- EE392 - INDUSTRIAL AUTOMATED SYSTEMS

FINAL PROJECT

January 2024

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Contents

Introduction

Embarking on an exploration of control systems, our report features two distinct projects - The Traffic Lights Controller and the Toy Claw. The Traffic Lights Controller focuses on enhancing traffic management at intersections, smoothly adapting to varying conditions with user-friendly controls. On the other hand, the Toy Claw project introduces a captivating gaming experience, where users control a claw to grab toys within a set timeframe. These projects highlight the versatility of control engineering, addressing practical challenges in traffic control and providing hands-on insights into the application of smart systems in diverse scenarios.

This project is held by four electric and electronic engineering students who is enrolled to EE392 Industrial Automation Systems 2023-2024 Fall course,
Berke ÇEÇEN, Efe Can ÖZHAN, Genco GÜVEN, Kubilay ULUÇAY for final project.

Traffic Lights Controller

Problem Statement

The core problem addressed in this project is the efficient control of traffic at an intersection, considering both normal and after-hours operation. The state transition diagram illustrates the various states and transitions the Traffic Lights Controller undergoes based on different inputs. The transitions include the normal operating conditions and the after-hours mode triggered by the After Hours Operation button.

Project Components

Inputs

- B1: System Turn On/Off (latching button)
- B2: After Hours Operation (latching button)

Outputs

- 8 traffic lights (2 pairs for each of the 4 intersections: L1, L2, L3, L4)
- Traffic system working indicator.

HMI Design

The HMI design has 8 traffic lights, an indicator if the system is on or off and 3 different buttons which represents “Start the system”, “Stop_the_system” and “After Hours”.
When the system is on normal mode, lights continues to their normal cycle (90 Seconds red, 5 seconds yellow and 120 seconds green light on) and after After Hours button (B2) is activated, all lights only flashes yellow lights at 1Hz.

As shown in the figure below, that is how HMI are designed in our project.

