ÖZYEĞİN UNİVERSİTY
FACULTY OF ENGINEERING

EE 392

FINAL PROJECT REPORT

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1. Introduction 3

1.1 Claw Machine and Traffic Lights 3

Traffic Lights Controller Project: 3

Toy Claw Project: 3

1.2 About Group Members 3

2. Toy Claw Machine 3

2.1 Problem Definition and State Diagram 3

2.2 Component Selection 4

2.3 HMI Description and Screen Shots During Operation 7

2.4 How Our Claw Machine Work 9

2.5 Overall Wiring Diagram 9

2.6 Animation Table 9

2.7 Result Analysis 10

3.Traffic Lights 10

3.1 Problem Definition and State Transition Diagram 10

3.2 HMI Description and Screen Shots During Operation 11

3.3 Animation Table 12

3.4 Wire Diagram 13

3.5 Result Analysis 13

4. Conclusion 13

4.1 Claw Machine 13

4.2 Traffic Lights 14

5. References 15

1. Introduction

These PLC projects include a Traffic Lights Controller and a Toy Claw Game. The Traffic Lights Controller ensures efficient traffic management, incorporating features like normal and after-hours operation, as well as advanced modes with load sensing. On the other hand, the Toy Claw Game offers an interactive experience, allowing users to control a claw machine using a joystick, with specific game rules and outcomes.

Through these projects, you'll gain hands-on experience in PLC programming, HMI design, and system integration. Key learnings include developing automated control systems for traffic intersections, understanding sensor-based decision-making, and implementing game logic with motor control and HMI feedback. These projects provide a practical understanding of industrial automation, enhancing your skills in designing and programming PLC systems for diverse applications.

1.1 Claw Machine and Traffic Lights

Traffic Lights Controller Project:

The Traffic Lights Controller project focuses on developing a robust system for managing traffic flow at an intersection. The Human-Machine Interface (HMI) provides control through various buttons and sensors, allowing for normal operation, after-hours operation, and advanced features such as automatic after-hours mode and load sensing. The project aims to enhance traffic efficiency, promote safety, and automate certain functionalities to adapt to different operational scenarios.

Toy Claw Project:

The Toy Claw project centers around creating an interactive and engaging game featuring a claw machine. The Human-Machine Interface (HMI) includes joystick controls, game start buttons, and a display for game status and messages. The claw's motion is controlled by motors, and the game has specific rules governing its operation. Players are given a set time to manipulate the claw and attempt to win prizes, with the system providing feedback through messages on the HMI. The project seeks to provide an entertaining and rewarding experience for users interacting with the toy claw machine.

1.2 About Group Members

Our project group consists of four people, all of us 3rd year electrical and electronics engineering students. We decided on the project as partners and shared tasks based on those decisions.

2. Toy Claw Machine

2.1 Problem Definition and State Diagram

The goal of this project is to design a Toy Claw Game System, incorporating various elements such as user interface, motor control, sensors, and gripper mechanisms. The system is intended to provide an engaging and interactive experience for players who aim to maneuver a claw to capture a toy within a specified time frame.

