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

PLANT MONITORING SYSTEM

GROUP B1

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PREFACE

In recent years, there has been a growing interest in using technology to monitor and control various aspects of our daily lives. One area where this technology is increasingly being applied is in the field of agriculture, where it has the potential to improve and better harvest more consistently

The Arduino Uno ATmega328P is a versatile microcontroller platform that is ideal for building various projects such as a Plant Monitoring System. This project is designed to help people monitor the health of their plants by measuring various environmental factors such as soil moisture, surrounding environment temperature, and humidity of air using two sensors, YL39 and DHT11. 5 LEDs will act as indicators of environment quality that impact the plant ranging from healthy to critical.

The purpose of this report is to look at some of the problems that are related to agriculture and provide our own solutions to that problem while still following the requirements that are required by Digilab's Lab Assistant. We will also show the implementation of our solutions and the testing and evaluation that has been done.

We from Group B1 want to thank our lecturer, F. Astha Ekadiyanto S.T, M.Sc. for all the guidance, we would also like to thank Lab Assistant from Digital Laboratory for giving us this great opportunity to used what we have learn to making this project.

Depok, May 13, 2023

Group B1

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CHAPTER 1

INTRODUCTION

1.1 PROBLEM STATEMENT

- It is difficult to identify when plants are experiencing issues related to their growing conditions. This can lead to poor growth, reduced yields, and even plant death.
- Manual monitoring of plants can be time-consuming and may not always provide accurate data.
- Manual monitoring of plants also can be expensive and complex, making them inaccessible for people that want to plant on a small scale.
- The current methods of monitoring and managing plant health and growth lack efficiency, accuracy, and real-time capabilities, leading to suboptimal resource allocation, increased crop loss, and reduced overall productivity.

1.2 PROPOSED SOLUTION

To address the problems above, we proposed the solution to be the development of plant monitoring systems using Arduino microcontroller ATmega328P. This Arduino will consist of various sensors to measure environmental factors that impact the plant growth such as temperature, humidity, and soil moisture. The Arduino will also be equipped with 5 LEDs as an indicator of environmental quality.

This solution is relevant to the problems because it provides cost-effective and efficient solutions. This solution is user friendly for people that want to grow their own plant but at the same time also can be upscale to suit the needs of large farms or gardens.

Overall, the plant monitoring system using an Arduino is a promising solution to the problem of inefficient and inaccurate plant monitoring. It provides a cost-effective and automated way to monitor and maintain optimal growing conditions, that results in better plants' health.

1.3 ACCEPTANCE CRITERIA

The acceptance criteria of this project are as follows:

1. The system must be able to monitor environmental factors that impact on the plant such as temperature, humidity, and soil moisture.
2. The system must be able to show the reading of the sensors using Max7219.
3. The system must be able to show the environmental quality using LEDs as indicators.
4. The system must be cost-effective and accurate.

1.4 ROLES AND RESPONSIBILITIES

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

Roles	Responsibilities	Person
Lead Role	• Lead the group to assemble the circuit • Merge all the code and fine tune the code • Make the protheus simulation • Write the MAX7219 Arduino Code. • Write the LDR Arduino Code	Juan Jonathan
Role 2	• Write DHT11 assembly Arduino code. • Collaborate with the group to assemble the circuit • Helped fine tune the protheus simulation	Rafi Fauzan W

	• Write the MAX7219 Arduino Code.	
Role 3	• Write LED status and buzzer assembly Arduino code. • Collaborate with the group to assemble the circuit • Helped fine tune the protheus simulation • Write the MAX7219 Arduino Code.	Farrel Mirawan
Role 4	• Write YL39 assembly Arduino code. • Collaborate with the group to assemble the circuit. • Weld the pin on the MAX7219. • Helped fine tune the protheus simulation	Eriqo Arief W

