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Original Research Paper

Flood Detection and Prevention System

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Abstract: Flood is the most damaging natural disaster that happens everywhere in the world. The government would spend billions of ringgits to tackle it by creating public info flood website. The website could only be accessed by the user with an internet connection. To tackle this the researcher, develop a Flood Detection and Prevention System to sends a flood SMS alert directly to the user without the use of an internet connection. FDAP hardware consists of one microcontroller to process input and output, three sensors to detect rain, water level, and temperatures, and One GSM module to send SMS to the user directly to their phone. Development of the system will use Rapid Prototyping that focused on creating multiple prototypes until a finished product is developed. The product then will be analyzed for its usage on flood detection and prevention of flooding. A fully functional system will be developed including an SMS feature and a Web Server. Test involved functionality and acceptance test which uses a simulation environment that is created using a physical model and replica of flood phenomenon. FDAP system developed will be useful to rural villages to detect flood earlier and prevent it from harming live or properties. The finding of this study is expected to gain informative data for future flood analysis and study.

Keywords: Arduino Uno, Flood Detection, IoT.

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1. Introduction

In this current time, technological advancement has made a great leap in today's society to better daily human life. IoT system not just to better daily human activities but to use the technology to encounter a disaster that can be detected early on and prevented from taking the life of a loved one and valuable property. Internet of things (IoT) is a technology that connected anything and everything to the internet. IoT is the newest technology that rapidly widens in its usage. This technology brings new products such as disaster monitoring. Flood disaster is the main concern in Malaysia because every year there are flood occurred. We can use this technology to do monitoring activity that people are not able to do it in 24 hours and inform to the user in real-time [1].

Using the concept of IoT, the research focused on combining the use of an embedded system and mobile phone messaging as the main platform to encounter this problem. Embedded system plays a big role in detecting the problem going to occur such as the water level during an upcoming flood, flow of water intensity to measure the different rate of flow from calm water and intense water flow that could lead to the flood disaster, also the humidity and temperature of the surrounding area during prolonged rain and GSM module to spread the news and information for any incoming flood disaster.

Afterward, the use of mobile phone messaging, which will get the information directly from the embedded system, will be used to warn the locally affected area about the flood. However, the IoT system will be designed to send important information by SMS such as the current situation of the area for the user that only use it as a warning system but result such as the water level, water flow, humidity, and temperature shall not be provided but only to the researcher of the IoT system. For people with no internet connection, the GSM module will be in-used as a tool to send a message to nearby locals about the flood.

According to the UN (United Nations), in the 21st century, about 2.8 billion people suffered from natural disasters, the damages exceeded US$ 1.7 trillion. Between 1995 and 2015, the flood affected about 26% of the deaths from natural disasters. In the same period around the world, the flood hit 56% of people affected by some kind of natural disasters. According to data from the IBGE (Instituto Brasileiro de Geografia e Estatisca), more than 45% of the municipalities in the Southeast Region of Brazil have already suffered floods [2].

These statistics already shown the numbers affected by floods all around the world and flood has become one of the major natural disasters occurring in the world. These not only affect human life but material possession, the economy, and social losses are considered as the main effects of floods. Knowing this is happening to reduce the human and economic losses, there are some necessary steps to be followed. One of the most and the preliminary step is to alert the people before the occurrence of the disaster. There are some places with early flood alert system, but most of them need internet access whereas information can only be received by area with good internet access, but for some example, rural area which caters farmland will have a different problem with the internet. So, if the information is not received by these peoples, for example, a farm owner, a devastating loss will surely happen, and nothing could be done as the water rises rapidly within less time. Usually, the flooding cannot be abandoned, but early detections can be made; for example, flood detection and prevention IoT system with the help of continuous monitoring can be used to reduce the losses faced by society.

Effective applications of IoT (Internet of Things) for disaster prevention are highly expected. In particular, in applications for flood disaster prevention, an early warning of the flash flood caused by locally heavy rain is required as well as a flood impact analysis based on water level and rainfall monitoring in the whole drainage basin [3].

Disaster brings with it is incredible harm, loss, devastation, what's more, demolition to human life and property as well as to government, transport systems, and economy. It is very basic to designate the information and assets appropriately with the end goal that the most extreme number of the majority outlives the harmful impacts of the fiasco. Even though it is not very conceivable to dodge the event of a disaster, yet the effect can be limited by making legitimate strategies for the consciousness of likely disaster and its belongings by building up a system that channels this data to the concerned specialists. IoT can play a critical job in this directing and transmission of information through proficient utilization of existing innovation.

IoT can play a critical role in impacting people's life. In this advanced technology world project like flood detection and prevention, the IoT system can make a huge change in helping peoples. At the initial stage, a project to indicate the level of water and to alert the surrounding peoples in remote areas using this system is when the hardware which is used as a monitoring system will communicate via GSM module to send the information of temperature and humidity, level of water and flow of the

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water. All of the information gathers it is from sensors that are placed alongside the Arduino microcontroller, which is located within the area that is commonly affected by the flood. Suppose any anomalies happen, which will trigger the sensor. Afterward, a message will be sent to the residence that will be affected by the flood. This system utilizes simplicity, whereas a simple text message of an early flood warning will be sent to the phone of the local there. Using this system will greatly help areas which have low connectivity internet or none at all.

Floods are the most damaging natural disaster in this world. On the occasion of a heavy flood, it can destroy the community and killed many lives. The government would spend billions of dollars to recover the affected area. It is crucial to develop a flood control system as a mechanism to reduce the flood risk. Providing quick feedback on the occurrence of the flood is necessary for alerting residents to take early action, such as evacuate quickly to a safer and higher place [4].

Kampung Gajah as they were the sub districts which received the worst hit from the 2014 flood. Nevertheless, it was still a challenging task considering the large area and a few difficulty in accessing some of the areas [5].

In this system WSN system architecture for flood forecasting consists the weather monitoring, wireless sensors are used to measure various parameters like Temperature (T), Humidity level (H), Snow melt (S), Wind speed (W), Rainfall (R), and Air Pressure (P) [6].

The rise of IoT has been started long ago when the very first internet connection becomes globally used is the use of only a small fraction of information to identify the occurrence of flooding in that particular area. Such as observing only the water level and monitoring the frequency of rain in that area. Because of this accurateness of the system will be greatly questioned, and a lot of false warnings will be triggered. Hence, if the warning is triggered, but the actual disaster did not happen, it will affect the reliability of the system. The user will be skeptical when by the average user. During this time, a lot of systems built around flood detecting and preventing is a common occurrence now a day. But what all the system was lacking using the system because false warning will affect their emotion and their time because of the false warning that triggered. To avoid this circumstance, we use all the information on factors that will trigger the flood, such as humidity, temperature, water level, and flow rate. This will simulate the actual phenomenon of flooding and will be used as a based detection of an occurrence of flooding.

There is also a question of flooding in the rural area where there is no or lacking internet service there. It seems a lot of the systems created before did not take any consideration of this matter before and only target urban areas as their main targeted choice. But a lot of flooding primarily happen at a rural area where there is no accessibility of internet services to warn them about the disaster that is coming. In the rural areas, there seem to be people who will be greatly affected by this due to a lot of local there seem to be financially low income. Taken this matter into consideration, we added a GSM module that works without an internet connection to notify the user of an upcoming flood by messaging.

Furthermore, having this system will greatly avoid any unnecessary losses of life, and that is why the system is created. Having to save a life by using this system will be our main priority because early detection of a flood by analyzing all the factors that trigger a flood is an outstanding endeavor. Moreover, a financial crisis can also be avoided if the warning is ahead of time and the local can save valuable item before the actual disaster happen. Users also can monitor any unusual phenomenon before the flood happens for the advanced user by using the sensors provided. This study is focusing on more just developing a system but targeting to save life and avoid financial crises that could be easily be prevented.

2. Literature Review

2.1. Flood Phenomenon and Problem

Flooding is a natural disaster that occurs in many countries. Many occasions are responsible for flooding such as heavy rainfall or dam fractures. In case of flooding or dam fractures, it rapidly releases a huge quantity of water and out [7].

Floods, the naturally occurring hydrological phenomena, caused due to the meteorological events like intense or prolonged rainfall, unusual water overflow of high coastal estuaries on the result of storm surges. On an account of a lot of concrete structures in urban areas, high-intensity rainfall causes urban flooding and as there is no much soil available for water to percolate, this leads to huge drainage problems in urban cities [8].

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Flooding is a phenomenon that is a situation where water from a river or rain covers large areas of land. It is also defined as a temporary rise of the water level, as in a river or lake or along the sea coast, resulting in its spilling over and out of its natural or artificial confines onto land that is normally dry. Flooding in Malaysia is a normal phenomenon occurring every year. It usually occurs in a low surface area and exposed to the river. It can occur in suburban or rural areas like Kampar, Perak or Kampung Kuala Rasau, Slim River, Perak [5].

Flooding commonly happens at the dry area, but suddenly gets submerged underwater [9]. Flooding can happen all of a sudden and retreated rapidly. It also takes a long time for the water to recede. Flood can also occur at irregular intervals and vary in size, duration and area affected. During flood, water flows from high area to low lying area. This means low-laying areas might be flooded quickly before it starts to get to higher ground. This can be illustrated by Figure 1.

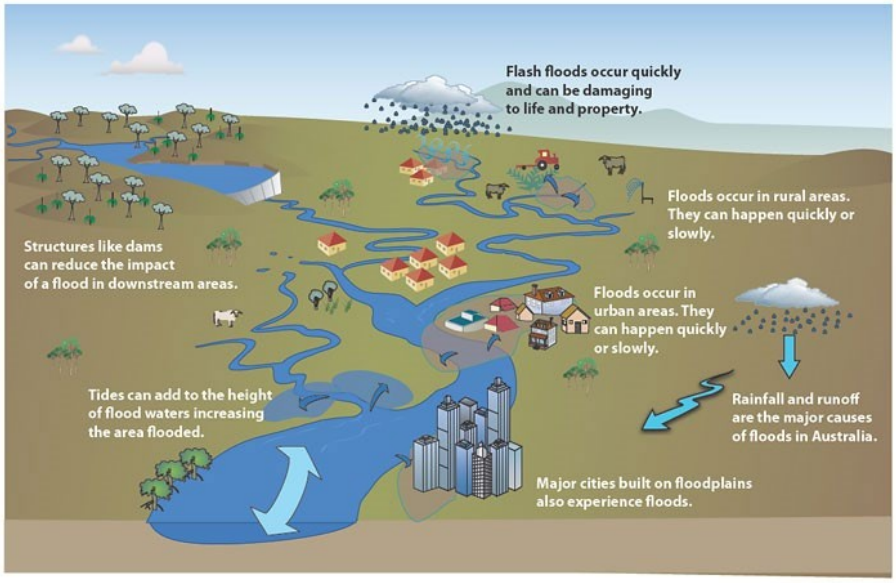

Figure 1. Flood Flow

Flood is one of the most destructive natural disaster that can affect hundreds of thousands people and infrastructure that can cost in the range billion of rupees [10]. After so much research in this field, we still suffer from the disastrous effect of it due to lack of consideration of small-scale flood affecting parameters affecting regional floods.

Flood is a phenomenon by which the living and non-living entities that belong to the environment suffers various losses [11]. Human beings cannot totally avoid floods but the only thing humans can do is, they can develop suitable systems to predict & subsequent measures to alert the people about its occurrence. There are many technologies available to predict and prevent. There are many natural disasters that lead to floods. Some of them are heavy rains and tropical cyclones. These floods cause materialistic and human damage.

Flood is also categorized as a natural disaster. Natural disasters are the serious issues that disrupt the normal life in the world [12] [13] [14]. The natural disasters are main causes for the society that lead to loss of life, damage property and the environment. Natural disaster is mainly classified into two ways, they are geological hazards namely earthquakes, hurricanes, volcanic eruption, tsunami and another one is climatic hazards majorly floods, cyclones, landslides, droughts, soil erosion, etc. Based on the magnitude of the disaster it can affect social, economic and environmental losses. The impact of natural disaster can be short-term which lasts for few hours and long-term events that can affect over several years.

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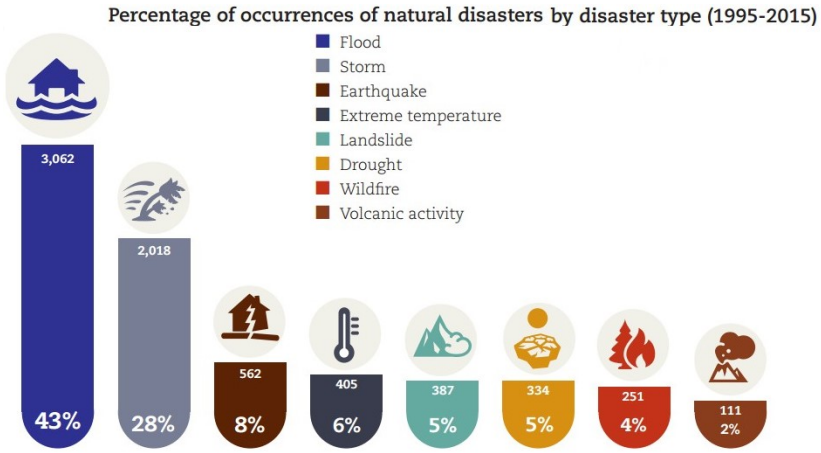

Figure 2. Top Natural Disaster Occurrence on 1995 to 2015

2.2. Research on Study Location

Upon further research on location to implement the project, the researcher has narrowed the scope of the location for the rural areas project implementation. The rural area is a less populated area with a low internet connection or none at all. Both of these research areas are near a river basin, which considers a highly suspectable area to be flooded. The location of the river basin near these areas also a good place for the researcher to implement the product for testing and deployment of the prototype.

This study mostly covers the Perak Tengah area. This area is chosen as the area of study as it was the district where the most severe flood damage was observed. The Perak Tengah district covers approximately 9,308 hectares. The total population was 88,446 in 1996, which by now could be approximately more than 120,000 population. There are 12 sub-districts in Perak Tengah which are: Belanja, Layang-Layang, Bota, Lambor Kanan, