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

Enhanced Reading Assistant With Adaptive Environment Feedback

GROUP A2

Bernanda Nautval R.I.W.	**2106708463**
M. Najih Aflah	**2106653880**
R.B.S. Kresna Ramdani G.R.	**2106702610**
Reichan Adhiguno	**2106703273**

PREFACE

Assalamualaikum wr.wb. Praise be to Allah SWT for His mercy and blessings, which have allowed us to complete our Final Project Report titled "Reading Assistant."

We prepared this Final Project Report to fulfill the requirements of the Cyber-Physical Systems Laboratory Practicum, under the supervision of Mr. F. Astha Ekadiyanto, S.T., M.Sc. Additionally, the purpose of this report is to broaden readers' understanding of the application of a reading assistant system.

Our group would also like to express our gratitude to Mr. F. Astha Ekadiyanto, S.T., M.Sc., and the Assistant of the Digital Laboratory for guiding us in the preparation of this final project. Thanks to this given project, we have gained insights into the implementation of a reading assistant using assembly. The authors would also like to extend their heartfelt appreciation to all those who have assisted in the process of preparing this paper.

The authors acknowledge that there may be many errors in the preparation and writing. Therefore, we apologize for any mistakes and imperfections found in this report. The authors also welcome criticism and suggestions from readers if any errors are discovered in this report.

Depok, May 16, 2023

Group A2

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 PROBLEM STATEMENT

Reading or viewing digital screens for extended periods can often lead to eye strain and discomfort, especially when the user is positioned too closely to the screen or when the ambient lighting conditions are inadequate. These issues can significantly impact the reading experience and potentially affect the user's overall well-being. To address these challenges, our group aims to develop a Reading Assistant system, as it aims to assist users in optimizing their reading experience by providing real-time feedback on their proximity to the screen and the illumination level of the surrounding environment.

The main problem that this paper seeks to address is the lack of an automated system that can effectively monitor and adjust reading conditions based on user proximity and room illumination. Existing solutions rely on manual adjustments or do not provide personalized feedback, resulting in suboptimal reading experiences and potential discomfort for the users. Therefore, there is a need to develop a reliable and user-friendly Reading Assistant system that can intelligently detect the user's distance from the screen and the lighting conditions of the room, and provide timely alerts or adjustments to ensure optimal reading comfort and screen visibility.

By implementing a Reading Assistant system equipped with sensors, such as the HCSR04 for measuring reading distance and the LDR for assessing room illumination, the user will receive real-time notifications when they are positioned too closely to the screen or if the lighting conditions are insufficient. Additionally, the system will provide appropriate responses, such as activating a buzzer when the user is too close to the screen and illuminating an LED when the room is too dark. Such a system will enable users to maintain an optimal reading distance and ensure adequate lighting, ultimately enhancing their reading experience and minimizing potential discomfort.

Therefore, our group aims to design, develop, and evaluate a Reading Assistant system that utilizes proximity and illumination sensors to assist users in achieving an optimal reading experience by providing timely feedback and automated adjustments.

1.2 PROPOSED SOLUTION

To address the challenges mentioned earlier, we propose the development of a comprehensive Reading Assistant system that incorporates the use of sensors, actuators, and intelligent algorithms. This system will provide real-time feedback and automated adjustments to optimize the reading experience based on the user's proximity to the screen and the ambient lighting conditions

By implementing this proposed solution, users will benefit from an intelligent Reading Assistant system that actively assists them in achieving an optimal reading experience. The system will provide real-time feedback on their proximity to the screen and the lighting conditions, allowing them to make necessary adjustments for enhanced comfort and reduced eye strain. Ultimately, this solution aims to improve reading efficiency, user comfort, and overall well-being during prolonged screen usage.

