Internet of Things Innovation for Flood Detection: Monitoring Water Level, Temperature, and Humidity with Node MCU and Telegram Bot

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ABSTRACT
The problem of this research is the existence of Climate Change that occurred in the Indonesian region in 2024, especially in the Kudus, Demak, and Pati areas, there was a major flood that caused 20,772 refugees spread across 59 refugee locations, 93,149 people were affected by the flood, and there were 4 fatalities. This is a concern for researchers for experiments on flood detection devices. The purpose of this study is to develop a prototype of a water level, air temperature and humidity monitoring system in an effort to prevent flooding. The main difference from this research is not only focused on monitoring water levels, air temperature, humidity but also accompanied by message notifications delivered via telegram bots that convey information about the status of water levels, air temperature, and humidity, where there are 3 categories of notification status, namely safe, alert, and danger. The method used is a Literature Study on Flood Detection Devices, Tool Assembly, IoT Design, Integration with Telegram Bots, Buzzer Settings, Solar Cell Installation, Trial, Validation and Evaluation. The results of the research that has been done, after testing the IoT circuit to monitor water level, air temperature and humidity have shown very satisfactory results. This is evident from the notification in the form of air temperature status, humidity, and water level prototype simulation which includes when the water level is 0 - 7 cm the notification status is safe, when the water level is 8 - 15 cm the notification status is alert, and when the water level is above 16 cm the notification status is danger and a warning appears on the notification and the buzzer notification sound sounds.

Keywords: IoT, Monitoring, Temperature, Water Level, Humidity.

INTRODUCTION

Climate change that occurred in the Indonesian region in 2024, especially in the Kudus, Demak, and Pati areas, caused a major flood that caused 20,772 refugees spread across 59 refugee camps, 93,149 people were affected by the flood, and there were 4 fatalities. This has become a concern for researchers for experiments on monitoring tools for water levels, air temperature, humidity in an effort to detect floods.
The Internet of Things, or IoT, can be an effective solution in the development of more sophisticated flood detection tools. By utilizing IoT technology, researchers can create a system that is directly connected to various sensors to detect water levels in real-time[1][2]. This is expected to help provide early warning to the public regarding potential flooding and reduce the negative impacts caused by natural disasters. Through the application of IoT to flood detection tools, it is hoped that it can increase disaster resilience and public safety in the future. With a system that is directly connected to sensors, information about water levels can be sent directly to the flood control center for immediate preventive action. In addition, with more accurate early warnings, people can be better prepared for potential

floods and save themselves and their property more effectively. Thus, in reducing losses due to flood disasters in the future[3].

Previous research on IoT has proven that this technology can be an effective solution in developing more sophisticated flood detection tools.[4][5] Through the application of IoT, researchers can create a system that can provide real-time early warnings to the public regarding potential floods, so that the negative impacts of natural disasters can be minimized. It is hoped that by continuing to develop IoT technology in flood detection tools, disaster resilience and public safety will increase in the future[6]. Through the use of IoT, researchers can develop a system that is able to provide accurate and fast early warnings to affected communities. By continuing to conduct research and development on IoT technology for flood detection tools, it is hoped that it can increase disaster resilience and public safety in the future. Further research is expected to optimize the performance of IoT-based flood detection devices so that they can provide more accurate and real-time information. In addition, integration with weather prediction systems and river monitoring can also increase the effectiveness of flood early warning systems. By continuing to innovate and collaborate between researchers, IoT technology for flood mitigation will become more mature and can provide greater benefits to society in the future[1][7].

The purpose of this study is to develop a prototype monitoring system for water levels, air temperature and humidity in an effort to prevent flooding. The main difference of this study is not only focused on monitoring water levels, air temperature, humidity but also accompanied by notification messages delivered via telegram bots that convey information about the status of water levels, air temperature, and humidity, where there are 3 categories of notification status, namely safe, alert, and danger.

LITERATURE REVIEW

NodeMCU ESP8266 as one of the platforms that can be used to control and monitor IoT sensors can also be an effective solution. By using NodeMCU ESP8266, residents can easily monitor environmental conditions around them and take the necessary actions if something unwanted happens[7][8][9]. In addition, so that sensor data can be stored and analyzed more efficiently. By utilizing NodeMCU ESP8266 technology, residents can be calmer and more confident that their IoT sensor system is functioning properly and can provide the protection needed. [10][11]Introduction Ultrasonic Sensor is one of the sensors that can be used in this system to detect the distance of objects accurately. This sensor can be installed in various strategic locations around the house to monitor the movement and presence of objects. With the integration of the HC-SR04 Ultrasonic sensor, residents can more easily control their surroundings and quickly identify potential hazards. In addition, this sensor can also be used to measure humidity levels and indoor temperatures, so users can adjust environmental conditions according to their needs. Thus, the use of IoT sensors such as the NodeMCU ESP8266 and the HC-SR04 Ultrasonic Sensor can provide great benefits in maintaining the security and comfort of the residential environment[12][13].

Arduino Uno as a microcontroller that can be combined with these sensors also makes it easier for users to build more complex and efficient IoT systems. With the Arduino platform, users can easily develop various applications that can improve their quality of life. In addition, Arduino Uno also has a large and active community, so users can easily get support and the latest information regarding the development of IoT technology. With the increasing development of IoT technology, users are expected to be more aware of their surroundings and can take appropriate action to maintain the security and comfort of their homes.[14][15] With the increasing number of applications that can be developed with Arduino Uno, users are expected to be able to use it to monitor their surroundings, such as temperature, humidity, or air pollution. This can help them to maintain the health and safety of themselves and their families. In addition, the ability to automatically control various household devices can also increase energy efficiency and make everyday life more comfortable. With this platform, IoT technology is no longer something that is difficult to access, but rather something that can be enjoyed by the wider community [16]. Blynk IOT is one platform that can be used to integrate various IoT sensors, including the NodeMCU ESP8266 and the HC-SR04 Ultrasonic Sensor. With Blynk IOT, users can easily monitor and control these sensors through an application on their smartphone. In addition, Blynk also provides a notification feature that can notify users if a potential hazard or significant change in environmental conditions is detected. Thus, users can respond quickly and take the necessary actions to maintain the safety and comfort of their living environment. [17][18][19]

Telegram Bot is one example of the implementation of IoT technology that can be used to monitor and control household devices remotely via text messages. [18][20][2] By using Telegram Bot, users can easily send commands to their household devices, such as turning on the lights or adjusting the AC temperature, without having to be at home. This of course provides convenience and comfort for users in

managing their household, as well as increasing the overall efficiency of energy use. In addition, Telegram Bots can also be used to provide notifications to users about environmental conditions around them, such as air pollution levels or weather, so that users can take appropriate action to maintain their health and safety[21][22]. Solar Cell Panels are one of the innovations that can be used to utilize solar energy as an environmentally friendly electricity source. By using solar cell panels, users can reduce dependence on electricity from PLN and also reduce greenhouse gas emissions that are detrimental to the environment. The use of solar cell panels can also help save electricity costs in the long term, thus providing economic benefits to users. In addition, the use of solar cell panels can also increase the value of home property, as more and more people realize the importance of using renewable energy sources[8][23][24].

RESEARCH METHOD

The data collection methods that will be used are direct observation, interviews with related experts, and analysis of related documents[25][26][27][6]. Direct observation is carried out to directly observe the flood conditions and the monitoring system used. Interviews with experts will be conducted to gain insight and a deeper understanding of the technology used in the IoT-based flood monitoring system. Analysis of related documents will also be conducted to complete the data needed in this study[28][29][30].

The stages of this research include the following activities:

1. Literature Study on Flood Detection Tools

At this stage, a search and review of literature related to existing technologies and methods for detecting floods is carried out. The main focus is to find references regarding the use of ultrasonic sensors, IoT platforms, and integration with communication devices such as telegram bots. In addition, this study will explore information related to the efficiency and accuracy of the tools that have been developed and the potential for improvements that can be applied in this project.

2. Component Assembly

This stage involves the process of assembling the hardware components needed to detect floods: HC-SR04 Ultrasonic Sensor: Used to measure water level by calculating the travel time of ultrasonic waves from the sensor to the water surface and back. NodeMCU ESP8266: As the main microcontroller that integrates all sensors and sends data to the server or IoT platform. LCD: Used to display water level information directly at the location of the device. Real Time Clock (RTC): Used to record time accurately and synchronously in data measurement. DHT11: Sensor to measure temperature and humidity which also affects the assessment of flood potential.

Figure 1. Component Assembly

3. IoT Design

At this stage, the IoT system is designed to allow data measured by sensors to be sent to an online platform in real-time. This process includes setting up connectivity between NodeMCU and the internet network using the ESP8266 Wi-Fi module.

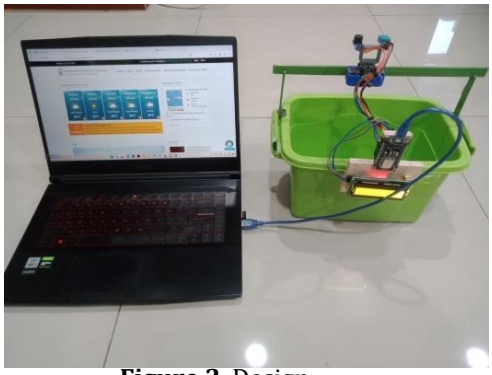

Figure 2. Design

4. Integration with Telegram Bot

Once the IoT system is up and running, the next step is to integrate it with a Telegram bot. This bot will be designed to send notifications to users when sensor data indicates a potential flood hazard. Users can access data in real-time and receive alerts through this Telegram bot.

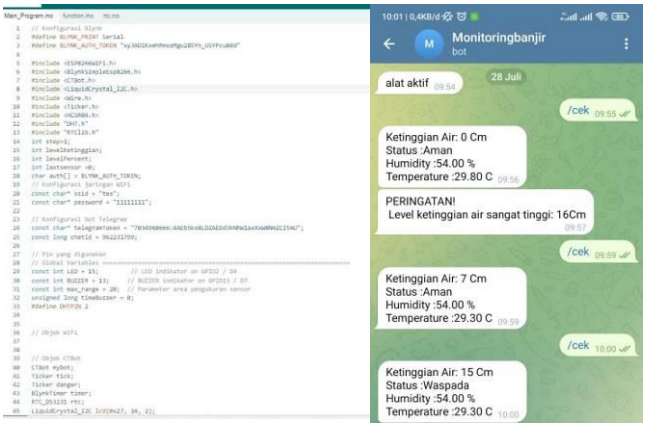

Figure 3. Integration with telegram bot

5. Buzzer Settings

The buzzer is installed as a local warning device. When the sensor detects a water level that exceeds the specified threshold, the buzzer will sound as a direct warning sign at the location. This stage involves setting the threshold and programming logic on the microcontroller to activate the buzzer with a prototype simulation when the water level is 0 - 7 cm the notification status is safe, when the water level is 8 - 15 cm the notification status is alert, and when the water level is above 16 cm the notification status is danger and a warning appears on the notification and the buzzer notification sound sounds.

Table 1. Buzzer Setup Prototype

Ketinggian Sensor (cm)	Keterangan Bot Telegram
0 – 7	Aman
8 – 15	Waspada
>= 16	Bahaya

6. Solar Cell Installation

To support the operation of the device in locations that may be far from electricity sources, solar cells are used as the main power source. This stage includes selecting the appropriate solar cells, installing solar panels, and integrating with a power storage system (battery) so that the device can function independently.

Figure 4. Solar Cell Installation

7. Prototype Trial

After the device is assembled and the system has been integrated, a trial is conducted to ensure all components are working properly. This trial is conducted under simulated conditions as well as under actual conditions to test the reliability of the device in detecting water levels, sending data, and providing warnings.

