Prototype of Water Level and Turbidity Monitoring System in Water Tanks using Blynk Based on Internet of Things (IoT)

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Abstract

Water is a vital resource for human survival. Adequate availability and good quality of water are essential for various daily activities. Water tanks are commonly used as water storage media. Weather changes, pollution, and other factors can affect water quality. One important factor in maintaining water quality is continuously monitoring water level and turbidity. Currently, Internet of Things (IoT) technology has developed and provides solutions for monitoring water level and turbidity in tanks. This system provides ease in monitoring water conditions in tanks in real-time via the internet. The purpose of this research is to create a system and device that can monitor water level and turbidity in tanks with the help of camera technology. The results of this research show that the system can maintain water levels; if below 20%, the pump will be activated to fill the tank, and if the water level is above 80%, the pump will automatically turn off. Turbidity notifications will automatically be sent to Blynk if water turbidity exceeds 25 NTU.

Keywords*: maximum 5 keywords from paper, separated with a comma, ended with a full point/period.*

1. Introduction

Research on monitoring systems for water source turbidity based on the Internet of Things. This research uses a turbidity sensor as a tool to detect water turbidity and an ultrasonic sensor to detect the presence of objects by estimating the distance between the sensor and the object. The result of the research is a prototype water turbidity monitoring system. Based on prototype testing using the system, the turbidity sensor can correctly detect water source turbidity, and the ultrasonic sensor can monitor water turbidity in the main tank with good performance [1].

Research on the analysis of water turbidity control and monitoring systems based on Arduino Uno and IoT. This research has several variables consisting of independent variables: water turbidity level, LDR sensor, turbidity sensor, and sensor position. The dependent variables are: sensor voltage, comparison of measurement results for each sensor position. And control variables: controllable water turbidity levels. The result of this research is a prototype analysis of water tank turbidity control and monitoring system based on Arduino Uno and IoT. The results of prototype testing using the system show that the LDR sensor and turbidity sensor function well, but the turbidity sensor has some NTU and voltage readings that are higher compared to the LDR sensor, making the LDR sensor readings more stable than the turbidity sensor [2].

Research on designing a device that can monitor and measure water clarity levels in tanks remotely or using IoT. In this study, there are two sensors: the turbidity sensor, which can detect and help read water clarity levels, and the ultrasonic sensor, which functions to detect water levels. The result of this research is a prototype water clarity monitoring system with a turbidity sensor in tanks based on IoT. The prototype testing results were not very precise due to the bucket size with a diameter of 20 cm and a height of 25 cm, which caused sensor measurements to fluctuate. In the ultrasonic sensor test that displays the percentage of water height, there was a difference of 0.2 percent from the real calculation. In the turbidity sensor test results, 4 different types of water were used, but there were data changes in several types of water because water impurities settled to the bottom, making the turbidity sensor imprecise in reading water clarity [3].

Research on designing internet technology-based applications to control water storage devices. This research uses Mamdani fuzzy logic as a research methodology. It also uses sensors such as the YF-S201 water flow sensor, HY-SRF05 ultrasonic sensor, and TDS meter sensor. The result of this research is a prototype control system for internet technology applications to control water storage devices using Blynk. Prototype testing shows that the control system can be accessed in real-time via smartphone and can display information about tank conditions, as well as monitor water usage and quality through a smartphone. In experiments using the fuzzy logic method, the system achieved a success rate of 97% with an error rate of less than 15% [4].

Research on the design of automatic water pumps and IoT-based water monitoring systems in tanks. This research uses the research and development (R&D) method. The sensors used in this research are turbidity sensors and ultrasonic sensors. The result of this research is a prototype water monitoring system and automatic water pump in tanks. Based on the prototype test results using the system, it is concluded that the turbidity and water level monitoring system, plus checking the acidity level or pH of water based on IoT, functionally produces results as expected. The information on turbidity levels, height, and water acidity is quite helpful for officers to monitor clean water supply [5].

To understand what is meant by the Internet of Things, it can be explained that this term consists of two words, namely "Internet" and "Things." "Internet" itself is a computer network that uses Internet Protocol (TCP/IP) to communicate various information in a certain environment. Meanwhile, "things" refers to objects in the physical world that can be obtained through sensors and sent via the internet. Kevin Ashton, a technology pioneer and creator of the term Internet of Things, provides a definition stating that the Internet of Things is sensors connected to the internet. This allows computers to understand the world around us and become part of people's lives by establishing open connections, freely sharing data, and acting as the internet to enable unpredictable applications. There are three supporting elements in implementing the Internet of Things, namely internet, objects, and semantics [6].

