EARLY WARNING SYSTEM FOR FLOOD IN GUNUNGSARI DISTRICT BASED ON IOT WITH TELEGRAM BOT AS A WARNING MESSAGE SENDER

Hambali[1*]; Ardiyallah Akbar[2]; Ahmad Yani[3].

[1]Technical Information, [2]Computer Engineering, [3]Information Technology
Mataram University of Technology
Mataram, Indonesia
https://utmmataram.ac.id/
[1]08mi071@gmail.com, [2]ardiyallah_akbar@ymail.com, [3]m4dy45@gmail.com
(*) Corresponding Author

Abstract— Entering the rainy season with a high level of rainfall will impact vulnerability to floods that will hit several areas in various parts of Indonesia. As is often the case in the Gunungsari Sub-district, West Lombok Regency, heavy rains that come early with high intensity for several days often occur, which causes flood disasters and the absence of an automatic system or tool that can detect flooding in the area so that people around the difficulty of detecting floods that come early and cause many people to lose their homes and property due to the flood disaster. The purpose of this study is to provide information related to signs before a flood disaster using the Raspberry Pi 4 as the primary tool and the Hc-SR04 ultrasonic sensor as a tool for measuring the distance of an object where this system can monitor the water level of the river, then disseminate information—related to the water level periodically via Telegram. The test results of the detection sensor system show that the level of accuracy in reading the water level, with an average error of 0.48%, indicates that this IoT system has good accuracy.

Keywords: Raspberry Pi, Ultrasonic Sensor, IoT, Telegram.

Abstrak— *Memasuki musim hujan dengan tingkat curah hujan yang tinggi akan berdampak pada kerentanan bencana banjir yang akan menerjang sejumlah daerah diberbagai wilayah Indonesia. Seperti halnya yang sering terjadi di daerah Kecamatan Gunungsari Kabupaten Lombok Barat, hujan deras yang datang secara dini dengan intensitas tinggi selama beberapa hari sering terjadi, yang menyebabkan terjadinya bencana banjir dan belum adanya suatu sistem atau alat otomatis yang dapat mendeteksi banjir di daerah tersebut sehingga masyarakat sekitar kesulitan untuk mendeteksi banjir yang datang secara dini dan mengakibatkan banyak masyarakat yang kehilangan tempat tinggal dan harta benda akibat bencana banjir tersebut. Tujuan dari penelitian ini adalah, memberikan informasi terkait tanda-tanda sebelum bencana banjir menggunakan alat Raspberry Pi 4 sebagai alat utama dan sensor ultrasonik Hc-SR04 sebagai alat pengukur jarak suatu objek, dimana sistem ini dapat melakukan monitoring ketinggian permukaan air sungai, kemudian menyebarkan informasi terkait ketinggian permukaan air tersebut secara periodik melalui Telegram. Hasil pengujian sistem ensor deteksi menunjukan bahwa tingkat akurasi dalam membaca ketinggian air dengan rata-rata error 0,48%, menunjukan bahwa sistem IoT ini memiliki akurasi yang baik.*

***Kata Kunci**: Raspberry Pi, Sensor Ultrasonic, IoT, Telegram.*

INTRODUCTION

Flood disaster is one of the most frequent natural disasters in Indonesia. High levels of rainfall impact the risk of flooding in several areas in Indonesia. Flood disasters must be handled immediately, considering the disaster cycle's potential and pattern that repeats itself in a specific time interval. Technology in the form of automation tools, such as flood risk management, has become essential for all regions of Indonesia.

Entering the rainy season with a high level of rainfall will impact vulnerability to floods that will hit several areas in various parts of Indonesia. Suppose the condition of an area includes a lower land surface than sea level. In that case, the area is located in a basin surrounded by hills with little water infiltration, the construction of buildings along the banks of the river, the river flow is not smooth due to obstruction by garbage, when high rainfall will cause the inability of rivers to accommodate water discharge, resulting in an increased risk of flooding.