Figure 5. Prototype Trial

8. Validation and Evaluation

The final stage is to validate the measurement results of the tool with actual data and evaluate the overall system performance. If problems or deficiencies are found, improvements and adjustments are made. The evaluation also includes an analysis of the effectiveness of the tool in providing early warnings and the accuracy of the data sent to the IoT platform.

RESULT AND DISCUSSION

1. Hardware Implementation

The prototype of the hardware circuit needed to create this water level, air temperature and humidity monitoring system includes: NodeMCU ESP8266, HC-SR04 Ultrasonic Sensor, LCD, Real Time Clock, DHT11, Buzzer, Solar Cell Panel

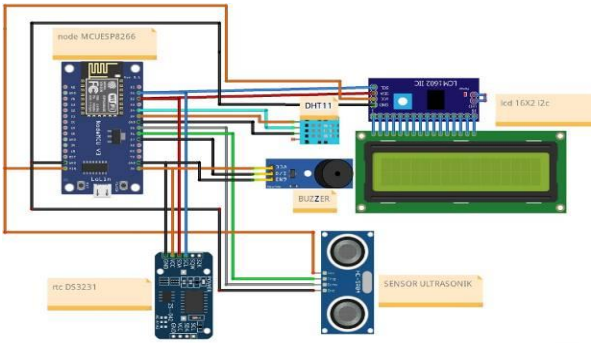

Figure 6. Prototype of flood monitoring and detection tool

2. Installation of Tool Use
Here's how to use the prototype of the water level, air temperature and humidity monitoring tool including:
a. Connect the tool to a power source.
b. Wait a few seconds, the system will automatically become an Access Point.
1) Connect to WiFi "test"
2) Password: 11111111
3) Will automatically connect to the wifi that has been set
4) Change the Telegram ID and Token if necessary
5) Wait for the system to reconnect
c. If successfully connected, the message "tool active" will appear.
d. Then you can control the charity box from the telegram bot.
• /cek: To find out the current water level, humidity, and humidity conditions.
e. Then in Blynk we use it as an interface to display and monitor conditions in real time

Figure 7. Flood monitoring and detection tool prototype

3. Telegram and Blynk Bot Command Installation
a. Telegram Bot Commands
• When the charity box system gets power, the system will automatically send a message like the following:

Figure 8. Command to activate the telegram bot

• /check: to see information about the current condition, as follows:

Figure 9. Command to check the water level status

2. Notification on Telegram Bot
• When the sensor is active and the ultrasonic sensor detects an increase in water level, the system will send a warning notification as follows

Figure 10. Warning notification when the water level is very high

3. Display on BLYNK
• Initial Display on Blynk

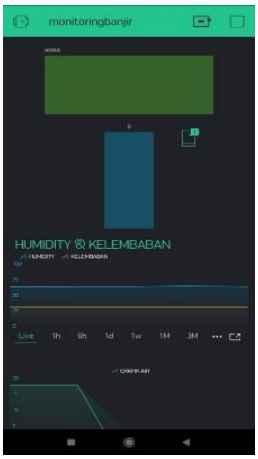

Figure 11. Water level display

In Blynk we can monitor in real time because in this application there is a display to see the current water level conditions and we can also monitor water grative for some time. Not only monitoring my water level on Blynk we can also see weather conditions namely humidity and humidity in Real Time

• Safe Condition Display

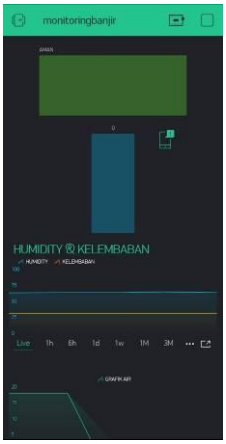

Figure 12. Monitoring the water status in a safe condition

The image above shows the safe condition where the water level is at a height of 0, humidity 60, and humidity 30.
• Alert condition display

Gambar 13. Monitoring status air dalam keadaan waspada

Pada gambar di atas terlihat kondisi dalam keadaan waspada yang mana level air dengan mencapai

ketinggian 14, humdity 60, dan kelembapan 30.