Arduino IDE is a special program application that runs on a computer that allows you to write sketches for Arduino boards with a simple language based on the processing language. Then after writing sketches on the IDE, uploading the sketch to the board, and the written code is translated into C language and then processed by the avr-gcc compiler, a very important software because it can translate into a language understood by the microcontroller [7].

ESP8266 is a chip developed by Espressif, a company based in Shanghai, China. This chip has a Tensilica L106 32-bit microcontroller (MCU) with an oscillation speed of 80 MHz and is equipped with a WIFI transceiver so it can connect to WIFI routers or access points. This chip has 17 pins, where 11 pins are used as Input/Output (I/O) pins and 6 pins for communication with flash memory chips. ESP8266 can operate at 3.3V and is equipped with SPI, I2C, and UART communication. This chip can also perform analog to digital conversion of 10 bits [8].

Ultrasonic sensors are a type of sensor that converts sound waves into electrical signals with the help of an object called a piezoelectric. This sensor is commonly used to measure distance by emitting ultrasonic waves to a target which then reflects the waves back to the sensor. By calculating the time it takes for the waves to return to the sensor, distance can be calculated using the speed of sound in the medium encountered. Ultrasonic sensors are widely used in devices that require distance measurement such as smart robots, ships, submarines, and others. This sensor works on the principle of sound wave reflection and can sense solid, liquid, granular, and textile objects. Some types of ultrasonic sensors that are widely used are the SRF and PING types. In its working principle, this sensor uses signal transmitters and receivers at a frequency of 40kHz [9].

The turbidity sensor is a sensor that functions to detect water quality by measuring its turbidity level. This sensor can detect particles dissolved in water by measuring changes in light transmission speed and scattering, which depend on the total amount of suspended solids in the water. When the total amount of suspended solids in water increases, the turbidity level of the water will also increase. This turbidity sensor has two output signal modes, namely analog and digital [10].

ESP32-CAM is a microcontroller equipped with a camera and designed to be used in various applications such as monitoring, recognition, video, and image capture, and is supported by Arduino programming. With a secure small digital memory card and a 2 MP OV2640 camera, ESP32-CAM is also equipped with several General Purpose Input/Output (GPIO) for connecting peripherals, and the ability to store images produced by the camera. One of the reasons why ESP32-CAM is chosen is because it is integrated with a camera. The ESP32 chip used in ESP32-CAM has also been upgraded so that it is capable of image processing. In terms of specifications, ESP32-CAM is equipped with 520 Kb of RAM and 4 MB of built-in flash memory, and supports UART and PWM interfaces. In addition, ESP32-CAM also has a built-in wifi module and bluetooth module with BLE that allows data transfer and device connection [11].

A relay is a simple circuit consisting of a switch, electromagnet, and iron shaft that functions as an automatic electrical switch that can be controlled by electrical voltage. The main components of a relay consist of a coil and a contactor. The coil is copper wire wound into a coil, which can generate a magnetic field when given electrical voltage. Meanwhile, the contactor is a mechanical switch controlled by a magnetic field [12].

A water pump is a device that functions to move liquid or water from one place to another, using electrical power as a resource to increase water pressure to overcome flow resistance. The working principle of a water pump is based on the conversion of electrical energy into kinetic energy of the fluid. The purpose of using this water pump is to drain water into the tank when the tank is empty [13].

A solenoid valve is also referred to as a faucet where opening and closing are done by an electromagnet, not by humans. Commonly used solenoid valves have a space divided into two compartments by a diaphragm that ensures both compartments are sealed. The electromagnet is connected to the diaphragm, and when supplied with electrical power, for example with a voltage of 24V DC, the diaphragm will lift and allow water flow. Solenoid valves are usually set to "closed," which means without electrical power at the end of the solenoid, the valve is closed and does not allow fluids such as water to flow from the inlet to the outlet. Conversely, if the valve is set to "open," then without electrical power at the end of the solenoid, the valve will remain open and allow fluid flow through the channel [14].