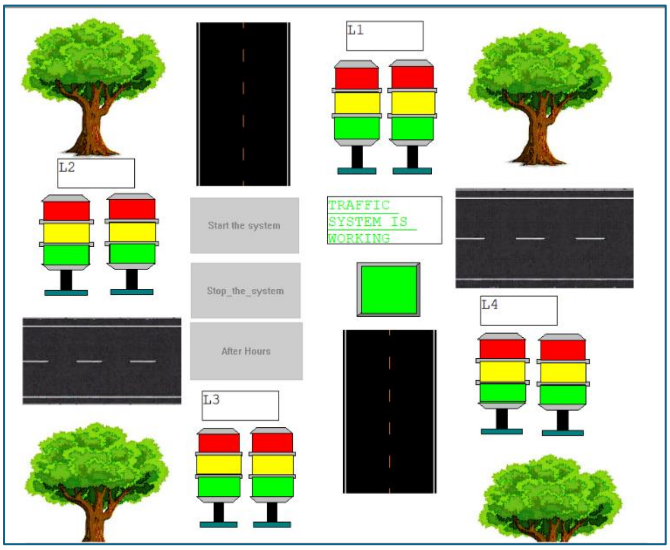


Figure 1 System on presentation

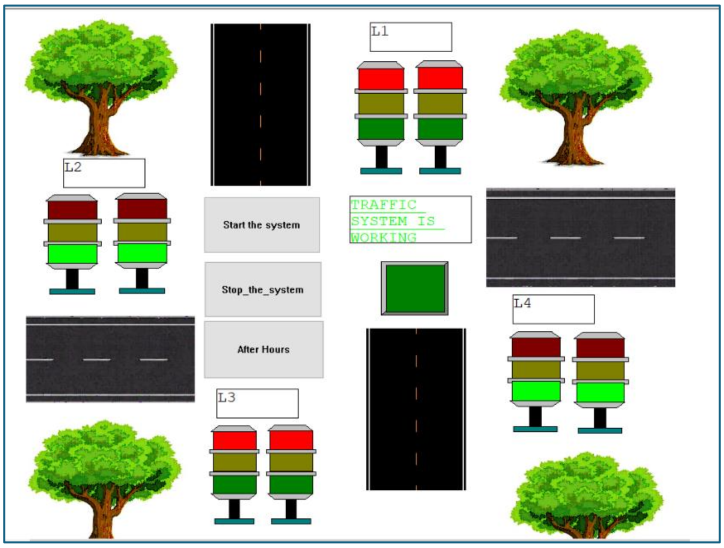


Figure 2 System off presentation

firststate	0	EBOOL
secondstate	0	EBOOL
thirdstate	0	EBOOL
fourthstate	0	EBOOL
reverse_firststate	0	EBOOL
reverse_secondst...	0	EBOOL
reverse_thirdstate	0	EBOOL
reverse_fourthstate	0	EBOOL
stateafterhours	1	EBOOL
new_redlight	0	EBOOL
new_yellowlight	0	EBOOL
new_greenlight	0	EBOOL
redlight	0	EBOOL
yellowlight	0	EBOOL
greenlight	0	EBOOL
start_traffic_lights	0	EBOOL
stop_traffic_lights	0	EBOOL
afterhours	0	EBOOL
traffic_lights_on	1	EBOOL
flashinggreen	0	EBOOL
flashingyellow	0	EBOOL
newflashinggreen	0	EBOOL
newflashingyellow	0	EBOOL

Figure 3 Animation table of Traffic Lights

Animation table is shown in the Figure 3.

Every statement is displayed at animation table.

Project Objectives

Part a) Normal Operation: The primary objective is to design and implement the normal operating conditions of the Traffic Lights Controller. When the system is turned on (B1=1), the lights' behavior should follow the specified timing diagram below. This phase ensures optimal traffic flow during standard operational hours.

Timing diagram of the traffic lights:

1. State 1: Red light turned on for 90 seconds.
2. State 2: Yellow light turned on for 5 seconds.
3. State 3: Green light turned on for 120 seconds, after 120 seconds should be flash at 1Hz for 5 seconds.
4. Repeat the cycle, go back to state 1.

State Diagram is presented as shown below at Figure 4.

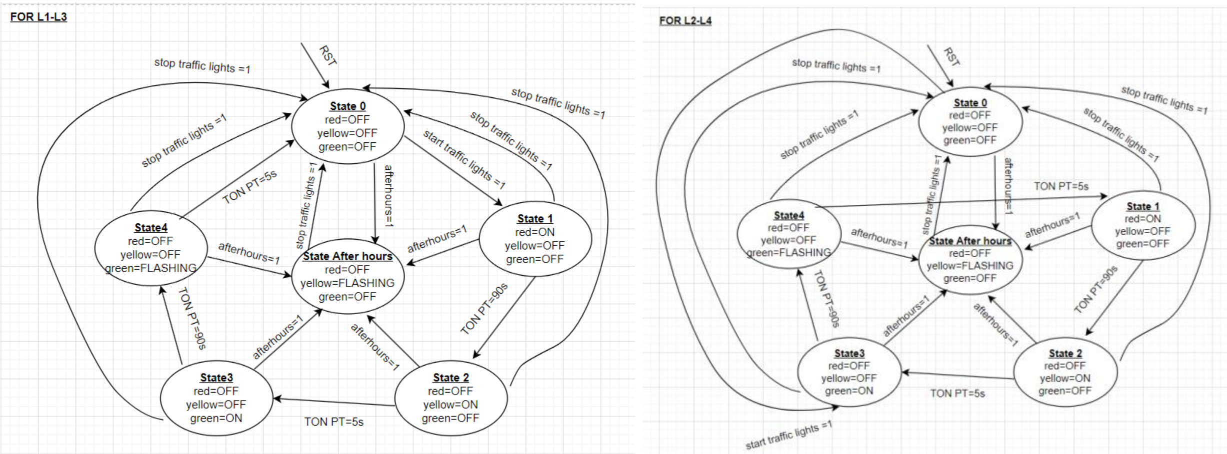


Figure 4 State Diagram for traffic lights L1-L3 and L2-L4

Part b) Afterhours Operation: In response to the desire for an after-hours or off-duty mode, the system incorporates a dedicated button (B2 - After Hours Operation). When activated (B2=1), the traffic lights transition into a different operational cycle, which is

- Yellow light flashes at 1Hz.

Once the after-hours operation is interrupted by system start, B2 returns to zero and the system seamlessly reverts to the normal operation cycle, ensuring adaptability to changing traffic conditions.

