CYBER-PHYSICAL SYSTEM FINAL PROJECT REPORT
DEPARTMENT OF ELECTRICAL ENGINEERING
UNIVERSITAS INDONESIA

AUTOMATIC WAITER CALLER FOR CHEF

GROUP B4

RAYHAN AKBAR A.	**2106632655**
ENRICCO VERINDRA PUTRA	**2106651793**
M. AQIL MUZAKKY	**2106731604**
ELDISJA HADASA	**2106640133**

PREFACE

We are delighted to present this project report, which documents our timeline in developing and implementing an automatic waiter caller system. This project was undertaken as a requirement for our final project. The primary objective of this project was to address the challenges faced in the hospitality industry, particularly in restaurant settings, regarding the communication and coordination between chefs and waitstaff.

Our aim was to develop a solution that would streamline the process of notifying waitstaff when food is ready to be served, thereby improving operational efficiency and customer satisfaction. Our approach involved integrating various hardware components, such as the HC SR04 sensor, Hall effect sensor, LED, buzzer, MAX7219 display, and servo mechanism, with the corresponding software algorithms to ensure seamless functionality.

By adhering to a well-defined timeline and conducting thorough testing and evaluation, we were able to validate the effectiveness of our system in accurately detecting food readiness and providing real-time notifications to the waitstaff. We also evaluated the system's performance under different scenarios to ensure its reliability and suitability for real-world restaurant environments.

Depok, May 16th, 2023

Group B4

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CHAPTER 1

INTRODUCTION

1.1 PROBLEM STATEMENT

The hospitality industry, particularly the restaurant sector, relies on efficient communication and coordination between chefs and waitstaff to ensure timely food service. However, the manual process of signaling the readiness of food to be served can be prone to errors and delays, leading to customer dissatisfaction and operational inefficiencies. This project addresses the problem of streamlining the communication process between chefs and waitstaff by developing an automatic waiter caller system.

The primary issue is the lack of a reliable and automated system to notify waitstaff when the food is ready for serving. This can result in situations where food is left waiting in the kitchen while the chef is occupied, leading to a loss of freshness and quality. The proposed system aims to overcome these challenges by utilizing sensors, output devices, and a display to accurately detect and signal the readiness of food to the waitstaff, thereby improving overall operational efficiency and customer satisfaction.

1.2 PROPOSED SOLUTION

The proposed solution is the Automatic Waiter Caller for Chef system, which utilizes sensors and intelligent signaling mechanisms. The system incorporates an HC-SR04 sensor placed near the food to detect its presence. Additionally, a Hall effect sensor is placed on the waiter's side. When the food is detected, indicating it is ready for serving, the system triggers the LED to illuminate and the buzzer to sound, signaling the waitstaff. To ensure a seamless interaction, the waiter triggers the Hall effect sensor, which opens the separating glass using a servo mechanism. The system also employs a MAX7219 display to provide real-time status updates, including "Cooking" during food preparation, "Ready" when the food is detected, and "Opened" when the waiter triggers the system.

By automating the food readine ss notification process, the proposed solution eliminates the need for manual coordination, reduces the risk of errors, and improves communication efficiency between chefs and waitstaff.

1.3 ACCEPTANCE CRITERIA

The acceptance criteria of this project are as follows:

- Accurate and reliable detection of food readiness using the HC SR04 sensor.
- Timely signaling to the waitstaff through LED illumination and buzzer activation.
- Proper interaction between the waiter and the system using the Hall effect sensor, resulting in the opening of the separating glass.
- Display of accurate and up-to-date status information on the MAX7219 display.
- Overall improvement in communication and coordination between the kitchen and the waitstaff, leading to enhanced operational efficiency.

