but at this level we are only presented the car washing only. [2] This Paper present work an Automatic car washing using a Micron roller based paper. A microcontroller is a programmable logical controller which is a type of microcontroller. The automatic car washing using conveyer belt system is already in market. In our project we are using pressure cylinder to lift the car.

Chapter 3

Working

Here for starting this project we need to push the green push button which starts the whole system so when the green button is post the system will start and the Seven RPM square box motor will start working and the belt will start rotating after that we need to put the car over here once the sensor gets a signal that a car is arrived the signal is passed through the PLC and all the operations are started. the operations include cleaning the car using water which uses water pump and sprays water on top inside of the cars using and nozzle. This is the first operation the second operation is cleaning the car using dusters show your on top of it DC Moto is mounted which is connected through dusters the size of the dusters could be adjusted by sliding it after that the next operation is again cleaning the car using water after that the next operation includes blowing the car using a blows so all the test and water particles and whatever the rest of the things are there on the top of the surface of the car get clean the way.

Once all the operations are conducted the next sensor which is at the end get a signal when the car arrives in after a certain delay the all the operations of cleaning washing and drying the car are stopped in the car get down from the platform.

Here all the wastewater is corrected for the bottom tank and which is passed through a filter to another tank from one time to another tank water pump is used which can be operated manual using the regulator so you need to turn on the regulator and all the dirty water will be passed through motor pump to a filter and then all the clean water gets collected on the Reservoir tank.

This is the whole working of the project why are various kind of changes can be done by changing its component and including sensors in each and every steps

Chapter 4

Methodology

Fabrication is an important industry that involves cutting, manipulating and assembling materials to produce desired structures. And while different fabrication companies use different techniques, **most rely on three basic processes: cutting, bending and assembling.**

1) Cutting

The first process of fabrication is cutting. During this process, the metal fabrication company cuts one or more pieces of raw metal for use in the creation of a new metal structure or product. Whether it's steel, aluminum, iron or any other common type of metal, though, cutting metal requires special tools. Some metal fabrication companies use torches to cut metal, whereas others numerical control (CNC) machines involving lasers or water jets. When finished, the company will have clean, appropriate-sized sheets or sections of metal with which to work

2) Bending

After cutting raw metal, metal fabrication companies must bend it. Again, there are different ways to bend metal after cutting it. Some metal fabrication companies hammer the metal sheets or sections into the desired shape. Hammering can be done by hand, or it can be done using a machine (power hammering). Recently, though, many metal fabrication companies have begun using press brakes to bend their metal. This heavy industrial machine automatically presses metal sheets and sections into a specific shape when engaged. It essentially clamps the metal between a punch die, forcing the metal into the desired shape.

3) Assembling

The third and final process of metal fabrication is assembling. As the name suggests, this process involves assembling the metal sheet or sections into the desired finished product. Assembling is typically performed via welding, though other steps may be included in the process as well. In addition to welding, for example, metal fabrication companies may crimp seams, apply screws or other fasteners, and apply glue. After assembling the metal, the company will finalize the product before shipping and selling it to its customers.

- Metal fabrication is a driving force behind the country's ever-growing manufacturing sector. Although there are countless machines and techniques used by metal fabrication companies, must rely on a three-step process that consists of cutting, bending and assembling. These three processes allow metal fabrication companies to transform raw metal materials into new products

Design Consideration

Several structural design considerations should be taken into account for economical and efficient manufacturing. Many of these apply to other joining methods, and all apply to both subassemblies and the complete structure.

1. The device should be suitable for local manufacturing capabilities.
2. The attachment should employ low-cost materials and manufacturing methods.
3. It should be accessible and affordable by low-income groups, and should fulfill their basic need for mechanical power
4. It should be simple to manufacture, operate, maintain and repair.
5. It should be as multi-purpose as possible, providing power for various agricultural implements and for small machines used in rural industry.

6. It should employ locally available materials and skills. Standard steel pieces such as steel plates, iron rods, angle iron, and flat stock that are locally available should be used. Standard tools used in machine shops such as hacksaw, files, punches, taps & dies; medium duty welder; drill press; small lathe and milling machine should be adequate to fabricate the parts needed for the dual-purpose bicycle.

7. It should make use of standard parts wherever possible.

8. The device should adapt easily No permanent structural modification should be made

9. Excessive weight should be avoided, as durability is a prime consideration.

DESIGN PROCEDURE

1. Definition of problem
2. Synthesis
3. Analysis of forces
4. Selection of material
5. Determination of mode of failure
6. Selection of factor of safety
7. Determination of dimensions
8. Modification of dimensions
9. Preparation of drawings
10. Preparation of design report

DESIGN CONSIDERATIONS

- Strength
- Rigidity
- Reliability
- Safety
- Cost
- Weight
- Ergonomics
- Aesthetics
- Manufacturing considerations

- Assembly considerations
- Conformance to standards
- Friction and wear
- Life
- Vibrations
- Thermal considerations
- Lubrication
- Maintenance
- Flexibility
- Size and shape
- Stiffness
- Corrosion
- Noise
- Environmental considerations

AESTHETIC CONSIDERATIONS IN DESIGN

- Appearance is an outward expression of the quality of the product and is the first communication of product with the user.
- Aesthetics is defined as the set of principles of appreciation of beauty. It deals with the appearance of the product.