Table 1. Roles and Responsibilities

1.5 TIMELINE AND MILESTONES

NUMBER	TASK TITLE	START DATE	DUE DATE	DURATION	MAY														
					2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	HARDWARE DESIGN																		
1.1	Preparation	2/5/23	2/5/23	1															
1.2	Gathering Components	2/5/23	3/5/23	2															
1.3	Components testing	3/5/23	4/5/23	2															
1.4	Assembly	3/5/23	4/5/23	2															
2	SOFTWARE DEVELOPMENT																		
2.1	Setup Github	2/5/23	3/5/23	2															
2.2	Coding for MAX7219	4/5/23	13/5/23	10															
2.3	Coding for YL39	4/5/23	13/5/23	10															
2.4	Coding for DHT11	4/5/23	13/5/23	10															
2.5	Unifying All the Code	13/5/23	15/5/23	3															
3	IINTEGRATION & TESTING																		
3.1	Software & Hardware Integration	3/5/23	15/5/23	13															
3.2	Trial and Error	14/5/23	16/5/23	3															
3.3	Raw Testing	14/5/23	15/5/23	2															
3.4	Troubleshooting	14/5/23	14/5/23	1															
4	FINAL PRODUCT ASSEMBLY & TESTING																		
4.1	Final Assembly	15/5/23	16/5/23	2															
4.2	Final Testing	15/5/23	16/5/23	2															
4.3	Finishing Report	15/5/23	16/5/23	2															
4.4	FInished Product	16/5/23	16/5/23	1															

Table 2. Gantt Chart

CHAPTER 2

IMPLEMENTATION

2.1 HARDWARE DESIGN AND SCHEMATIC

Hardware design refers to the process of creating and developing physical components and systems that make up electronic devices, machinery, or other types of hardware. It involves designing and implementing the circuitry, layout, and functionality of various hardware components such as integrated circuits (ICs), printed circuit boards (PCBs), processors, memory modules, input/output (I/O) devices, and other electronic systems.

We use proteus as software to design hardware design for this project. Our goal of using Proteus is to simulate hardware before it will be implemented in the real world.

Then the components used in this project include:

- 1 Arduino Uno R3
- 1 Breadboard
- 30 Jumper Cable
- 3 LED
- 1 DHT11
- 1 YL39
- 1 MAX 7219
- 1 LDR Module
- 1 Buzzer

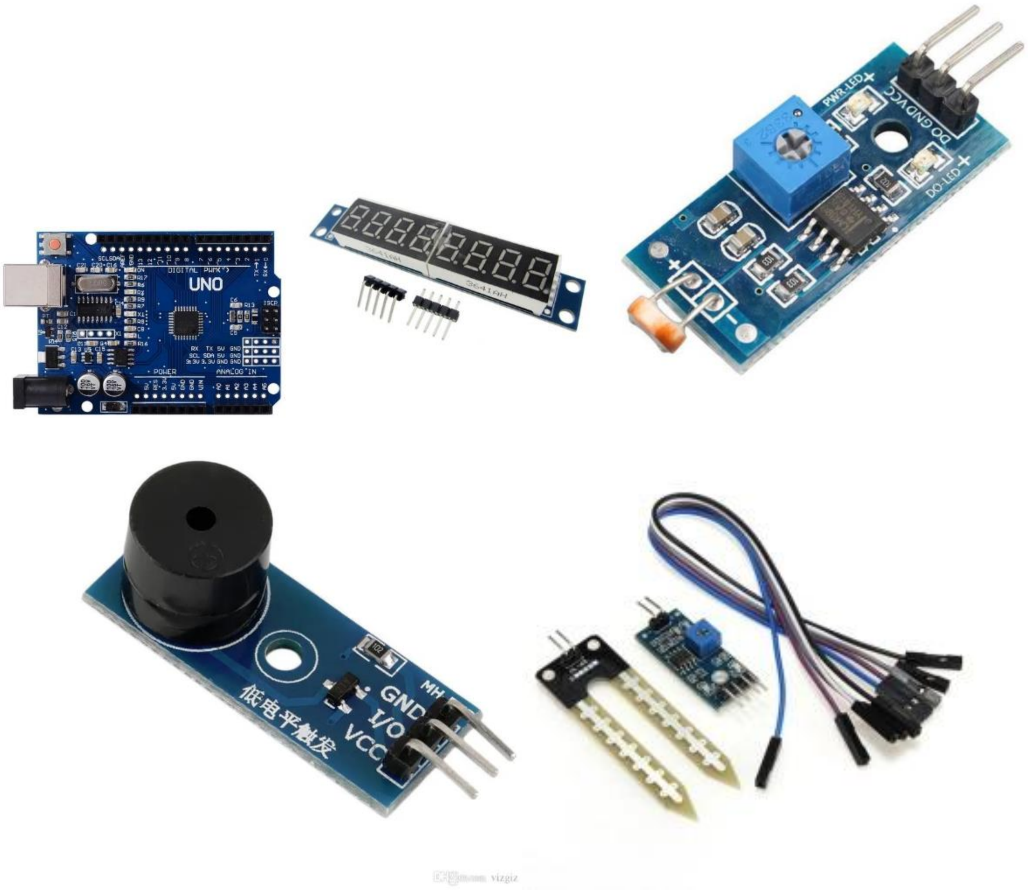

Fig 2.1. Arduino Uno R3, MAX7219, LDR, Buzzer, YL39.

Schematic:

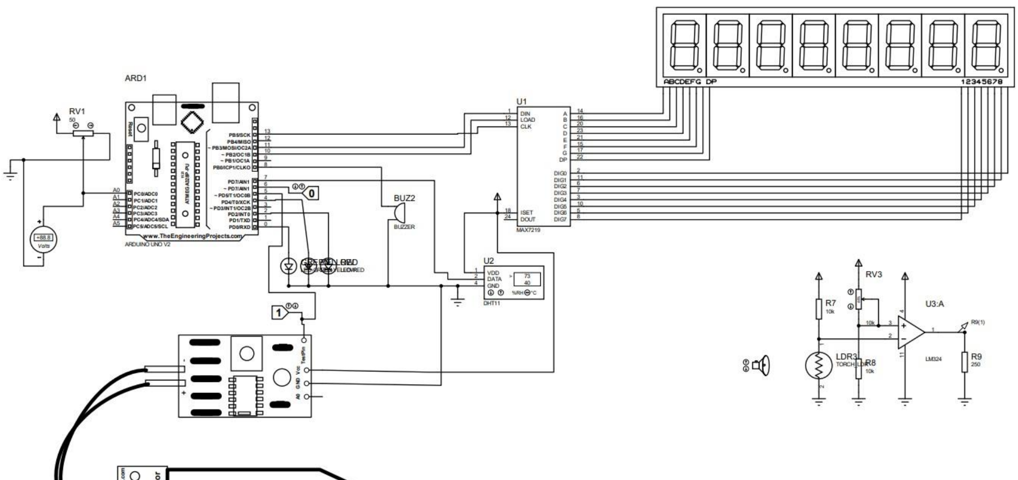

Fig 2.2. Hardware Schematic

2.2 SOFTWARE DEVELOPMENT

Software design is the process of creating a blueprint or a plan for developing a software system. It involves defining the architecture, structure, components, interfaces, and behavior of the software. The goal of software design is to transform requirements and specifications into a detailed representation of the system that can be implemented by programmers.

We use the Arduino IDE to program using assembly language. Assembly programming is done by programming each component individually from DHT11, YL39, and also MAX 7219. These three components can be programmed via the Arduino Uno R3 microcontroller based on the ATMega28p chip.

The following is a flowchart for the software we made for this project:

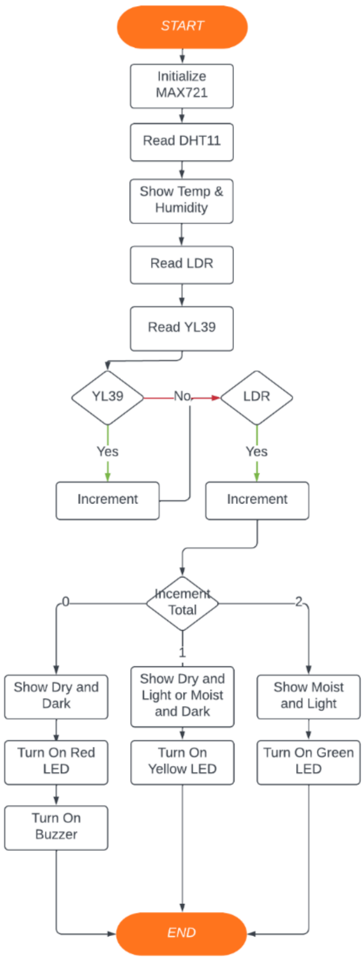

Fig 2.3. Flowchart

2.3 HARDWARE AND SOFTWARE INTEGRATION

Integration between hardware and software refers to the seamless interaction and coordination between the physical components of a computer system (hardware) and the programs, applications, and instructions that run on it (software). It involves establishing communication channels, data transfer mechanisms, and compatibility to ensure proper functionality and optimal performance of the overall system.

In this project we do the integration between software and hardware. in software design, we use the Arduino IDE as a text editor to compile assembly programs which will then be uploaded to Arduino Uno. While for hardware we assemble hardware components that are implemented using breadboards as a medium to be able to integrate each component used. In order to be able to integrate between hardware and software we need to find out the pins that is used for the sensors in Arduino Uno, so when we code in Arduino IDE, we will be able to correctly determine the right pin and the right sensor so that we can code those sensors.

The software code that we programmed will direct how the Arduino behave. Our most important feature is to show the reading from the sensors to the Max7219. The code will allow us to determine how the sensors and Max7219 send each other data. The code will also be used to determine the status of the LED, for the full table of LED status is down below:

LED Status	LED 1 (Green)	LED 2 (Yellow)	LED3 (Red)
Moist/Terang	**On**	Off	Off
Moist/Gelap	Off	**On**	Off
Dry/Terang	Off	**On**	Off
Dry/Gelap	Off	Off	**On**

Table 3. LED Status

CHAPTER 3

TESTING AND EVALUATION

3.1 TESTING

The Plant Monitoring System project was developed using Arduino assembly to create an automated system for monitoring the health and environmental conditions of plants. To ensure the reliability and functionality of the system, rigorous testing was conducted at various stages of development. This section outlines the testing methodologies employed and the results obtained.

Unit Testing:

Unit testing was performed on individual components of the Plant Monitoring System to verify their proper functioning. Each module, such as the moisture sensor, DHT sensor, and MAX7219 display, was tested separately using appropriate test cases. This testing ensured that each component was calibrated correctly and generated accurate reading.

Integration Testing:

Integration testing aimed to assess the seamless integration of all the individual components and modules of the Plant Monitoring System. The objective was to ensure that data flow and communication between various modules were functioning as expected. Test cases were designed to simulate different scenarios. The system was tested for stability, responsiveness, and data accuracy during these scenarios.

In this case, we tested the system integrating only the DHT sensor and MAX7219 first to see if those two components can communicate and display the correct reading. Next, we also tested moisture sensor and MAX7219, along with just the LDR sensor with MAX7219 only.

User Acceptance Testing:

User acceptance testing involved testing the device in the environment that can emulate the real-world use cases of the device, such as putting the moisture sensor into water and simulating different temperature reading using DHT sensor also different light level with LDR sensor. with the Plant Monitoring System. Feedback and observations were collected to assess the system's usability, intuitiveness, and overall experience. Any identified issues or suggestions for improvement were noted for further refinement.

3.2 RESULT

All individual components passed the unit testing phase successfully. The moisture sensor provided accurate moisture level readings, the temperature sensor measured the ambient temperature accurately, and the LCD display exhibited the correct output.

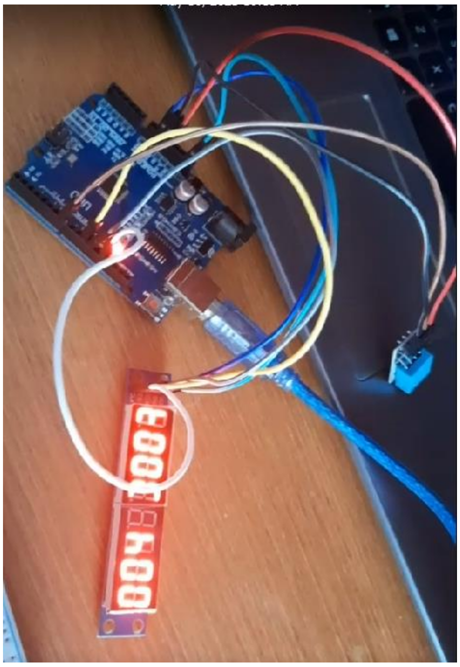

Fig 3.1. Unit Testing

The integration testing phase verified that the components of the Plant Monitoring System were effectively integrated. Data flow between modules was smooth, and the system provided accurate and real-time readings of environmental parameters for multiple plants.