1.3 ACCEPTANCE CRITERIA

The acceptance criteria of this project are as follows:

1. The system must be able to implement proximity detection accurately
    - The Reading Assistant system can accurately measures the user's distance from the screen using the HCSR04 proximity sensor.
    - The system detects when the user is positioned too closely to the screen which is below or equals 16 centimeters and triggers the buzzer actuator accordingly.
2. The system must be able to implement illumination assessment accurately
    - The Reading Assistant system can effectively measures the ambient lighting conditions using the LDR illumination sensor
    - The system accurately detects when the room lighting falls below a certain threshold
    - The LED actuator is promptly illuminated when the lighting conditions are insufficient, providing additional light for improved screen visibility
3. The system must be able to provide a good overall performance and user experience

- The Reading Assistant system significantly improves the reading experience by reducing eye strain and discomfort

1.4 ROLES AND RESPONSIBILITIES

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

Roles	Responsibilities	Person
Role 1	Made the code and circuit	Bernanda Nautval R.I.W
Role 2	Made the report and powerpoint slide	M. Najih Aflah
Role 3	Made the report and powerpoint slide	R.B.S. Kresna Ramdani G.R
Role 4	made the powerpoint slide	Reichan Adhiguno

Table 1. Roles and Responsibilities

1.5 TIMELINE AND MILESTONES

Gantt Chart

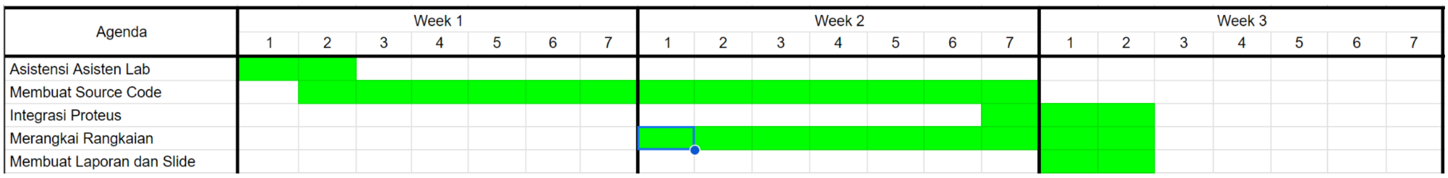


Fig 1. Gannt Chart

a) Asistensi Asisten Lab: A milestone indicating the date when the hardware design for the embedded system is finalized, including schematic.

b) Membuat Source Code: The date when the development of the user-created assembly code (software) begins, focusing on specific tasks and functionalities.

c) Integrasi Proteus: A milestone indicating when the hardware and software components are integrated and tested together to ensure proper functionality.

d) Merangkai Hardware: A milestone marking when the final system product is assembled, tested, and verified to meet the acceptance criteria.

e) Membuat Laporan dan Slide: A milestone indicating when the report and powerpoint slide is made

CHAPTER 2

IMPLEMENTATION

2.1 HARDWARE DESIGN AND SCHEMATIC

The hardware design of the Reading Assistant system comprises several key components, including an Arduino microcontroller, an HCSR04 sensor for proximity detection, an LDR sensor for ambient light assessment, and a MAX7219 seven-segment display for visual output and auditory output.

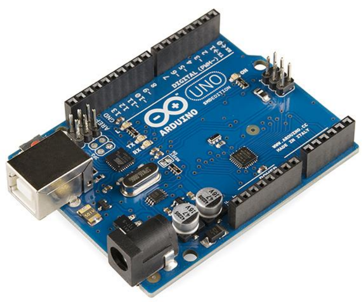


Fig 2. Arduino Microcontroller

Fig 3. HCSR04 Sensor

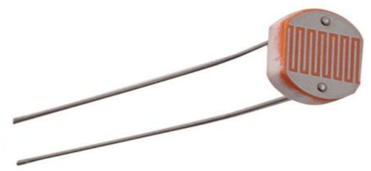


Fig 4. LDR Sensor

The schematic diagram illustrates the connections between the various components. The Arduino microcontroller serves as the central control unit of the Reading Assistant system. It is responsible for processing sensor data, executing algorithms, and generating appropriate output signals. The HCSR04 sensor is connected to the microcontroller and is utilized to measure the user's distance from the screen accurately. It employs ultrasonic waves to determine the time taken for the sound waves to travel and return after being emitted by the sensor. The LDR sensor is also connected to the microcontroller and plays a vital role in assessing the ambient lighting conditions in the room. It measures the intensity of light falling on its surface. The LDR sensor provides analog output that corresponds to the amount of light detected. Lastly, the MAX7219 seven-segment display is connected to the microcontroller and serves as the visual output component of the Reading Assistant system

