Thingsboard-based prototype design for measuring depth and pH of kulong waters

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Abstract. Kulong is a post-tin mining area that is not reclaimed, resulting in the formation of a basin that is gradually filled with water through natural processes. In carrying out an inventory of kulong water to find out the potential and benefits of its water, a method is needed to measure the depth and pH value of kulong water in a practical way and can be monitored in real-time. Depth measurement usually uses an echosounder and to check the pH value using a manual pH meter. However, this method is somewhat less effective because it requires a relatively long process and the resulting data must be recorded manually. In this study, a thingsboard-based prototype design was designed to measure the depth and pH of the Kulong waters. Measurement data is processed using a hotspot or WIFI internet connection. The measured value data will be processed and uploaded to the Thingsboard server, which is an online-based Internet of Things (IoT) platform. So that data can be displayed in real-time through the website and can be accessed via a laptop or smartphone.

1. Introduction

The process of tin mining in Bangka Belitung is a series of long history and has been going on for a long time since the 17th century to be precise in 1709. These activities have resulted in the formation of many kulong, which is a mining basin that has not been reclaimed. So that gradually filled with water which is then given the term kulong by the community. There are a total of 12,610 kulong found throughout the province of the Bangka Belitung Islands with a total area of 15,582.46 ha or a percentage of about 10.059% of the province's area of around 1,642,406 ha. The average number per district is around 1801 kulong. With this amount, Kulong has great potential to be used as a solution to the problem of handling the water crisis. Therefore it is necessary for Kulong Inventory activities that are part of the management of water, which is based on two criteria, namely kulong utilization of water quality and water availability [1-10]. Measurement is a process that will be carried out in the kulong inventory activity, to determine the quality of the water, it is necessary to measure the pH value of the kulong water. Meanwhile, to determine the level of water availability, it is necessary to measure the depth of the kulong.

Generally, an echosounder is used which is a navigation tool to measure the depth of the water by sending ultrasonic acoustic pressure waves from the surface to the bottom of the water and recording the time until the echo bounces back from the bottom of the water. This measurement survey method is usually carried out by transporting a single-beam or multi-beam echosounder on manned and unmanned vessels. This method of measuring depth with echosounder somewhat less effective because it requires
a relatively long process and the resulting data must be recorded manually. As for measuring the pH of the kulong using a pH meter. Measurements were made by taking a sample of kulong water and then measuring the pH level of the sample. This method is somewhat less effective because the pH conditions in wide waters can change. The solution to quickly and effectively measure depth and pH of kulong is to design a prototype based on IoT (Internet of Things) Thingsboard to display measurement data in real time equipped with a Ping Sonar Altimeter and Echosounder sensor to measure the depth and a pH Meter sensor SKU SEN0161 to measuring the pH of kulong water [11-16].

2. Materials

2.1 NodeMCU esp8266
NodeMCU can be analogous to the Arduino board from the ESP8266 chip (WIFI SoC chip), is a platform for the development of the open source Internet of Things (IoT) consisting of the On Chip ESP8266 system device made by Espressif. The system with the firmware used uses the Lua Scripting programming language. NodeMCU is used to upload measurement data to the website. NodeMCU connects the equipment to the internet network. So that the data measured by the sensor and sent by Arduino can be processed and uploaded to the Thingsboard server (Saputra et al., 2020).

2.2 Arduino uno
According to Muhammad Syahwil (2013:16) Arduino is an ATMega-based microcontroller board that has 14 digital input and output pins (6 pins are used as PWM outputs), 6 analog inputs, 16 MHz clock speed, USB connection, power jack, ICSP header, and reset button. This toolkit is intended for artist, designers, hobbyists and anyone interested in creating interactive objects or environments. Arduino is used to process the measurement data by the sensor.

2.3 Ping sonar altimeter and echosounder
Ping Sonar Altimeter and Echosounder is an underwater sonar sensor that functions to measure the distance to objects under water. The Ping has a depth measurement range of up to 30 meters, a signal beam width of 30 degrees, and is capable of operating to a depth of 300 meters. This sensor can be used for water depth measurements, as an altimeter on an ROV or AUV, for onboard bathymetric surveys or USVs, or as a sonar sensor on underwater robots to avoid obstacles in the water.