Blynk is a platform that provides applications for users and developers on iOS and Android, with the aim of controlling various types of microcontrollers such as ESP8266, Arduino, RPi, SparkFun, and others. This platform allows developers to drag and drop widgets into a dashboard to create a Graphical User Interface (GUI) according to project needs. These widgets are used to control hardware remotely, as well as visualize and display sensor data. Blynk is also an end-to-end solution for IoT, which helps reduce the time and resources needed to build applications for connected products and services. In addition, the Blynk platform also allows organizations to move smoothly from prototype to production in short iterations, and helps developers gather feedback and refine products at each stage of development. Blynk is known as a secure, scalable, lightweight, and fast platform in managing billions of requests to and from edge devices. The Blynk library used to communicate between Blynk servers and hardware such as RPi is also a JavaScript library. This library functions to receive data from sensors and display that data in the Blynk application [15].

Water, consisting of H2O compounds, is very important for human life. Most of the human body, about 85%, consists of water, and the more active a person is, the more water they need. According to the Ministry of Health Regulation in 2002, the average water requirement per person is about 60 liters/day, with 30 liters for bathing, 8 liters for drinking, and the rest for cooking and washing. Water functions as a carrier of nutrients, vitamins, minerals, and oxygen to the organ cells of the human body, so it is very important for human health and life [16]. Based on the Regulation of the Minister of Industry of the Republic of Indonesia No. 78 of 2016 concerning provisions for the turbidity level of clean water of 25 NTU and Total Dissolved Solids (TDS) of 1500 mg/L.

A water tank is a storage place for PDAM water, groundwater, and well water that functions to provide an adequate water supply when needed, especially in situations where the water supply is inconsistent or limited.

FT232RL is a chip that functions as a USB to TTL serial interface converter. This chip is often used in applications where USART devices need to be connected and communicate with external devices via USB connection [17].

Step-up is a series of electronic devices that function to increase electrical voltage so that the resulting electrical voltage is greater than the source voltage.

2. Method

The following are the stages of methodology in this research, as shown in the Figure:

Figure 1. Research Stages

2.1 Data and Information Collection

The method used in this process is to search for literature studies from various journals, books, and others to examine issues that support theories in planning and designing water level and turbidity monitoring systems in tanks.

2.2 System Analysis

System analysis aims to break down the requirements that must be provided by the system in order to meet user needs and in accordance with the research objective, which is to conduct an IoT-based Water Level and Turbidity Monitoring System.

2.3 System Design

System design can provide an overview of how the water level and turbidity monitoring system works. At this stage, the system is processed to work well and efficiently. In general, this system design is to identify the components of the system to be created. System design requires several designs including: flowchart, use case diagram, cloud monitoring and controlling system, GUI application design, and schematic diagram.

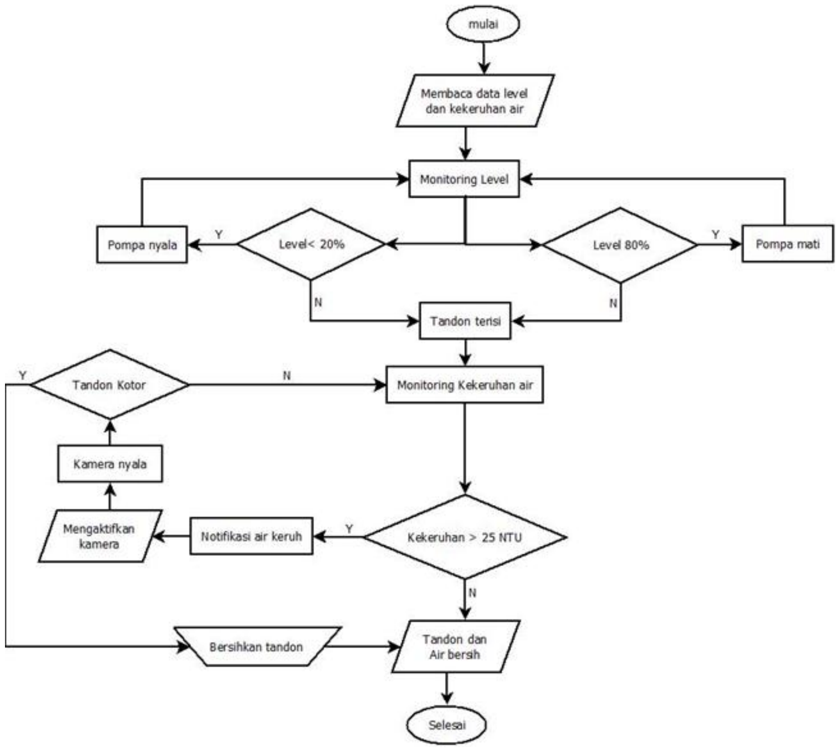

Figure 2. System Flowchart

The Water level and turbidity monitoring system flowchart works as follows: If water level < 20%, the pump automatically turns on to fill the tank. If water level = 80%, the pump turns off. If not, the tank is filled. For water turbidity, if > 25 NTU, notification "turbid water". If < 25 NTU, "clean water". Camera is active to monitor the tank; if dirty, clean manually. If not, the tank is clean.

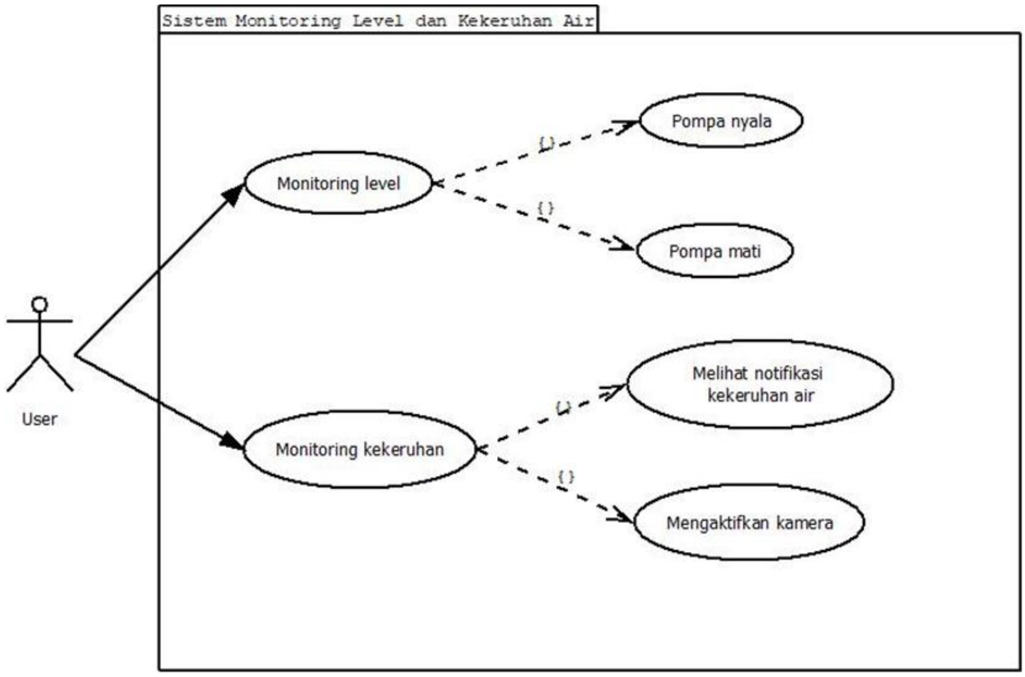

Figure 3. Use Case Diagram

The figure above shows the interaction of users with the system, where users can find out information about water level and turbidity by monitoring using the Blynk application. This system can also send water level and turbidity data in real-time.

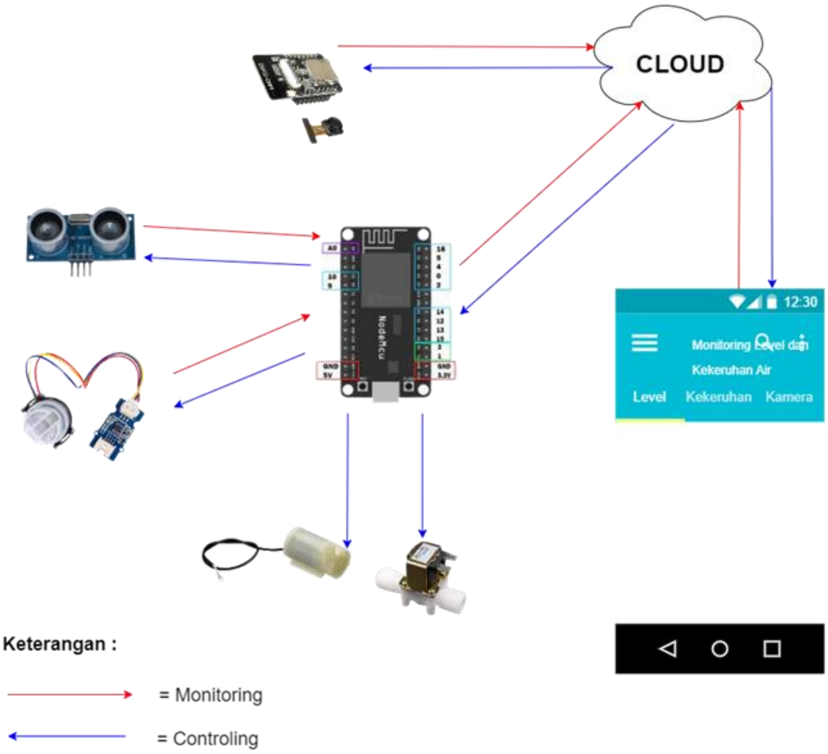

Figure 4. Cloud Water Level and Turbidity Monitoring System

In the Internet of Things (IoT), we can integrate monitoring and controlling in the system. The system also needs a cloud to store data. The cloud referred to is virtual data storage that has the function to manage everything in the cloud and can be accessed in real-time when connected to the internet.

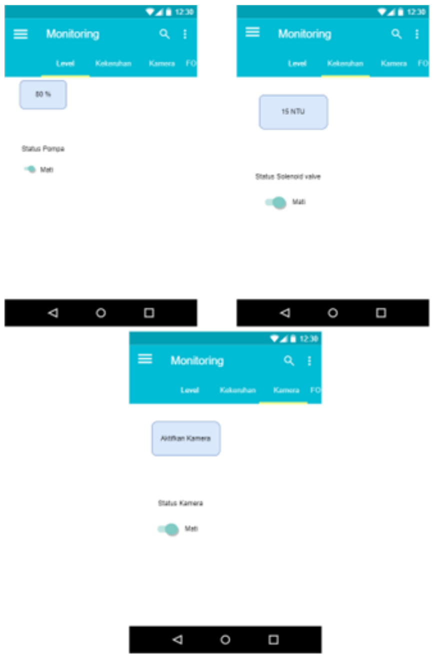

Figure 4. Application GUI Design

The GUI (Graphic User Interface) Application Design is the initial design of the interface for the level and turbidity monitoring system in the Blynk application.

2.4 Prototype Design

Prototype design is the first step to create a prototype of the system to be built in physical form, which is a simpler method of the original form with the aim that the features and functions of the system can be tested and evaluated. At this stage, prototypes are usually built with materials that are easily changed.

The water level and turbidity monitoring system has 2 schematic diagrams. The device scheme to provide information about water level and turbidity is shown in Figure 5, and information about water level and turbidity will be sent to the Blynk application. Meanwhile, the device scheme about the condition of the tank and water is shown in Figure 5.