1.4 ROLES AND RESPONSIBILITIES

The roles and responsibilities assigned to the group members are as follows:

Roles	Responsibilities	Person
Role 1	Made all the code and the circuit, wrote the report	Rayhan Akbar Arrizky
Role 2	Made all the Proteus simulation, wrote the presentation slide	Eldisja Hadasa
Role 3	Filled application letter for borrowing components	M. Aqil Muzakky
Role 4	Bought the components, wrote the report	Enricco Verindra Putra

Table 1. Roles and Responsibilities

1.5 TIMELINE AND MILESTONES

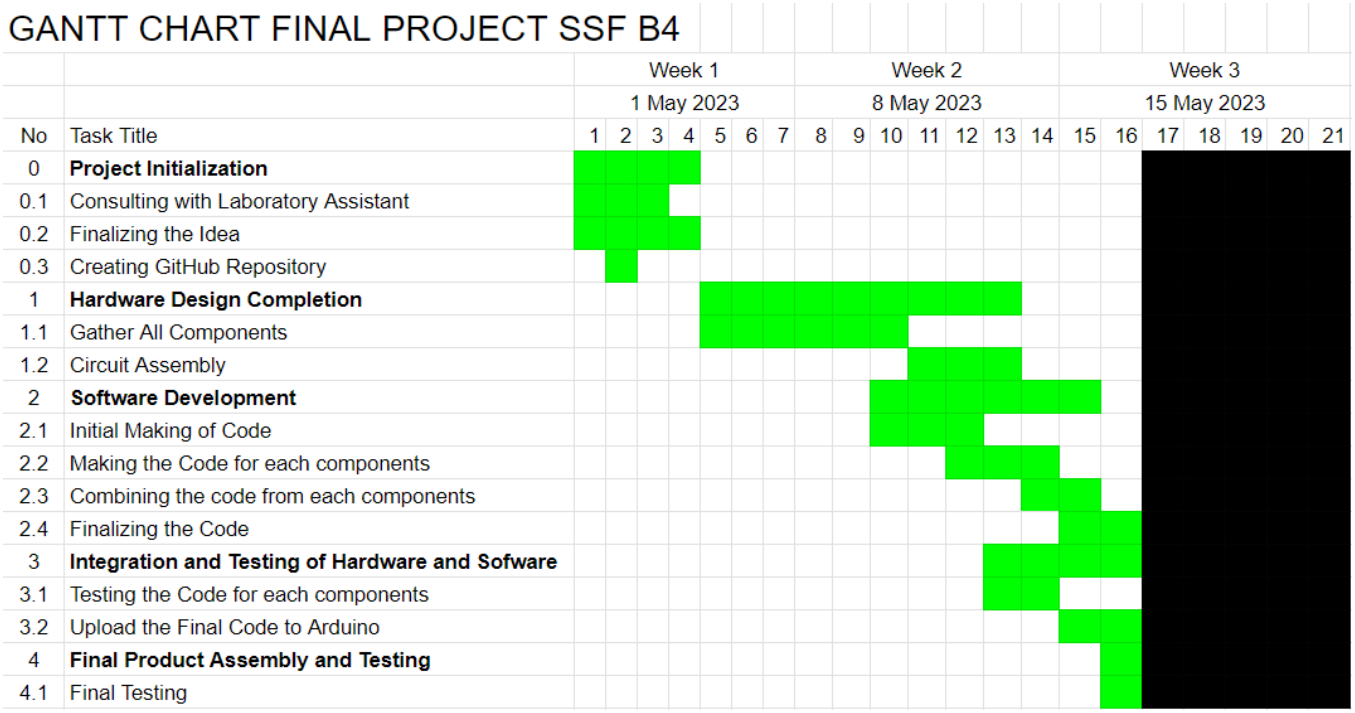


Fig 1. Gantt Chart for timeline and milestones

CHAPTER 2

IMPLEMENTATION

2.1 HARDWARE DESIGN AND SCHEMATIC

The hardware design of the Automatic Waiter Caller for Chef system consists of several components that work together to achieve its functionality. The system includes an HC SR04 sensor placed near the food, which detects its presence and readiness. Additionally, a Hall effect sensor is positioned on the waiter's side to facilitate interaction with the system. The system also use LED, buzzer, and MAX7219 sevent segment display for visual and auditory output.

