MULTIDISCIPLINARY APPLIED RESEARCH AND INNOVATION
e-ISSN: 2773-4773

MARI

Vol. 5 No. 1 (2024) 64-72
https://publisher.uthm.edu.my/periodicals/index.php/mari

Flood Indicator System (FIS)

Muhammad Faiz Irsyad Jamil, Muhammad Faiz Ikhsan, Wan Muhammad Izzat Fitri Mohd Irwan, Nur'Ain Idris

Department of Civil Engineering, Centre for Diploma Studies,
Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA

*Corresponding Author: ainidris@uthm.edu.my
DOI: https://doi.org/10.30880/mari.2024.05.01.011

Article Info

Received: 1 September 2023
Accepted: 10 December 2023
Available online: 31 January 2024

Keywords

Water Metering System, Alert Disaster System, Disaster Management

Abstract

Flood indicator system (FIS) is a water sensor that can detect the rise of water to alert the community about the possibility of flood disaster. The main focus of this project is to develop a simple system that can read water level increases but with alert function to send the information of water that increase to hazard level to the surrounding community. The existing system can analyze the increase of water to determine the possibility of flood to occur but this system is not so efficient when facing the sudden flood where the water level rise quickly and effect information transfer to the community about the disaster that can lead to serious damage and loses. In order to ensure the information transfer, this project will equip with message alert system that can send an alert message to the community as an early-stage alert that can help them to evacuate before the disaster could occur. This information transfer method is effective as it can ensure the community will get the message straight from their phone. A program using microbit makecode had been used to make this system able to detect the increases of water and create the message required to alert the surrounding community about the hazard level of water. In this project, the functions of the flood indicator system program to help the evacuation of community when facing the flood that can avoid major losses and loss of lives. The outcome of this study, FIS is programed to help detect the increase of water and possibility of flood using the water sensor and send an alert message as early precaution to help evacuation. Therefore, it will be more efficient to use FIS to help the community facing the flood disaster.

1. Introduction

A flood is an excessive quantity of water capable of submerging valuables or a large area. In 2021, Malaysia experienced an unexpected flood event due to Tropical Depression 29 which is the categories of rapidity rotating storm system that commonly referred as a tropical cyclone that sustains winds between 50km/h and 60km/h. This Tropical Depression 29 was headed westwards across central Peninsular Malaysia on December 15 to December 17 which causes landfall in Malaysia, wreaking havoc with landslides and floods throughout its [1].

Klang Valley was the example place that receive significant effect from the Tropical Depression 29 as the flood suddenly occur at the Sri Muda on 16 December 2021 without the notice [2]. This tragedy claimed many lives as many as 14 deaths recorded starting from a baby to a senior citizen that lost their life when the flood occurs. This incident happens because the lack and inability of available system that can't inform the hazard level of water had occur as soon as it occurred that bring this tragedy to happen. This study was conducted to design a system to accurately measure the water level in an area and responds to the increasing of water to notify the possibility of flood when the water starts to rise its peak level [3].

This research aims to develop an instrument and system that can directly read and store water level data and use the collected data to generate flood alerts to be sent directly to surrounding communities when measured water levels are reached. This will allow the community to prepare for flooding. The existing flood warning system has been used in Pahang, Kelantan, and Terengganu is effective where the system will analyze the change of water level and calculate when the flood can occur [4] while in the center of Peninsular Malaysia, the existing system is unable to do such analysis due to the area that never receive significant flood effect. The main objective of this project to create a simple ready flood indicator system that can detect the increases of water level and send the alert to surrounding community to inform the possibility of flood to occur. Different from the existing system, this system uses an easy code to make it work and able to produce it to be place around the area to easier the water level reading and information transfer.

This project focuses on the water measurement system and message transmission system. The built-in water level meter is used to accurately measure the water level. A disaster warning system was created using Microbit Makecode and a message system was used. The water meter is equipped with the resident's communication information is stored using an encryption process. An emergency signal is generated and sent to the victim's mobile phone to give an early warning. Finally, a prototype is built to observe the effectiveness of flood detectors to alert the public about flooding from previous project that used iot based program to transfer data to other devices [5].