![Figure 1](source: www.bluerobotics.com)

2.4 SKU SEN0161 pH Meter
The pH meter sensor is an electrode device that functions to measure the pH level (degree of acidity or alkalinity) of a liquid. A pH meter consists of a measuring probe (electrode) connected to an electronic device that measures and displays the pH value. The use of pH sensors is found in various activities and industries such as laboratory activities, drinking water, aquariums, the clothing industry such as batik and clothing dyes. Glass electrode is a term for ion sensitive electrodes. One of the pH sensors that is often used is the Analog pH Meter SKU SEN0161 sensor. The SKU SEN0161 pH Meter sensor can
read the value of a solution in the form of resistance which is then converted using a BNC connector into pH value data.

2.5 Thingsboard

Thingsboard is an IoT (Internet of Things) platform that can perform several functions such as data collection and processing, device visualization, device management. This platform provides solutions to enable server-side infrastructure using on-premise or out-of-the-box IoT cloud. Built on the basis of the Java 8 platform, 100 percent of standard IoT protocol support is provided for by the thingsboard platform for device connectivity such as, MQTT, CoAP, and HTTP(S). Until now there have been three different database options (SQL, NoSQL, and Hybrid). The database available in thingsboard is used to store entities such as (devices, assets, dashboards, customers, users, alarms, etc.) (Aghenta, 2019).
3. Data transfer process

The first process begins with input, this process involves the use of sensor devices, namely the Ping Sonar Altimeter and Echosounder sensor and the SKU SEN0161 pH Meter sensor. The sensor will work and read the depth value in meters (m) and the pH value of the kulong water in pH units. Then the measurement data that has been read by the sensor will be sent via serial communication (jumper cable) to the Arduino Uno module. Next is the process, in this section it involves the use of two modules, namely, Arduino Uno and NodeMCU ESP8266. Arduino functions to process the data sent from the sensor and convert it in the form of an array to be sent to the NodeMCU ESP8266 module using serial communication (jumper cable). The data received by NodeMCU will be processed by the module and prepared for uploading. Using the ESP8266 chip NodeMCU can upload to the thingsboard server using an internet connection with MQTT protocol communication. The last is the output, this involves the thingsboard platform which is used to display data in real time from the readings and processing of the Ping Sonar Altimeter and Echosounder sensors and the SKU SEN0161 pH Meter sensor. The data will be displayed in the form of values in meters (m) and pH, and is equipped with monitoring using graphs. Data can be accessed through devices such as laptops and smartphones using an internet connection by accessing the thingsboard website.

4. Wiring design

4.1. Connecting system

Figure 5. Wiring diagram of prototype
Based on Figure 5, the tool consists of 6 (six) components, namely Batteries, Modem, Arduino UNO, NodeMCU ESP8266, pH Meter Sensor SKU SEN0161, Ping Sonar Altimer and Echosounder. The pin configuration is shown in (Table 1). Arduino voltage supply is connected using a +9V battery to powering the prototype, the positive (+) pin is connected to the Arduino Vin pin while the negative (-) pin is connected to the Arduino GND (Ground) pin. NodeMCU uses a voltage supplied from Arduino of 3.3V, Vin pin is connected to Arduino 3V3 pin and NodeMCU GND (Ground) pin is connected to Arduino GND (Ground) pin. Meanwhile, to provide a sensor voltage of +5V, it is supplied from Arduino via the +5V output pin to each VCC of the ping sonar sensor and SKU SEN0161 sensor while the GND (Ground) pin of the sensor is connected to the GND (Ground) pin of the Arduino. The ping sonar sensor has 2 TX (Transmitter) and RX (Receiver) pins connected to Digital 4 (D4) and Digital 2 (D2) pins of Arduino which function as TX and RX pins.

| Battery | Arduino | Nodemcu | Ping sonar | Sku sen0161 |
|---------|---------|---------|------------|-------------|
| -9V     | +9V     | -       | VCC (+5V)  | VCC (+5V)   |
|         | -       | 3V3     | Vin        | -           |
| -9V     | -       | GND     | GND        | GND         |
| -       | D4      | -       | TX         | -           |
| -       | D2      | -       | RX         | -           |
| -       | TX      | RX      | -          | -           |
| -       | A0      | -       | -          | A0          |

5. Result and discussion
5.1. The process of uploading pH measurement data to the thingsboard website
The process of uploading the measurement data for the pH value of the solution to the thingsboard website is carried out in real time. The data upload process uses a WIFI connection sourced from an available hotspot. Using the nodemcu esp8266 component as a data uploader and the thingsboard website to display data. The following (Figure 6) is a pH data display on the thingsboard website.

![Figure 6. Display of pH value data on the thingsboard website](image-url)
5.2. Ultrasonic sensor calibration process

The ultrasonic ping sonar sensor calibration process is carried out by connecting the sensor to a laptop using the FTDI USB to Serial Adapter component and Ping Viewer software. This calibration process is needed to determine the accuracy of sensor readings. The calibration results displayed are the distance of the sensor to the object of the obstacle in this case the bottom of the water surface. Here (Figure 7) is what the ping viewer looks like.

![Figure 7. Display depth data on ping viewer software](image)

5.3. Kulong’s map

![Figure 8. PL kulong water catchment area map (Muhammad Novriansyah, 2021)](image)

Under the Air PL kulong is located at the coordinates: 48 M 0625608, UTM 9758682, Altitude : 31 m in Pangkalanbaru District. Surface area under 1.41815 ha located 31 meters above sea level, and the catchment area 49.579726 ha and the current volume of under water is 19251.9 m. under in the highland area category from GPS data the water level elevation is +31 m and around under the many highlands
and hills of Kolong Air PL has the potential for water availability that is able to meet water needs standard of 4.02 liters/second. Laboratory tests say that the pH value from this bottom of 6.06 with a nitrate content of less than 0.05 mg/liter and nitrite 0.0193 mg/liter. Based on the level of acidity is still there within the quality standard interval or can still be used, but it is better further maintenance was carried out to increase the pH of the water.

5.4. Prototype test results on kulong PL

From the testing process, the data is obtained as in (Table 2). The data shows changes in values that are changing, this is because the level of sensitivity of the sensor is good, but the sensor has a weakness, the measured value does not match the actual value. This shows that the calibration process still needs to be improved on the accuracy of the sensor readings. To see a comparison of the increase and decrease in the value of depth and pH, look at (Figure 9). The graph shows the average value for a depth of 6.21 meters and the average value of pH is 9.36.

| Timeseries | pH value | depth value |
|------------|----------|-------------|
| 8:10 AM    | 11.10    | 5.87 m      |
| 8:11 AM    | 11.02    | 6.02 m      |
| 8:12 AM    | 10.83    | 5.90 m      |
| 10:29 AM   | 8.96     | 6.53 m      |
| 10:30 AM   | 8.90     | 6.49 m      |
| 10:31 AM   | 8.85     | 6.37 m      |
| 14:34 PM   | 8.22     | 5.64 m      |
| 14:35 PM   | 8.20     | 6.33 m      |
| 14:36 PM   | 8.19     | 6.70 m      |
| Average    | 9.36     | 6.21 m      |

![Figure 9. Test result graph](image)

6. Conclusion

The conclusion is in making a prototype measurement tool. Especially depth measurements using ultrasonic sonar sensors and pH sensors, this must pay attention to the sensor calibration process before the sensor is ready for use. This is very necessary to make readings with a high level of accuracy. The use
of the thingsboard website as an Internet of Things (IoT) platform really helps make the measurement process faster and more efficient. The prototype design process requires a planning stage by preparing the necessary tools and materials. Then do the prototype design and wiring. Then specify the pins on the wiring diagram. Designing measurement methods in the field. Finally, it is necessary to integrate the tool into an IoT (Internet of Things) system using an internet connection-based Thingsboard Platform. So the data can be displayed in real time. Prototype requires further development to support the process of inventory activities kulong. In order to know the benefits of kulong.

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Acknowledgement
We gratefully acknowledge the funding from Universitas Bangka Belitung through the RKAKL FT for the publication of this paper.