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Design and Development of Cleaning System for Cups Using PLC

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ABSTRACT

Cleaning has been a very necessary and unavoidable daily routine. It becomes even more important when to perform cleaning for all cups or cup tumbler and in houses, hostels, hotels, canteens and kitchen. In such cases it is not reliable of cleaning multiple cups at a time manually with proper hygienic conditions. So here is an idea of an automatic cup cleaning system that can reduce the wastage of water during the process of cleaning.

Keywords : Programmable Logic Controller, Conveyer System, Sprinkler System, DVP-SS2, PID

I. INTRODUCTION

To develop an automated cup or tumbler cleaning assistance. This helps in cleaning hollow surface of cup with the ease of with greater efficiency at work. This is solely aimed to replace the men at work and prove "no man at work" The cup cleaning machine is proposed in this project, that helps in cleaning of hollow and vertical surface of cups. The automatic cup cleaning system has an advantage of providing efficient cleaning which can be performed semi-manned or fully automated.

In in fully automated system the operator can control remotely and all cleaned cups are stacked by using a conveyer system. Here we considered semi- manned cleaning platform, where the direction control was established using an operator to facilitate control over the system from a distance. In both semi- manned and fully automated system for controlling all the operations are controlled by PLC. Programmable logic controller plays a role to improve the efficiency, speed of cleaning. The PLC program managed by ladder logic diagram.

II. METHODOLOGY

i) **Conveyer system**
ii) **Sprinkler system**

i) Conveyer system

In this system, the cups are kept on a conveyor belt, when the number of cups on the conveyor goes beyond a number (say 4 or 5), cups sensed by a sensor (say proximity sensor – capacitive type) and the conveyor starts moving. The conveyer system is operated by a motor. The motor in turn gets the control signal from the PLC. The PLC gets the inputs from all the sensors and operates the motor accordingly and conveyor starts moving the cups are taken the washing area

ii) Sprinkler system

Inside the washing area, with the help of sprinklers and water tubes, the water put across the cups and they are washed. One after the other all the cups goes the process of washing. After the process of washing all the clean cups that can be used again are brought

below the conveyor system and placed in series. The conveyor system goes to off state after this.

Number of pumps are used to take water to the from a storage tank to the sprinklers. This system fully automated system that needs no human intervention and reduces the amount of water wastage during the process of cleaning to cups. In future, the used water can aging be filtered to be used for the cleaning process again by this limited amount of water can be used hygienically for this process. This will decrease the amount of water wastage.

III. MODEL AND PROCESS

During the starting of cleaning process the conveyor and the other components or elements of the system will be in off state except the sensor. The capacitive proximity sense is used to measure the distance of the cup. As the first cup nears the system, mainly the brush assembly gets activated This will save power.

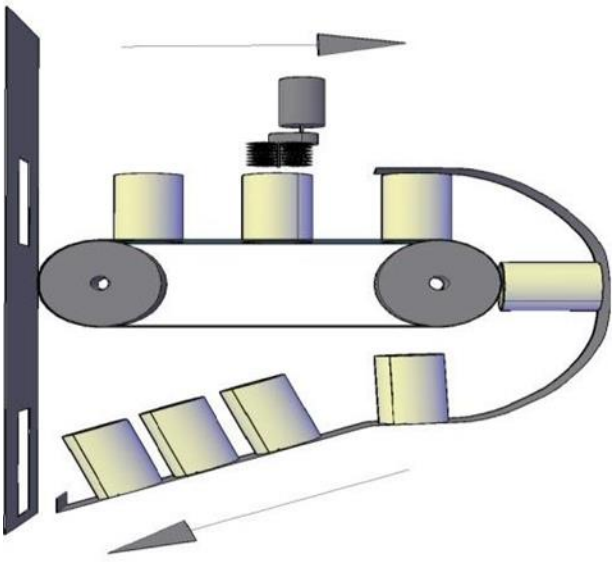

Fig.1 Model of conveying and stacking the cups

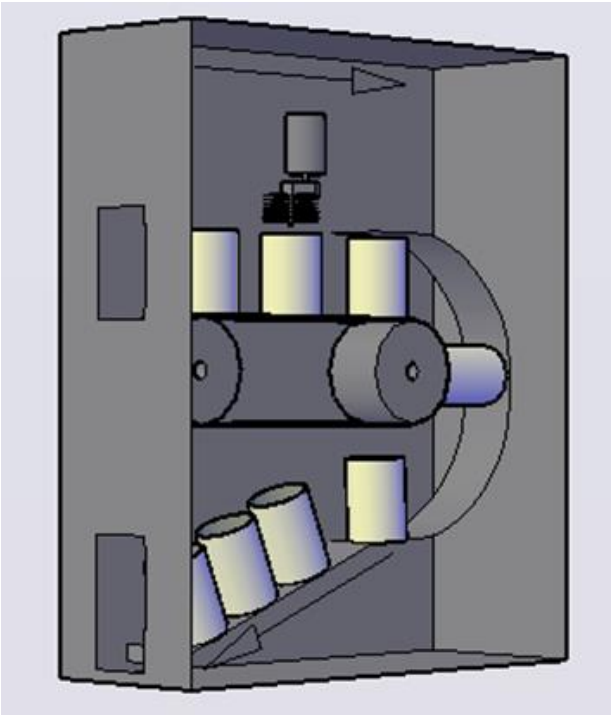

Fig.2 Side view of conveying model

The process of cleaning starts only after the first cup reaches near the brush assembly on the conveyor. When the first cup reaches near the sensor, the conveyor starts. This takes the cups between the sprinklers and under the brush assembly. The conveyor stops under the brush assembly. Sprinklers are used to distribute water from both sides of the cup and another with a brush from the top.

During this process the brush comes down, cleans the cup from inside and returns back to its initial position. After this process gets over the cup is inverted and is kept inside below. Fig 1(a) and (b)shows the side view of our model. The used water from the conveyor and the left-out water from the clean water section are collected. This water can be filtered and used again for the process of cleaning. By doing this a limited amount of water can be used for cleaning of cups. For the brush and conveyor assembly 12V DC gear motors are used. The whole process is controlled with PLC.

IV. DESIGN OF BLOCK DIAGRAM

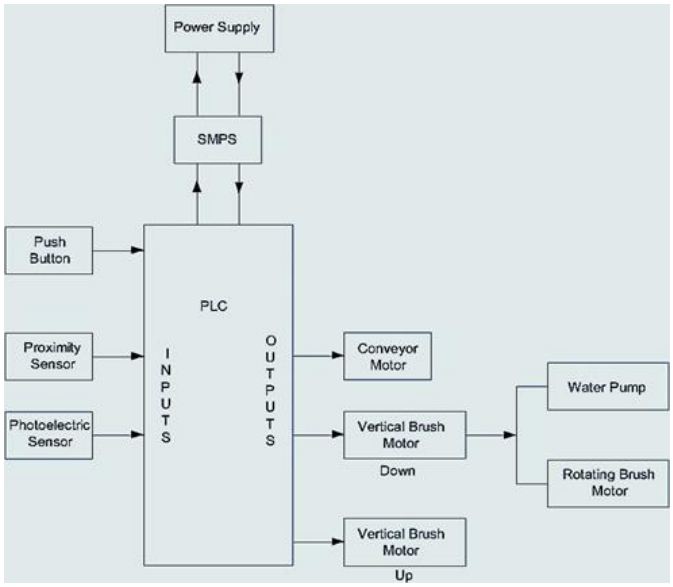

Fig.3 Block diagram of PLC based control of cup cleaning system

In this design PLC is the main component that takes input from the two proximity sensors and two limit switches to control the output components. The proximity sensor 1 controls either the buzzer or the conveyor motor at once. The proximity sensor controls solenoid lock. The position of the vertical motor is controlled by two limit switches, one for top position and the other one for bottom position.

The above schematic is the design of project. The input devices are two inductive type proximity sensors and two limit switches. The proximity sensor 1 checks if the cup is placed in proper position. If it is placed in proper position the conveyor motor starts and it takes the cup inside. If it is not placed in proper position the buzzer will start and indicate to keep the cup in proper position. The proximity sensor 2 checks if the cup has arrived under the brush assembly.

When the cup reaches under the brush assembly the conveyor motor stops and the two solenoid locks are energized. These locks help us to keep the cup still during the process of cleaning.

After the cup is locked the two processes starts simultaneously, cleaning with water and cleaning with brush. The cup is cleaned with water both from outside and inside. The brush is bought to the bottom position by a vertical moving motor.

The position of the vertical motor is controlled by two limit switches, one for sensing the top position and another for sensing the bottom position.

After the brush reaches the bottom position it is rotated in clockwise and anticlockwise direction to clean the cup from inside along with water. The brush is rotated by another motor. When the process of cleaning get over the lock is unlocked and the cup is moved forward.

After this the cup is inverted and is transferred to a place where all the clean cups are kept. At this place water is sprayed to clean any left-out substance post cleaning.

V. COMPONENTS REQUIRED FOR MECHANICAL DESIGN AND ELECTRICAL DESIGN

(a) Mechanical design:

- Acrylic sheets.
- Water sprayers
- Aluminium Sheet.

(b) Electrical design Specifications

- 12V DC gear motor, 30RPM (for Conveyor belt)
- 5V DC motor (for Rotating motor and vertical moving brush)
- 12V DC pump, 5M, 600L/H, 60°C: (for water supply)
- 12V DC capacitive proximity sensor (for sensing cup)
- 12V DC photoelectric sensor (for counting cups)
- Submersible Pump
- Solenoid lock
- Limit Switch

- Proximity sensor
- SMPS

VI. SOFTWARE & HARDWARE OF PLC

The project uses Delta DVP-SS2 Series PLC (Programmable Logic Circuit) to control the whole procedure. Programming of the PLC is done with WPLSoft version 2.41. The ladder diagram is drawn n this software. All the changes can be made by this software. 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. This PLC is used in applications such as, Spinning machine, conveyer belt (rotation speed control), winding machine (tension control).

PLC hardware Specifications

- MPU points: 14 (8DI + 6DO).
- Max. I/O points: 494 (14 + 480).
- Program capacity: 8k steps.
- COM port: Built-in RS-232 & RS- 485 ports, compatible with Modbus ASCII/RTU protocol. Can be master or slave.
- High-Speed Pulse output.
- Supports PID Auto-tuning : DVP- SS2 saves parameters automatically after the PID auto temperature tuning is completed.

VII. LADDER LOGIC DIAGRAM

In step 0, an Emergency Stop switch named as E_STOP a normally closed switch, a Start switch named as START a normally open switch, a Stop switch named as STOP a normally closed switch and a Proximity sensor names as PS are connected in series with a comparator.

The ladder is designed is such a way that when the value of D0 is greater than or equal to a pre-set value (say K5) the control goes to step number 11 or 15 and the conveyor motor names as C_MOTOR starts and if the value of D0 is less than K5 the control goes to step number 17 and a buzzer named as BUZZER starts.

The process starts when the start button is pressed. When a cup is kept on the conveyor if the position is correct it moves inside else the buzzer starts. All these procedures can be seen in ladder diagram (LD1).

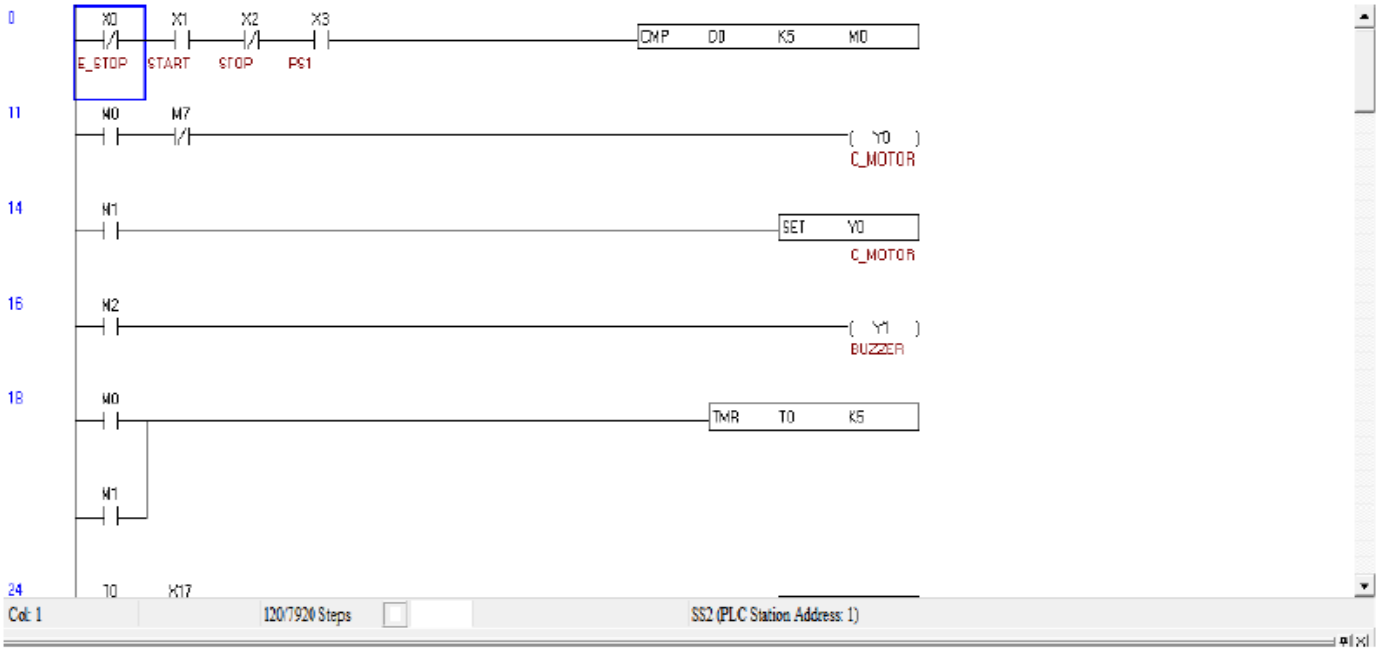

Fig.4 Ladder Diagram 1

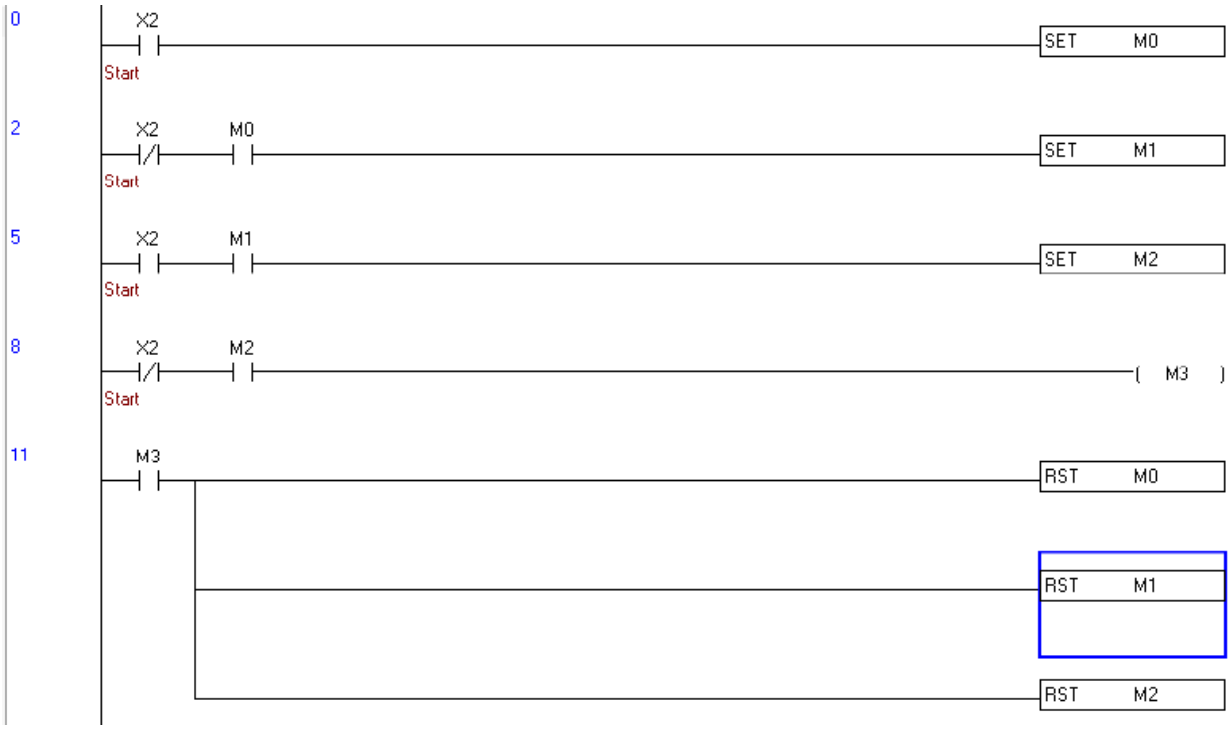

Fig.5 Ladder Diagram 2

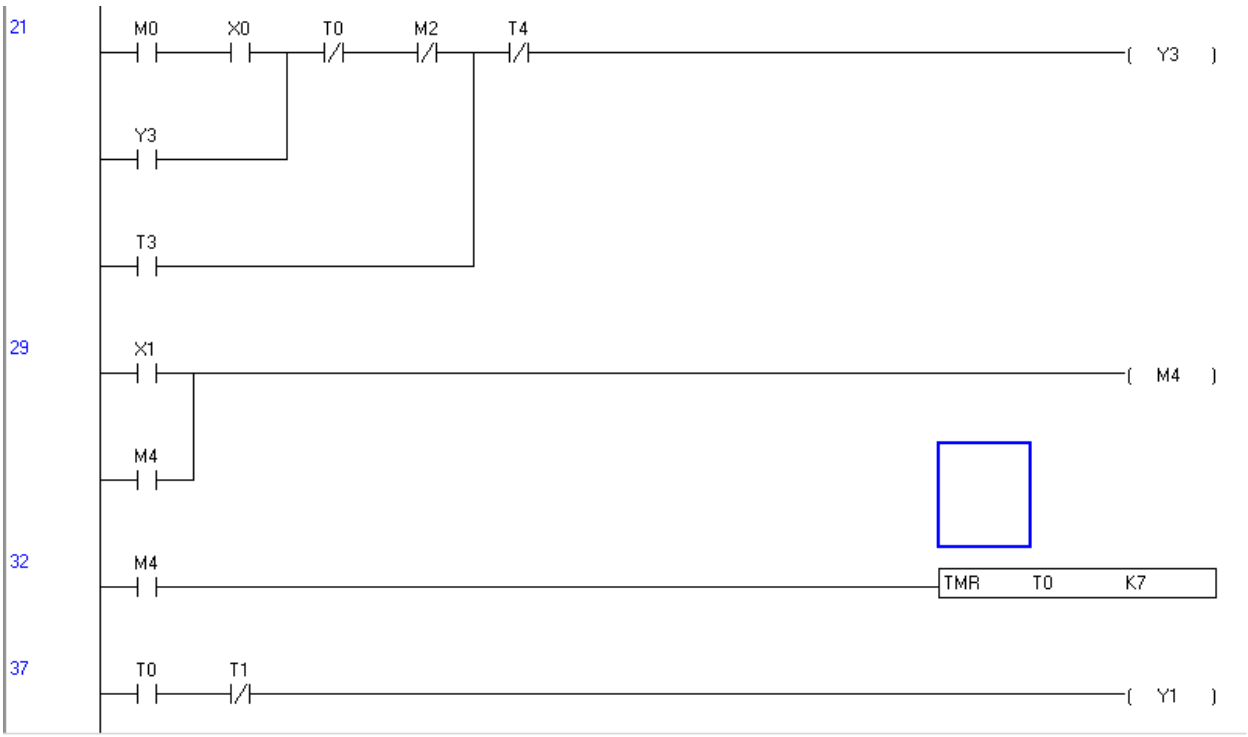

Fig.6 Ladder Diagram 3

VIII. LADDER DIAGRAM EXECUTION & RESULTS (Running conditions)

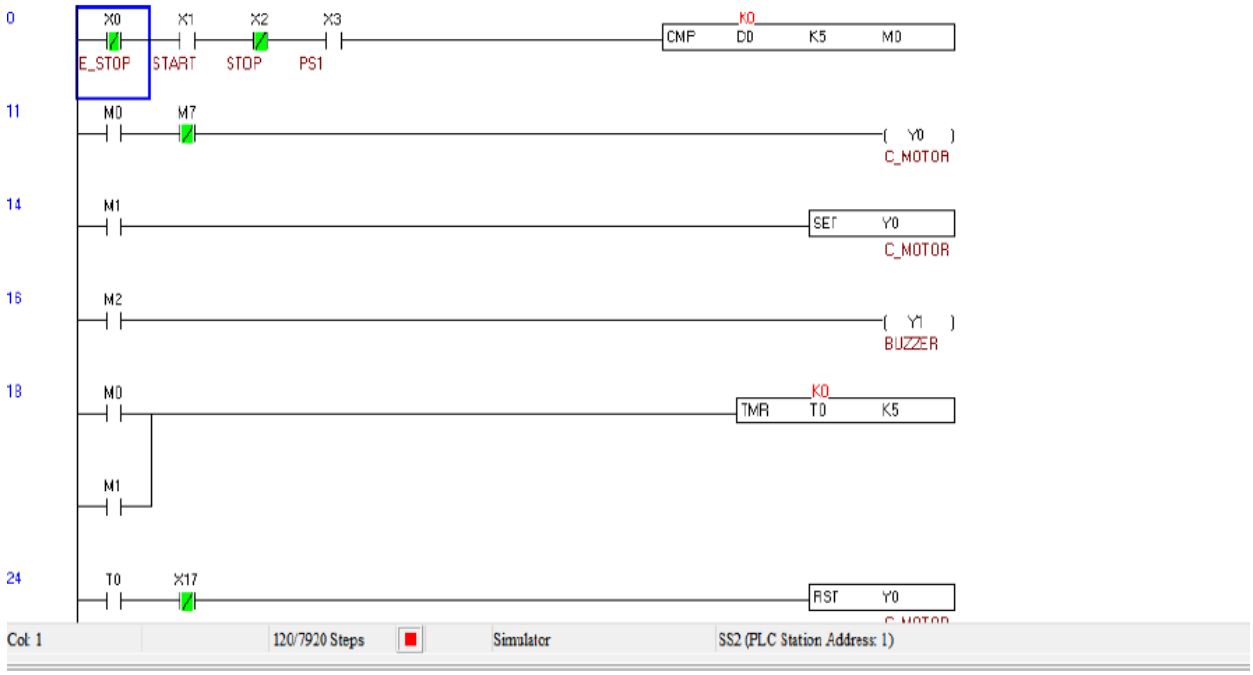

Fig.7 Ladder Diagram 4 (Proximity sensor & start cycle excited)

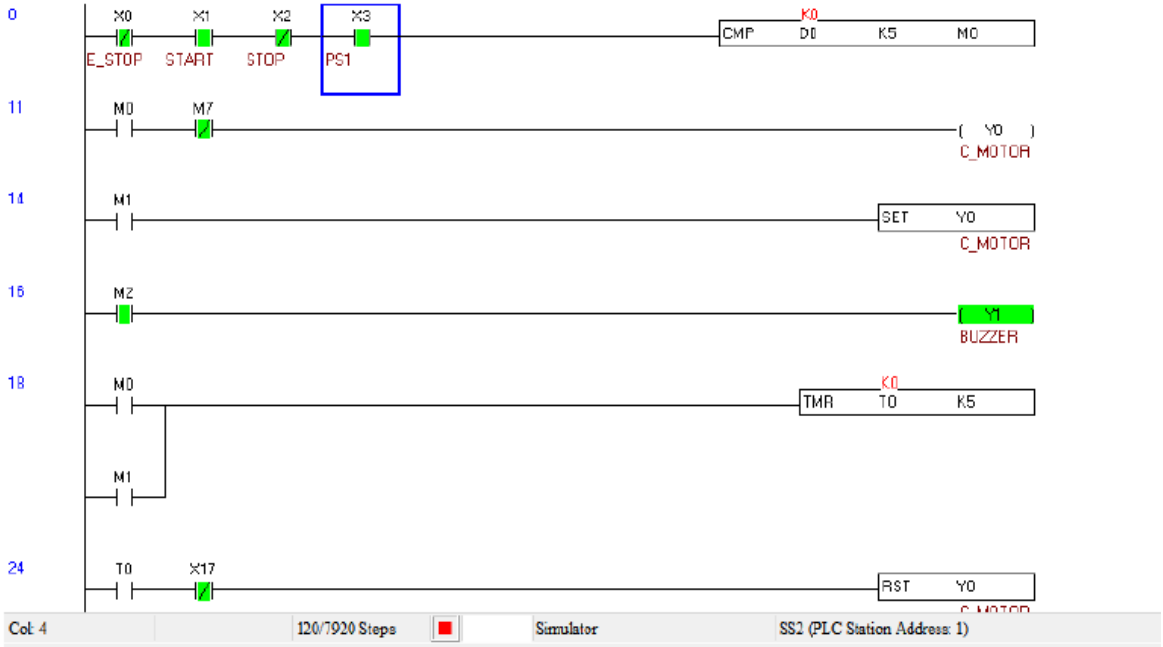

Fig.8 Ladder Diagram 5 (Buzzer Initiated)

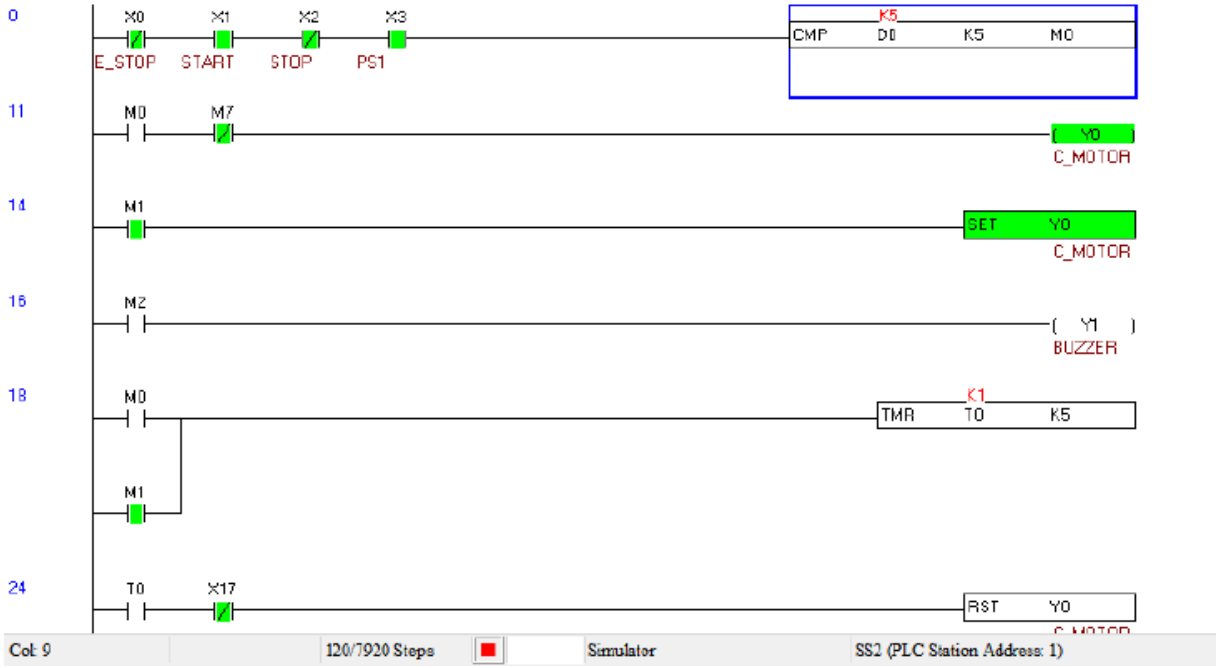

Fig.9 Ladder Diagram 6 (conveyer started)

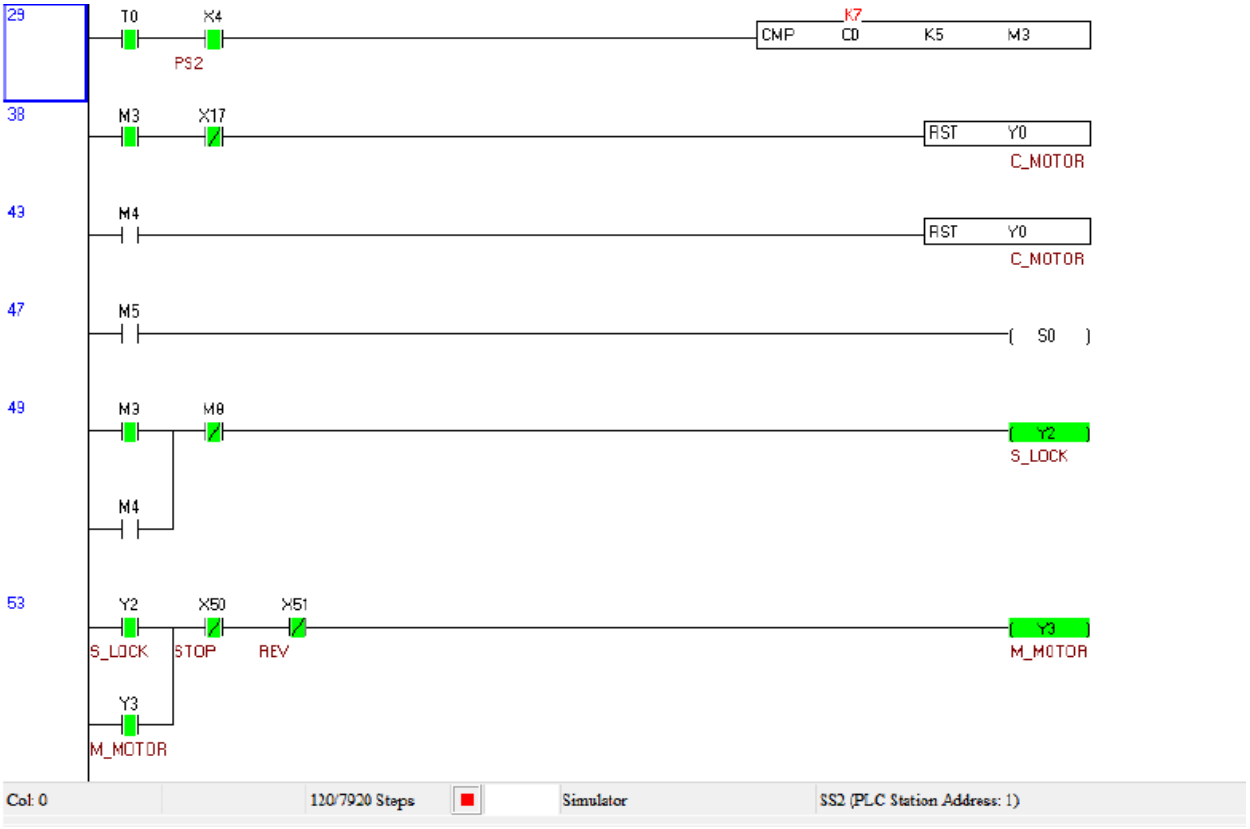

Fig.10 Ladder Diagram 7 (cup is locked and Brush motor started started)

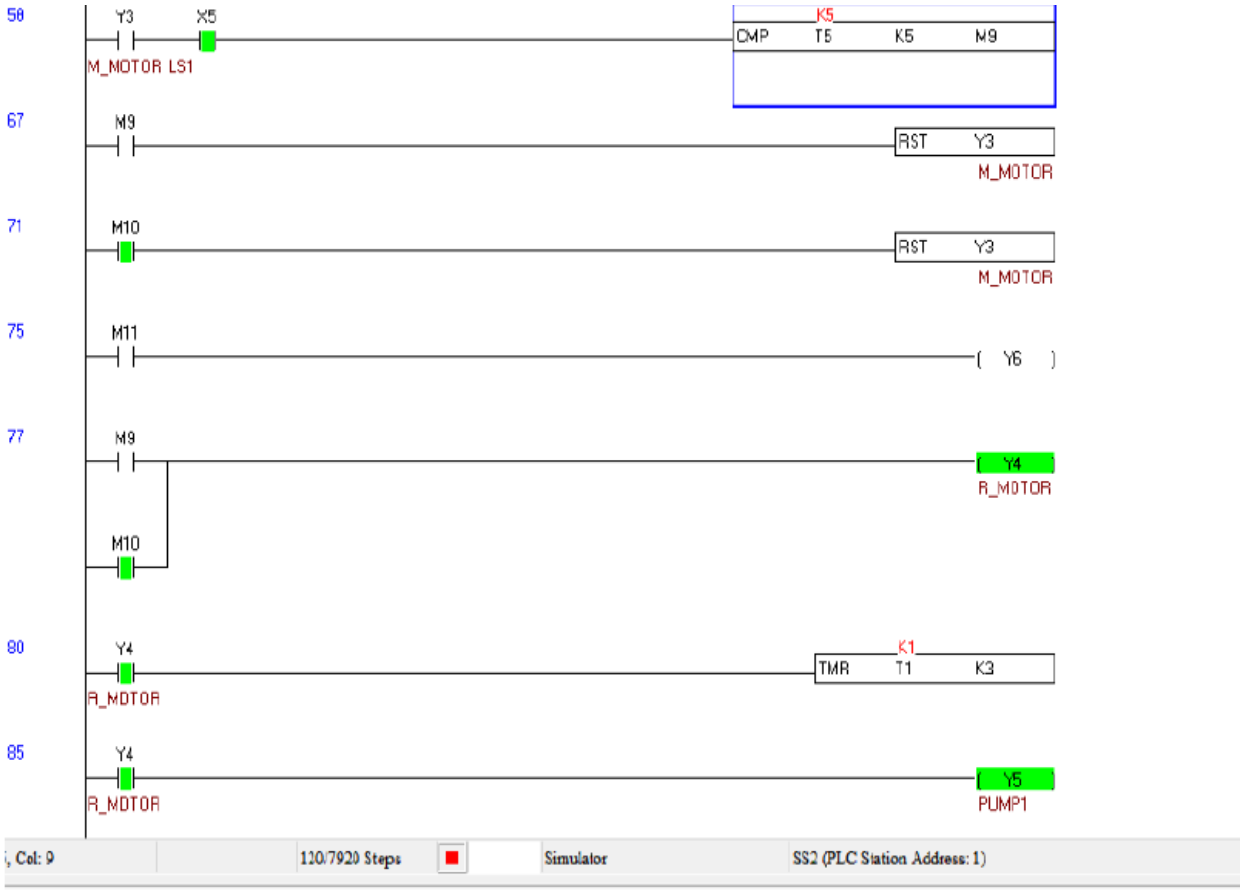

Fig.11 Ladder Diagram 8 (sprinkler started with brush motor ON)

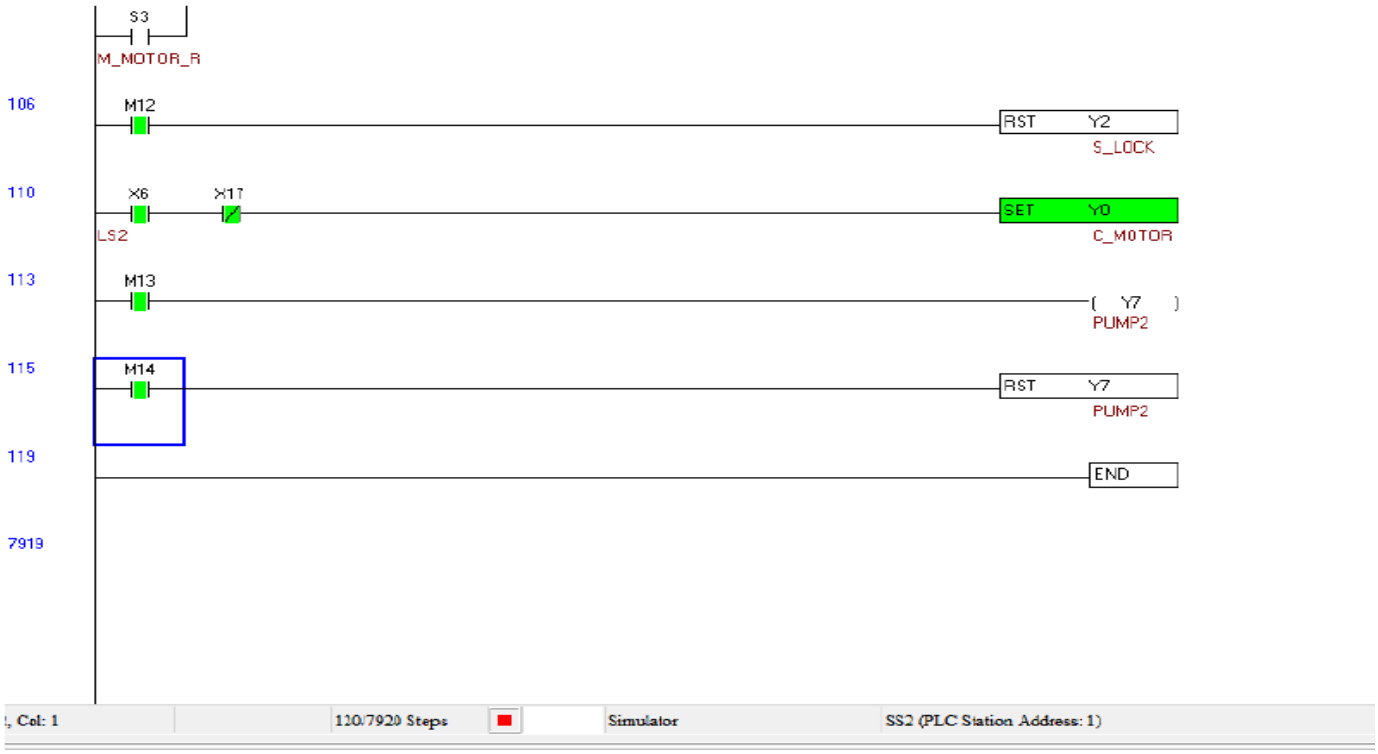

Fig.12 Ladder Diagram 9 (conveyer motor started for stacking cups)

In ladder diagram 4, proximity sensor is turned ON. When a cup is kept on the conveyor if the position the conveyor motor starts and the cup moves inside else the buzzer starts the conveyor motor runs for a

fixed value of time to move the cup inside so the next cup can be placed and the conveyor motor stops after a fixed time (say 5 seconds). The conveyor motor runs till the cup comes under the brush assembly. The time is controlled a timer. The conveyor motor stops when the cup comes under the brush assembly. After the conveyor motor stops, a solenoid lock is energized. so that the cup does not move from its position during the washing procedure. In that a vertically moving motor starts that brings another motor down to which the bush is attached. A limit switch is used to stop the vertically moving motor to a fixed position.

The vertically moving motor stops when the limit switch turns ON After the vertically moving motor stops, the rotating motor attached to the vertically moving motor starts. This motor rotated for a fixed time (say 3seconds), it is controlled by timer T1. As the rotating motor starts simultaneously pump1 is also switched on. Both the rotating motor and the pump are on for the same time period. This pump is used to spray detergent water from the top and from both sides outside the cup.When the rotating motor and the pump stop, the vertically moving motor is moved back to its top position. The motor continues moving top till another limit switch LS2 is OFF state. Once LS2 becomes on the vertically moving motor stops. After this the solenoid lock is unlocked so the cup could move forward.

While the cup is moving forward, another pump a switched ON and OFF for a short period of time that sprays normal clean water to wash out the detergent water. After this, the cup is turned around and is kept below. This process is repeated again and again for every cup that is placed on conveyor till the cup storage becomes full. At the last ladder diagram, we can observe that the conveyor motor is ONAt the end of this project we will be able to clean the cups as a result of automation with less wastage of water and with more efficiency.

IX. WORKING Model

Fig.10.Working model

X. CONCLUSION

An electromechanical setup is designed with the synergies of PLC (ladder logic) to provide efficient cleaning system for cups and glass tumblers with more hygiene and less quantity of water.

XI. FUTURE WORKS

This contemporary design helps to overcome the limitations of the existing manual cleaning and surpass them in terms of automation. By integrating this design with some robotics are expected to attain superior intelligence to wash dishes, clean floor etc.,

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