2.2 SOFTWARE DEVELOPMENT

The software development for the Reading Assistant system focuses on programming the Arduino microcontroller to process sensor inputs, trigger appropriate output signals, and control the MAX7219 display to provide relevant status feedback to the user.

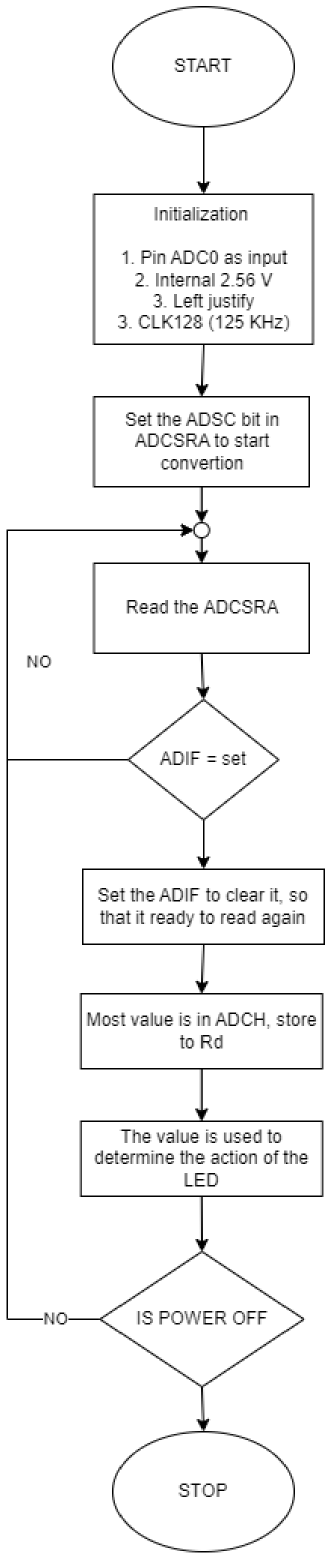
The microcontroller is programmed to continuously read the input from the LDR sensor, which measures the ambient lighting conditions in the room. The software algorithm compares the analog value obtained from the LDR sensor with a predefined threshold that indicates sufficient lighting. If the measured light intensity falls below this threshold, the software triggers an output signal to light up the LED, indicating that the room lighting is inadequate for optimal reading.

In addition to lighting assessment, the microcontroller is programmed to read the input from the HCSR04 sensor, which measures the user's distance from the screen. The software algorithm compares the distance measurement obtained from the HCSR04 sensor with a predefined threshold that indicates an appropriate reading distance. If the user's proximity exceeds this threshold, the software triggers a buzzer to alert the user, ensuring they maintain an optimal reading distance.