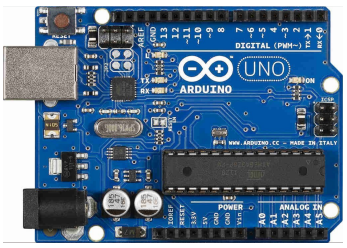


Fig 2. Microcontroller used in the system

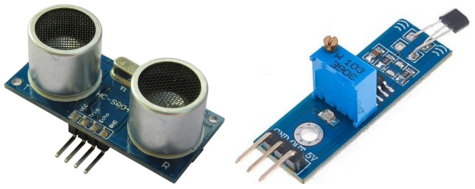


Fig 3. Sensors used in the system

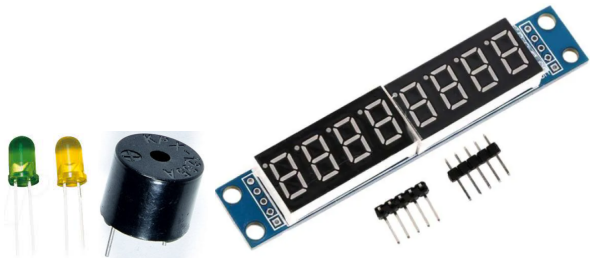
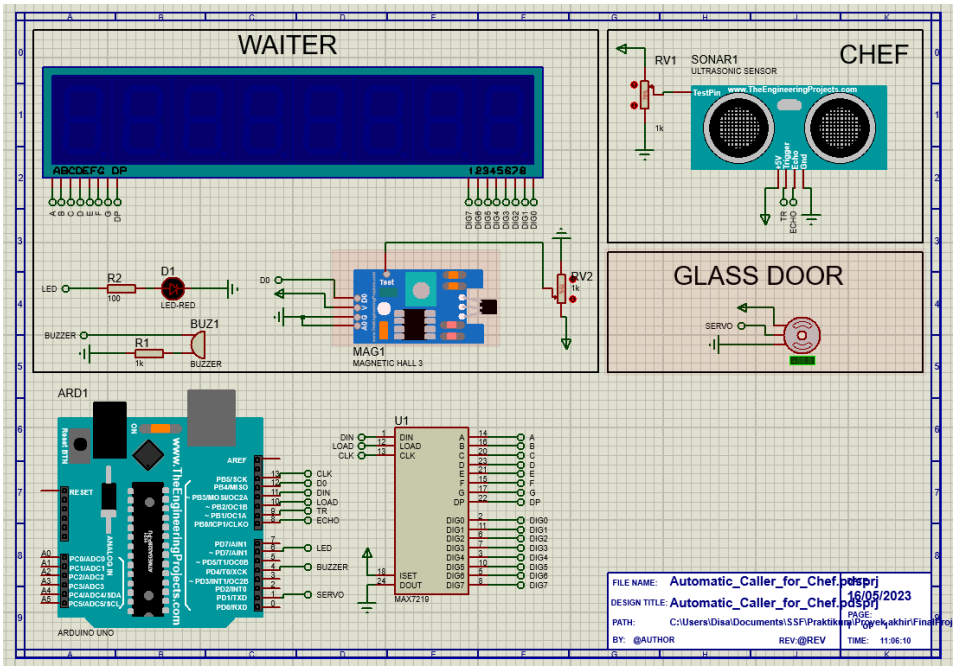


Fig 4. Indicator & Display used in the system

The schematic diagram illustrates the connections between the various components. The HC SR04 sensor is connected to the Arduino, which processes the input and triggers the

necessary output signals. The Hall effect sensor is also connected to the microcontroller to receive the waiter's interaction. A servo mechanism is integrated to control the opening and closing of the separating glass. Furthermore, the MAX7219 display is connected to the microcontroller to provide visual feedback on the status of the food.



