Simulation of the Automatic Car Washing Station in CODESYS

Mukhamedzhan Nurmukhamed
Nazarbayev University
Nur-Sultan, Kazakhstan
mukhamedzhan.nurmukhamed@nu.edu.kz

Karina Burunchina
Nazarbayev University
Nur-Sultan, Kazakhstan
karina.burunchina@nu.edu.kz

***Abstract*—The industrial automation processes are designated the crucial place in our lives. Our project aims to implement automatic car washing station in CODESYS. The system uses proximity sensors, motors, pumps and fan to simulate the project. For program was coded on the Ladder Diagram language.**

***Index Terms*—CODESYS, industrial, automation, ladder diagram**

I. Introduction

The primary purpose for having your automobile cleaned is to remove dirt, debris, and other impurities that might harm your vehicle. If left untreated, the substances can cause metal corrosion (rust) and paint damage. As a result, it is critical to get such impurities eliminated. In an idealistic situation, a professional would clean your automobile by hand, using specialized materials. Professional hand-washing is not always an option in busy and hectic society. So, if you want to maintain your car clean and corrosion-free on a regular schedule, a professional automated car wash is your best choice.

In order to implement the project of the automated car washing station, we are going to use the Programmable Logic Controller (PLC). Because they are quick, easy to operate, and easy to program, PLCs are the preferred technique of controlling, measuring, and carrying out operations in complicated manufacturing and industrial applications. PLCs may be programmed in a variety of methods, ranging from ladder logic (electromechanical relays) through particularly specialized programming languages.

The utilization of this project can allow for easier car-washing process without the need for human assistance. In order to do so, we have decided to use CODESYS because it has successfully enabled us to quickly integrate the majority of automation elements into our architecture.

II. Problem Statement

The project is designed to introduce a simulation of the process of automatic car washing station (Fig. 1).

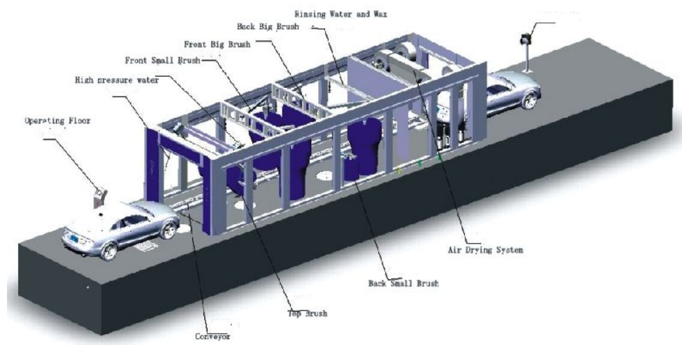


Fig. 1. Process of automatic car washing.

The main process will consist of four main stages. The first step is to sprinkle the car with the soap water (Fig. 2). The primary pump will be showering while the car is passing it.

Fig. 2. Soap water stage.

The second stage is brushing the car (Fig. 3). The brush motors will be turned on when the car is passing them.

Fig. 3. Brushing stage.

The next step is to rinse the car with clear water (Fig. 4). The pump with clear water will be showering while the car is passing it.

Fig. 4. Rinsing with clear water stage.

The last stage is the dryer (Fig. 5). The fan is drying when the car is passing it.

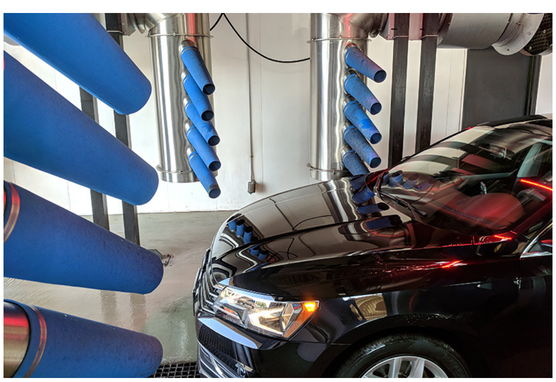


Fig. 5. Drying stage.

III. Implementation

The car washing station is going to incorporate several stages in order to complete the car washing process: 1) the start of the conveyor belt; 2) sprinkling the car with water; 3) soaping process; 4) brushing and washing; 5) washing off the soap with water; 6) drying; 7) the stop of the conveyor belt.

A. *Inputs and Outputs*

- Inputs for starting and stopping the conveyor belt: start and stop.
- Inputs for sensing if the car is present for other five out of seven stages (2-6): proximity sensors.
- Output for the conveyor motor (used for stage 1).
- Output for the pump (used for stages 2, 3, 5 for water).
- Output for the motor of the brush (used for stage 4).
- Output for the fan (used for stage 6).
- Output for finishing the process (used for stage 7).

B. *Components*

- Conveyor belt (Fig. 6). A conveyor belt is the carrying medium of a belt conveyor system, which is one of many different types of conveyor systems available today. Each conveyor system necessitates the use of several modules in order to work effectively and carry out the functions assigned to the belts. A conveyor belt system is made up of two or more pulleys (referred to as drums) and an unending loop of carrying medium – the conveyor belt – that revolves around them, providing a pull effect on the objects it is transporting. One or more of the pulleys will be motorized, propelling the belt and its contents forward and along the system [1].

Fig. 6. Conveyor belt.

- Proximity sensors (Fig. 7). A proximity sensor is a non-contact sensor that detects the presence of an item (also known as the ”target”) when it enters the sensor’s field. Depending on the type of proximity sensor, the sensor may detect a target via sound, light, infrared radiation (IR), or electromagnetic fields. There are several types of proximity sensors, and each detects targets in a unique way. The inductive proximity sensor and the capacitive proximity sensor are the two most prevalent types of proximity sensors [2].

Fig. 7. Proximity sensor.

- Solenoid valve (Fig. 8). A solenoid valve is a valve that is operated by electricity. A solenoid, which is an electric coil with a moveable ferromagnetic core (plunger) in its middle, is used in the valve. The plunger shuts a tiny aperture in the rest position. A magnetic field is created by passing an electric current through the coil. The magnetic field pushes the plunger higher, opening the aperture. This is the fundamental concept that allows solenoid valves to open and close. Solenoid valves are used to control fluid flow in situations when it must be done automatically. They are increasingly being employed in a wide variety of plants and equipment. Because of the many designs available, a valve may be chosen to exactly fit the application in issue [3].

Fig. 8. Solenoid valve.

- DC motor (Fig. 9). A direct current motor, sometimes known as a DC motor, is an electrical machine that converts electrical energy into mechanical energy by producing a magnetic field generated by direct current. When a direct current motor is turned on, a magnetic field is formed in the stator. The magnetic field attracts and repels magnets on the rotor, causing it to revolve. The commutator, which is coupled to brushes connected to the power source, supplies current to the motor's wire windings to maintain the rotor turning continuously. One of the advantages of DC motors over other types of motors is their ability to precisely adjust their speed, which is essential for industrial machines. DC motors can start, stop, and reverse instantly, which is critical for managing the operation of manufacturing equipment [4].

- Fan (Fig. 10). The current rollover car washing machines' drying system is formed of two fixed vertical dryers on the sides, which are housed in the columns and fed by two centrifugal fans, as well as a moveable horizontal drier with two centrifugal fans installed at each end [5].

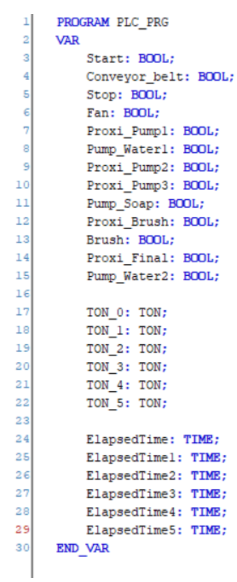
Fig. 9. DC motor.

Fig. 10. Drying system.

IV. CoDeSys Simulation

A. Ladder Logic

We used the Ladder Diagram as a language for our project. We implemented the problem using inputs and outputs discussed before. For simulation in CoDeSys we included TON blocks to simulate moving conveyor belt. So that the proximity sensors were automatized. The Diagram itself is on Figure 15 and variables for it on Figure 11.



```
PROGRAM PLC_PRG
VAR
    Start: BOOL;
    Conveyor_belt: BOOL;
    Stop: BOOL;
    Fan: BOOL;
    Proxi_Pump1: BOOL;
    Pump_Water1: BOOL;
    Proxi_Pump2: BOOL;
    Proxi_Pump3: BOOL;
    Pump_Soap: BOOL;
    Proxi_Brush: BOOL;
    Brush: BOOL;
    Proxi_Final: BOOL;
    Pump_Water2: BOOL;

    TON_0: TON;
    TON_1: TON;
    TON_2: TON;
    TON_3: TON;
    TON_4: TON;
    TON_5: TON;

    ElapsedTime: TIME;
    ElapsedTime1: TIME;
    ElapsedTime2: TIME;
    ElapsedTime3: TIME;
    ElapsedTime4: TIME;
    ElapsedTime5: TIME;
END_VAR
```

Fig. 11. Variables

B. Visualization

For the visualization we have used lamps with different colors and one switch. The 'START' button begins the process. The turned on lamps indicate on which stage the car at the moment.

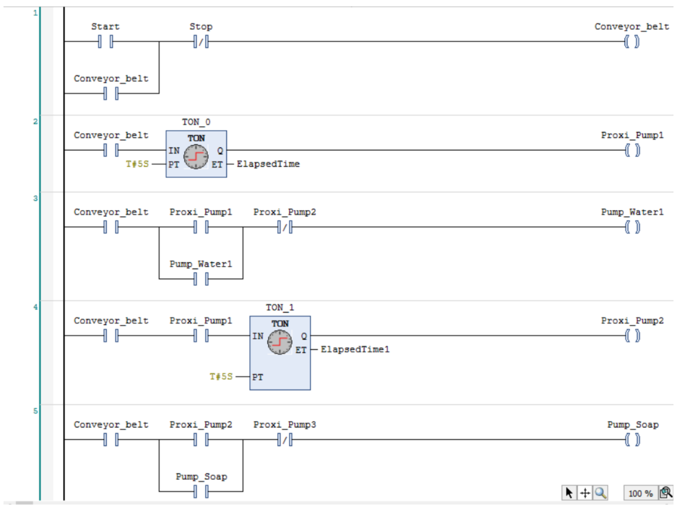


Fig. 12. Rungs 1-5

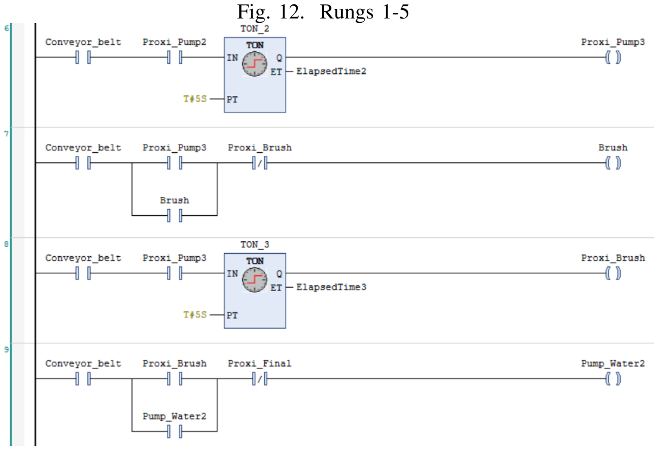


Fig. 13. Rungs 6-9

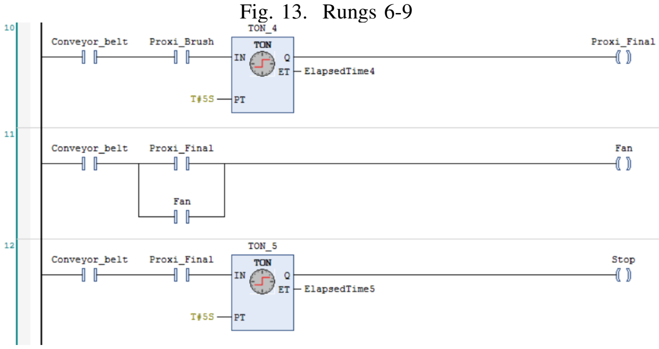


Fig. 14. Rungs 10-12

Fig. 15. Ladder Diagram

Fig. 16. Visualization.

V. Conclusion

We were able to design a system of the automatic car washing station. This project helped us in understanding the basics of the designing a system in CoDeSys by applying our knowledge from the course material. Moreover, we have understood the complexity of the automatic car washing stations. One of the obstacles that we have encountered was designing a logic system for our project.

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