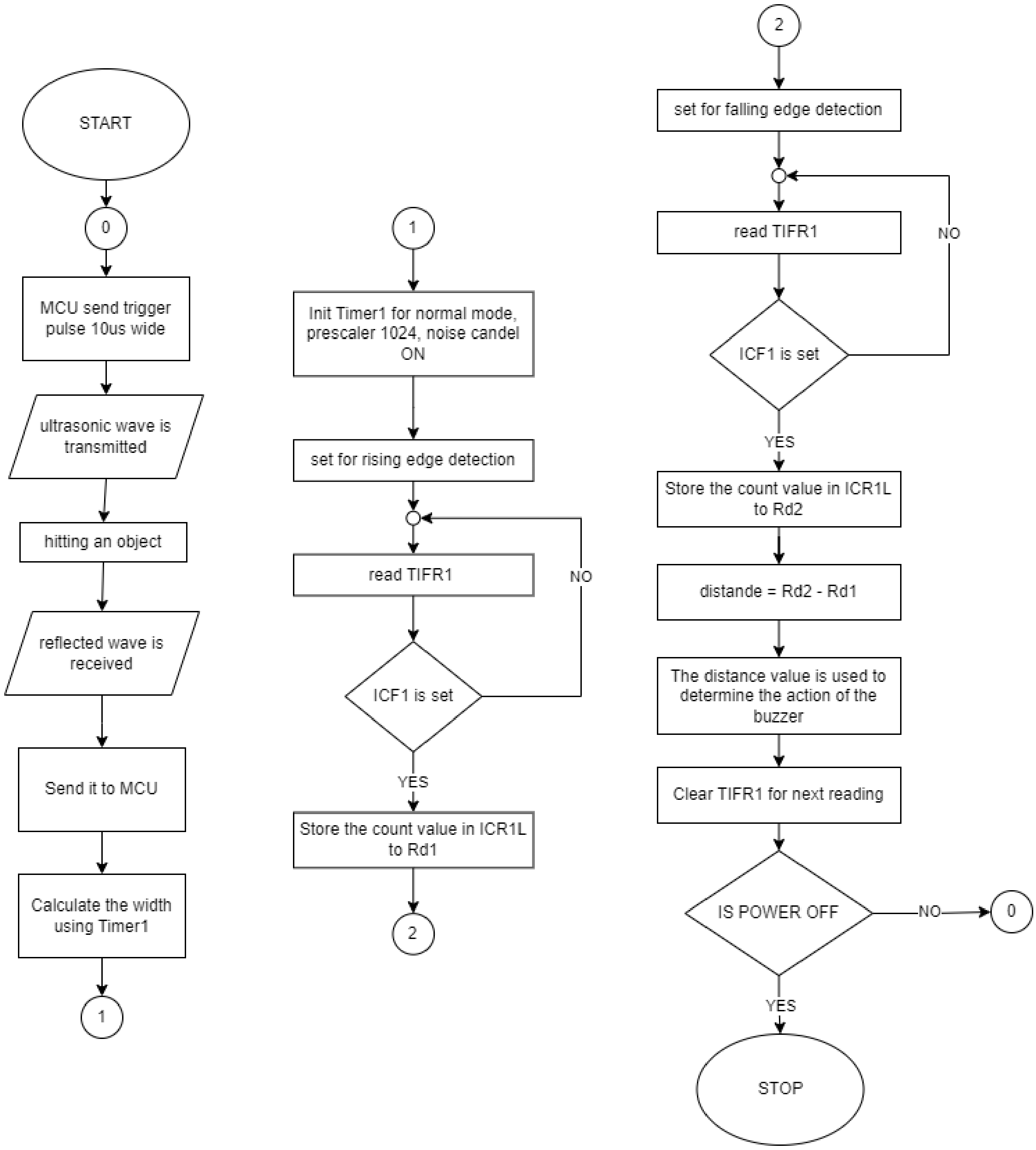
To provide clear and informative visual feedback, the microcontroller controls the MAX7219 seven-segment display. Based on the sensor readings and the predefined thresholds, the software algorithm determines the relevant status to be displayed on the display. If the lighting and distance are both within the appropriate range, the display will show the status "Good". If the lighting is insufficient, the display will indicate "Dark". Similarly, if the user is too close to the screen, the display will show "Close".