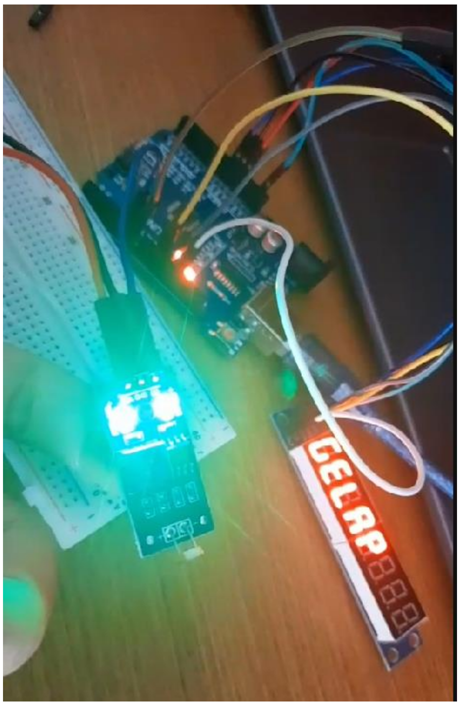

Fig 3.2. Integration Testing

User acceptance testing demonstrated that the system, when all the components are connected and used together in order to try it in the real-world environment has successfully outputted a correct reading of the environment temperature which was displayed on the MAX7219, the moisture level and the light level have also been successfully displayed on the display this is showed by the display showing the status as one of GELAP, TERANG, DRY, MOIST.

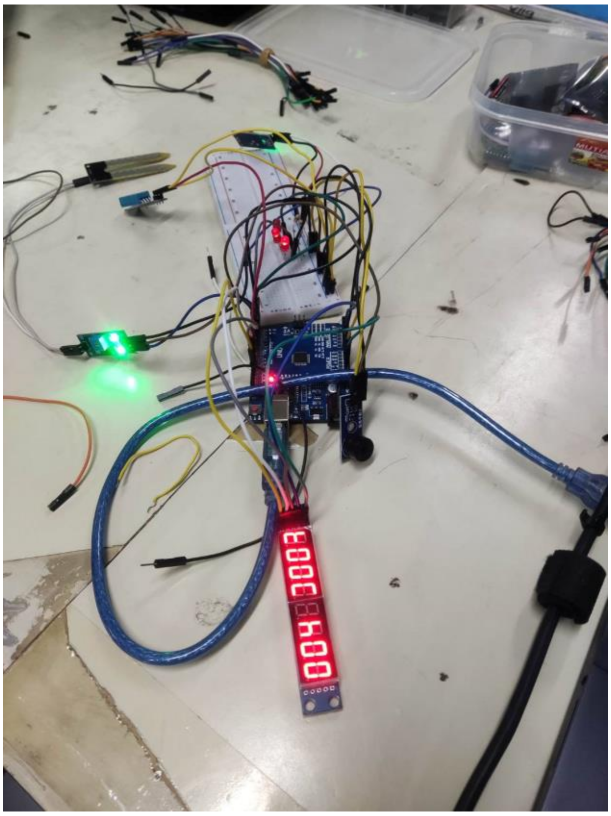

Fig 3.3. Full Testing

In conclusion, the testing process for the Plant Monitoring System encompassed unit testing, integration testing, and user acceptance testing. The system passed all testing phases successfully, exhibiting accurate readings, seamless integration, efficient performance, and positive user feedback. These tests assure the reliability and functionality of the Plant Monitoring System, making it a valuable tool for plant enthusiasts and professionals alike.