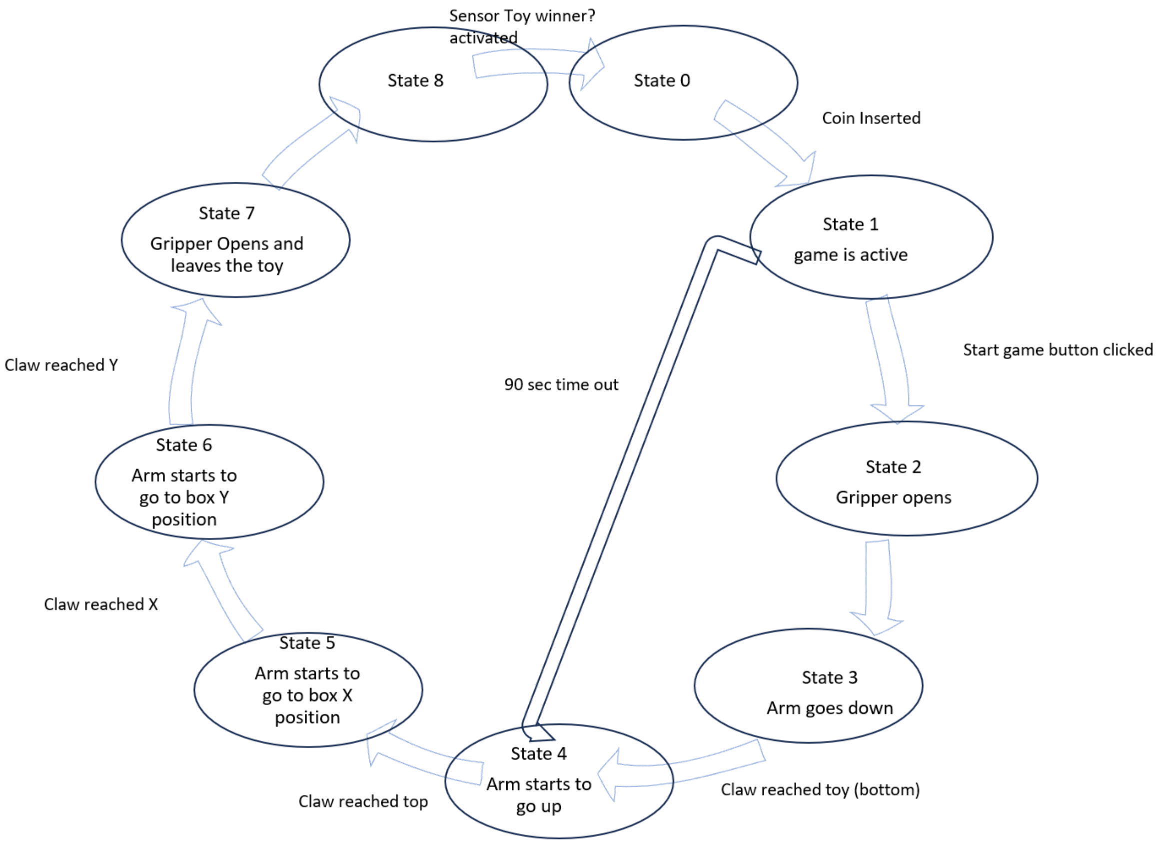


Figure 1 State Diagram for Claw Machine

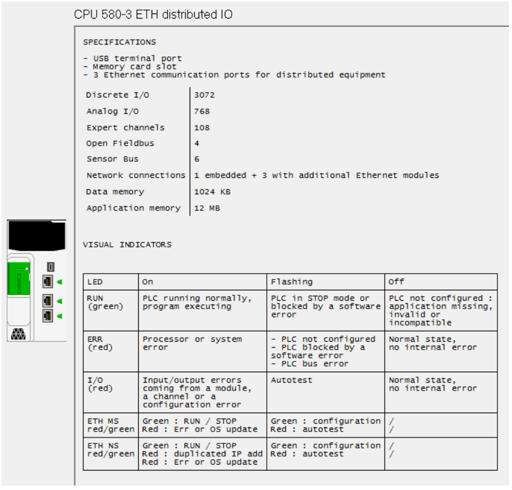
The image above is the claw machine state diagram. This diagram helped us a lot to follow the stages while doing the project.

2.2 Component Selection

The components required to complete this project are as follows:

- **BME P580 3020 as a PLC:**
  The reason for using this PLC in the project is very simple, we have always worked with this PLC in the labs so far. For detailed information you can click here.

Figure 3 This is how BME P580 looks like



CPU 580-3 ETH distributed IO

SPECIFICATIONS

- USB terminal port
- Memory card slot
- 3 Ethernet communication ports for distributed equipment

Discrete I/O	3072
Analog I/O	768
Expert channels	108
Open Fieldbus	4
Sensor Bus	6
Network connections	1 embedded + 3 with additional Ethernet modules
Data memory	1024 KB
Application memory	12 MB

VISUAL INDICATORS

LED	On	Flashing	Off
RUN (green)	PLC running normally, program executing	PLC in STOP mode or blocked by a software error	PLC not configured : application missing, invalid or incompatible
ERR (red)	Processor or system error	- PLC not configured - PLC blocked by a software error - PLC bus error	Normal state, no internal error
I/O (red)	Input/output errors coming from a module, a channel or a configuration error	Autotest	Normal state, no internal error
ETH MS red/green	Green : RUN / STOP Red : Err or OS update	Green : configuration Red : autotest	/ /
ETH NS red/green	Green : RUN / STOP Red : duplicated IP add Red : Err or OS update	Green : configuration Red : autotest	/ /

Figure 2 This is a general specification for our PLC.

- **Crane Machine Grippers as a Gripper:**
  In this section, the most logical, most widely used, and cheapest option is the claw machine gripper. The price range varies between 25 and 35 dollars. You can access the datasheet here. Alternatively, the 3D printed gripper was more costly, starting at $50. This increases the cost.

Figure 5 This grapper what will we use.

Figure 4 3D printed grapper.

- We have five different scenarios for sensor use. We will explain them separately:

  1. **Sensor_toy_reached (Claw Bottom Sensor):**
     Type: Proximity sensor or Limit switch.
     Technology: Inductive proximity sensors or mechanical limit switches can be used to detect the arm reaching the bottom position.
     In this part we will choose proximity sensors over limit switch because of price range.

  2. **Sensor_arm_at_top_level:**
     Type: Proximity sensor or Limit switch.
     Technology: Like the first sensor, you can use either inductive proximity sensors or mechanical limit switches to detect the arm reaching the top position.
     The price range was also decisive in this section.

3. **Sensor_arrm_x_at_box_location:**
   Type: Position sensor or Encoder.
   Technology: Optical encoders or potentiometers can be used to precisely measure the position of the arm along the X-axis.
   Although the price of the encoder is higher, we preferred the encoder as it provides higher accuracy.