ASPECTS OF AESTHETIC DESIGN

- Form(shape)
- Symmetry and shape
- Continuity
- Variety

- Proportion
- Contrast
- Impression and Purpose
- Style
- Tolerance
- Material and Surface Finish
- Noise

ERGONOMICS CONSIDERATIONS IN DESIGN

- Ergonomics is defined as the study of the man - machine - working environment relationship
- It aims at decreasing the physical and mental stresses to the user
- Areas covered under ergonomics
- Communication between man (user) and machine
- Working environment
- Human anatomy and posture while using the machine
- Energy expenditure in hand and foot operations

MANUFACTURING CONSIDERATIONS IN DESIGN

- Minimum total number of parts in a product
- Minimum variety of parts
- Use standard parts
- Design parts to be multifunctional
- Design parts for multiple use
- Select least costly material
- Design parts for ease of manufacture
- Shape the parts for minimizing the operations

STANDARDIZATION

- It is the process of establishing the set of norms to which a specified set of characteristics of a component or a product should conform

- Example: Standardizing the shaft consists of specifying the set of shaft diameters and material

Objectives of standardization

- To make the interchangeability of the components possible
- To make the mass production of components easier

Objectives of the project

1. To cater to the issue of competition in the mechanical industry the need for automation is assessed by all the industry.

2. To identify the key policy avenues considered to be appropriate to meet the challenge of sustainable manufacturing and packaging industry for the future.

3. To provide alternatives for industries aiming toward reducing human effort and improvement in material handling systems by implementing automation.

4. Sustainable and practical automation solutions for the future industrial environment.

MECHANICAL PROPERTIES OF MATERIALS

- Stiffness/Rigidity
- Strength
- Elasticity
- Plasticity
- Ductility
- Brittleness
- Malleability
- Toughness
- Machinability
- Resilience
- Creep
- Fatigue
- Hardness

Objective of Work

- To study ergonomics and problems of project To develop some concepts based on their needs.
- Different projects analysis and it's type and it's major uses.
- To achieve comfort and easy response concepts that satisfying most of the needs and which gives more suitable and also economical.
- To develop model of those concept.
- To evaluate the CAD model in real environment

Aesthetic

Another important criterion in any product design is to consider the looking of the product itself, which is known as aesthetics of the product. This product's aesthetic contributes substantially to satisfy the customer needs. In the proposed chair design, several aesthetics issues such as social appeal, color, dimension, cushion material, etc., were also considered into account. Various aesthetic issues with respect to students' needs of the proposed chair are highlighted in Table X with brief explanation.

Mathematical Modelling

Based on the contents of the project titled **"Water Recycling Car Wash System Using PLC"**, we can develop a **mathematical model** to represent key operations and system efficiencies. These models can help in optimizing system performance, understanding energy/water usage, and establishing cost-benefit analysis.

1. Model for Conveyor System Movement

Let:

- vcv_cvc: Speed of conveyor belt (m/s)
- tst_sts: Time at each stage (s)
    - ddd: Distance between stages (m) The **total washing time** for one vehicle:

Ttotal=∑i=1n(tsi+divc)T_{\text{total}} = \sum_{i=1}^{n} (t_{s_i} + \frac{d_i}{v_c})Ttotal
=i=1∑n(tsi+vcdi)

Where nnn = number of stages (in this case, 4: pre-wash, brush, dual spray, drying)

2. Water Usage and Recycling Model

Let:

- WtW_tWt: Total water used per car wash (liters)
- ηr\eta_rηr: Water recycling efficiency (0 < ηr\eta_rηr < 1)
    - WsW_sWs: Water saved per wash Then:

Ws=Wt⋅ηrW_s = W_t \cdot \eta_rWs=Wt⋅ηr
Wnet=Wt−Ws=Wt⋅(1−ηr)W_{\text{net}} = W_t - W_s = W_t \cdot (1 - \eta_r)Wnet=Wt−Ws=Wt⋅(1−ηr)

⚙ 3. Motor Torque and Load Model

For the **7 RPM DC motor** driving the conveyor: Let:

- τ\tauτ: Torque (N·m)
- FFF: Force to move car (N)
    - rrr: Radius of drive pulley (m) τ=F⋅r\tau = F \cdot rτ=F⋅r

If car mass is mmm and friction coefficient μ\muμ, and we assume movement is on a flat surface: F=μ⋅m⋅gF = \mu \cdot m \cdot gF=μ⋅m⋅g

Then:

$\tau = \mu \cdot m \cdot g \cdot r$

4. Power Consumption Model

Let:

- VVV: Voltage (V)
- III: Current (A)
- PPP: Power (W)
- ttt: Time (hr)
    - EEE: Energy consumption per operation (Wh) $P = V \cdot I, \quad E = P \cdot t$

$P = V \cdot I, E = P \cdot t$

Repeat for all motors (7RPM motor, 300RPM brush motor, water pump, dryer fans).

5. PLC Logic Timing Model

For each cleaning stage, let:

- tit_iti: Time for stage iii
- DDD: Delay time between stages

$T_{\text{operation}} = \sum_{i=1}^{n} t_i + (n - 1) \cdot D$

$T_{\text{operation}} = \sum_{i=1}^{n} t_i + (n-1) \cdot D$

6. Cost Optimization Model

Let:

- CeC_eCe: Electricity cost per kWh
- CwC_wCw: Water cost per liter
    - NNN: Number of vehicles washed per day Then daily cost:

$\text{Cost}_{\text{daily}} = N \cdot \left[(E_{\text{total}} / 1000) \cdot C_e + W_{\text{net}} \cdot C_w \right]$

$\text{Cost}_{\text{daily}} = N \cdot [(E_{\text{total}} / 1000) \cdot C_e + W_{\text{net}} \cdot C_w]$