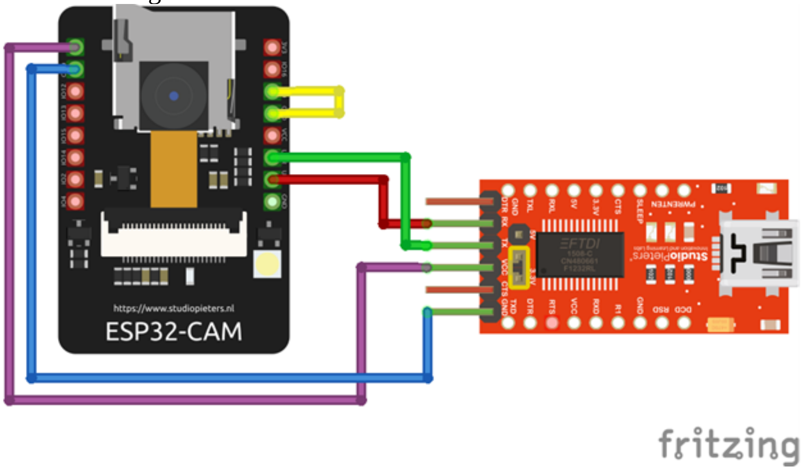

Figure 5. Schematic Diagram of Water and Tank Condition Monitoring

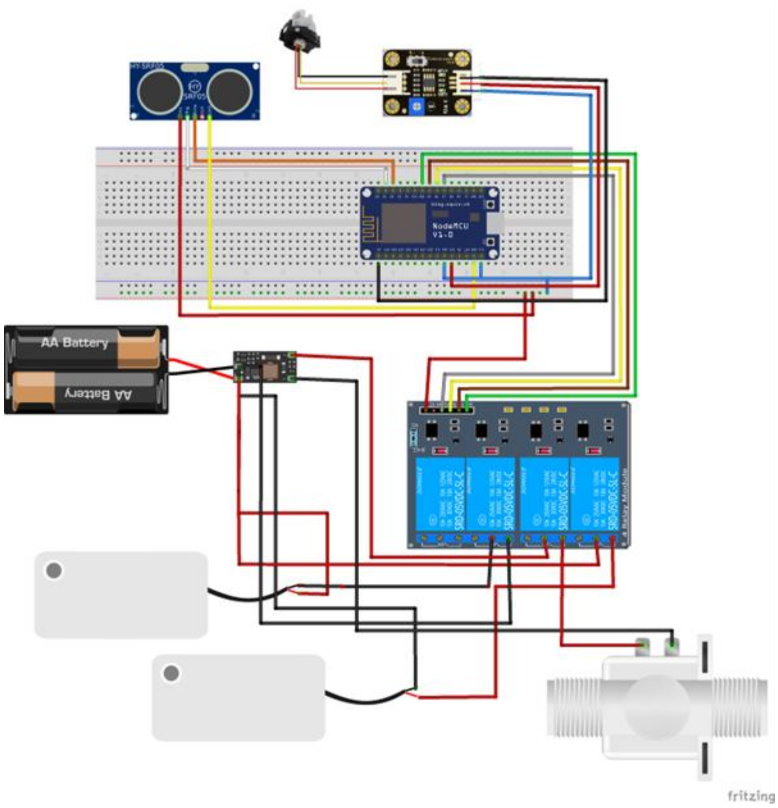

Figure 6. Schematic Diagram of Water Level and Turbidity Monitoring

2.5 Prototype Testing

Prototype testing is the process of validating and evaluating the initial model of the system that has been created. The purpose of prototype testing is to test and evaluate performance, functionality, and design suitability with requirements. Prototype testing can be done with various techniques and methods. Prototype testing is carried out by collecting data and feedback from users to evaluate the success of the prototype in meeting needs and objectives.

3. Result and Discussion

In this research, a water level and turbidity monitoring system in tanks integrated with the Blynk application was produced. The water level and turbidity monitoring system can provide information about tank conditions in real-time that can be accessed anywhere and anytime if connected to the internet. This system can also carry out desired commands adjusting to the required conditions. The system that has been created will automatically be able to monitor water level and turbidity.

3.1 Initial Display of Water Level and Turbidity Monitoring System

This display is the initial display of the Blynk application that will be used to monitor water level and turbidity remotely. Previously, water level and turbidity monitoring had been created using the Blynk application, and when opening the application, then click on the Level and Turbidity Monitor section.

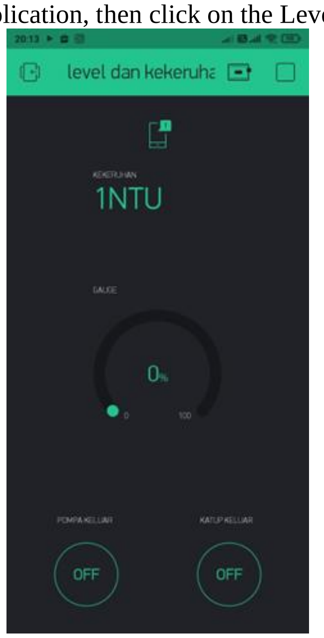

Figure 7. Running Mode Display of Water Level and Turbidity Monitoring System

3.2 Water Turbidity Notification Display

The automatic notification display is sent to Blynk for tank turbidity warnings > 25 NTU. It appears when opening or not opening the Blynk application. If not opened, the notification appears in the top panel of the phone. When the application is opened, a pop-up notification appears on the phone screen.

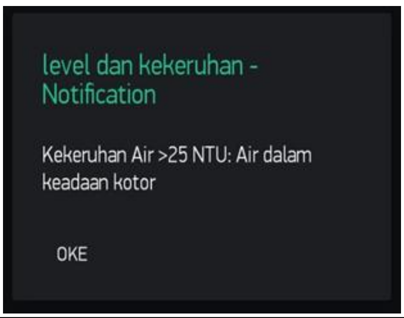

Figure 8. Pop Up Notification Display

3.3 Water and Tank Condition Monitoring Display

This display is the initial display of the Blynk project for monitoring water and tank conditions through live broadcast. The following display has 2 modes, the first mode is the initial display or edit mode and the second display is running mode or the system is running and ready to use.