4. **Sensor_arrm_y_at_box_location:**
   Type: Position sensor or Encoder.
   Technology: Like the previous sensor, optical encoders or potentiometers can be used to measure the position of the arm along the Y-axis.
   Since we prefer an encoder on the x axis, we also prefer an encoder on the y axis.

5. **Sensor_toy_winner:**
   Type: Presence sensor or Photoelectric sensor.
   Technology: Photoelectric sensors, particularly through-beam or retro-reflective types, can be used to detect the presence of a toy in the result box.
   In this last part, we prefer the presence sensor because its cost is much lower than the photoelectric sensor.

Figure 7 Photoelectric sensor

Figure 6 Proximity sensor.

Figure 8 Limit Switch

Figure 9 Encoder

2.3 HMI Description and Screen Shots During Operation

What we aimed for in the HMI design was to take into account the entertainment factor in arcade halls as well as understandability. For this reason, we chose bright colors. Visually, we hoped that the cute visuals would balance the difficulty element in the claw machine.

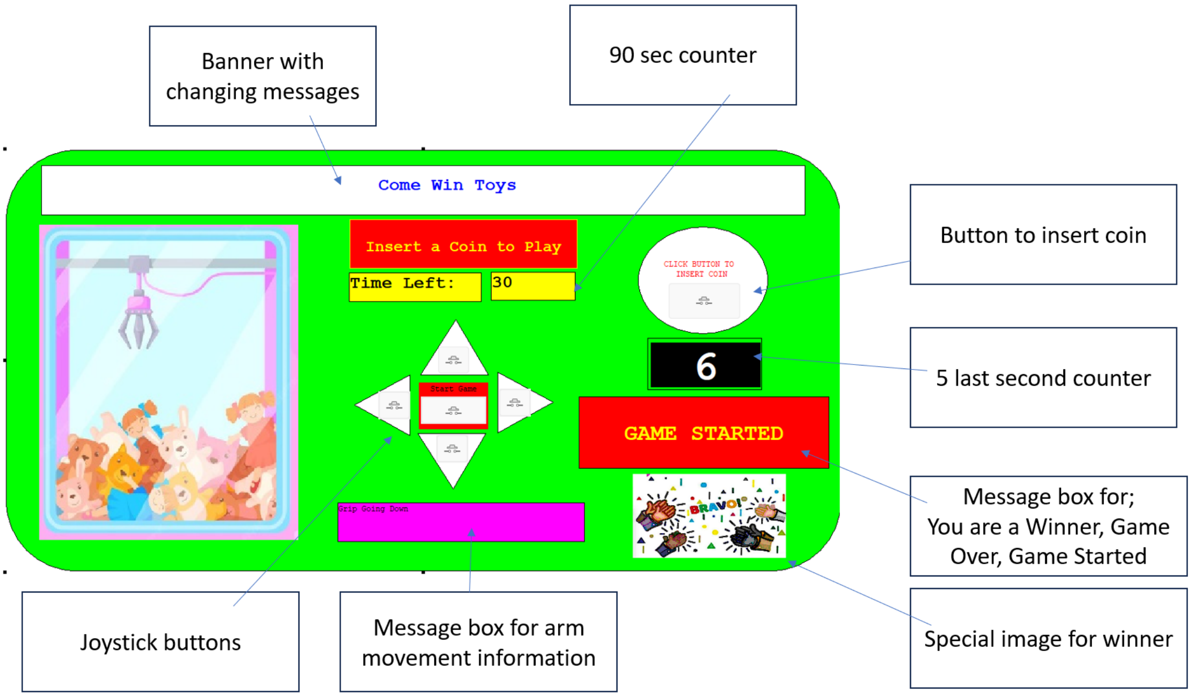


Figure 10 Explained HMI

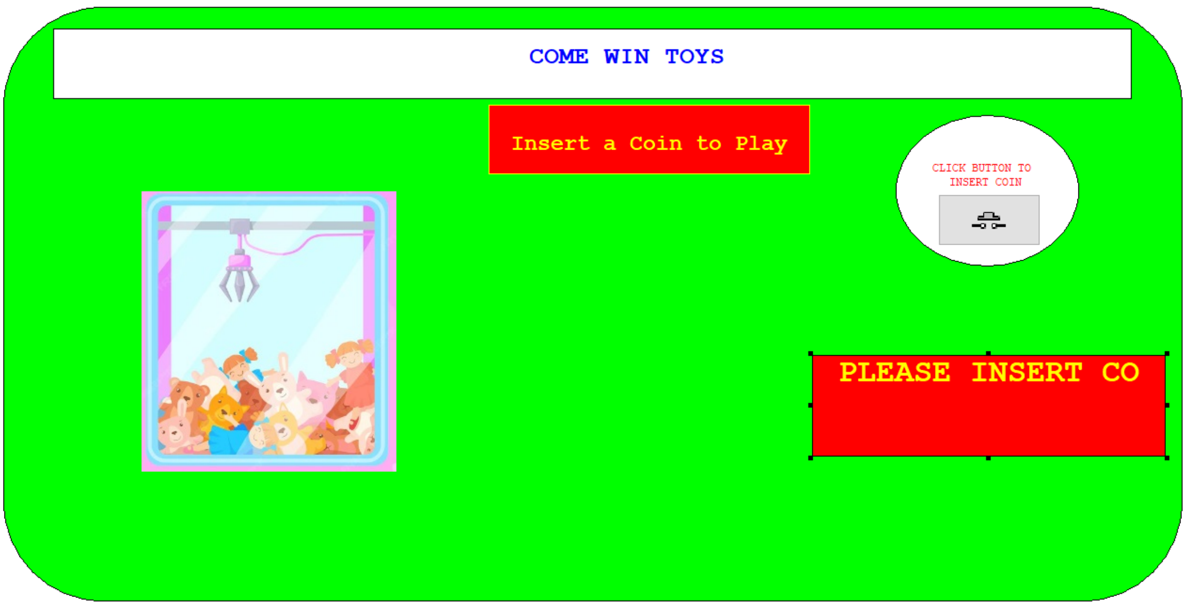


Figure 11 HMI when game is not started.

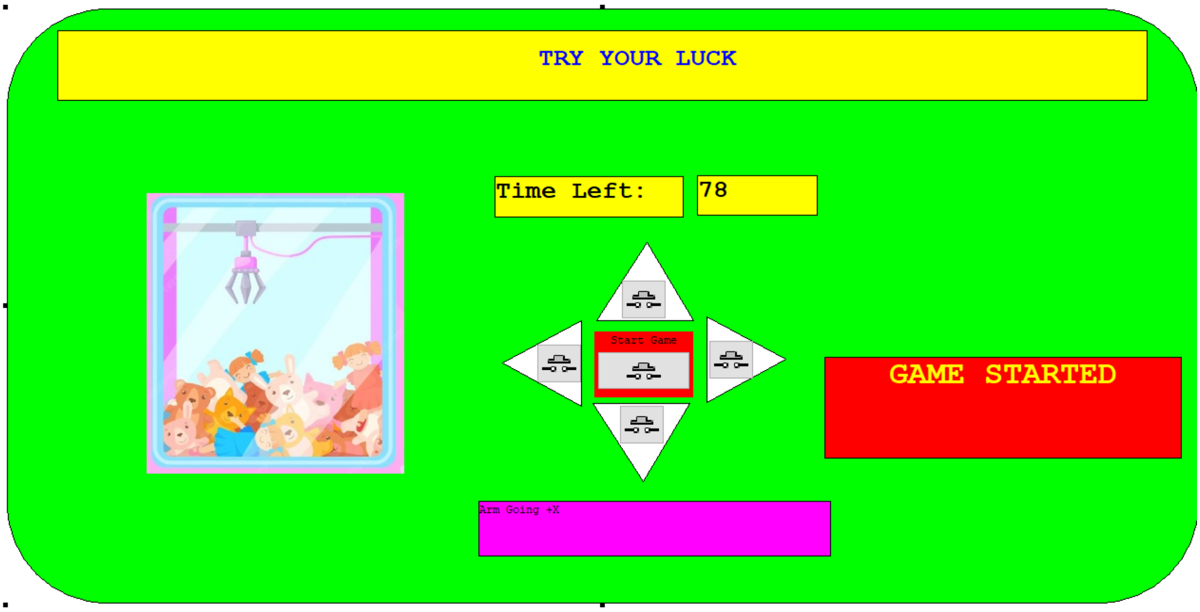


Figure 12 While Game is active.