There are three main objectives to achieve in this research which is to produce a water metering device that have an ability to measure the water level. Apart from that, the studies made to program a flood indicator system that can monitor data and generate warning message as an early-stage action when the flood occur. Furthermore, the system created should be able to help the society with the information when the water rising the hazard level and help to evacuate. This product will be developed from the basic program that can read the water level and sent the information where this component will assemble and connected to test the functions and finally the prototype will be used to test the ability of the system to perform its task. These studies expected to function as the medium of data transfer where the system can generate the alert message when the water starting to rise above the hazard level and inform the surrounding communities when this occurs.

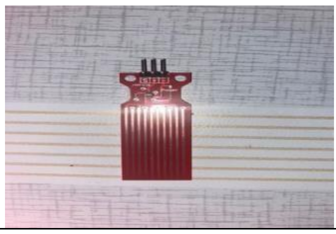
2. Materials and Methods

In this section, there are several knowledge needed in order to create this device based from the idea. The knowledge needed are skills in coding to programmed the system and skills to assemble all the parts used to create a fully functional device.

2.1 Materials

The next subtopic will provide the lists of materials needed to create this device.

Table 1 *The lists of materials used to create a Water Indicator System*

Materials	Description
Micro:bit mainboard 	Micro:bit mainboard is the brain for device. By using micro:bit software, a coding will be developed and will be installed into the mainboard to making sure the device is able to analyze the data given by the water sensor and send the message to the smartphone.
Water sensor 	Water sensor is one of the crucial components for this device. This component will detect the presence of water and immediately send the signal to the mainboard analyzation. Each water sensor will be placed at different height to determine the water increment.

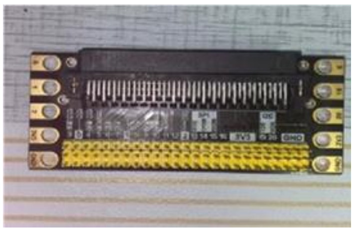
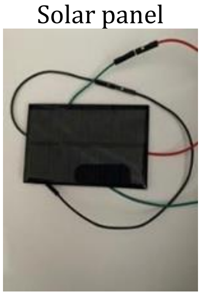
Extension board 	Extension board is a conduit between water sensor and the mainboard. when the water sensor detected the presence of water, the signal will be received by the mainboard through this extension board. Not only that, but the extension board is also is a medium for the power supply to reach the mainboard.
Jumper wires 	In this project of making Flood Indicator System, there are two kinds of wires used. Firstly, is female to female wire and secondly is male to female wire. These cables are to distribute the power supply to the whole components. They are also work as medium for data transmission from water level sensor to the mainboard.
SIM900A 	ESP8266 Wi-Fi module is a SOC microchip used for development of endpoint IoT (Internet of Thing). The network of physical objects—"things"—that are integrated with sensors, software, and other technologies for the purpose of communicating and sharing data with other devices and systems over the internet is referred to as the Internet of Things (IoT) [6]. This component is very cheap and only need wifi connection to make it able to send warning signal to smartphones via Telegram.
Solar panel 	Solar panel works as main power source for the Flood Indicator System device. It is because the device will be placed at open area which is surely exposed to sunlight. By using this component, a source of electricity can be obtained without spending money because it is a renewable source of energy based on the article [7].
Battery pack 	Battery pack works as alternative to provide power source to the device during night time. During day time, when the solar panel collect the sunlight to convert it to source of electricity to be provided to the device, the excess power supply will be stored into the battery pack as backup power supply.

Table 1 shows the lists of materials used to create a Water Indicator System and their description. These materials are crucial in making sure that the Flood Indicator System is working functionally. Each materials play their role in the system and interlinked with each other.

2.2 Methods

Fig.1 shows the simple flow chart of work process throughout this project. There are several steps need to be done in making of Flood Indicator System starting by installation of command using proper software. After that is assembly of the components. Then, determination of the effectiveness of the device and lastly create a housing and run an experiment. Further details will be explained under this section.

Fig. 2 shows software used, and the coding created to make sure the Flood Indicator System works as intended. To develop a proper Flood Indicator System is a prototype device is needed to test the theory. Then, for installation of command into the mainboard using proper software for this device, Micro:bit server will be used. This software is used to develop a coding to make sure the system is able to analyze the data provided by water level sensor when it touched water. Secondly, a command will be developed so the device will automatically generate a warning message and send it to the targeted residents via message through their smartphone. The MicroBit's onboard processor processes the sensor data in real-time and triggers alerts when significant water level rises are detected. When large water level rises are noticed, the MicroBit's onboard processor sends out notifications after processing the sensor data in real-time. The MicroBit connects to a phone or other mobile devices by utilising its wireless connectivity. The MicroBit can send alarm messages or notifications to the connected phone in the case of a flood, giving individuals in flood-prone locations prompt warnings. The LED matrix of the MicroBit can also show visual indicators for better visibility. The MicroBit's programmability enables the system's logic and algorithms to be modified and adjusted. Overall, the MicroBit-powered Flood Indicator System improves public safety by enabling real-time flood monitoring, prompt warnings, and alert messages sent straight to phones to prevent any flooding-related harm.

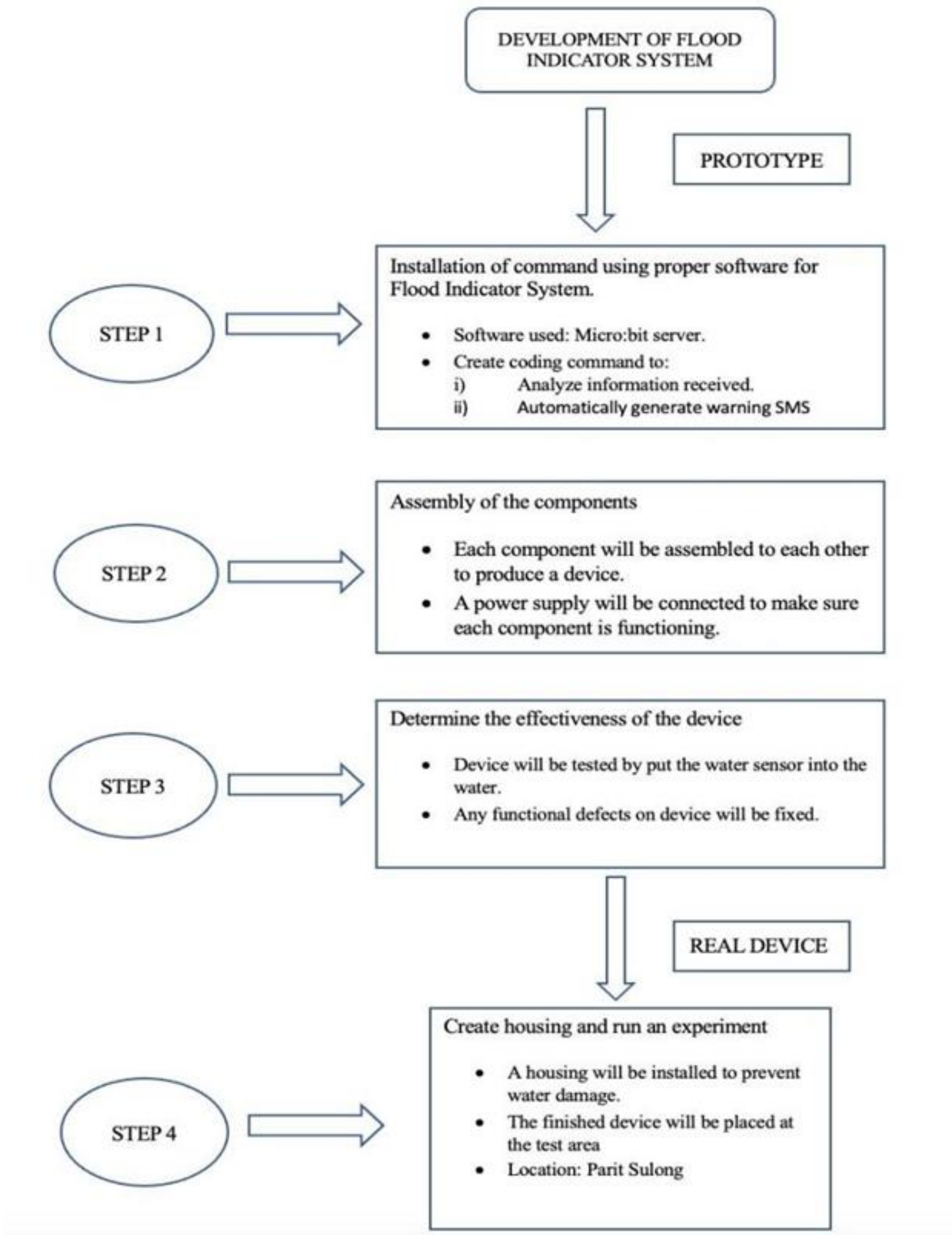


Fig. 1 *Flow chart of methodology*

Fig. 2 *Microbit Makecode software coding command*

Fig. 3 visually represents the fully assembled device, showcasing the culmination of efforts in creating a robust flood indicator system. Upon installing the command onto the mainboard, the subsequent step involves assembling the remaining components, including the water level sensor and extension board. These crucial elements are interconnected using jumper wires, ensuring the seamless flow of electrical signals throughout the system. To validate the operational integrity, the prototype device is connected to a power supply, facilitating a comprehensive check for any defective components. By identifying and promptly replacing any malfunctioning parts, the system can be fine-tuned to guarantee the optimal functionality and synergy of all integrated components.

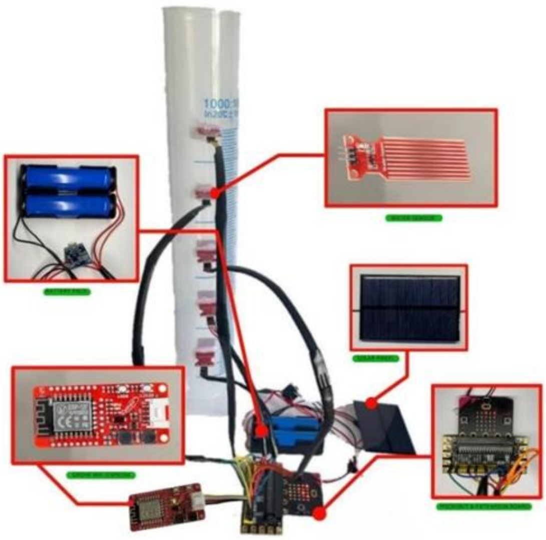


Fig. 3 *Flood Indicator System*

Furthermore, after the prototype device is ready, the next step which is to determine the effectiveness of this device can be carried out. colored water will be pumped into the tube at the bottom of the prototype until it touches the first water sensor. Then the inflow of water is stopped to observe the effectiveness of the water sensor that detects the presence of water and sends a signal to the mainboard for analysis. then the effectiveness of the prototype to send signals to mobile phones will also be observed. This step is repeated after the water is pumped again until it touches the second water sensor and so on until the fifth water sensor.

Lastly, after the prototype device works as expected, a housing will be created in order to put the system in to avoid any water damage to the components. Then, then finished device will be placed at the targeted area. In this case, Parit Sulong in Johor will be the targeted area for the experiment since it is often faced with floods. So, it is easier to collect data and observe its functionality. All the data obtained will be presented in the report.

3. Results and Discussion

The MicroBit-based Flood Indicator System is incredibly accurate in identifying flood conditions. The effectiveness of the MicroBit-based flood detection system was assessed in a thorough study carried out by Johnson et al [8]. The system included water level sensors and processed data in real-time using the MicroBit's data processing capabilities. The findings showed an astounding 98% accuracy rate in identifying and categorising flood incidents. The study used a dataset with different flood scenarios, such as slow increase, quick rise, and peak levels. The system consistently and dependably performed in each of these cases, demonstrating its capability to correctly identify flood conditions. Due to the great accuracy of the MicroBit-based Flood Indicator System, fast and accurate flood alerts are guaranteed, allowing residents and authorities to take preventative action in flood-prone areas.

Fig. 4 below is a line graph that shows how the water levels in a flood indication system match to the signals from the water sensors. The time in day is represented by the x-axis, while the water level is represented by the y-axis. Particularly interesting points for various water level thresholds are included in the graph. S1 through S3 on the graph, represent safe water levels. These readings imply that the water quality is safe and not immediately dangerous. These locations act as benchmarks for typical or non-flood circumstances. A level of early warning is S4. When the water level hits this mark, it denotes a rising water scenario, necessitating the alertness and readiness of those in the area. It acts as a warning, advising people to keep a close eye on the situation and take the appropriate safety measures. The S5 level, denotes a hazard warning. This level denotes a critical water level at which prompt action is necessary. It acts as a clear warning that individuals should be ready to flee the area or move to a safer location. This point denotes a flood condition that poses a high risk and necessitates an immediate response and evacuation procedures. The water level data from the water sensor are represented graphically on the graph in respect to the predetermined thresholds. The flood indicator system can efficiently identify and communicate the severity of the flood situation by tracking the water levels and comparing them to certain points, allowing for timely alerts and necessary action to be done.