Part c) Advanced Lights:

After our researches we have found FCT Push/Pull Load Cell from KOBASTAR, that sensor allows us to measure weight between 500Kgs to 500 ton. 500 ton is overkill but it is the only sensor we can find between 500kg and 3000kg , these limits are chosen according to lightest car for fiat 500 which is 500kgs and heaviest car Mercedes EQS SUV which is 2,810kgs.

Here is the specification of the FCT Load Cell from KOBASTAR on the Figure 5.

Capacity	: 0.5 – 50 Ton / 75 – 500Ton	Isolation Resistance	: ≤ 5000 MΩ (100VDC)
Accuracy Class (ISO 376)	: 1	Compansated Temperature	: -10 ~ + 40 ºC
Minimum Load	: 0 kg	Operating Temperature	: -30 ~ + 70 ºC
Linearity	: ≤ ±0.05 %FS / ≤ ±0.1 %FS	Excitation, Recommended Voltage	: 10 VDC
Repeabilityl	: ≤ ±0.05 %FS	Maximum Excitation Voltage (Umax)	: 15 VDC
Total Error	: 0.05 ~ 0.25	Safe Overload	: 150 % FS
Output Sensitivity (FS)	: 2.00 mV/V ± 0.1 % F.S	Ultimate Overload	: 300 % FS
Zero Balance	: ≤ ± 0.1 %FS	Ingress Protection (EN60529)	: IP 68 / IP 67
Input Resistance	: 750 Ω ± 30 Ω / 400 Ω ± 20 Ω	Element Material	: Alloy Steel / Stainless steel
Output Resistance	: 703 Ω ± 5 Ω / 352 Ω ± 5 Ω	Cable	: 4x022mm^2

Figure 5 Specifications of FCT Load Cell

Observations

When we tested our claw game and we have faced some issues, they are listed below:

- System is not changes to Normal state, after it started to Afterhours, lights are turned off directly but systems is not changed to off mode.
- We could not implement the Real Time Clock and could not finish L1 L2 Automation with sensors even we have found compatible sensors.
- When we leave the green light on for 120 seconds, after some time all of the lights are open and it can lead to accident on the road.

Overall, the Traffic Lights Controller project demonstrates a comprehensive approach to traffic management, with specific attention to normal and after-hours operational scenarios, providing a robust and intelligent solution for traffic control at the designated intersection.

Toy Claw

Problem Statement

The Toy Claw project aims to create an interactive and engaging experience for users by simulating a claw machine. The block diagram illustrates the key components and their interactions within the system. The primary challenge is to design a control system that activates and operates the claw based on user inputs, providing a realistic and enjoyable gaming experience.

Project Objectives

The Toy Claw project is designed with the following key objectives, aiming to create an engaging and interactive gaming experience.

Game Rules and Game Play

- Detecting the insertion of a coin to activate the game.
- Displaying the joystick on the HMI only when the game is active.
- Providing the player with 90 seconds to maneuver the claw to their desired position.
- Activating the claw upon pressing the start button, following a specific sequence of motions.
- Displaying appropriate messages ("Winner" or "Game Over") based on the game outcome.
- Ending the game sequence and deactivating the system after completing the claw's actions.

Here below state diagram of the operation is shown at Figure 6.