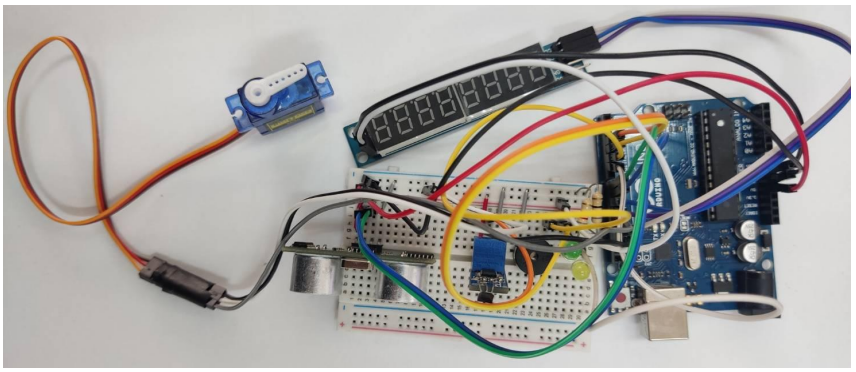


Fig. 5 Overall schematic of the system's hardware

2.2 SOFTWARE DEVELOPMENT

The software development for the Automatic Waiter Caller for Chef system involves coding the necessary algorithms and functionalities. The microcontroller is programmed to read the input from the HC SR04 sensor and trigger the appropriate output signals when the food is detected. This includes illuminating the LED and sounding the buzzer to call the waiter.

The microcontroller also handles the interaction with the Hall effect sensor. When the waiter triggers the sensor, indicating their presence, the microcontroller initiates the opening of the separating glass using the servo mechanism. A delay is implemented to ensure that the waiter has enough time to reach the food before the glass closes. Additionally, the microcontroller controls the MAX7219 display to show the relevant food status, such as "Cooking," "Ready," or "Opened."

The flowchart of the software as follows:

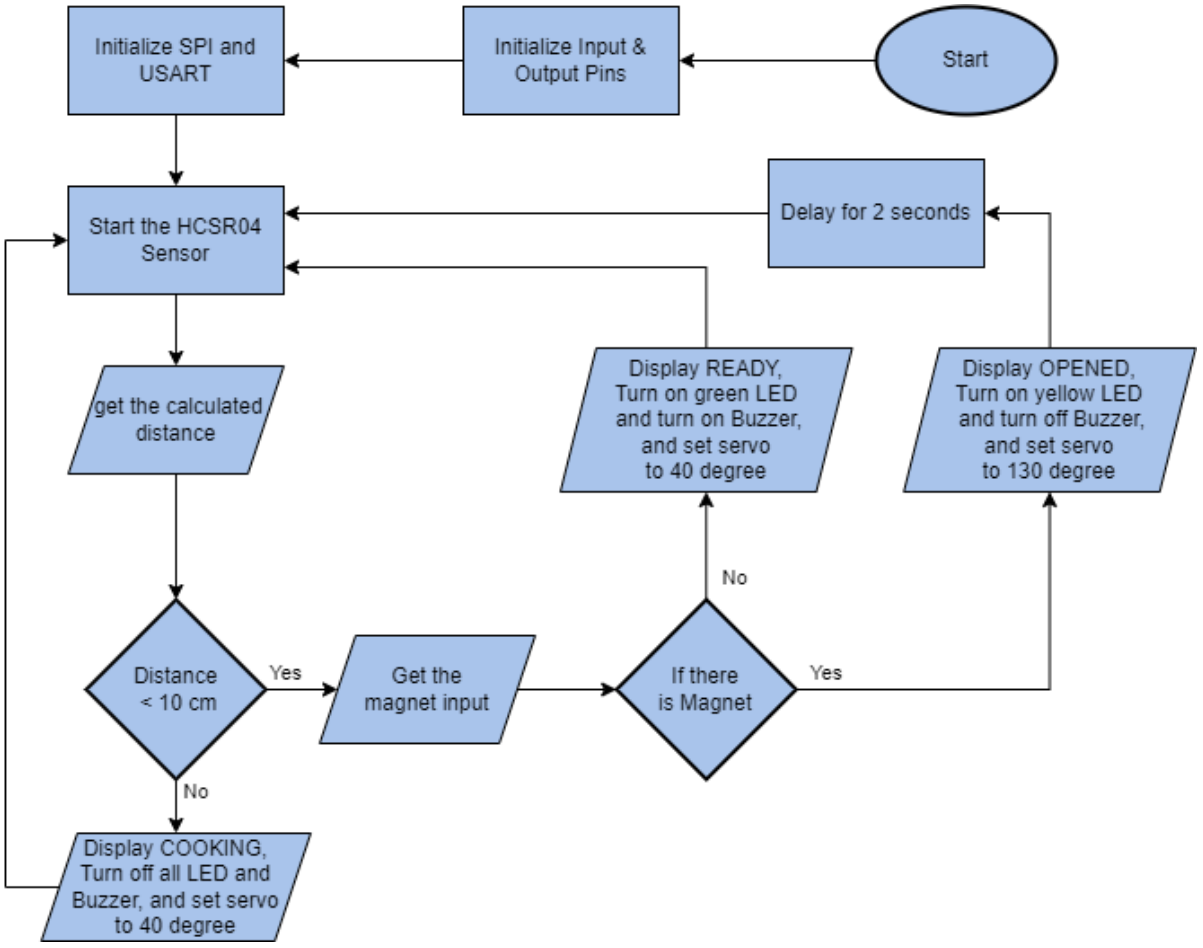


Fig. 6 Flowchart of the software

2.3 HARDWARE AND SOFTWARE INTEGRATION

The integration phase involved connecting the hardware components to the Arduino microcontroller and ensuring seamless interaction between the software and hardware. The hardware components were interfaced with the Arduino, with the appropriate pins assigned for sensor inputs, output device control, and communication with the MAX7219 display.

Careful attention was given to establishing the correct communication protocols and configuring the necessary settings.

The software code was uploaded to the Arduino board, allowing it to execute the defined instructions and control the hardware components based on the input signals from the sensors. Testing and debugging were performed during the integration phase to ensure the smooth operation of the complete system. Adjustments and refinements were made as needed to achieve optimal hardware and software integration.

By successfully integrating the hardware and software components, we were able to create a cohesive system that accurately detected food readiness, provided clear notifications, and facilitated effective communication between the kitchen and the waitstaff.

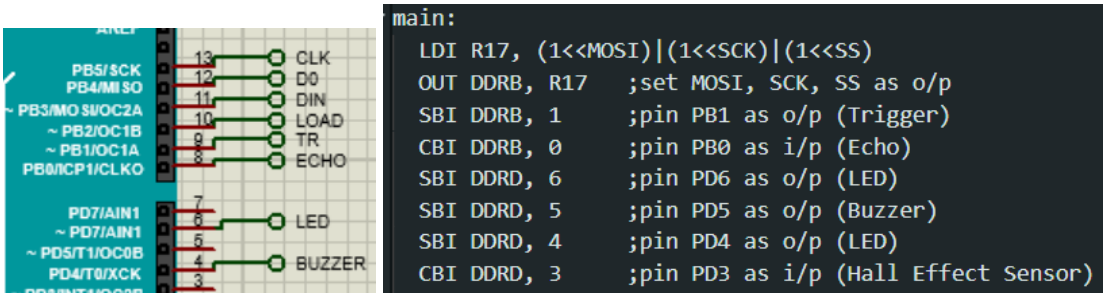


Fig 7. Examples of integrating the code for each corresponding hardware pins

CHAPTER 3

TESTING AND EVALUATION

3.1 TESTING

To validate the functionality and performance of the automatic waiter caller system, testing procedures were implemented. The testing phase aimed to verify the system's ability to detect food readiness, trigger the appropriate signals, update the display, and operate the servo mechanism accurately. Various tests were conducted to assess the system's accuracy, responsiveness, and reliability. The following tests were performed:

- Food Detection Test: This test verified the system's ability to accurately detect the presence and readiness of the food using the HC SR04 sensor. Different scenarios and placements were tested to ensure consistent and reliable detection.
- Alert Triggering Test: The triggering of alerts, including LED illumination and buzzer sound, was tested to ensure they activate promptly and effectively when the food is detected.
- Hall Effect Sensor Interaction Test: The interaction between the waiter and the Hall effect sensor was tested to ensure that triggering the sensor accurately indicates the waiter's presence. This test validated the system's ability to distinguish between the food being ready and the waiter being ready to collect it. This test also ensured that the waiter can't open the separating glass if there is no food detected.
- Servo Mechanism Test: The servo mechanism responsible for opening and closing the separating glass was tested for smooth operation. The timing and movement of the servo were evaluated to ensure that the glass opens after the waiter triggers the Hall effect sensor.

3.2 RESULT

The results of the testing phase confirmed the successful implementation of the automatic waiter caller system. The system exhibited reliable food detection, triggered appropriate signals, and provided clear notifications to the waitstaff. The LED, buzzer, and

MAX7219 display worked in unison to deliver timely and accurate status updates, facilitating efficient coordination between the kitchen and the waitstaff.

Furthermore, the servo mechanism operated reliably, opening the separating glass to grant access to the food when it was ready for serving. The system demonstrated its ability to streamline the communication process, reduce wait times, and enhance customer satisfaction.

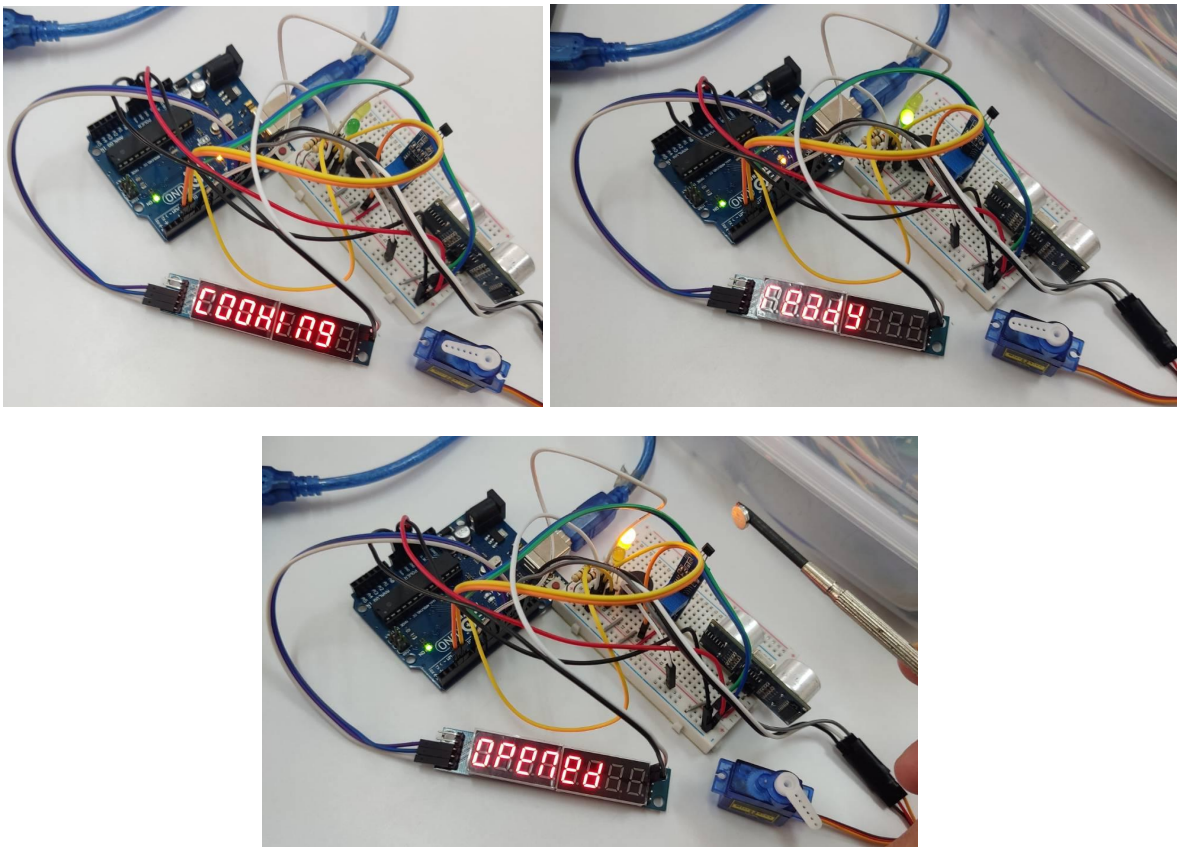


Fig 8. Testing Result

The results of the testing phase indicated that the automatic waiter caller system met the predefined acceptance criteria. It effectively addressed the problem of timely food service coordination and showcased its potential to optimize restaurant operations.

3.3 EVALUATION

Based on the testing results, the automatic waiter caller system proved to be a successful solution to improve communication and coordination between chefs and waitstaff in a restaurant setting. The integration of hardware components, software algorithms, and

proper sensor functionality yielded a robust system that accurately detected food readiness and facilitated efficient notification.