The flowchart of the software is as follows:

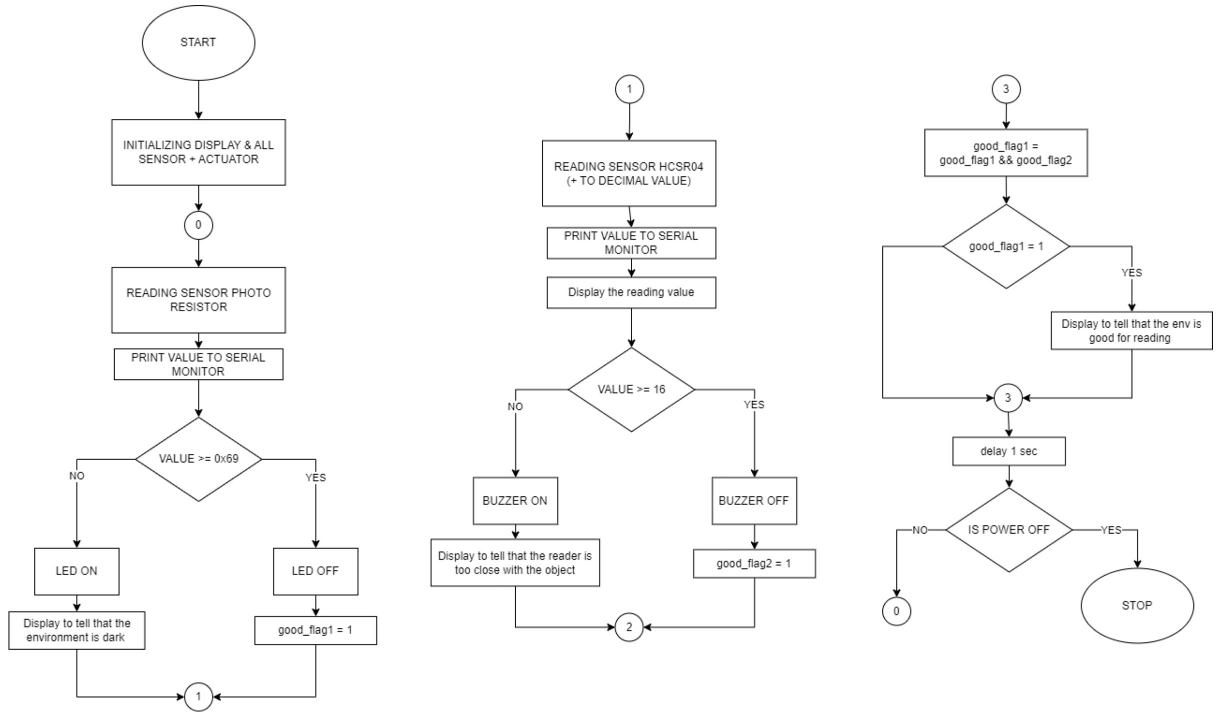
a. Illumi Read


START
Initialization
1. Pin ADC0 as input
2. Internal 2.56 V
3. Left justify
3. CLK128 (125 KHz)
Set the ADSC bit in ADCSRA to start convertion
Read the ADCSRA
NO
ADIF = set
Set the ADIF to clear it, so that it ready to read again
Most value is in ADCH, store to Rd
The value is used to determine the action of the LED
NO
IS POWER OFF
STOP

b. Opti Guard


START
0
MCU send trigger pulse 10us wide
ultrasonic wave is transmitted
hitting an object
reflected wave is received
Send it to MCU
Calculate the width using Timer1
1
1
Init Timer1 for normal mode, prescaler 1024, noise candel ON
set for rising edge detection
read TIFR1
ICF1 is set
NO
YES
Store the count value in ICR1L to Rd1
2
2
set for falling edge detection
read TIFR1
ICF1 is set
NO
YES
Store the count value in ICR1L to Rd2
distande = Rd2 - Rd1
The distance value is used to determine the action of the buzzer
Clear TIFR1 for next reading
IS POWER OFF
NO
0
YES
STOP

c. Whole System



2.3 HARDWARE AND SOFTWARE INTEGRATION

The hardware and software integration is a critical aspect of the system development process. In this project, the integration of the hardware and software is done by connecting the sensors and actuators to the microcontroller and programming it to control them based on the inputs received.