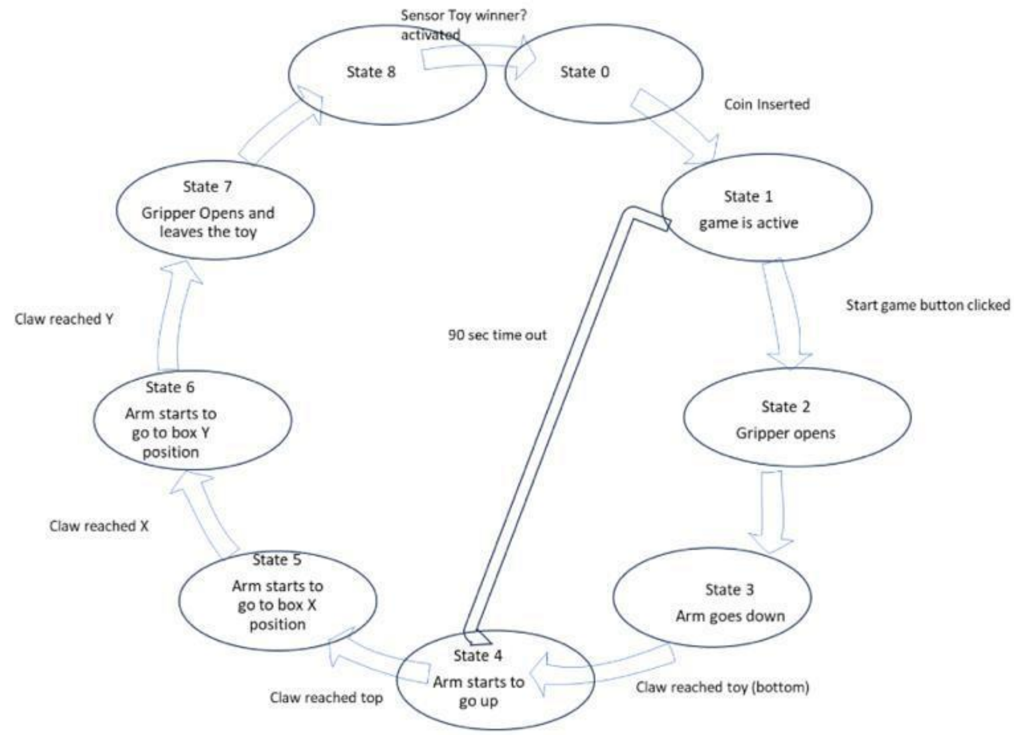


Figure 6 State Diagram of Claw Machine

Project Components

Inputs

- B0 (Game Start Button - momentary)
- S0 (Input Coin OK - momentary)
- X2(-x_motion), X3(+x_motion), X4(-y_motion), X5(+y_motion), Other sensor inputs of your choice

Internal Variables

- Total_Number_of_Games_Played
- Total_Number_of_Wins
- Date_and_Time_of_Last_Win

Outputs

- X_Motor_Right
- X_Motor_Left
- Y_Motor_Right
- Y_Motor_Left
- Z_Motor_Up
- Z_Motor_Down
- Gripper_Open
- Gripper_Close

Gameplay Sequence

1. Initiating the game upon coin detection.
2. Displaying the joystick on the HMI only during active gameplay.
3. Allowing 90 seconds for the player to control the claw.
4. Activating the claw, following a predefined sequence of motions.
5. Displaying appropriate messages based on the game outcome.
6. Ending the game sequence and deactivating the system.