As is often the case in the Gunungsari District, West Lombok Regency, heavy rains that come early with high intensity for several days often occur, which causes flooding disasters and the absence of a system or tool that can detect flooding in the area so that the surrounding community difficult to detect floods that come early. Many people lost their homes and property due to the flood.

Disaster information (Tenda et al., 2021) can be conveyed in various forms in critical and straightforward language. Information about potential hazards is the output of data processing from various sources, which is processed at maximum speed so that quality, fast, and easily accessible information is obtained. By utilizing the telecommunications network and formulating simple information, disaster information can be disseminated quickly and accurately.

IoT is an information technology concept where all physical objects with computing capabilities are globally interconnected through Internet protocols (Al-Turjman, 2019) so that they can be connected and share information, making it easier for humans as users. IoT has been applied in various fields, including in the development of Smart Cities (Hidayatulloh, 2016), Smart home systems (Malche & Maheshwary, 2017), monitoring agriculture (Syawal, 2018) and animal husbandry as well as for work safety management (Umam, 2018).

Several studies on disaster early warning systems, more specifically flood disasters, have now been carried out. Researchers use different tools and systems, including developing IoT and Twitter-based flood early warning systems. The ESP2866 MCU Microprocessor reads water level sensor data and sends data automatically. Wirelessly to Android smartphones, a Microcontroller and ultrasonic sensors to detect water level and reading information are accessed via SMS Gateway.

In this study, using the Hc-SR04 Ultrasonic sensor to measure distances based on ultrasonic waves (Puspasari et al., 2019), the Raspberry Pi 4 as the primary tool as a Web browser link (Mulyanto et al., 2021) reads sensor data and the Telegram application to disseminate information related to river water level monitoring and classification. Periodic flood risk to the community.

This study aims to provide information related to signs before a flood disaster and preparedness that allows individuals, communities, and the government to take quick action to minimize the impact of disasters. Internet of Things (IoT) tools used in this research is Raspberry Pi and ultrasonic sensors and Telegram applications to disseminate information related to river water level monitoring and periodic flood risk classification to the public.

MATERIALS AND METHODS

This research is an experimental device development consisting of hardware and software. The stages in this research are 1) Literature study; 2) System architecture; 3) Device design, consisting of Voltage Circuits, Implementation of Distance Measurements, and Development of Telegram Bots; 4) System implementation scenario. And 5) Results and Conclusions. The stages of the research can be seen in Figure 1 below:

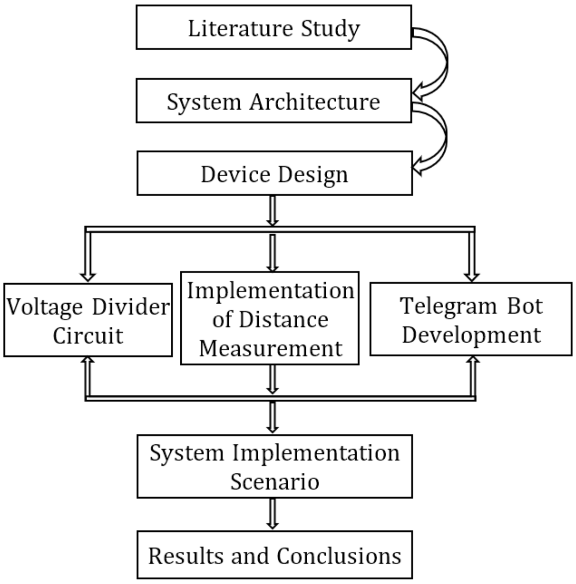

Figure 1. Research Methods

1. Literature Study
   A literature study was conducted to study the literature and theories used in the research. A literature study was conducted to find information on topics relevant to the method proposed in this study. The literature study is sourced from journals, books, articles, and research reports online and offline.
2. System architecture
   The system will read data from the ultrasonic sensor, which is processed by the computer periodically. The Raspberry Pi will ask the Telegram Bot API to make post requests on the Telegram account that was previously set up. The architectural system at the research stage can be seen in Figure 2:

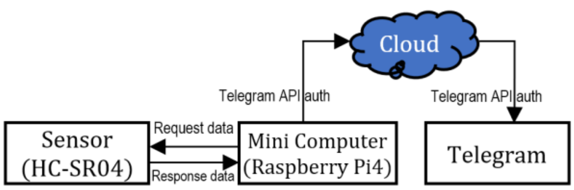

Figure 2. System Architecture

3. Device design
   a) Voltage Divider Circuit
   The voltage needed to receive the input signal data by the Raspberry Pi 4 device is 3.3 Volts, and the voltage for the Ultrasonic sensor is 5 Volts. In voltage division, a voltage divider circuit consists of two resistors that lower the output voltage from the sensor connected to the Raspberry. The resistor is connected in series to the input voltage (Vin), which needs to be reduced from 5V to an output voltage (Vout) of 3.3V. The voltage divider circuit in the study can be seen in Figure 3 below:

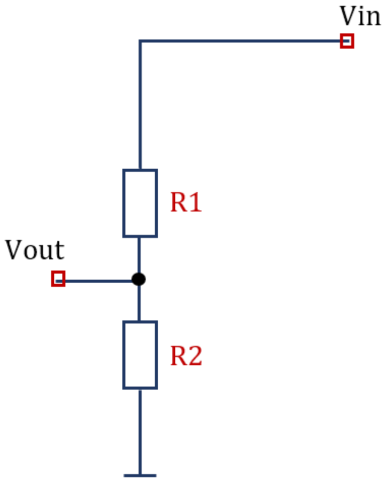

Figure 3. Voltage Divider Schematic

To get the size of the resistance/resistors R1 and R2, use the equation:

$$Vout = Vin \times \frac{R2}{R1+R2} \quad \text{...(1)}$$

$$\frac{Vout}{Vin} = \frac{R2}{R1 + R2}$$

By entering the value of the resistor, it becomes:

$$\frac{3.3}{5} = \frac{R2}{1000 + R2}$$

$$0.66 = \frac{R2}{1000 + R2}$$

$$0.66(1000 + R2) = R2$$

$$660 + 0.66R2 = R2$$

$$660 = 0.34R2$$

$$1941 = R2$$

Assemble the HC-SR04 Ultrasonic sensor circuit using four pins on the Raspberry Pi 4 with the schematic: GPIO 5V [Pin 4]; Vcc (Daya 5V), GPIO GND [Pin 34]; GND (0V Ground), GPIO 23 [Pin 16]; TRIG (Output GPIO) dan GPIO 24 [Pin 18]; ECHO (Input GPIO). The ultrasonic sensor circuit in the study can be seen in Figure 4 below:

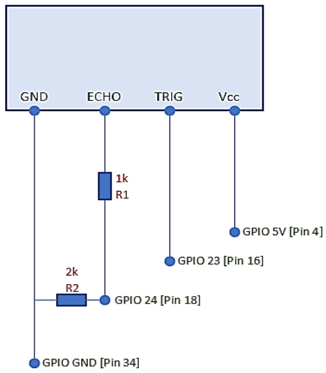

Figure 4. Ultrasonic Sensor Circuit

The pin scheme on the Raspberry Pi 4 GPIO that connects the Raspberry Pi to other devices the GPIO Pin scheme can be seen in Figure 5 below:

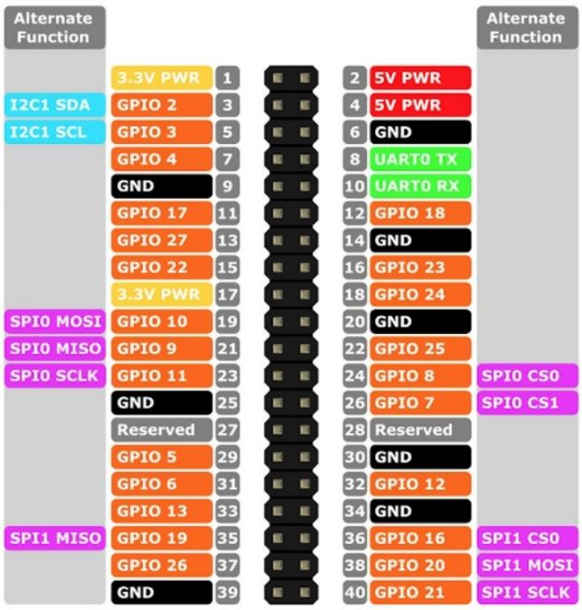

Figure 5. Pin Schematic on the GPIO Raspberry (Source: Raspberry Pi 4 Pins – Complete Practical Guide (Back-End, 2021))

After designing the voltage divider circuit, then assemble the Raspberry Pi 4 device with an Ultrasonic Sensor with supporting components such as cables, resistors, and circuit boards, as shown in Figure 6 below:

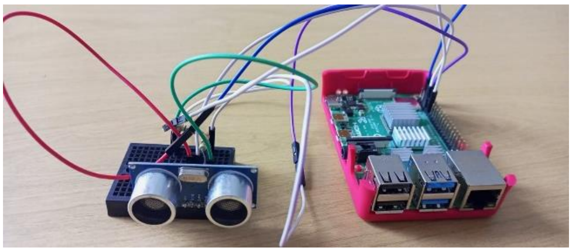

Figure 6. Raspberry Pi 4 Device Design with Ultrasonic Sensor (HC-SR04)

1) Connect the four jumper wires to the pins on the HC-SR04 as follows: Red; Vcc, Blue; TRIG, Yellow; ECHO and Black; GND
2) Plug the Vcc into the positive Breadborad hole, and plug the GND into the negative Breadborad hole.
3) They plugged GPIO 5V [Pin 4] into the positive Breadborad hole and GPIO GND [Pin 34] into the negative Breadborad hole.
4) Plug the TRIG into the empty Breadborad hole, and connect the jumper cable to GPIO 23 [Pin 16].
5) Plug the ECHO into an empty Breadboard hole, then connect R1 (1k resistor).
6) Connect the Breadboard hole R1 with the Breadboard GND hole using R2 (2k resistor). Put some distance between the two resistors.
7) Add GPIO 24 [Pin 18] to the Breadboard hole with R1 (1k resistor). This GPIO pin must be between R1 and R2.

b) Implementation of Distance Measurement
Distance measurements are carried out using the HC-SR04 Ultrasonic sensor. The distance that can be measured is about 2 – 450 cm, which can work by sending ultrasonic waves around 40KHz (Hut, 2013). The signal emitted will propagate as sound waves with a speed of about 34300 cm/s3 will be reflected by the object, which can trigger pulse waves as fast as 20 times per second (Puspasari et al., 2019). The object distance is calculated based on the formula:

$$distance = \frac{time\ x\ 34300}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where:
Distance = distance between the sensor and the measured object (cm).
Time = The time it takes the signal to return to the sensor.

The programming language used in making programs to read the data generated by this ultrasonic sensor uses the Python programming language by entering the following calculations into the Python script:

$$distance = \frac{(pulse\_duration \times 34300}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The result of the calculation is rounded up to 2 decimal places by entering the Python script:

$$distance = round(distance, 2) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

To print the results of the distance calculation formula that has been decimalized by entering the Python script:

Print "Distance," distance," cm."

The program script is designed to read sensor data at a specific time interval which can be shown in Figure 7:

```
def mainprogram():
    GPIO.output(TRIG, True)
    time.sleep(0.00001)
    GPIO.output(TRIG, False)

    while GPIO.input(ECHO)==0:
        pulse_start = time.time()

    while GPIO.input(ECHO)==1:
        pulse_end = time.time()

    pulse_duration = pulse_end - pulse_start

    global distance
    distance = (pulse_duration * 34300)/2
    distance = round(distance)

    global chat_id
    global globalMessage
    global globalMessageNew
    print('Distance:', distance,"cm")
```

Figure 7. Script Program Pembacaan Data Sensor

Telegram Bot Development
The Telegram application is used as a medium for disseminating water level information by utilizing Bots contained in the Telegram application. The Telegram Bot functions to update information automatically at every specific time interval. There is a Python package to access the Teleport API from Telegram. To get access to the API token on the Telegram application, first prepare the following:
1) Telegram account by accessing Telegram BotFather
2) Create a new Bot on the Telegram app
3) Prepare an HTTP API access token from the results of the new Bot on the Telegram application, which will be used as authentication for access to the flood disaster detection program.