3.3 EVALUATION

The evaluation of the Plant Monitoring System focused on assessing its performance, alignment with project goals, user satisfaction, impact, and potential areas for improvement. During performance testing, the system exhibited accurate sensor readings, responsiveness, stability, and efficient power consumption. It successfully achieved the project's primary goal of automating plant monitoring, providing reliable measurements of moisture levels, temperature, and other environmental parameters. User acceptance testing yielded positive feedback. The system's impact includes improved plant care, time savings, and reduced risks of plant damage. However, areas for improvement were identified, such as incorporating analog reading of the moisture sensor in order to have a more accurate reading of the moisture level.

CHAPTER 4

CONCLUSION

Plant Monitoring System is an Arduino Uno project that is fully coded in Assembly Language and is used to monitor factors that impact the plants such as soil moisture level, light intensity, temperature and humidity using three sensors that is YL38, DHT11, and LDR. Then show that reading to MAX7219. After that the LEDs will light up according to the truth table that has been set.

This project will be able to make plant monitoring more efficient, reliable and less time-consuming. This project also is user friendly towards small farmers / gardeners because it's cost efficient and easy to implement. But at the same time this project is easy to scale up so that big farms can also use this project as well.

Through this project we used and learn various hardware such as all the sensors and the Arduino itself, we first tried to make this project in Protheus in which it worked really well and according to what we wanted. But when we tried to assemble and integrate the hardware and software, we faced some difficulties along the way. The most prominent one was working with Max7219 that sometimes doesn't show the accurate reading of the sensors and even sometimes it bugged out and doesn't show the output at all.

But through all those difficulties in the end we managed to fix all the problems and make sure that everything worked accordingly. We learn the importance of the quality of the material because it impacts greatly on how the hardware worked. Overall, this project was a really fun learning experience for us, and we hoped that this project will be used and improved by adding new features such as the feature to automatically pour water if the soil moisture is dry.

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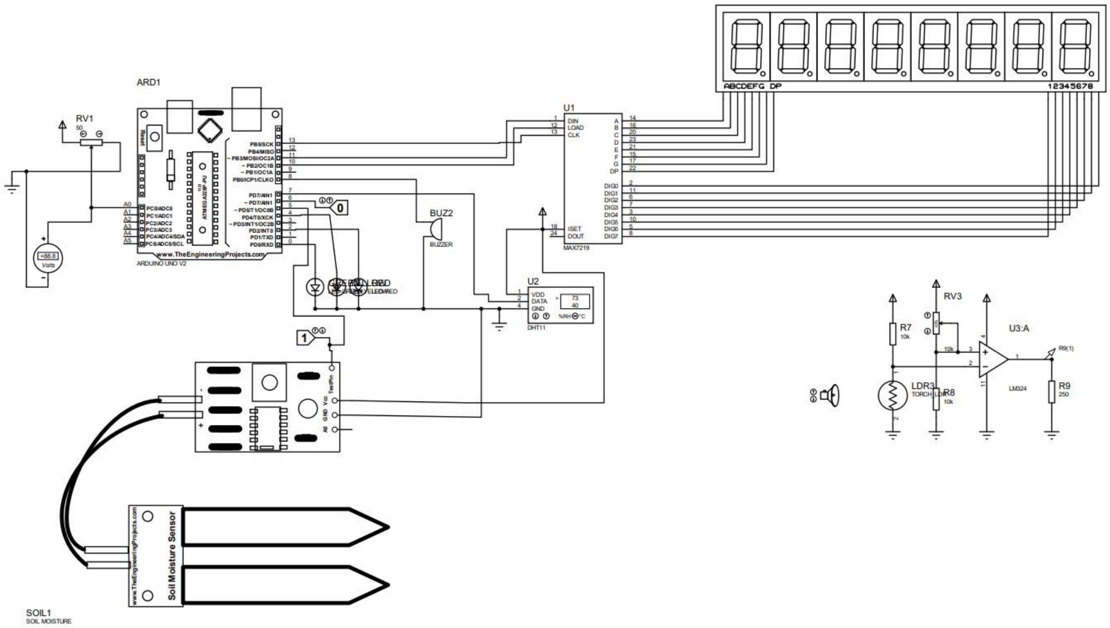
APPENDICES

Appendix A: Project Schematic



Appendix B: Documentation