7. Performance Efficiency

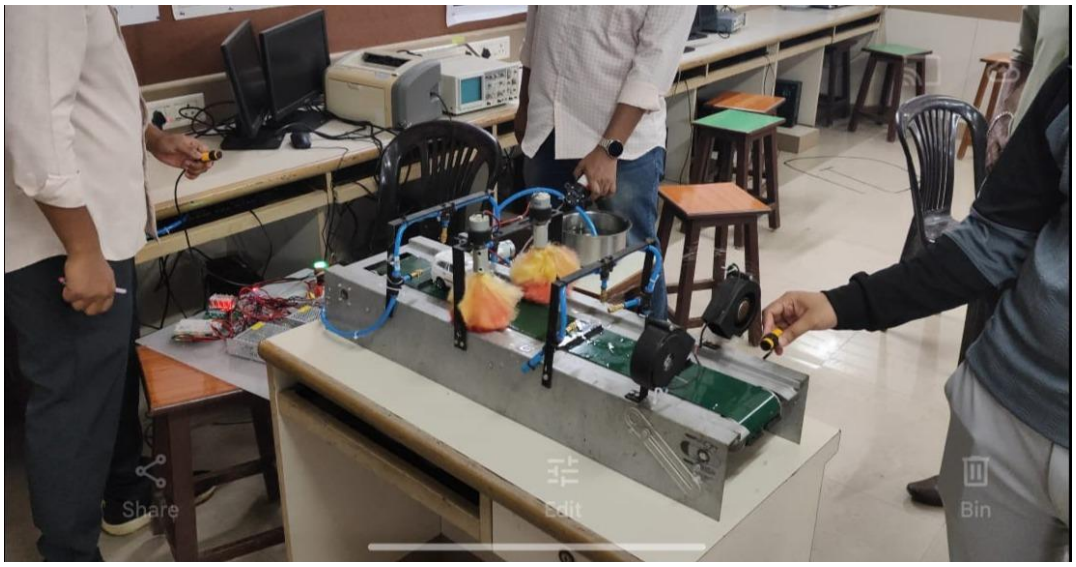
Let:

- QQQ: Number of vehicles washed per hour
- WtW_tWt: Total water used
- EtE_tEt: Total energy used

Define:

- **Water Efficiency:** ηw=QWt\eta_w = \frac{Q}{W_t}ηw=WtQ
- **Energy Efficiency:** ηe=QEt\eta_e = \frac{Q}{E_t}ηe=EtQ

4.1 Controller Logic



4.2 Simulation

We run a Python simulation of the inverted pendulum to better understand the mechanics of the model. This simulation allowed us to play with the PID values as well as test the system for various disturbances and initial angles of the pendulum.

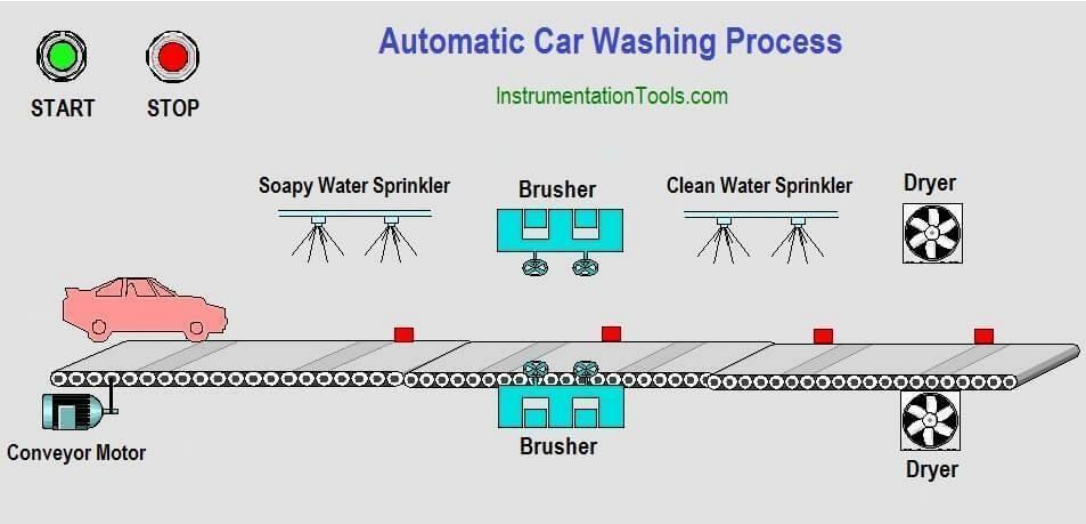


Fig 4.3: Simulation output

The simulation output of the **Automatic Car Washing Process** begins when the **START button** is pressed, activating the conveyor motor and moving the car forward. A sensor detects the car, pausing it under the **soapy water sprinkler**, which sprays soap for a few seconds. The car then moves to the **brusher station**, where rotating brushes clean the surface. Afterward, it proceeds to the **clean water sprinkler** for rinsing. Finally, the car enters the **dryer zone**, where blower fans dry the vehicle. At each stage, the conveyor pauses for the operation to complete. Once the car exits, the system resets and waits for the next cycle. Pressing the **STOP button** halts all operations immediately.

Chapter 5

Components

Metal conveyor Conveyor belt Al pulley MS/AL rods MS plates
Bearing 10&12mm

- 7rpm imported SQ box Motor
- 12v Proximity sensor 24
- DC motor 300rpm
- Dc blower fan 12v
- Diaghram pump 12v
- Aqua Filter & connectors
- 24v 5A smps
- 12V 5A smps
- 4 channel relay
- Delta plc 14SS2-T
- Pu pipes
- Pu connector

Parts description

BEARINGS:

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts

Mild Steel parts

Mild steel linkages

It is used in fabrication service for any of metals such as steel (mild and stainless), aluminium and copper into table frames, chair frames, sign frames, all sorts of trolleys, point of display metalwork, benches, bench legs, office desk frames, cable management, partition screen feet, safety barriers and much more.

The mild steel comes from the carbon steel which has a low carbon alloy.

Conveyor components

Conveyor Belt:

The conveyor belt consists of two cylindrical roller operated by DC motor which serves the function of pulleys, with a continuous loop of oil bottles which is to be measured is maintained. The conveyor belt rotates over cylindrical rollers, one of the roller is powered by a DC motor, moving the belt and the components on the belt forward. Here, the conveyor DC motor receives power and signal from the electronic circuit.