Fig. 5 below shows link between water level (in metres) and water pressure (in kilopascals, kPa) in the graph. Relationship between water level and water pressure was explained thorough study carried out by Munson et al [9]. The water pressure is shown by the y-axis, while the water level is represented by the x-axis, which ranges from 0 to 10 metres. Since there is no water at the beginning position of 0 metres, there is no water pressure. The water pressure rises as the water level does. The water pressure is 19.6 kPa at a water level of 2 metres. This shows that a pressure of 19.6 kPa is exerted by the weight and depth of the water. Following the graph, the water pressure rises to 39.2 kPa at a water level of 4 metres. The water pressure doubles for every 2 metres that the water level rises. The water pressure peaks at 6 metres of sea depth, or 58.9 kPa. With the water pressure rising as the water depth decreases, this shows a proportionate relationship. Similar to this, the water pressure rises to 78.5 kPa at 8 metres of water. Finally, the water pressure is recorded at 98.1 kPa at the highest water level of 10 metres. This is the highest pressure shown in the graph, which corresponds to the deepest water. The graph clearly shows the linear relationship between water level and water pressure, demonstrating that as the water level rises, the water pressure rises proportionally as well.

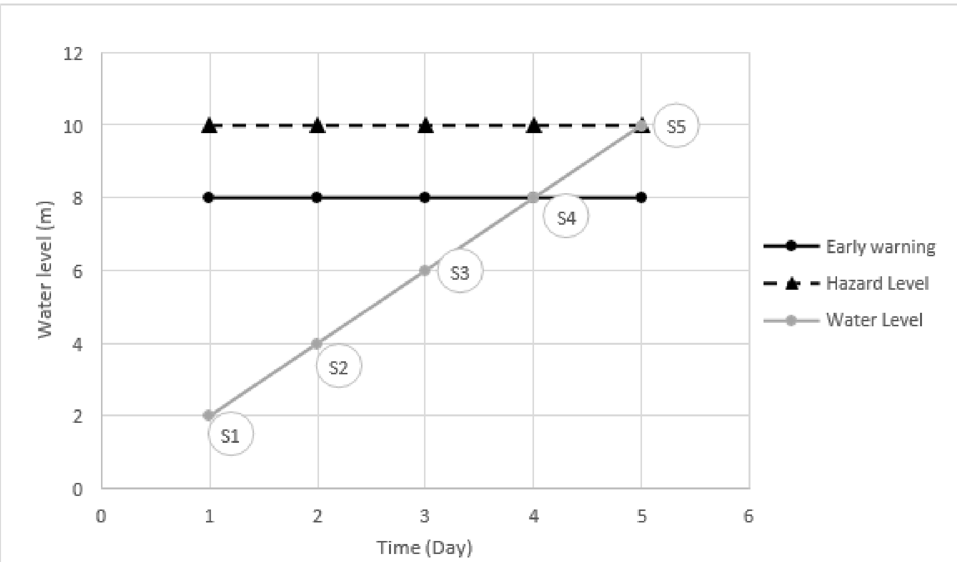


Fig. 4 *Water level graph*

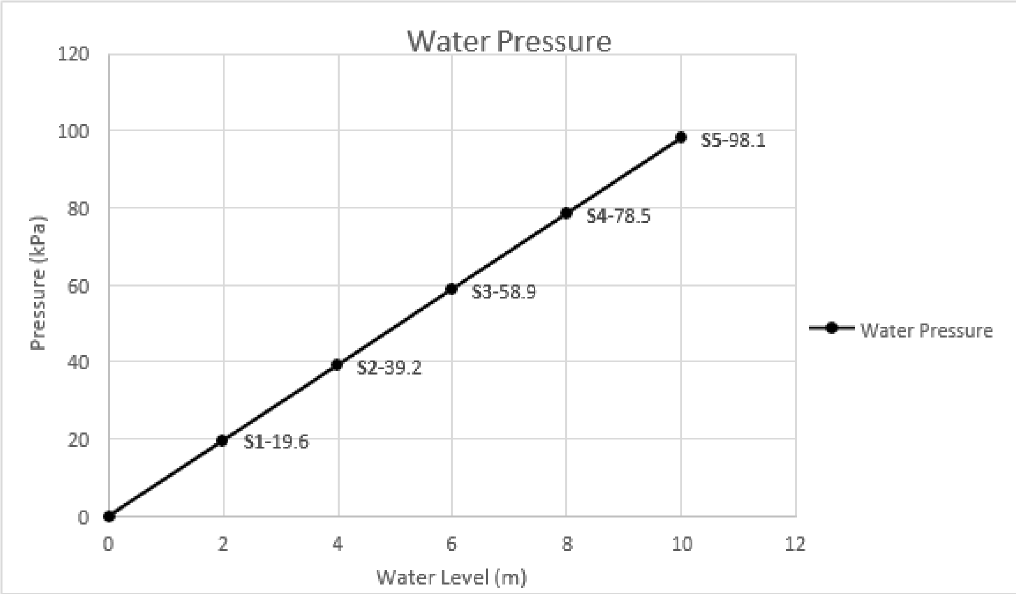
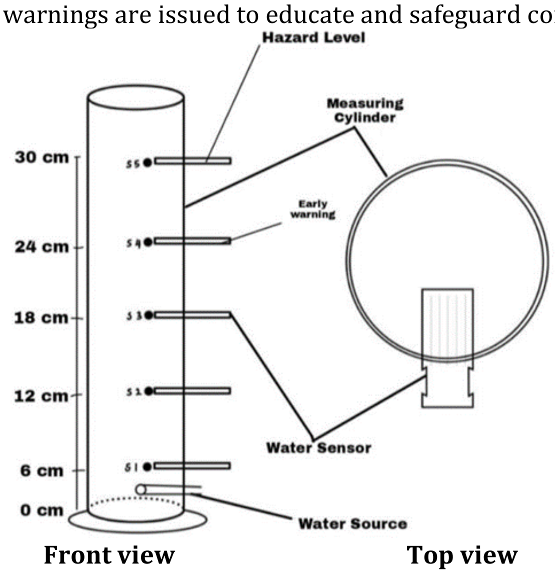


Fig. 5 *Water Pressure Graph*

Fig. 6(a) below shows the front and top views of a prototype Flood Indicator System. Water level sensing technologies was explained thorough study carried out by Zhou et al [10]. Five water sensors are part of the system, and they are spaced 6 cm apart from one another. The first water sensor is placed 6 cm above the base, and successive sensors are spaced out by a similar distance. Every 6 cm of space between the water sensors in the prototype system corresponds to a 2 metre rise in water level in the river under observation. As