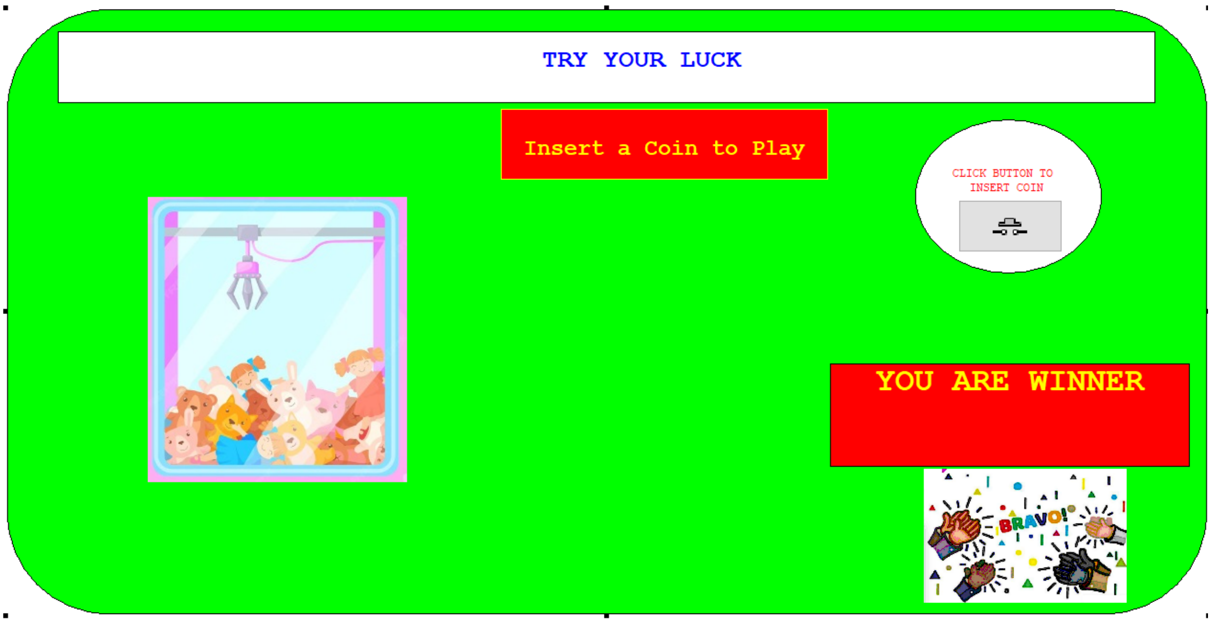
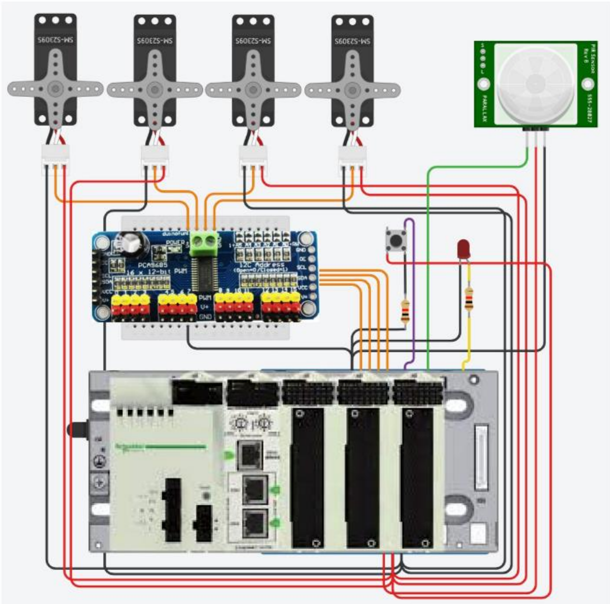


Figure 13 Game when you won.

2.4 How Our Claw Machine Work

If we want to accurately capture the movements of the claw in the claw machine we designed, we need to activate the sensors. The sensor values we see in Figures 14 and 16 are for this reason. Sensors should always remain on during gameplay. The sensor that determines whether we win or not is sensor_toy_winner.

2.5 Overall Wiring Diagram



This is an our overall wiring diagram for the claw part of final project.

2.6 Animation Table

sensor_arm_at_top_level	0	EBOOL	
sensor_arm_x_at_box_location	0	EBOOL	sensor that says the arm is at box x location
sensor_arm_y_at_box_location	0	EBOOL	sensor that says the arm is at box y location
sensor_toy_reached	0	EBOOL	
sensor_toy_winner	0	EBOOL	sensor tat says it is a winner

Figure 14 These are sensors we need to activate.

animation_table

Modification Force

Name	Value	Type	Comment
Total_Number_of_Games_Played	4	INT	
Total_Number_of_Wins	2	INT	
Date_and_Time_of_Last_Win	2024-01-08-15:59:45	DT	

Figure 15 Animation Table

sensor_arm_at_top_level	1	EBOOL	
sensor_arm_x_at_box_lo...	1	EBOOL	sensor that says the arm is at box x location
sensor_arm_y_at_box_lo...	1	EBOOL	sensor that says the arm is at box y location
sensor_toy_reached	1	EBOOL	
sensor_toy_winner	1	EBOOL	sensor tat says it is a winner

Figure 16 Activated versions.

2.7 Result Analysis

Overall, the project demonstrates a well-thought-out design that incorporates interactive HMI elements, realistic game rules and play, appropriate gripper selection, and sensible sensor choices. For a more comprehensive evaluation, additional details on gripper specifications and sensor datasheets/pricing would be beneficial. The project effectively balances functionality, user experience, and practical considerations.

3.Traffic Lights

3.1 Problem Definition and State Transition Diagram

The Traffic Lights Controller project aims to design and implement an intelligent and adaptable traffic control system for a four-way intersection. The system needs to address various operational scenarios, providing efficient traffic flow and enhanced safety. The project involves integrating a Human Machine Interface (HMI) with latching buttons and momentary sensors, along with a set of traffic lights for each direction.