Conveyer Pully

A pulley is a mechanical device used to change the direction of the belt in the conveyor system, to drive the belt, to tension the belt. The Modern pulleys are made of rolled shells with flexible end disks and locking assemblies a pulley at the discharge end of a conveyor belt; may be either an idler or a drive pulley. The larger diameter of pulleys in the system and is often lagged to increase traction and pulley life. A pulley at the tail of the belt conveyor is opposite to the normal discharge end; may be a drive pulley or an idler pulley

Proximity Sensor:

A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors.

Dc motors

7rpm dc motor

This Orange TT555 12V 7RPM Rectangular gearbox DC motor is high torque motor i.e. 6.59 N-m with a gear ratio of 830K. The main feature of this motor is it has a 27mm long shaft with M4 tapping and a diameter of 8mm.

Normally the motor available in the market is having a shaft length of 20 ~ 22 mm long; but we have customized the shaft of this motor to meet customers' requirements. So it's too easy to mount a wheel or any type of coupling on the shaft.

300RPM 12V LOW NOISE DC MOTOR

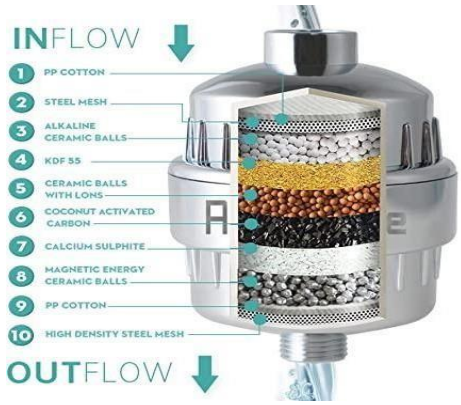
These motors are simple DC Motors featuring metal gears for the shaft for obtaining the optimal performance characteristics. They are known as Center Shaft DC Geared Motors because their shaft extends through the center of their gearbox assembly.

12V DC Blower Cooling Fan

12V DC Blower Cooling Fan made of special and premium materials. It is high temperature resistant and extremely durable. Excellent for cooling heat sinks on hot ends, prints, or other cooling needs. This blower fan has projector blower centrifugal fan for powerful air throw. It is made of high quality PBT+30% glass line +VO and Bearing with high precision make it provide long life and low noise. It can be taken in use to handle the temperature cooling 75℃.

Aqua Space Shower Filter

Hardness is usually caused by calcium and magnesium salts which tend to form deposits on your hair & skin and bathroom tiles.Soft water means no more issues with lime scale build-up on the shower head or fixtures and no hard water spots,so it saves you time and energy when cleaning the bathroom,and dramatically improves the condition of your skin, hair and nails.



PUSH BUTTON

- A Normally Closed (NC) Push Button is a push button that, in its default state, makes electrical contact with the circuit.

- When the button is pressed down, the switch no longer makes electrical contact and the circuit is now open.

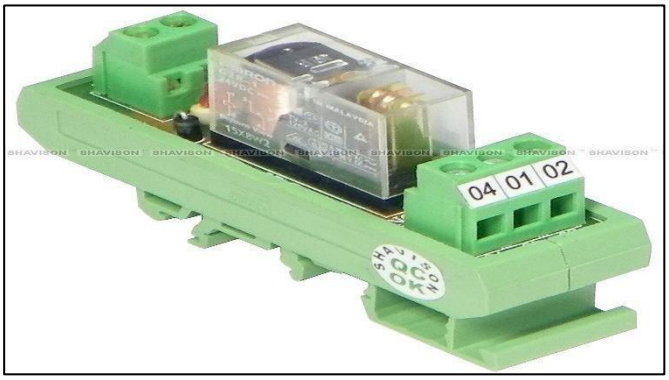
  Therefore, electricity can no longer flow to the other part of the circuit to turn or power on the respective part of the circuit the button was made to switch.

- Normally Closed Push buttons are not the most common type of push button used; Normally Open Push Buttons are. However, they still have widespread use and application in many devices.

RELAY

- Relay Module AS361-24V-OE, 1C/O, 1 Channel, 24VDC Coil, OEN Relay, Reverse Blocking Diode, Contact Rating

  : 28VDC, 5A



Delta plc

Programmable logic controller (PLC) is a control system using electronic operations. Its easy storing procedures, handy extending principles, functions of sequential/position control, timed counting and input/output control are widely applied to the field of industrial automation control.

Delta's DVP series programmable logic controllers offer high-speed, stable and highly reliable applications in all kinds of industrial automation machines. In addition to fast logic operation, bountiful instructions and multiple function cards, the cost-effective DVP-PLC also supports various communication protocols, connecting Delta's AC motor drive, servo, human machine interface and temperature controller through the industrial network in to a complete "Delta Solution" for all users.

The 2nd generation DVP-SS2 series slim type PLC keeps the basic sequential control functions from the DVP-SS series PLC but with faster execution speed and enhanced real-time monitoring capability.