Gripper Selection

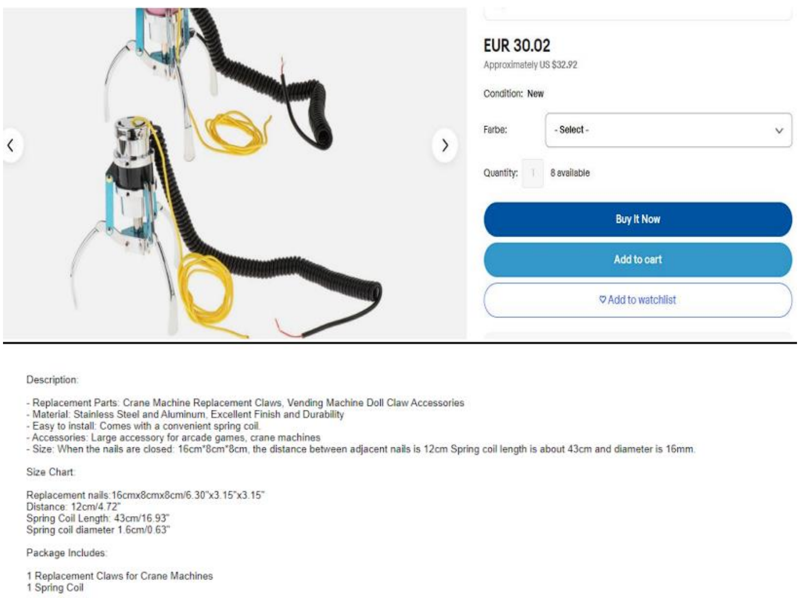


Figure 7 Claw selection

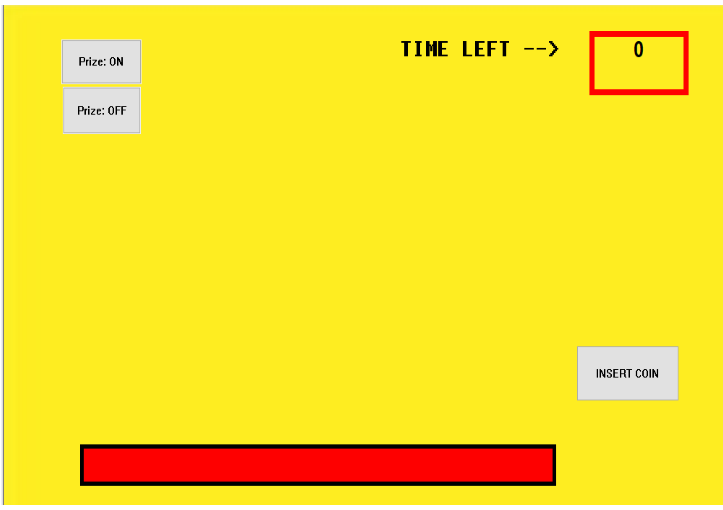
We have selected Gripper from gazechimp as shown in Figure 7.

We have chosen that component because it is easy to use and barely cheaper than the other in the market

HMI Design

Designing a user-friendly HMI displaying

- Joystick buttons for all four directions (UP, RIGHT, DOWN, LEFT)
- A button to start the game (START GAME)
- A display showing the remaining time in seconds.
- Game Over or Winner messages.
- Real-time display of arm motion directions during movement.



Before we have started the game our HMI looks like the Figure 8 on the left.

For that state HMI only shows

if it is gives prizes or not on the top left part,
how much time left on the top right,
text box on the down middle with red box,

and INSERT COIN button to start game.

Figure 8 HMI before starting game

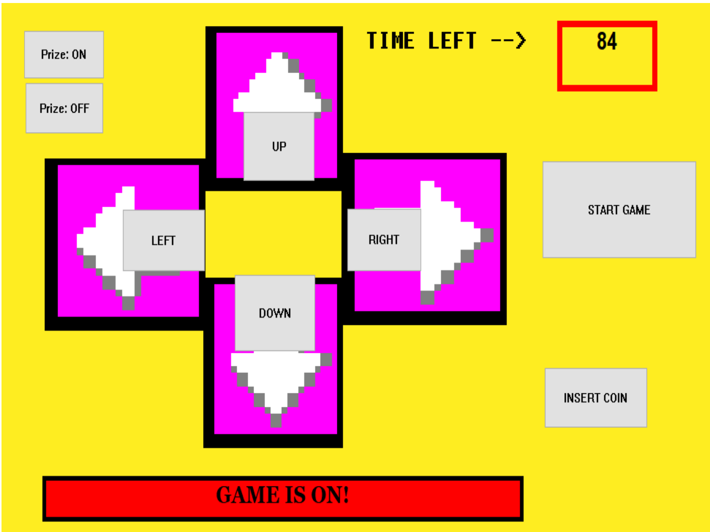


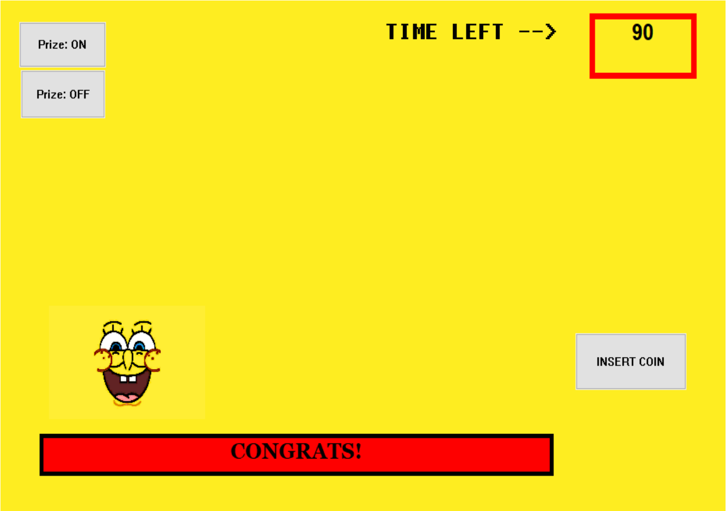
Figure 9 HMI after starting game

When the game is started by inserting coin (Pressing insert coin button) HMI will show the buttons to control claw to four different directions as shown in Figure 9.

Then time starts from 90 and goes down to 0.

