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Design and Construction of a Water Monitoring System at PDAM Tirta Pakuan Bogor Based on Ethernet Shield and LCD

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Abstract

Conventional water monitoring at PDAM Tirta Pakuan Bogor is inefficient and prone to manual errors. This study aims to design a real-time monitoring system to improve operational effectiveness and data validity. Following a four-stage methodology analysis, design, implementation, and testing the device was constructed using an Arduino Uno R3, an Ethernet Shield for stable network connectivity, an ultrasonic sensor, and a 16x2 LCD. The integration of intelligent logic in such systems is crucial for identifying optimal boundary parameters to support decision making. Results demonstrate that the device successfully provides continuous, real-time measurement data via both a web interface and a physical display, aligning with desired specifications. This digital technology support facilitates optimal monitoring through easy access to information. While minor measurement errors occur due to environmental factors, the tool significantly increases the flexibility of information access. In conclusion, the Ethernet Shield and LCD-based system enables reliable monitoring without manual intervention, though it currently requires manual web refreshing to update data.

Keywords: Water Monitoring, Arduino Uno, Ethernet Shield, LCD, Real-time System.

INTRODUCTION

The adoption of data-driven technology is now crucial for accelerating decision-making and increasing productivity in various industrial sectors (Hasanah & Hafni, 2025). Digital transformation through intelligent IoT systems ensures the validity of information for stakeholders (Rivaldi & Said, 2025), with the integration of intelligent logic crucial for optimally identifying boundary parameters to support operational decisions (Santosa et al., 2023). As a public service provider, the Regional Water Company (PDAM) is responsible for maintaining the continuity of clean water supply (Jefri & Huda, 2025). This requires strict infrastructure monitoring for early detection of changes in conditions (Siskandar et al., 2022) and modern asset management for distribution efficiency (Darso et al., 2023).

However, PDAM Tirta Pakuan Bogor still faces inefficiencies due to conventional monitoring methods that risk slowing down the handling of anomalies (Qulub et al., 2023). Without a real-time monitoring system, field staff productivity is hampered and the risk of manual reading errors increases (Mase et al., 2025). Therefore, digital technology support is essential to facilitate optimal monitoring through easy access to information content (Lestari et al., 2020).

The proposed solution is a web-based reservoir monitoring tool with an Ethernet Shield for a stable network connection (Wicaksono et al., 2023). This system features a responsive interface that enables secure remote monitoring (Mujiana et al., 2023) and an ultrasonic sensor for accurate water level data. The integration of a physical LCD into the tool also serves as a local information medium for technicians in the reservoir area. This technological innovation aims to create a more effective work experience and increase the flexibility of information access (Lestari et al., 2021). Based on these needs, the design of a monitoring system for PDAM Tirta Pakuan Bogor based on an Ethernet shield and LCD was formulated.

METHODS

The method used in the design process of an Ethernet shield and LCD-based water condition monitoring tool is a method consisting of several stages: the analysis stage, the design stage, the implementation stage, and the testing stage. The process flow can be seen in Figure 1.

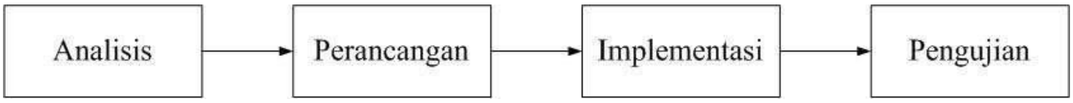

Figure 1. Process Stage Flow

1. Problem Analysis

At this stage, two types of analysis are carried out, namely problem analysis and needs analysis. Problem analysis is carried out to identify problems that exist in the PKL environment. Needs analysis is carried out to determine the hardware requirements that will be used as the background in creating a water monitoring system tool based on Ethernet shield and LCD.

2. Design

In this stage, the tool is designed, including all components that will be used. The coding necessary to ensure the tool functions as intended is also created. This design is adjusted based on the results of the previous stage, the analysis stage, to ensure it meets the criteria for problem analysis and needs analysis.

3. Implementation

At this stage, the equipment that has been tested and successfully meets expectations and needs will be implemented directly in the field. This is where the equipment is installed and installed in the water reservoir, where it will be monitored in real time and continuously.

4. Testing

This is the final stage in the field work practice. At this stage, testing is carried out on the results of the tool design that has been carried out in the previous stage, namely the implementation stage. Testing is carried out to find out whether the design of the Ethernet Shield and LCD-based water monitoring tool runs as desired.

RESULTS AND DISCUSSION

1. Problem Analysis

The Tirta Pakuan Water Company (PDAM) in Bogor is responsible for providing clean water to the people of the Bogor area. To carry out this task, PDAM Tirta Pakuan Bogor requires skilled personnel and technology in water management.

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To facilitate PDAM Tirta Pakuan Bogor's water monitoring, a device capable of continuous, real-time monitoring is required without the need for manual operation by staff or workers. This makes it easier, faster, and more effective to determine the water condition of a reservoir.

To illustrate the general operation of the device, the following block diagram of the design of the water monitoring device at PDAM Tirta Pakuan Bogor based on an Ethernet Shield and LCD is shown in Figure 2.

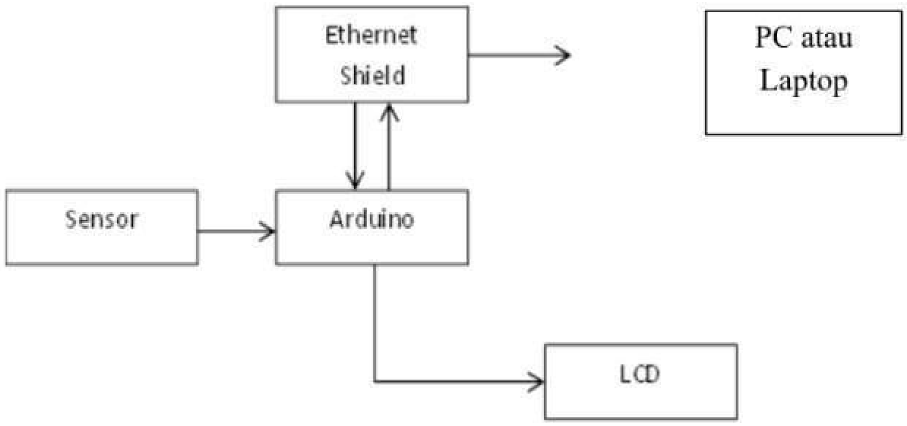

Figure 2. SEQ Image * ARABIC 5 Block Diagram

2. Design

In this phase, the design of the tool to be built is carried out. There are two stages in this phase: device creation and coding. The tools needed for this stage are: Arduino Uno R3, water monitoring sensor, Ethernet shield, 16x2 LCD, casing, PCB board, solder, and tin. The process of making a circuit is carried out by making a circuit schematic first. Schematic circuit images can be seen in Figures 3 and 4.

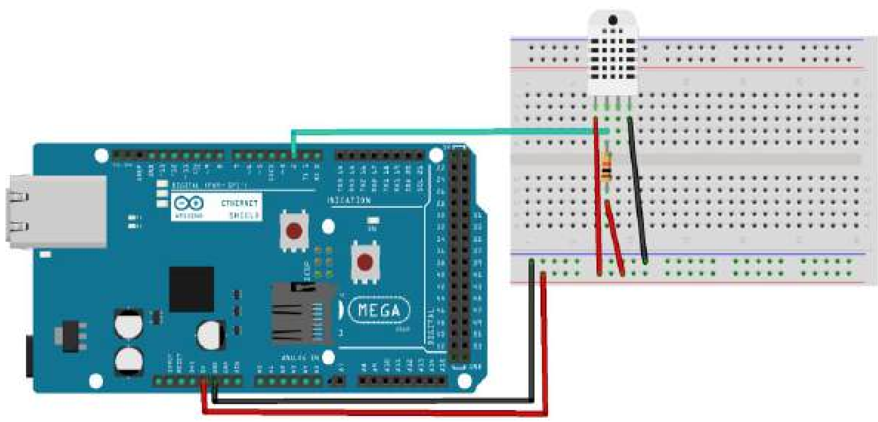

Figure 3. Ethernet Shield Schematic Circuit

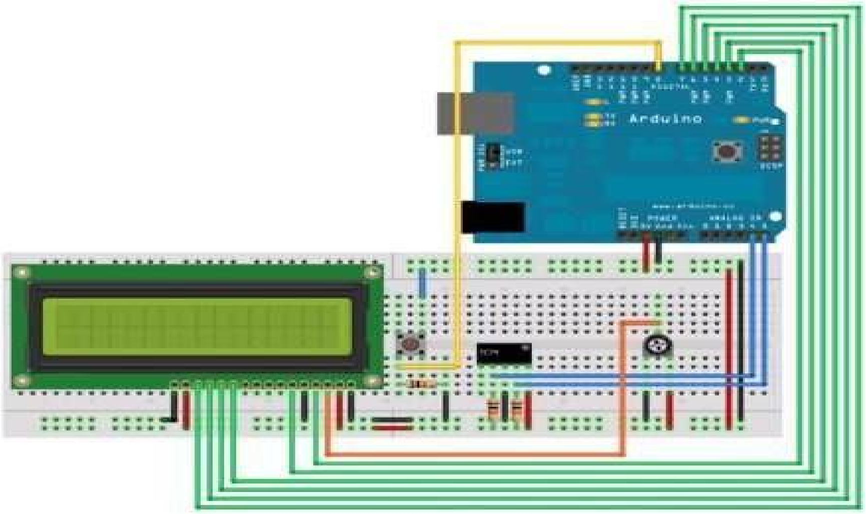

Figure 4. 16x2 LCD Schematic Circuit

The initial design step is to prepare the Arduino Uno, Ethernet Shield, 16x2 LCD, jumper cables, solder, tin, and PCB board. Once everything is assembled, the design process can begin.

First, connect the Ethernet Shield to the Arduino, then connect all the sensors and LCD for monitoring water conditions. Once the circuit is perfectly assembled, the next step is to prepare the casing for the circuit. This project uses a black rectangular box casing made of acrylic plastic. A picture of the box casing can be seen in Figure 8.

Figure 5. Casing Box for Water Condition Meter

After installing the device into the casing box, the device design stage is complete, all that remains is to connect the USB a-b cable from the Arduino Uno to a laptop or personal computer to proceed to the next stage, namely the coding stage.

The software used during coding is Windows 7 Ultimate 32-bit, and the application uses Arduino IDE 1.0.5. The hardware required for coding and uploading is a laptop or personal computer and a USB cable. The following is a screenshot of the Arduino IDE 1.0.5 application interface.

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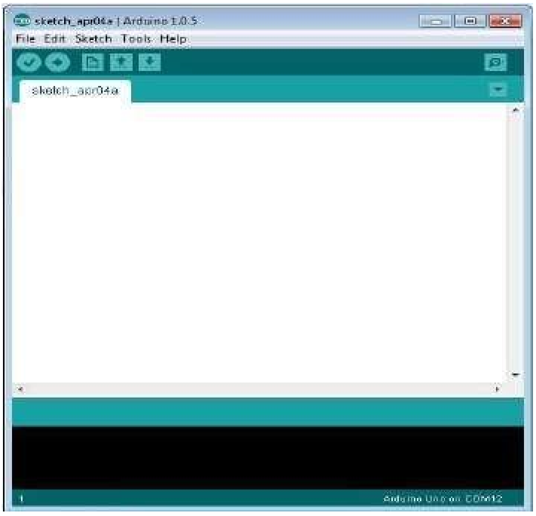


Figure 6. Arduino IDE 1.0.5 Application Interface Display

An example of a USB a-b cable connecting the Arduino Uno to a laptop or personal computer for the coding upload stage can be seen in Figure 7.


Figure 7. USB cable a-b

3. Implementation

Programming using the Arduino IDE 1.0.5 program, in this program it is necessary to determine the Arduino Board used by selecting the option in the Tools>Board menu and determine the serial port used by the Arduino Board by selecting the Tools>Serial port menu. For more details, see Figure 8.