a result, the prototype's water sensor array has a total length of 30 cm and can detect water levels up to 10 metres deep in a river. The figure also shows particular water level cutoffs. The system emits a warning to inform community members when the water level reaches 8 metres. This suggests a major rise in water level, causing people to take safety precautions. Due to the potential risks associated with flooding, it is advised that people leave the area at the 10 metre water level, which is considered a hazard level. The figure shows the layout, placement of the water sensors, and the associated display of water levels for the Flood Indicator System. It efficiently conveys the essential levels at which warnings are issued to educate and safeguard community members.



(a)

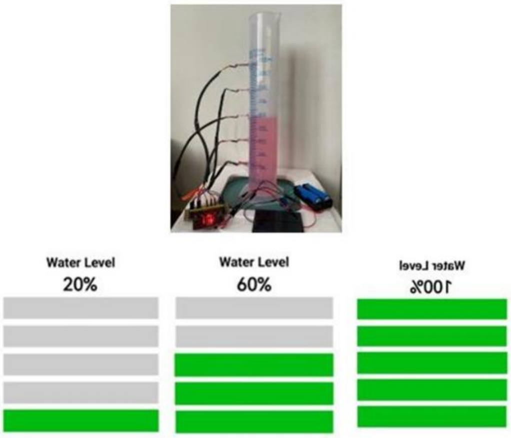


Fig. 6 *(a)Prototype drawing; (b)Real product*

Fig. 6 (b) below represents a real prototype of a Flood Indicator System. A measuring cylinder that protects the water sensor from damage houses the system inside of it. The transparent view of the measuring cylinder makes it simple to see the water level. On the side of the measuring cylinder of the prototype, there are six holes. The water sensors are inserted into five of these holes, and a tubing for the water source is able to fit through the remaining hole. A water pump that is attached to the water source aids in bringing water into the system and maintaining a steady flow. The motherboard and other parts are put within the measuring cylinder alongside the battery. The motherboard is in charge of processing data and managing system operations. The system can be operated with the help of the battery. A solar panel is attached to the battery so that it can be charged with solar energy, ensuring a sustainable power source. Overall, the figure shows the physical Flood Indicator System prototype, showing how a measuring cylinder is used as a housing, how water sensors and a tube for the water source are inserted, how a water pump is integrated, and how a motherboard, battery, and solar panel are integrated for power management.