Here we can move claw to any direction you want and by pressing START GAME button these actions are followed below.

1. Open the claw
2. Claw goes down
3. Claw closes
4. Claw goes up
5. and opens claw again



If we win any prize red text box displays "CONGRATS!" and happy sponge bob shows up as shown in Figure 10.

Figure 10 HMI if we win any prize

If we cannot win any prize red text box displays "NO PRIZE :(" and frustrated Mike Wazowski says "Bruh" to show how frustrated he is as shown in Figure 11.

Figure 11 HMI if we cannot win anything

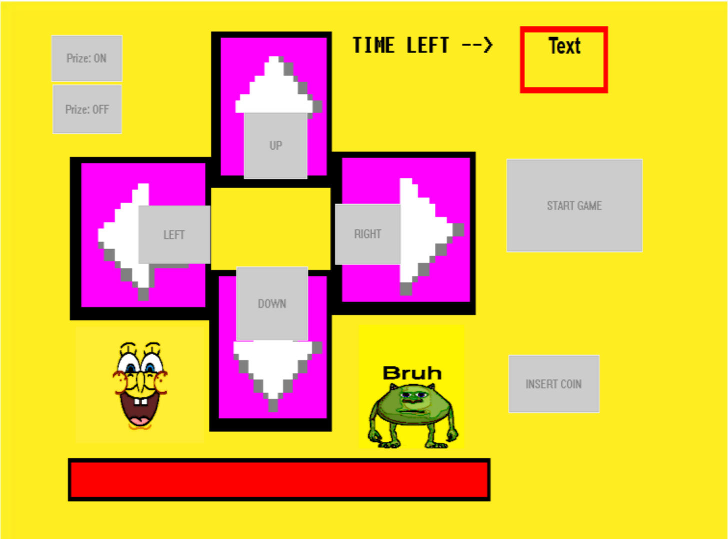


Figure 12 Overall look to HMI

When we did not run the PLC that is how overall HMI looks like. Here you can see every possible component on the Figure 12.

Total_Number_Of_Games_Played	1	INT
Total_Number_Of_Wins	0	INT
%SW49	1	INT
%SW50	2048	INT
%SW51	5401	INT
%SW52	277	INT
%SW53	8228	INT
Day_Of_Last_Win	0	INT

Figure 13 Animation table of the Claw machine

On the Figure 13 animation table of the system is shown.

Number of games played, number of wins and date of the last win are not shown at HMI however it is still counted in the system.

Observations

When we tested our claw game and we have faced some issues, they are listed below:

- After the game is finished, we can't use the "time left" clock for another round. In the animation table, only the last DAY of win can be seen, and it is not in a proper format. The buttons are designed as real-life joysticks so to move the claw, you have to press and hold the button.
- In the system, Date of The Last Win is not showing up in date format so we could not retrieve the last date of win.
- Other components are working in order without any interruption.

These issues are not fixed right now but they are not unfixable errors, with more experience and some testing they can be fixed easily.

Conclusion

In conclusion, our exploration of control systems through the Traffic Lights Controller and Toy Claw projects has provided valuable insights into the practical applications of industrial automated systems. The Traffic Lights Controller project showcased a robust solution for efficient traffic management at intersections. With an intuitive Human-Machine Interface (HMI) design and thoughtful transitions between normal and after-hours operations, the system presents a comprehensive approach to traffic control.

On the other hand, the Toy Claw project introduced an engaging gaming experience, simulating a claw machine. Despite facing some challenges in system functionalities, such as issues with the "time left" clock and date format display, the project successfully achieved its primary objectives. The HMI design effectively communicated game information to users, offering an interactive and enjoyable gaming interface. To improve the entertainment of program, more animations could be added to program.

Collaboratively undertaken by Berke ÇEÇEN, Efe Can ÖZHAN, Genco GÜVEN, and Kubilay ULUÇAY for the EE392 Industrial Automation Systems 2023-2024 Fall course, both projects emphasize the adaptability and versatility of control engineering and PLC programming skills. These experiences not only address practical challenges in traffic control and gaming entertainment but also showed the way for continuous improvement and reinforcement in future automation projects. The lessons learned from these projects contribute to the ongoing advancement of industrial automated systems, highlighting the importance of innovation, problem-solving, and hands-on experience in the field of electrical and electronic engineering.