- Tampilan Kondisi Bahaya

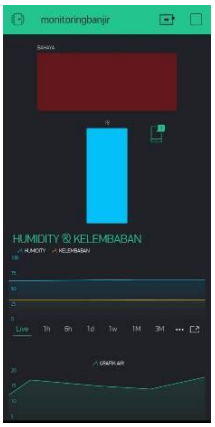

Figure 14. Monitoring the water status in a state of danger

The image above shows the condition in a state of alert where the water level reaches a height of 18, humidity 60, and humidity 30.

- Humidity and humidity graphic display

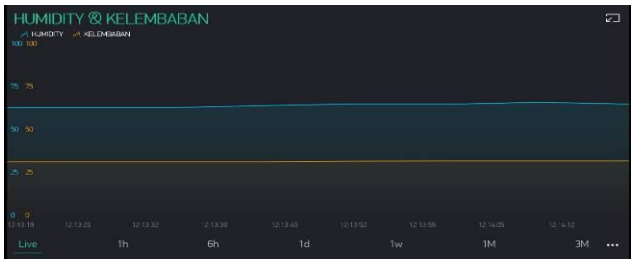

Figure 15. Humidity and humidity status graph

- Water Graph Display

Figure 16. Water status graph

- Hazard notification display on Blynk

Figure 17. Notification when in danger

The image above shows a notification that the condition is in danger if the water level is very high.

4. CONCLUSION

Based on the results of the research that has been carried out, testing of the IoT circuit to monitor water levels, air temperature and humidity has shown very satisfactory results. With the ability to detect environmental changes accurately and provide real-time notifications via Telegram, this system is able to increase preparedness for potential flooding. Not only relying on visual notifications, but also providing sound warnings via buzzers when conditions become critical. This innovation is not just a monitoring tool, but also an early warning system that can have a significant impact on disaster mitigation, especially in dealing with the threat of flooding in the community environment. This is evident from the notification in the form of air temperature status, humidity, and water level simulation prototypes which include when the water level is 0 - 7 cm the notification status is safe, when the water level is 8 - 15 cm the notification status is alert, and when the water level is above 16 cm the notification status is danger and a warning appears on the notification and the sound of the buzzer notification sounds.

REFERENCES

[1] D. Tazakka Ma'arij, A. Yudhana, D. T. Ma'arij, and A. Yudhana, "Temperature and Humidity Monitoring System in Internet of Things-based Solar Dryer Dome," Bul. Ilm. Sarj. Tek. Elektro, vol. 5, no. 3, pp. 323–335, 2023, doi: 10.12928/biste.v5i3.8633.

[2] A. S. Afifah, M. M. Sari, S. Suhardono, and I. W. K. Suryawan, "Inisiatif Penanaman Mangrove sebagai Upaya Mitigasi Banjir Rob di Kabupaten Kendal : Studi Literatur," J. Serambi Eng., vol. 8, no. 4, pp. 7249–7255, 2023, doi: 10.32672/jse.v8i4.6835.

[3] J. I. Keislaman, U. I. N. Sultan, and S. Kasim, "The Method of Learning of the Yellow Book at Daarun Nahdhah Thawalib Boarding School Bangkinang," vol. 17, no. 1, pp. 21–32, 2018.

[4] D. D. Ramadhiani, D. Dinda Ramadhiani, and A. Name, "2023, Flood Early Warning System Using Ultrasonic and Rainfall Sensors IoT-Assisted with Smartphone Display," J. Exp. Appl. Phys., vol. 1, no. 1, pp. 58–66, 2023, [Online]. Available: https://doi.org/10.24036/jeap.v1i1.4

[5] C. Massari, S. Camici, L. Ciabatta, D. Penna, A. C. Marra, and G. Panegrossi, Floods in the Mediterranean area: The role of soil moisture and precipitation. Elsevier Inc., 2020. doi: 10.1016/B978-0-12-818086-0.00008-X.

[6] S. Rumalutur and S. L. Allo, "Sistem Kontrol Otomatis Pengisian Cairan Dan Penutup Botol Menggunakan Arduino Uno Rev 1.3," Electro Luceat, vol. 5, no. 1, pp. 23–34, 2019, doi: 10.32531/jelekn.v5i1.129.

[7] M. S. Novelan, "Monitoring Water Levels As Flood Detectors By Utilizing Telegram Applications Based on Iot (Internet of Things)," Infokum, vol. 10, no. 2, pp. 810–817, 2022, [Online]. Available: http://infor.seaninstitute.org/index.php/infokum/article/view/420%0Ahttps://infor.seaninstitute.org/index.php/infokum/article/download/420/338

[8] D. N. Nugroho, A. Setiabudi, B. Utomo, and P. Diptya Widayaka, "Flood Notification System Using NodeMCU with Telegram Monitoring," Indones. J. Electr. Electron. Eng., vol. 6, no. 1, pp. 9–12, 2023.

[9] R. Nofrialdi, S. Komputer, S. Jayanusa Padang, M. Informatika, and A. Jayanusa Padang, "Rancang Bangun Monitoring dan Peringatan Dini Banjir Berbasis Internet Of Things (IoT) di Pusdaplops PB BPBD Sumatera Barat," J. Pustaka Robot Sister …, vol. 1, no. 1, pp. 1–5, 2023, [Online]. Available: https://jurnal.pustakagalerimandiri.co.id/index.php/robotsisterDOI:https://doi.org/10.55382/jurnalpustakarobotsister.v1i1.322

[10] S. Van Ackere, J. Verbeurgt, L. De Sloover, S. Gautama, A. De Wulf, and P. De Maeyer, "A review of the internet of floods: Near real-time detection of a flood event and its impact," Water (Switzerland), vol. 11, no. 11, pp. 1–26, 2019, doi: 10.3390/w11112275.

[11] M. Iqbal, A. Rosadi, and E. Kresna Andana, "Perancangan Deteksi Dini Banjir Berbasis Iot Dan Water Level Dengan Notifikasi Blynk Dan Alarm," Semin. Nas. Teknol. Inf. Ilmu Komput., no. x, pp. 6–13, 2023.

[12] N. Novianda, R. Akram, and L. Fitria, "Internet-Based Flood Detection System (Iot) and Telegram Messenger Using Mcu Node and Water Level Sensor," J. Informatics Telecommun. Eng., vol. 4, no. 1, pp. 230–235, 2020, doi: 10.31289/jite.v4i1.3892.

[13] N. Windasari and Y. Sudarti, "Analisis Efisiensi Mobil Listrik Berbasis Panel Surya Sebagai Upaya Pemanfaatan Energi Terbarukan," Sci. Technol. (J-HEST, vol. 6, pp. 41–47, 2023, [Online]. Available: https://www.j-hest.web.id/index.php

[14] 'Aisyah 'Aisyah, A. E. Burhandenny, H. Nugroho, and D. Suprihanto, "Design and Build of IoT Based Flood Prone Monitoring System at Semani's Pump House Drainage System," Ilk. J. Ilm., vol. 15, no. 2,