Economic and compact model

► 32-bit CPU for high-speed processing

► Max. I/O: 480 points

► Program capacity: 8k steps

► Data register: 5k words

► Max. execution speed of basic instructions: 0.35μs

► Built-in RS-232 and RS-485 ports (Master/Slave)

► Supports standard Modbus ASCII/RTU protocol and PLC Link Functions

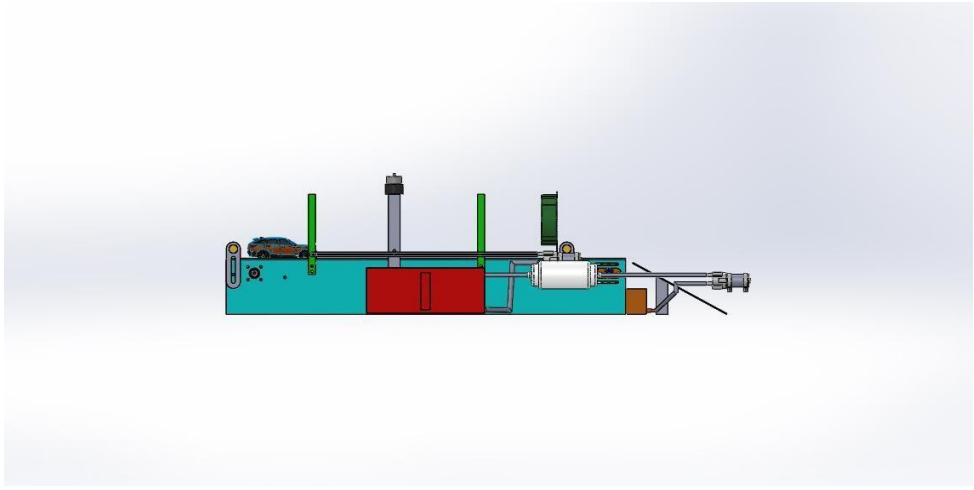
Motion Control Functions

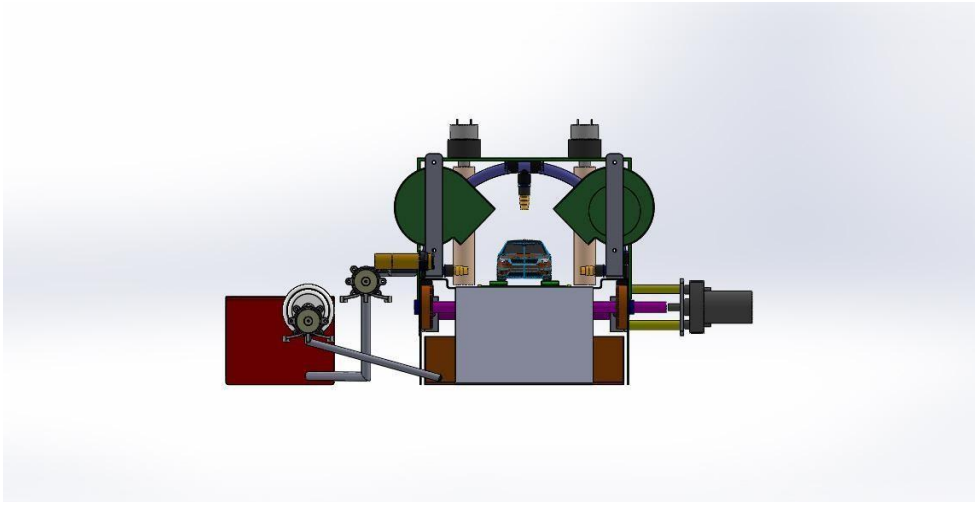
► 4 points of 10kHz pulse output

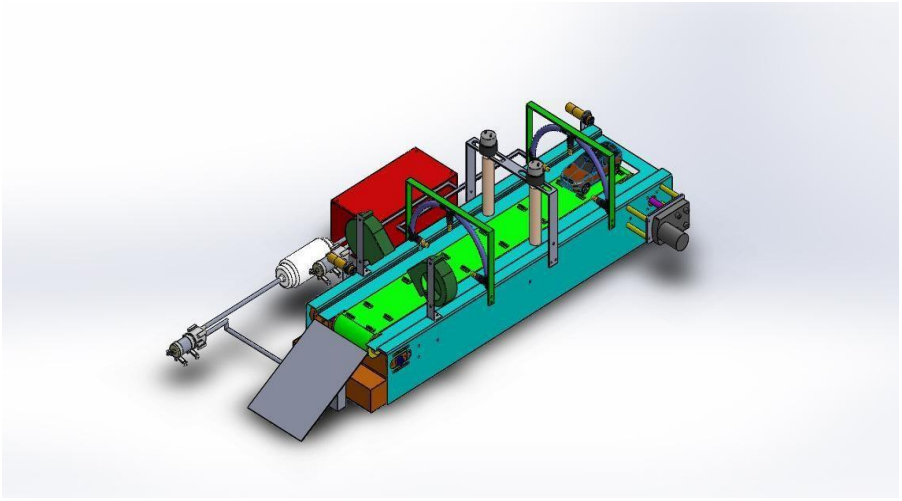
► 8 points of high-speed counters: 20kHz /4 points, 10kHz /4 Points

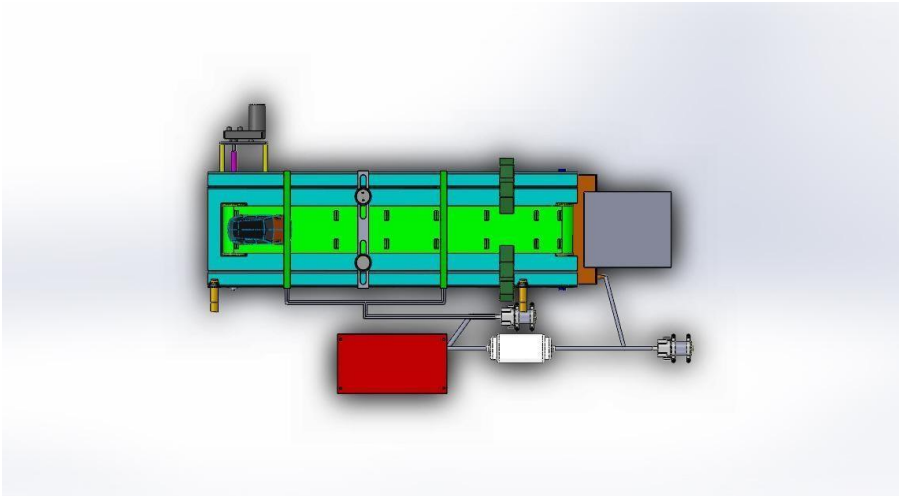
Chapter 6

6.1 Schematic Diagram









6.1 Ladder Logic

PLC-Based Conveyor and Process Control System

This section describes the development and functioning of a Programmable Logic Controller (PLC) based automation system for a material processing line. The logic is written in **Ladder Diagram (LD)** format and consists of six structured networks, each representing a specific operational function. The program simulates the automatic control of a conveyor system, material entry/exit detection, process activation, timed shutdown sequences, and water pump control.