The system's reliable performance and seamless operation contribute to enhanced operational efficiency, reduced errors, and improved customer service. By automating the waiter calling process, the system streamlines restaurant workflows and promotes effective collaboration between kitchen staff and waitstaff.

However, it is important to note that further evaluation could be conducted in real-world restaurant environments to assess the system's performance under varying conditions, such as high kitchen noise levels or different food types. This evaluation would provide valuable insights into the system's adaptability and effectiveness in diverse restaurant settings.

Overall, the testing and evaluation phase demonstrated the successful implementation and functionality of the automatic waiter caller system, affirming its ability to address the problem statement and improve communication efficiency within a restaurant.

CHAPTER 4

CONCLUSION

The Automatic Waiter Caller for Chef system has successfully addressed the problem of timely communication between chefs and waiters in a restaurant settings. Through the implementation of hardware components, including the HC SR04 sensor, Hall effect sensor, servo mechanism, LED, buzzer, and MAX7219 display, combined with software development and integration that our group studied from the experimental and classes, the system has demonstrated its effectiveness in indicating the readiness of food and then proceed to calling the waiter.

Throughout the development and testing process, the system consistently met the defined acceptance criteria. The HC SR04 sensor accurately detected the presence and readiness of the food, triggering alerts through LED illumination and buzzer sound. The Hall effect sensor allowed the waiter to interact with the system, initiating the opening of the separating glass using the servo mechanism.

The successful integration of hardware and software components ensured seamless communication and operation. The MAX7219 display effectively presented the status of the food, providing valuable information to both chefs and waitstaff. Overall, the system has proven to be reliable, responsive, and user-friendly, contributing to a more efficient dining experience.

In conclusion, the Automatic Waiter Caller for Chef system provides a practical solution for improving communication and coordination in restaurant kitchens. By streamlining the process of food readiness indication and waiter calling, the system enhances the efficiency and effectiveness of restaurant operations. Future work could involve further optimization of the system, exploring additional features or functionalities, and hopefully scaling the implementation in the real world to accommodate larger restaurant environments to enhance profits and bring an impactful benefit.

REFERENCES

[1] M. A. Mazidi, S. Naimi, and S. Naimi. "AVR Serial Port Programming in Assembly and C" in *AVR Microcontroller and Embedded Systems: Using Assembly and C*. Pearson Education, 2006.

[2] Tim Penyusun Modul. "Modul 2 SSF : Introduction to Assembly I/O Programming". [Online]. Digital Laboratory FTUI. 2023. Available: https://classroom.google.com/u/0/c/NTkzNjAyMDgzODQw [Accessed 15 May 2023]

[3] Tim Penyusun Modul. "Modul 4 SSF : Serial Port". [Online]. Digital Laboratory FTUI. 2023. Available: https://classroom.google.com/u/0/c/NTkzNjAyMDgzODQw [Accessed: 15 May 2023].

[4] Tim Penyusun Modul. "Modul 5 SSF : Aritmatika". [Online]. Digital Laboratory FTUI. 2023. Available: https://emas2.ui.ac.id/pluginfile.php/3744299/mod_resource/content/3/Modul%205%20SSF%20Aritmatika.pdf [Accessed: 15 May 2023].

[5] Tim Penyusun Modul. "Modul 6 SSF : Timer". [Online]. Digital Laboratory FTUI. 2023. Available: https://emas2.ui.ac.id/pluginfile.php/3754317/mod_resource/content/1/Modul%206%20SSF_%20Timer.pdf. [Accessed: 15 May 2023].

[6] Tim Penyusun Modul. "Modul 8 SSF : I2C & SPI". [Online]. Digital Laboratory FTUI. 2023. Available: https://emas2.ui.ac.id/pluginfile.php/3797142/mod_resource/content/1/ModSRul%208%20SSF_%20I2C%20_%20SPI.pdf. [Accessed: 15 May 2023].

[7] Tim Penyusun Modul. "Modul 9 SSF : Sensor Interfacing". [Online]. Digital Laboratory FTUI. 2023. Available: https://emas2.ui.ac.id/pluginfile.php/3797143/mod_resource/content/1/Modul%209%20SSF-%20Sensor%20Interfacing.pdf. [Accessed: 15 May 2023].