The first step in the hardware and software integration is to connect the HCSR04 sensor and LDR sensor to the microcontroller. The HCSR04 sensor is connected to two digital pins of the microcontroller, one for trigger and one for echo. The LDR sensor is connected to one of the analog pins of the microcontroller. The MAX7219 display is also connected to the digital pins of the microcontroller. Once the hardware is connected, the next step is to integrate the software. The software is developed using the Arduino Integrated Development Environment (IDE). The first step in the software integration is to define the pin connections for the sensors and actuators. This is done by assigning the appropriate pins to each of the sensors and actuators in the program.

The next step is to program the microcontroller to read the input from the LDR sensor and control the LED based on the input received. When the input indicates that the lighting is not sufficient, the microcontroller will turn on the LED. The microcontroller is also programmed to read the input from the HCSR 04 sensor and control the buzzer when the user gets too close to the screen. When the distance measured by the sensor is less than the optimal reading distance, the buzzer will be activated.

The final step in the software integration is to control the MAX7219 display to show the relevant status. The microcontroller is programmed to display "good" on the display when the lighting and distance are appropriate. When the lighting is not sufficient, "dark" is displayed on the MAX7219 display. Similarly, "close" is displayed on the MAX7219 display when the user is too close to the screen.

The integration of the hardware and software is tested by running the system and verifying that it is functioning as intended. Any issues that arise during testing are resolved by adjusting the software or hardware as needed.

CHAPTER 3

TESTING AND EVALUATION

3.1 TESTING

The testing phase of the Reading Assistant system aims to verify its ability to accurately detect the lighting adequateness and appropriate distance to the screen, trigger the appropriate signals to the LED and buzzer, and update the MAX7219 display accordingly. This phase is crucial to ensure the system functions as intended and provides reliable feedback to the user.

- Lighting assessment testing : To test the lighting assessment functionality, various lighting conditions are simulated in the room where the system is deployed. The LDR sensor readings are monitored, and the system's response is observed. The test scenarios include different levels of lighting, ranging from well-lit to dimly lit environments. The system should accurately detect when the lighting is insufficient and activate the LED accordingly.
- Proximity detection testing : To test the proximity detection functionality, The HCSR04 sensor readings are recorded while users position themselves at varying distances from the screen. The system should trigger the buzzer when the user gets too close to the screen, indicating that they should maintain an appropriate reading distance.
- MAX7219 display testing : To test the MAX7219 display testing, test cases are designed to cover different combinations of lighting and proximity conditions. If the lighting is sufficient and the distance to the screen is appropriate, then it should display “good”. If the lighting is not sufficient, then it should display “dark”, and if the distance to the screen is too close, then it should display “close”.

3.2 RESULT

Based on the testing conducted, the Reading Assistant system has been deemed successful in achieving its intended functionality and providing reliable feedback to the user. The results of the testing phase demonstrate that the system effectively detects lighting adequateness and appropriate distance to the screen, triggers the appropriate signals to the LED and buzzer, and updates the MAX7219 display accordingly.

Fig 2. Testing Result

Based on these results, it can be concluded that the Reading Assistant system has successfully achieved its goals of accurately assessing lighting adequateness, detecting proximity to the screen, triggering appropriate signals, and updating the MAX7219 display with relevant status information. The system's performance and user satisfaction validate its effectiveness as a reading assistance tool.

3.3 EVALUATION

Based on the testing conducted, the Reading Assistant system performed well in accurately assessing lighting conditions, detecting proximity to the screen, and updating the MAX7219 display accordingly. The system consistently provided timely feedback to the user, indicating whether the lighting was sufficient and if the user was too close to the screen. The hardware and software integration demonstrated reliable functionality, ensuring a good reading experience for the user.

CHAPTER 4

CONCLUSION

The Reading Assistant system has been successfully developed and evaluated as a cyber-physical system aimed at assisting users in achieving optimal reading conditions. The system incorporates hardware components such as the Arduino microcontroller, HCSR04 sensor, LDR sensor, and MAX7219 seven segment display, along with software development for accurate assessment and feedback.