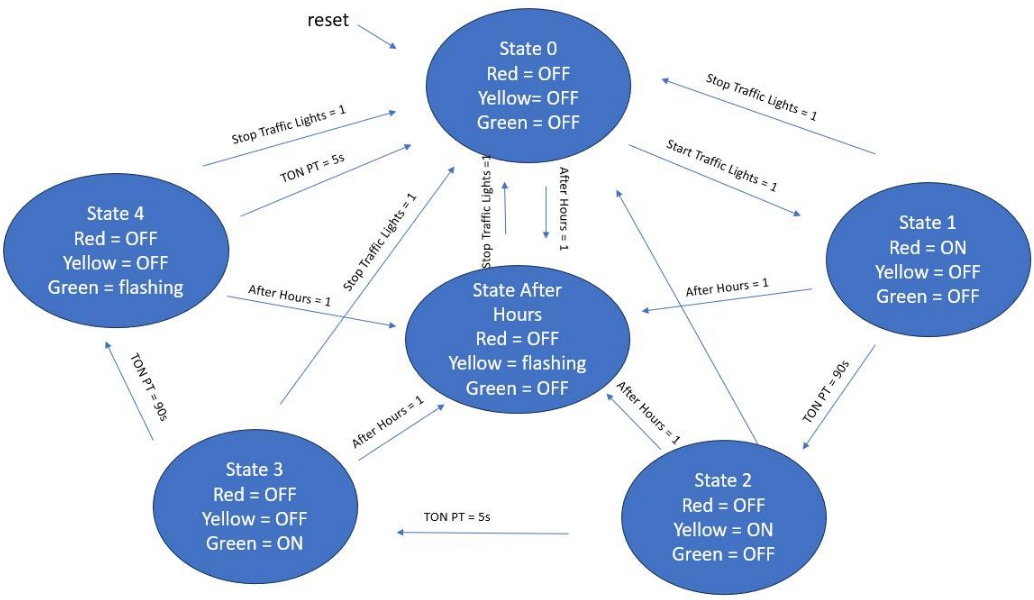


Figure 17 State Diagram for Traffic Lights

3.2 HMI Description and Screen Shots During Operation

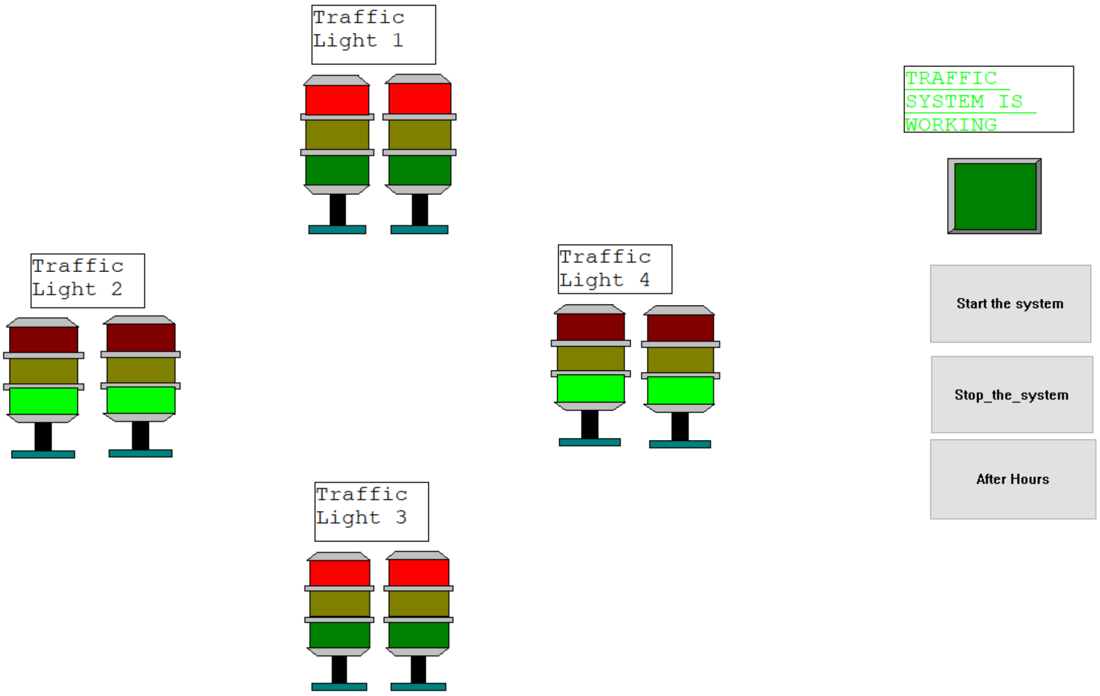


Figure 18 HMI when we started to system.