[8] "AVR instruction set manual - microchip technology," AVR Instruction Set Manual, Nov-2016. [Online]. Available: https://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-0856-AVR-Instruction-Set-Manual.pdf. [Accessed: 15 May 2023].

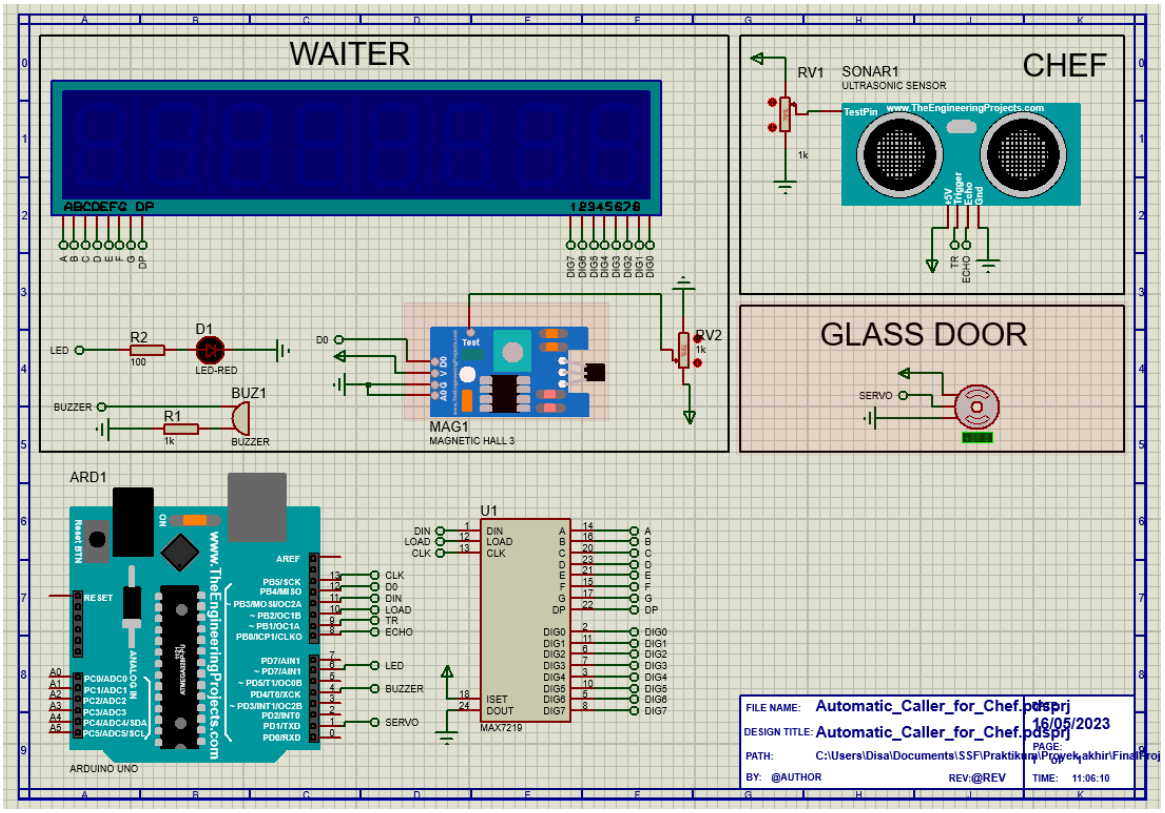
[9] Anas Kuzechie. "Assembly via Arduino (part 15) - Programming SPI". (Nov. 17, 2021). [Online Video]. Available: https://www.youtube.com/watch?v=N0tmYhU9sN8. [Accessed: 15 April 2023].

[10] Anas Kuzechie. "Assembly via Arduino (part 7) – Programming Serial Port". (Oct. 20, 2021). [Online Video]. Available: https://www.youtube.com/watch?v=7PVTnT59cqE [Accessed: 7 Mar 2023].

[11] Anas Kuzechie. "Assembly via Arduino (part 21) - HC SR04 Sensor". (Dec. 6, 2021). [Online Video]. Available: https://www.youtube.com/watch?v=dIIBG7Qz-_E. [Accessed: 16 May 2023].

APPENDICES

Appendix A: Project Schematic



Appendix B: Documentation