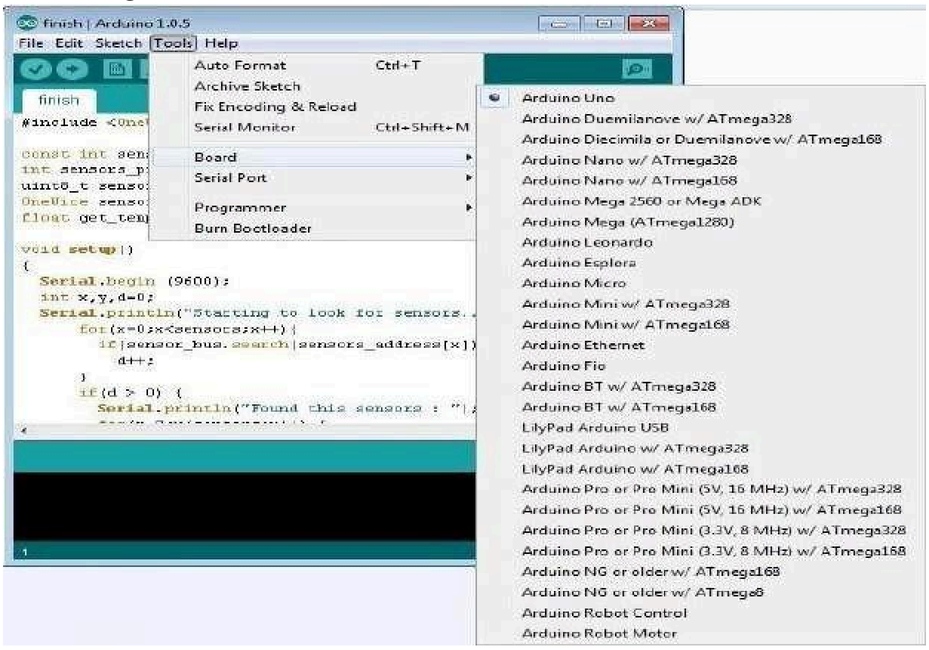
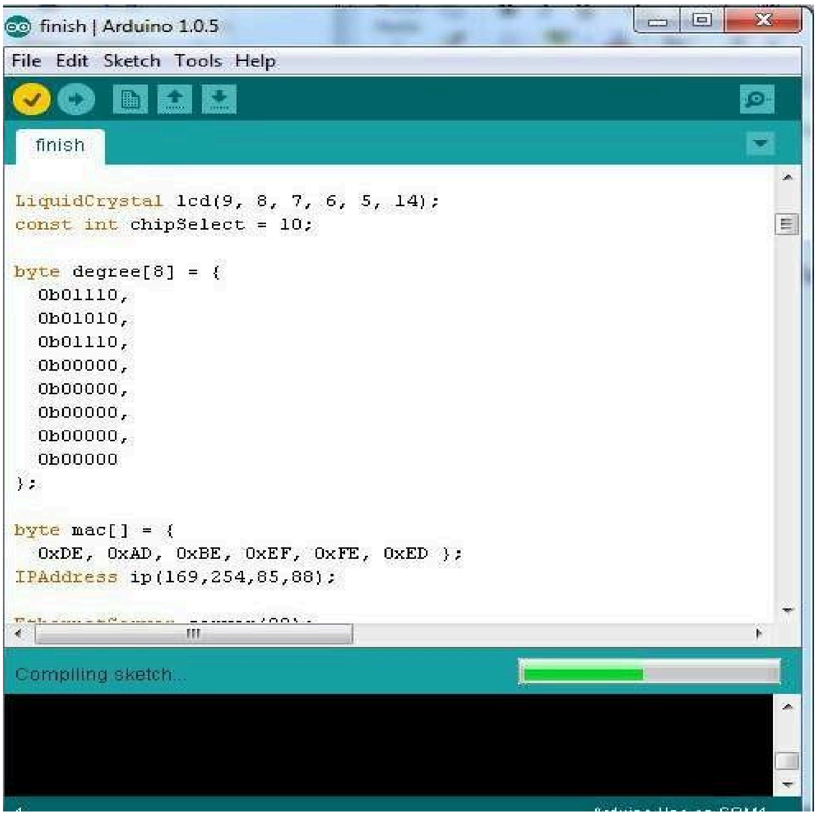


Figure 8. Arduino 1.0.5 Display

To upload a program to the Arduino Uno microcontroller, select the upload button in the software. The upload process can be seen in Figure 9.