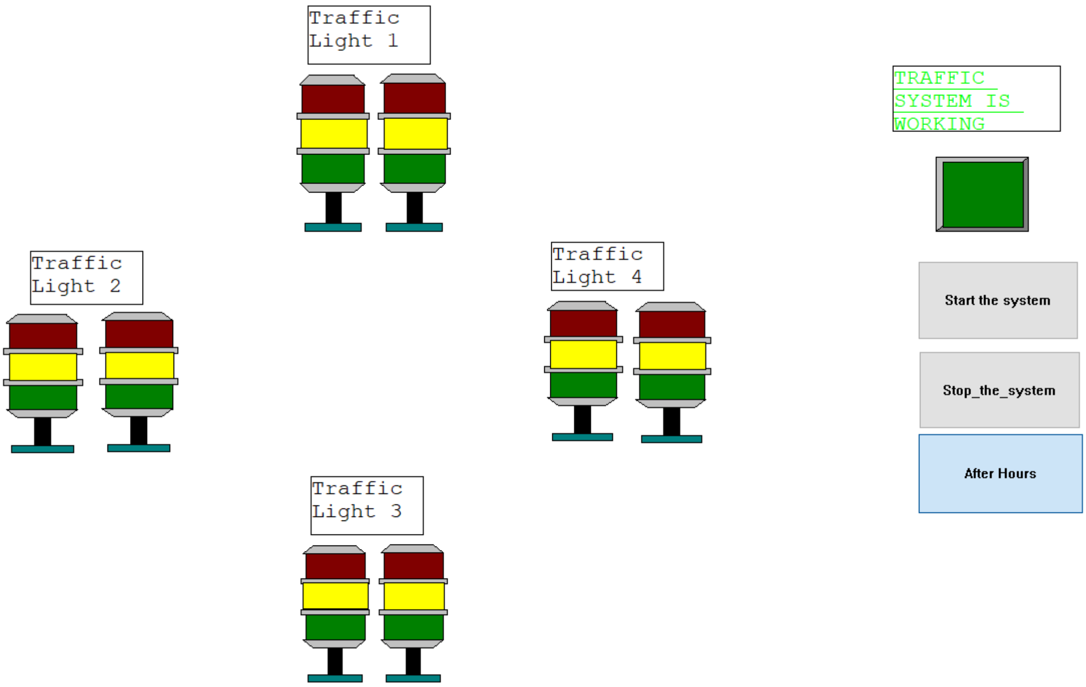


Figure 19 While After Hours

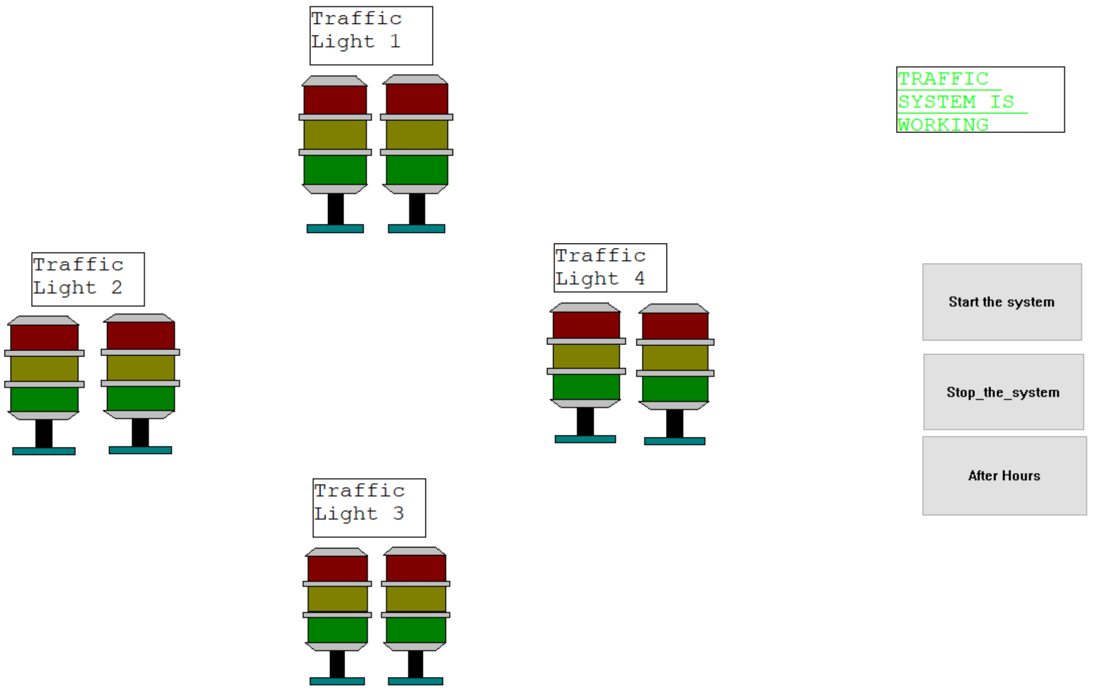


Figure 20 When system stopped.

3.3 Animation Table

Table

Modification | Force

Name	Value	Type	Comment
first_state	1	EBOOL	
second_state	0	EBOOL	
third_state	0	EBOOL	
fourth_state	0	EBOOL	
reverse_firststate	1	EBOOL	
reverse_secondstate	0	EBOOL	
reverse_thirdstate	0	EBOOL	
reverse_fourthstate	0	EBOOL	
stateafterhours	0	EBOOL	
new_redlight	0	EBOOL	
new_yellowlight	0	EBOOL	
new_greenlight	1	EBOOL	
red_light	1	EBOOL	
yellow_light	0	EBOOL	
green_light	0	EBOOL	
start_traffic_lights	0	EBOOL	
stop_traffic_lights	0	EBOOL	
after_hours	0	EBOOL	
traffic_lights_on	1	EBOOL	
flashing_green	0	EBOOL	
flashing_yellow	0	EBOOL	
newFlashing_green	0	EBOOL	
newFlashing_yellow	0	EBOOL	

Figure 21 Animation table for while system working.

3.4 Wire Diagram

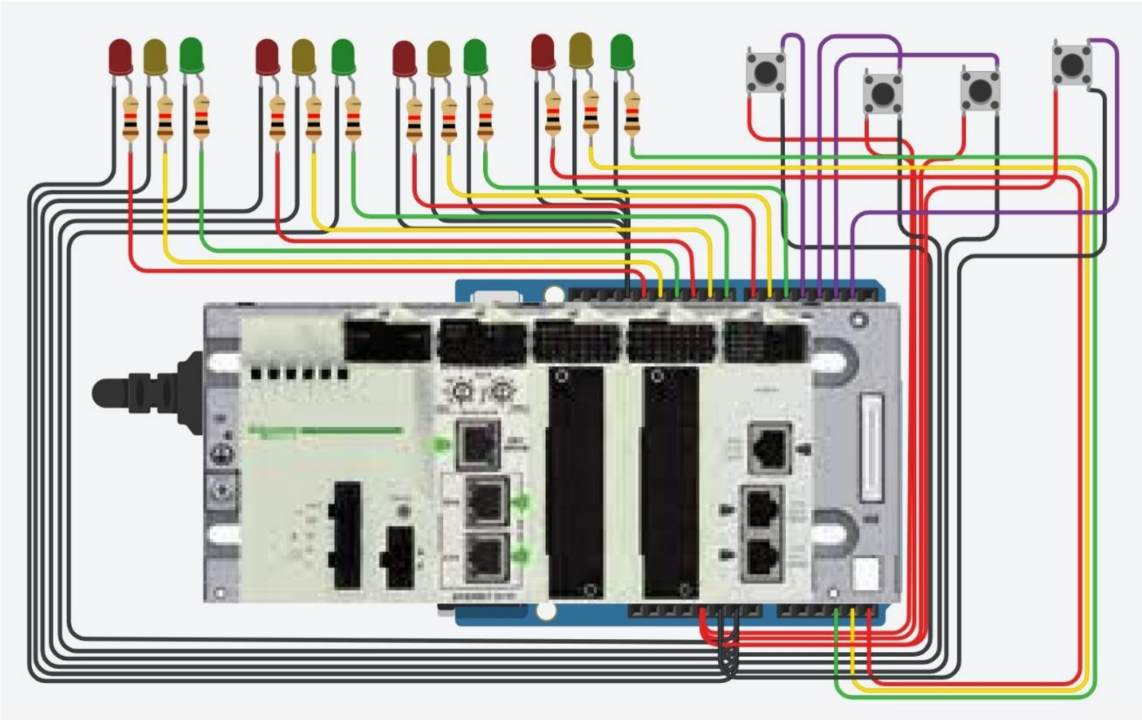


Figure 22 Wire Diagram for Traffic Lights

3.5 Result Analysis

The Traffic Lights Controller project successfully achieves its primary goal of efficiently managing traffic at the intersection. The inclusion of automated and manual modes, along with advanced features, demonstrates versatility in addressing various traffic scenarios. The HMI design and clear labeling contribute to the system's usability and user-friendliness. The bonus features, such as fully automated after-hours operation and advanced lights, showcase a forward-thinking approach to traffic control.

4. Conclusion

4.1 Claw Machine

In conclusion, the design and implementation of the claw machine game involves careful consideration of various components to ensure a seamless and enjoyable gaming experience. The game rules outline the sequence of events triggered by the detection of a coin, ensuring that the joystick is displayed only during active gameplay. The time constraint of 90 seconds adds an element of challenge for the player, with a visible countdown on the Human-Machine Interface (HMI).

Sensory selection plays a key role in the success of the game, with the chosen sensors contributing to the accuracy and reliability of the system. The selection process involves careful consideration of functionality, cost-effectiveness, and compatibility with the overall design. Datasheets and potential pricing for selected sensors would further enhance the project's transparency and feasibility.

The game's success is determined by the player's ability to manipulate the joystick within the given time frame, activating the claw to perform a series of motions aimed at capturing a toy. The feedback presented on the HMI, such as "Winner" or "Game Over" messages, adds to the overall user experience. After the completion of the game sequence, the system deactivates, providing closure to the gaming session.

In summary, the project combines mechanical, electrical, and software components to create an interactive and entertaining claw machine game. Attention to gripper and sensor selection, coupled with effective HMI feedback, ensures a well-rounded and engaging user experience.

4.2 Traffic Lights

In conclusion, the Traffic Lights Controller project successfully manages traffic at the intersection with a user-friendly interface. During normal operation (Part a), the lights follow a predefined schedule for efficient traffic flow.

In afterhours mode (Part b), activated manually or automatically (bonus Part b), the system adjusts the light timings for reduced traffic. It seamlessly returns to normal operation when conditions change.

The Advanced Lights feature (Part c) adds intelligence with pressure sensors. When enabled, it responds to waiting cars, ensuring smooth transitions between lights based on real-time conditions.

Overall, the project enhances traffic control with a simple yet effective system, prioritizing safety and efficiency. The colorful and intuitive interface makes it easy for users to manage traffic in various scenarios.

5. References

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