Through testing, it has been confirmed that the system effectively detects lighting adequateness, proximity to the screen, and triggers appropriate signals to the LED and buzzer. The MAX7219 display accurately reflects the status of the reading conditions, providing clear feedback to the user. The evaluation phase has further confirmed the system's functionality.

REFERENCES

[1] 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]

[2] Tim Penyusun Modul. “Modul 3 SSF : Analog to Digital Converter”. [Online]. Digital Laboratory FTUI. 2023. Available: https://classroom.google.com/c/NTkzNjAyMDgzODQw/a/NTk1MTc3NTE0MzI5/details [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].

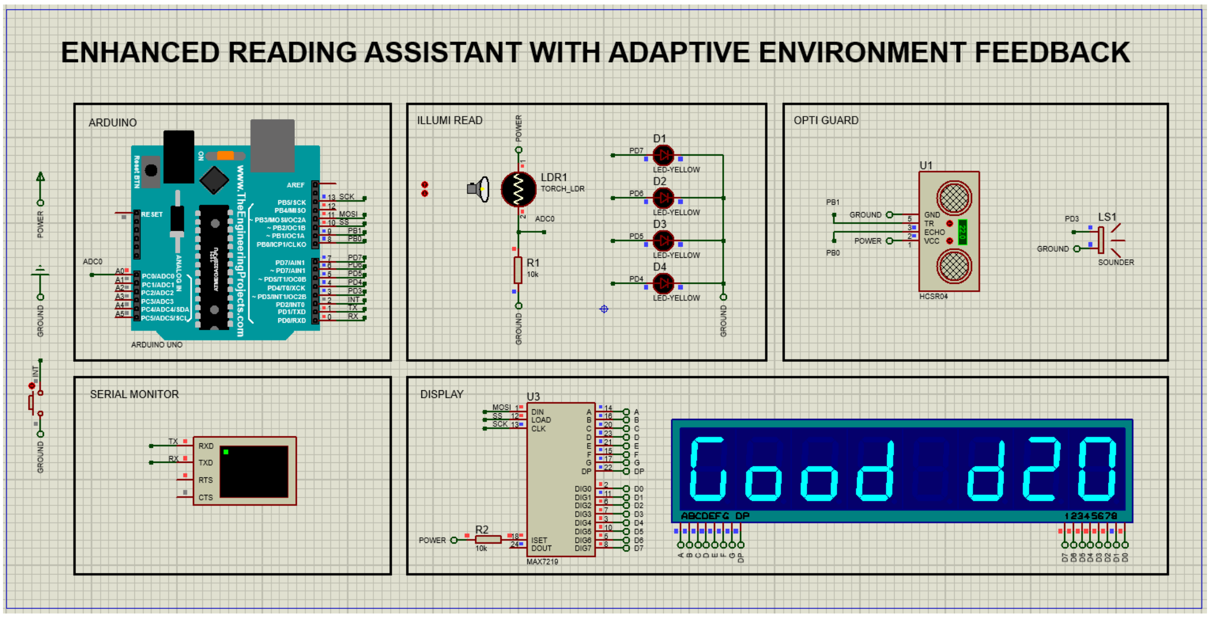
[8] “Assembly via Arduino (part 21) - HC SR04 sensor,” YouTube, https://www.youtube.com/watch?v=dIIBG7Qz-_E [accessed May 16, 2023].

[9] “Assembly via Arduino (part 7) - programming serial port,” YouTube, https://www.youtube.com/watch?v=a6LGLwfO154 [accessed May 16, 2023].

[10] “Assembly via Arduino (part 4) - programming ADC,” YouTube, https://www.youtube.com/watch?v=7PVTnT59cqE [accessed May 16, 2023].

APPENDICES

Appendix A: Project Schematic



Appendix B: Documentation