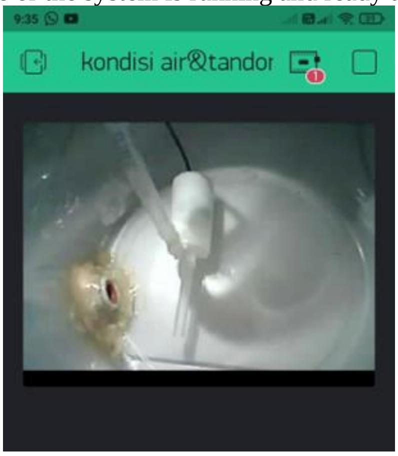

Figure 9. Running Mode Display of Water and Tank Condition Monitoring

3.4 Prototype of Water Level and Turbidity Monitoring System in Tanks

The prototype of water level and turbidity monitoring in this research can be seen in Figure 10.

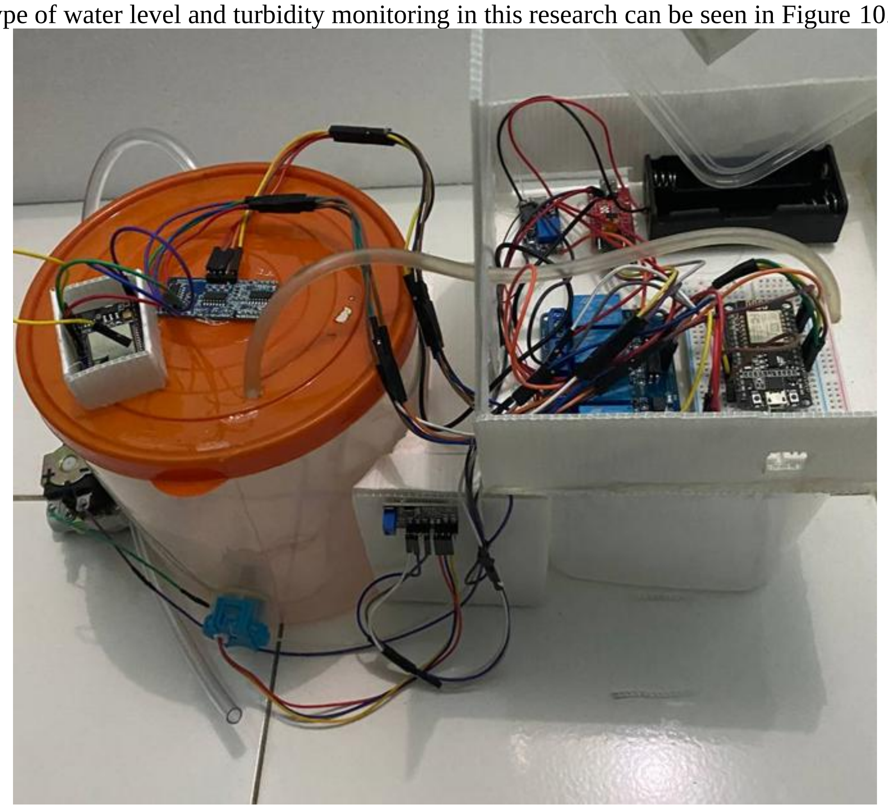

Figure 10. Prototype Image of Water Level and Turbidity Monitoring System in Tanks

4. Conclusion

In this research, a water level and turbidity monitoring system in tanks integrated with the Blynk application was produced. This system automatically maintains the water level in the tank by turning on the inlet pump if the water is at a level less than 20%. If the water level is more than 80%, the inlet pump automatically turns off. In turbidity monitoring, if water turbidity exceeds 25 NTU, a notification automatically enters the mobile Blynk that the water is in a dirty state. This system can provide information about tank conditions visually directly through the ESP32-CAM camera connected to the Blynk application that has been created. This system produces 2 Blynk projects that are used to monitor water level and turbidity as well as water and tank conditions. 1 Blynk project is used to monitor level and turbidity, and 1 Blynk project is used to visually see the condition of water and tanks.

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