pp. 303–316, 2023.
[15] D. N. Bestari and A. Wibowo, “An IoT-Based Real-Time Weather Monitoring System Using Telegram Bot and Thingsboard Platform,” Int. J. Interact. Mob. Technol., vol. 17, no. 6, pp. 4–19, 2023, doi: 10.3991/ijim.v17i06.34129.
[16] I. P. Dewi and R. Fikri, “Optimalisasi Keamanan Rumah dengan Implementasi Sistem Notifikasi Gerbang Cerdas Berbasis Internet of Things (IoT),” J. Comput. Syst. Informatics, vol. 4, no. 4, pp. 816–829, 2023, doi: 10.47065/josyc.v4i4.4004.
[17] M. Safii et al., “Monitoring Ketinggian Permukaan Air Menggunkan Telegram Bot Berbasis NODEMCU ESP8266,” Metik J., vol. 6, no. 2, pp. 123–132, 2022, doi: 10.47002/metik.v6i2.384.
[18] N. E. Wulansari, R. H. Kusumodestoni, A. Sucipto, and G. Sudiryanto, “Penerapan Bot Telegram Pada Aplikasi Pembayaran Sekolah Sebagai Sarana Informasi Orang Tua Wali Siswa,” Informatika, vol. 9, no. 1, pp. 12–19, 2021, doi: 10.36987/informatika.v9i1.1945.
[19] D. R Hadapiningradja K, “Penerapan Algoritma Crawling Dalam Otomatisasi Pembayaran Administrasi Sekolah,” vol. 15, no. 1, pp. 55–64, 2024.
[20] I. Mekongga, Mustaziri, A. Aryanti, and S. Intan Handayani, “Integrasi Telegram App dalam Sistem Pemantauan Ketinggian Air Berbasis Internet of Things (IoT),” J. Ampere, vol. 7, no. 2, pp. 154–164, 2023, doi: 10.31851/ampere.v7i2.13462.
[21] Preethi Rajan, “Integrating IoT Analytics into Marketing Decision Making: A Smart Data-Driven Approach,” Int. J. Data Informatics Intell. Comput., vol. 3, no. 1, pp. 12–22, 2024, doi: 10.59461/ijdiic.v3i1.92.
[22] M. S. Abdalzaher, H. A. Elsayed, M. M. Fouda, and M. M. Salim, “Employing Machine Learning and IoT for Earthquake Early Warning System in Smart Cities,” Energies, vol. 16, no. 1, pp. 1–22, 2023, doi: 10.3390/en16010495.
[23] P. Products, “Near-Real-Time Flood Forecasting Based on Satellite Precipitation Products,” 2019, doi: 10.3390/rs11030252.
[24] R. H. Kusumodestoni, B. B. Wahono, G. Sudiryanto, and A. Azis, “Clustering of students tahfidz ability based on k-means method,” AIP Conf. Proc., vol. 2706, no. September 2021, 2023, doi: 10.1063/5.0120369.
[25] Shipun Anuar Hamzah et al., “Flood Level Detection System using Ultrasonic Sensor and ESP32 Camera: Preliminary Results,” J. Adv. Res. Appl. Mech., vol. 119, no. 1, pp. 162–173, 2024, doi: 10.37934/aram.119.1.162173.
[26] D. Satria, S. Yana, R. Munadi, and S. Syahreza, “Design of information monitoring system flood based internet of things (Iot),” Emerald Reach Proc. Ser., vol. 1, pp. 337–342, 2018, doi: 10.1108/978-1-78756-793-1-00072.
[27] R. Muhendra and A. Amin, “Real-Time Monitoring: Development of Low Power Fire Detection System for Dense Residential Housing Based on Internet of Things (IoT) and Cloud Messenger,” Sci. J. Informatics, vol. 8, no. 2, pp. 202–212, 2021, doi: 10.15294/sji.v8i2.30811.
[28] F. Rahayu, A. Zuchriadi, A. F. Fauzi, and A. B. Dewantara, “Prototype Flood Detection Water Level Monitoring IoT Web Based With Ultrasonic Sensor HC-SR04,” J. Mantik, vol. 6, no. 36, pp. 2006–2014, 2022, [Online]. Available: http://iocscience.org/ejournal/index.php/mantik/article/view/2582%0Ahttps://iocscience.org/ejournal/index.php/mantik/article/download/2582/2164
[29] F. Fotovatikhah, M. Herrera, S. Shamshirband, K. W. Chau, S. F. Ardabili, and M. J. Piran, “Survey of computational intelligence as basis to big flood management: Challenges, research directions and future work,” Eng. Appl. Comput. Fluid Mech., vol. 12, no. 1, pp. 411–437, 2018, doi: 10.1080/19942060.2018.1448896.
[30] M. I. Hidayatullah, I. Sulistiyowati, D. Hadidjaja, and R. Saputra, “Automatic Roof Prototype on Aviary with Telegram Based Monitoring,” Bul. Ilm. Sarj. Tek. Elektro, vol. 5, no. 2, pp. 239–250, 2023, doi: 10.12928/biste.v5i2.8214.