Furthermore, if all authentication information has been completed and is valid, an automatic message to the Telegram application will be sent automatically.

4. System implementation scenario

At this stage, to test the developed system, a platform is needed in the form of a pole that functions as a support pole for computing and sensor equipment, as well as a manual measuring support pole. The battery power supply is used to power the system. As for the internet connection, a GSM 4G wireless model is used with a cellular internet service provider with a speed of 15 Mbps. The ultrasonic sensor is placed pointing at the surface of the water. The sensor is placed at the height of 4 meters from the riverbed. Monitoring data is taken and updated every 2 minutes. Measuring the riverbed against the sensor position is required to calibrate water level measurements. The scenario for implementing the system on river water can be seen in Figure 3. To facilitate the interpretation of information on river water levels and the risks faced, the classification of disaster risk is divided into three levels, namely:

a) Water level < 1 meter from the riverbed, Safe Condition
b) Be alert, and the water level is 1-2 meters from the riverbed
c) Danger, the water level is 2-3 meters from the riverbed
d) Disaster, water level > 3 meters from the riverbed.

The system implementation scenario is designed to find out the description of the placement of a water level monitoring device which looks like Figure 8 below:

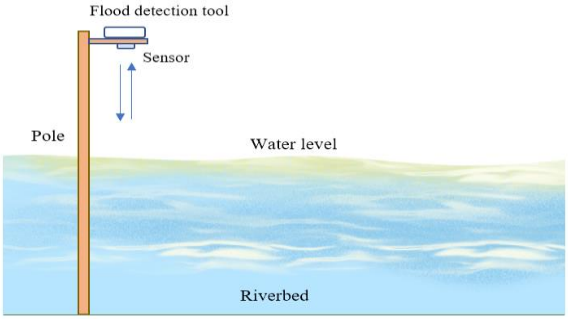

Figure 8. System Implementation Scenario

5. Results and Conclusions

At the stage of results and conclusions, first, calibrate the sensor distance to the riverbed to test the measurement results on the surface of the river water. The river's depth is measured using a measuring instrument (meter). Furthermore, the sensor distance to the riverbed is used as a reference for calculating the river water level, then checking the results of the Telegram bot. From the results of checking, it is found that the system has successfully displayed information in the form of water level, water level status, and measurement time correctly.

RESULTS AND DISCUSSION

Testing the distance reading system will be done by placing an object or object in front of a series of sensors to find out the results of distance measurements. In this experiment, objects or objects will be placed in front of the sensor at a predetermined distance position. Furthermore, for every 5-second interval, the measurement results are recorded, and the program will iterate five times. The average value of the distance measurement data is taken to get the difference from the manual measurement value. The test results will be entered into the table. After the test result data has been entered into the table, the next step is to find the error value (error). The results obtained will be summarized in the presentation of the error value, which can be seen in equation 1 and equation 2 for the average percentage error (Fathurrahman et al., 2021).

$$\% \; error = \frac{Nilai \; Sensor - Nilai \; Acuan}{Nilai \; Acuan} \; x \; 100 \; \% \quad \text{............} \; (5)$$

$$\% \; error = \frac{\sum error}{\sum uji \; coba} \; x \; 100 \; \% \quad \text{..................................} \; (6)$$

The sensor measurement results show that the reading accuracy with an average error of 0.49% is shown in Table 1.