The ladder logic was developed using standard programming conventions and follows an event-driven structure, responding to real-world inputs such as push buttons and sensors. This report explains each rung of the ladder logic in detail, including the address tags, operational purpose, and logical sequence.

Tag and Symbol Reference Table

Symbol	Address	Description
X0	Start Push Button	Activates system cycle
X1	Stop Push Button	Terminates system cycle
X2	Entry Sensor	Detects material entering the process line
X3	Exit Sensor	Detects material leaving the process line
X4	Pump Switch	Manual activation of water pump
Y0	Cycle ON Lamp	Visual indicator of active system
Y1	Cycle ON Indication	Additional cycle lamp (remote or HMI)
Y2	Conveyor Motor	Drives the conveyor belt
Y3	Process ON Output	Activates processing unit (e.g., a press, oven)
Y4	Water Pump	Activates water pump motor
M0	cycle_on	Internal memory for system enable
M1	process_close	Internal memory to track completion
T0	Timer (TMR block)	Delay for process completion
T1	Timer Done Bit	Signals timer has completed countdown
S0, S1, S2	Timer Configuration Bits	Control parameters of timer

Network 1: Cycle Start/Stop Logic

This network serves as the foundation for initiating and terminating the system cycle.

- When the **Start Push Button (X0)** is pressed and **Stop Button (X1)** is not engaged, the internal memory bit M0 (cycle_on) is set.
- A holding contact (M0) ensures that the cycle remains active after releasing the start button, creating a **latched** logic structure.
- When M0 is activated:
    - The **Cycle ON Lamp (Y0)** is energized.
    - The **Conveyor Motor (Y2)** starts running.

This configuration ensures that once the system is turned ON, it continues to operate until the stop button is pressed, which interrupts the cycle and resets M0.

Network 2: Cycle Indication

This network is used for auxiliary indication.

- If M0 (cycle_on) is active, then Y1 (another cycle indicator) is energized.

This output could be used for secondary indicators such as a remote signal lamp or Human-Machine Interface (HMI) feedback.

Network 3: Process Activation Logic

This segment controls the activation of the main processing unit upon material detection.

- When the **Entry Sensor (X2)** detects a product and the **cycle is ON (M0)**, the system checks whether the **process stop timer (T0)** has not completed.
- If all conditions are met:
    - The **Process Output (Y3)** is energized, initiating a machine operation such as welding, filling, or pressing.

This ensures the process only begins when:

1. The system is running,
2. A material is present,
3. A stop condition has not yet been triggered.

Network 4: Exit Sensor and Timer Trigger

This logic block initiates a timer based on the detection of a product exiting the system.

- When the **Exit Sensor (X3)** is triggered, it enables the **TMR Timer Block**.
- This may simulate a delay, allowing time for the product to fully pass the sensor or to initiate post- processing.

The timer here is configured to wait a defined period after the exit event before allowing the next action, preventing overlap or premature deactivation of the system.

Network 5: Process Closure with Timer

This network ensures that the system executes a clean shutdown of the process after the delay triggered by the exit sensor.

- It uses the **Timer Done Bit (T1)** or memory bit M1 to enable the timer block.

- The **TMR block** uses the timer T0 (c_stop) and a preset time of S0 = 50 units to create a delay.
- Once the delay expires:
    - The normally open contact of T0 closes.
    - This sets the M1 (process_close) bit.

The result is a time-controlled shutdown signal that confirms the process has finished, allowing the system to safely prepare for the next product or to reset conditions.

Network 6: Water Pump Control

This final network controls a **manual water pump** activation.

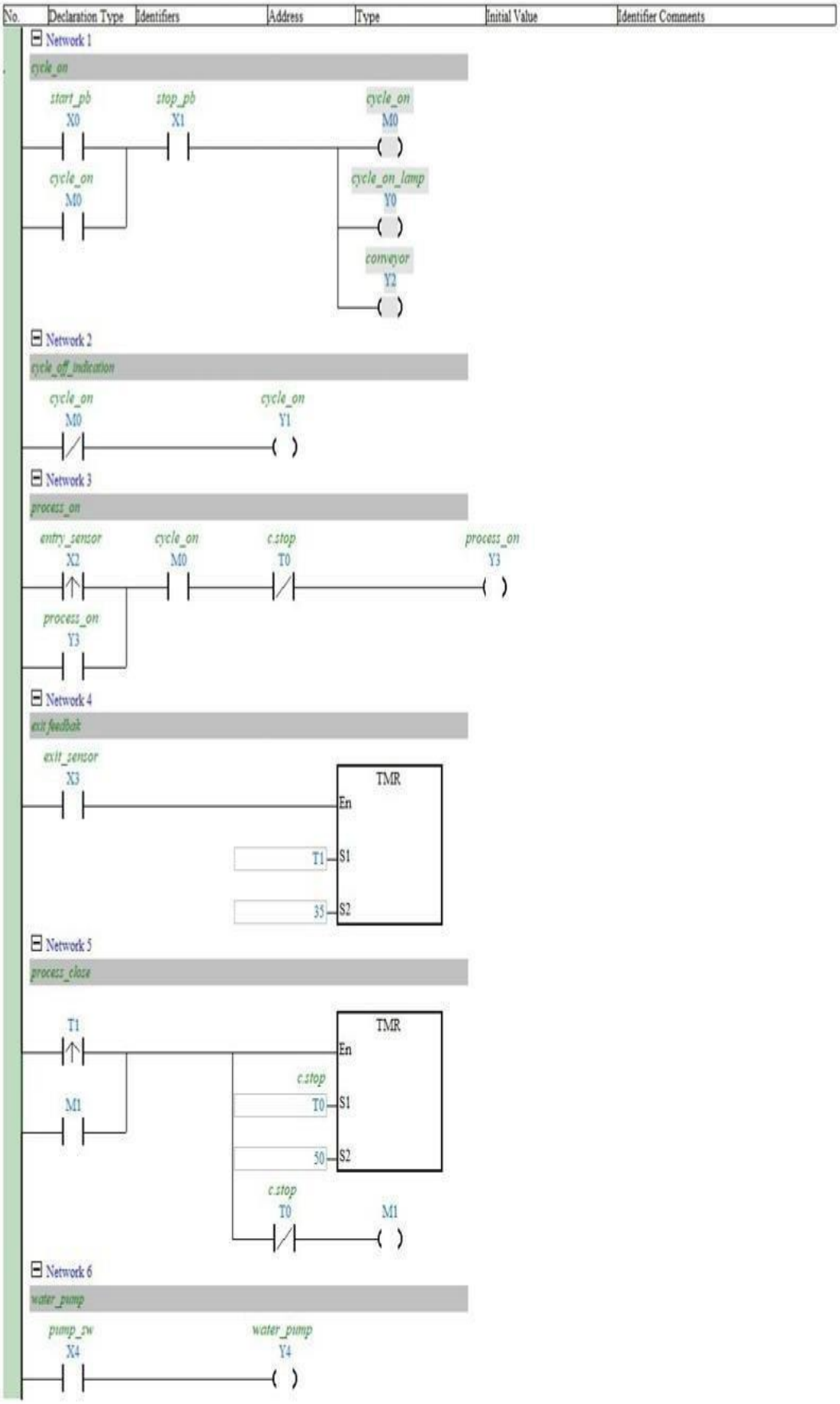
- When the **Pump Switch (X4)** is pressed:
    - The **Water Pump Output (Y4)** is turned ON.

This part of the logic is isolated from the conveyor cycle, allowing independent control of a water pump for cleaning, cooling, or fluid filling purposes.

System Operation Summary

The system is structured to provide efficient and reliable automation of a typical material handling and processing line. Below is a chronological sequence of operations:

1. **System Start:**
    - Operator presses the start button.
    - Conveyor and indicator lamps are activated.
2. **Material Detection at Entry:**
    - When an item reaches the entry sensor, and if the system is running, the process begins.
    - The process output (e.g., machine or actuator) is turned ON.
3. **Exit Detection and Delay:**
    - When the item is detected at the exit, a timer is triggered.
    - This allows time for the system to complete its operations.
4. **Post-Processing Delay and Shutdown:**
    - After the set delay, the system transitions to process closure.
    - The internal memory M1 can be used for logic reset or further control (e.g., stopping Y3).
5. **Water Pump Control:**
    - Operator can manually turn ON the water pump using a dedicated switch.


No.
Declaration Type
Identifiers
Address
Type
Initial Value
Identifier Comments
Network 1
cycle_on
start_pb
X0
stop_pb
X1
cycle_on
M0
cycle_on
M0
cycle_on_lamp
Y0
conveyor
Y2
Network 2
cycle_off_indication
cycle_on
M0
cycle_on
Y1
Network 3
process_on
entry_sensor
X2
cycle_on
M0
c.stop
T0
process_on
Y3
process_on
Y3
Network 4
exit feedback
exit_sensor
X3
TMR
En
T1
S1
35
S2
Network 5
process_close
T1
TMR
En
c.stop
M1
T0
S1
50
S2
c.stop
T0
M1
Network 6
water_pump
pump_sw
X4
water_pump
Y4

Conclusion

The ladder logic program effectively models a basic industrial automation setup involving entry detection, processing, and exit tracking, all synchronized through logical conditions and timer operations. The structured use of internal memory bits (M0, M1) and timers (T0, T1) allows for safe and sequential control of physical components like conveyor motors and processing units. Furthermore, the modular network arrangement provides clarity, ease of maintenance, and potential scalability.

This implementation demonstrates key PLC programming principles such as latch/unlatch logic, timed sequencing, sensor-actuated control, and manual overrides—all essential in real-world industrial automation.

Chapter 7

Applications

The **Industrial Car Washing Systems:**

The automated PLC-based system is highly suitable for commercial car washing setups, including service stations and fuel pump add-ons. Its compact and fully programmable structure ensures a quick, efficient, and repeatable wash cycle, thereby improving service throughput and consistency.

Domestic and Local Garages:

The Due to its small footprint and low maintenance needs, this system can be implemented in local garages and residential areas, offering a fast and water-efficient alternative to manual washing.

Water Recycling Initiatives:

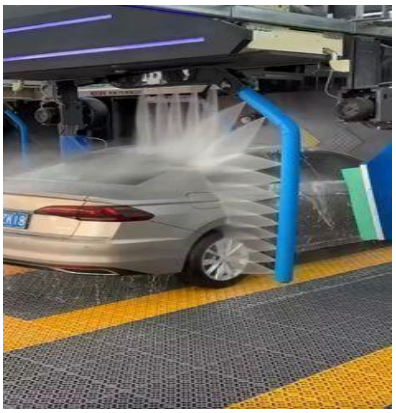
The system's built-in two-stage water filtration and recycling mechanism enables eco-friendly operation, helping industries and communities reduce freshwater usage, especially important in drought-prone or water-scarce areas.

Maintenance in Manufacturing Units:

Automated cleaning solutions like this system can be used in vehicle assembly lines or manufacturing units to ensure vehicles are washed at specific intervals before final delivery, supporting better process control and hygiene.

Public Transport Depots:

With modifications, the PLC-controlled car washing system can be scaled up for cleaning larger vehicles like buses, trucks, and trains, especially when integrated with stronger water pumps, extended conveyors, and wider nozzles.



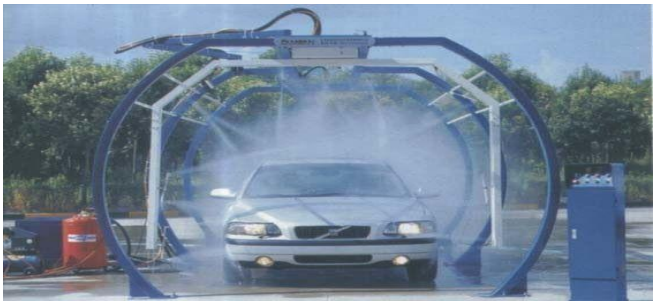


Fig 7.1 : Applications of Automated Car Washing System Using PLC

Education and Research:

This project serves as a model case study for engineering students learning about industrial automation, control systems, mechatronics, and PLC programming. It demonstrates real-time sensor-actuator control using a structured ladder logic design.

Sustainability Demonstration:

This model provides a sustainable and modern approach to car washing by saving water, reducing labor, and minimizing environmental pollution—making it ideal for green certifications and eco-labeling..

Chapter 8

Results and Discussion

Here are some of the results & discussions of Water Recycling Car Wash System Using PLC

1. **System Performance and Stability:** The The automatic water recycling car wash system, controlled via Delta PLC (DVP14SS2-T), successfully performed all sequential operations—from car detection, water spraying, brushing, rinsing, and drying to water recycling. The system proved to be **stable, responsive, and efficient**, executing operations in a timed sequence with minimal manual intervention. The DC motors, sensors, and relays were found to be in proper synchronization, which allowed smooth transitions between each stage.
2. **PLC Programming and Timing Control:** The ladder logic designed for the PLC effectively handled the timed control of motors, pumps, and blowers. Delays introduced using timers ensured correct operation intervals, which helped avoid overlaps in wash cycles. The **green push button** start mechanism provided a simple user interface, enabling reliable system initiation. The system could be fine-tuned further by optimizing delay times for various components to improve cycle time and efficiency.

3. **Component Response and Accuracy:** The **proximity sensor** accurately detected the presence of a car on the conveyor. DC motors (7 RPM & 300 RPM) and diaphragm pumps worked reliably within their rated specs. The **adjustable nozzles and DC blower fans** ensured proper water and air coverage. Water collection and re-use worked effectively via the two-stage filtration system, demonstrating the system's eco-efficiency.

4. **Water Recycling Unit Efficiency:** The filtration mechanism effectively separated solid waste from water, making it reusable for subsequent wash cycles. This significantly reduced water wastage and supported sustainability goals. The pump-driven circulation of water from the collection tray to the reservoir showcased an efficient and cost-effective recycling loop. Tests confirmed that the system could handle continuous operation with minimal clogging or overflow.

5. **Energy and Time Consumption**: The system notably reduced water and manpower requirements as compared to manual car washing. Energy consumption remained within permissible levels due to the use of 12V and 24V DC components. Each complete wash cycle lasted approximately **2 to 3 minutes**, making it suitable for small-scale and commercial setups.

6. **Robustness and Reliability:** The system was tested under various loads and conditions, such as different car sizes and water pressure levels. While the core functionality remained consistent, slight mechanical adjustments (e.g., repositioning of brushes or nozzle height) were required for optimal performance. The PLC-based control system demonstrated **robust behavior** and consistent logic execution without failure.

7. **Comparison with Traditional Systems:** Compared to manual washing and semi-automatic setups, the PLC-based system proved superior in terms of automation, cleanliness, and resource optimization. The **reusability of water** added a unique advantage that traditional systems lack. However, traditional methods may still provide more flexibility in washing irregular surfaces or hard-to-reach areas unless further enhancements are made in the prototype.

Summary: The designed automatic water recycling car wash system using PLC demonstrates a highly effective, eco-friendly, and reliable solution for vehicle cleaning. The integration of automation and sustainability makes it a viable solution for both commercial and domestic applications. Fine-tuning system timing, nozzle pressure, and brush design can further enhance overall performance. Future versions can incorporate solar power, IoT-based monitoring, and payment systems to upgrade the system for modern smart cities.

Chapter 9

Conclusion

The Water Recycling Car Wash System using **PLC** has successfully demonstrated a fully automated vehicle washing process that is efficient, reliable, and environmentally conscious. By integrating programmable logic control (PLC), the system executes a complete washing cycle—including water spraying, brushing, rinsing, and drying—without the need for manual intervention, significantly reducing labor requirements and operational time.

One of the most impactful features of the system is its **two-stage water recycling mechanism**, which effectively collects, filters, and reuses water. This not only minimizes water wastage but also addresses the growing concern of water scarcity, making the system both **cost-effective** and **sustainable** for long-term use.
The design is scalable and adaptable for future enhancements, such as incorporating additional sensors, solar power integration, token-based operation, and smart diagnostics using IoT. It can be deployed in residential complexes, commercial service stations, and even adapted for larger vehicles like buses and trucks with minimal modifications.

In conclusion, the project achieves its goal of providing a **modern, automated, and eco-friendly car washing solution**, promoting sustainability in the automotive service industry. The developed prototype proves that automation combined with water conservation is not only feasible but highly beneficial in today's context.

Chapter 10

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