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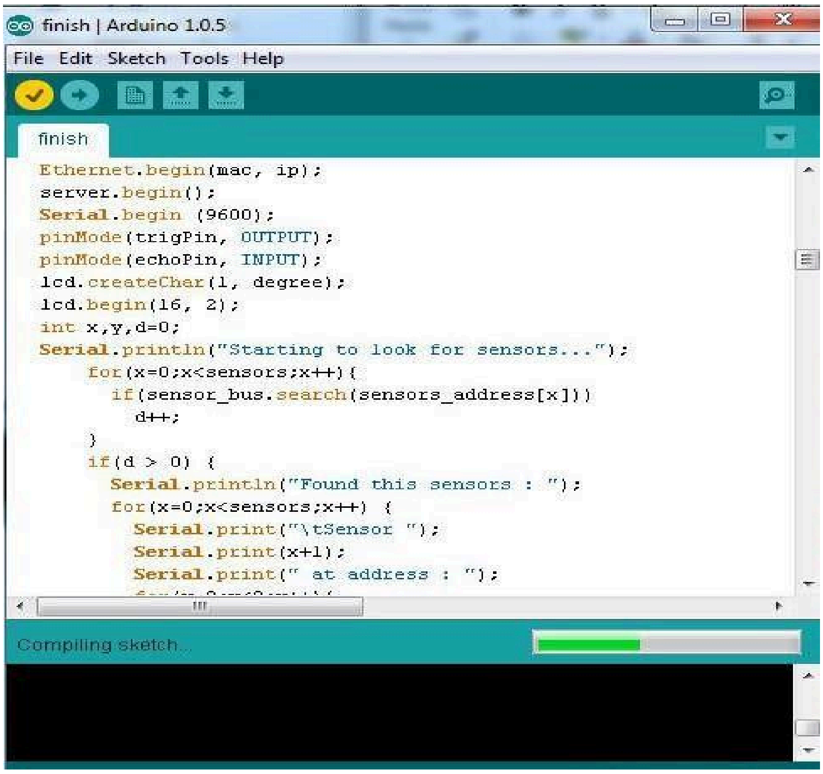

Figure 9. Coding Upload Process

4. Testing

Testing is conducted to determine whether the system being built is working or whether there are any problems. Some of the tests performed are as follows.

Figure 10. Display of Measurement Results Using WEB

Figure 11. Display of Measurement Results Using a 16x2 LCD

Based on the measurement data in Figures 13 and 14, the Ethernet Shield and LCD-based monitoring device meets expectations, and the results align with the measurements. Errors are always present in any measurement. These errors include random errors can occur due to several factors, such as: errors in estimating the smallest scale, which varies over time, fluctuating conditions, changes in air pressure and electrical voltage, and disturbances such as mechanical failures. Then systematic errors may occur due to several factors, such as: programming errors or individual errors. Then action errors may occur due to installation errors between the microcontroller and its Ethernet shield or LCD.

CONCLUSION

Based on the results of the device's construction and testing, it can be concluded that the Arduino Uno microcontroller, Ethernet shield, and LCD performed well and met the desired specifications. The advantage of this Ethernet shield and LCD-based water monitoring device is its ability to continuously and real-time monitor water conditions in a water reservoir. The disadvantage of this Ethernet shield and LCD-based water monitoring device is that it requires a laptop or personal computer to view the measurement results, and the webpage must be refreshed to update the measurement data.

This Ethernet shield and LCD-based water monitoring device is still imperfect, as it requires refreshing the webpage to see updated water condition reports. Perhaps this device should be expanded beyond monitoring, but should include additional functionality for when water conditions exceed expectations.

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