Table 1. Program Test Results

Testing	Object Distance (cm)	Sensor Detection Result (cm)	Failed (%)
1	10	10,2	1,96
2	20	20,13	0,64
3	30	30,2	0,66
4	40	40,12	0,29
5	50	50,25	0,49
6	60	60,39	0,64
7	70	70,3	0,43
8	80	79,48	0,65
9	90	90,33	0,37
10	100	100,15	0,15
11	110	109,56	0,40
12	120	120,4	0,33
13	130	130,1	0,07
14	140	140,2	0,14
15	150	150,2	0,13
Average Failed (%)			0,49

From the results of checking, it is found that the system has successfully displayed information in the form of water level, water level status, and measurement time correctly.

CONCLUSION

The HC-SR04 ultrasonic sensor used on the Raspberry Pi 4 can detect the river's water level in

Gunung Sari village. Testing the resulting flood disaster monitoring device is quite good at detecting river water levels, with an error rate of 0.49%. The development of an IoT-based system using the social networking media Telegram as a medium for sending messages or information related to monitoring river water levels and classifying flood disaster risks can be obtained and disseminated to the public efficiently and quickly.

REFERENCE

Al-Turjman, F. (2019). Cognitive routing protocol for disaster-inspired Internet of Things. *Future Generation Computer Systems*, *92*, 1103–1115. https://doi.org/doi.org/10.1016/j.future.2017.03.014

Back-End, R. (2021). *Raspberry Pi 4 Pins – Complete Practical Guide*. Obotics Back-End. https://roboticsbackend.com/raspberry-pi-3-pins/

Fathurrahman, I., Saiful, M., & Samsu, L. M. (2021). Penerapan Sistem Monitoring Hidroponik berbasis Internet of Things (IoT). *ABSYARA: Jurnal Pengabdian Pada Masyarakat*, *2*(2), 283–290. https://doi.org/10.29408/ab.v2i2.4219

Hidayatulloh, S. (2016). Internet of Things Bandung Smart City. *Jurnal Informatika*, *3*(2), 164–175.

Hut, T. P. (2013, July 1). *HC-SR04 Ultrasonic Range Sensor on the Raspberry Pi*. Thepihut.Com. https://thepihut.com/blogs/raspberry-pi-tutorials/hc-sr04-ultrasonic-range-sensor-on-the-raspberry-pi

Malche, T., & Maheshwary, P. (2017). Internet of Things (IoT) for building smart home system. *Proceedings of the International Conference on IoT in Social, Mobile, Analytics and Cloud, I-SMAC 2017*, *February 2019*, 65–70. https://doi.org/10.1109/I-SMAC.2017.8058258

Mulyanto, T. A., Habiby, M., Kusnadi, K., & Adam, R. (2021). Home Automation System Dengan Menggunakan Raspberry Pi 4. *Jurnal Digit*, *11*(1), 60. https://doi.org/10.51920/jd.v11i1.180

Puspasari, F.-, Fahrurrozi, I.-, Satya, T. P., Setyawan, G.-, Al Fauzan, M. R., & Admoko, E. M. D. (2019). Sensor Ultrasonik HCSR04 Berbasis Arduino Due Untuk Sistem Monitoring Ketinggian. *Jurnal Fisika Dan Aplikasinya*, *15*(2), 36. https://doi.org/10.12962/j24604682.v15i2.4393

Syawal, A. M. (2018). Perancangan Sistem Monitoring Suhu dan Kelembaban Tanah Perkebunan Berbasis Internet of Things Menggunakan Protokol Aplikasi Chatting Telegram. *Fokus Elektroda*, *03*(03), 1–7.

Tenda, E., Lengkong, A. V., & Feliciano Pinontoan, K. (2021). Sistem Peringatan Dini Banjir Berbasis IoT dan Twitter Flood Early Warning Sistem Based On Iot And Twitter. *Cogito Smart Journal |*, *7*(1).

Umam, K. G. L. (2018). Smart Kandang Ayam Petelur Berbasis Internet of Things untuk Mendukung SDGS 2030 (Sustainable Development Goals). *Jurnal Teknoinfo*, *12*(2), 43. https://doi.org/10.33365/jti.v12i2.86