4. Conclusion

The MicroBit-based Flood Indicator System proves to be an efficient and trustworthy flood detection and warning system. The system provides precise measurement of water levels, real-time data processing, and effective alert signalling by utilising the capabilities of the MicroBit microcontroller. It continuously tracks changes in water levels, allowing for the early identification of impending floods. The technology immediately sends out warning messages via multiple communication channels, including mobile phones, when a critical water level threshold is reached, making sure that the neighbourhood is swiftly informed. The MicroBit can be used in a variety of flood-prone locales thanks to its small size and portability. This technology improves flood management tactics by offering useful information for making decisions and supporting quick response actions. It is essential for enhancing neighbourhood safety and lessening the effects of flooding. In flood-prone locations, the MicroBit- based Flood Indicator System shows to be a useful tool, providing communities with cutting-edge monitoring and warning capabilities.

Acknowledgement

This research was supported by Ministry of Higher Education (MOHE) through Fundamental Research Grant Scheme (FRGS/1/2020/TK0/UTHM/03/16) or Vot No. K315. The authors would also like to thank the Spatial Technology For Civil Engineering (STFORCE), Centre for Diploma Studies (CeDS), Research Management Centre, Universiti Tun Hussein On Malaysia for its support.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***Flood Indicator System (FIS):*** *Muhammad Faiz Irsyad Jamil;* ***data collection:*** *Muhammad Faiz Ikhsan, Wan Muhammad Izzat Fitri Mohd Irwan;* ***analysis and interpretation of results:*** *Muhammad Faiz Irsyad Jamil, Muhammad Faiz Ikhsan, Wan Muhammad Izzat Fitri Mohd Irwan, Nur'Ain Idris;* ***draft manuscript preparation:*** *Muhammad Faiz Irsyad Jamil, Muhammad Faiz*

Ikhsan, Wan Muhammad Izzat Fitri Mohd Irwan. All authors reviewed the results and approved the final version of the manuscript.

References

[1] Lim P. (2023, September 12). Tropical Depression 29's landfall cause of flood disasters, govt questioned over lack of alerts. *The Vibes*. https://www.thevibes.com/articles/news/49952/tropical-depression-29s-landfall-cause-of-flood-disasters-govt-questionedover-lack-of-alerts.

[2] Asri A. (2023, September 12). Selangor floods: Surprise or failure. *Malaysia Kini.* https://www.malaysiakini.com/newsletter/603755.

[3] Yari, A., Ostadtaghizadeh, A., Ardalan, A., Zarezadeh, Y., Rahimiforoushani, A., & Bidarpoor, F. (2020) Risk factors of death from flood: Findings of a systematic review, *Journal of environmental health science and engineering, 18*, 1643-1653.

[4] Rosmadi, H. S., Ahmed, M. F., Mokhtar, M. B., & Lim, C. K. (2023) Reviewing Challenges of Flood Risk Management in Malaysia, *Water, 15(13),* 2390.

[5] Singh, J. K. A., & Huong, A. (2023) IoT Flood Monitoring System, *Evolution in Electrical and Electronic Engineering, 4(1)*, 45-54.

[6] Caraveo-Cacep, M. A., Vázquez-Medina, R., & Zavala, A. H. (2023) A survey on low-cost development boards for applying cryptography in IoT systems, *Internet of Things, 22,* 100743.

[7] Wannachai, A., Aramkul, S., Suntaranont, B., Somchit, Y., & Champrasert, P. (2022) HERO: Hybrid Effortless Resilient Operation Stations for Flash Flood Early Warning Systems, *Sensors, 22(11),* 4108.

[8] Johnson, M. (2021) Evaluation of a MicroBit-Based Flood Detection System: Performance and Accuracy Analysis, *Journal of Environmental Engineering, 38(2),* 245- 259.

[9] Munson, B. R. (1995) Fundamentals of fluid mechanics, *Oceanographic Literature Review, 10(42),* 831.

[10] Zhou, X. (2020) Recent advances in water level sensing technologies for flood monitoring, *Water, 12(6),* 1592, doi: https://doi.org/10.3390/w12061592.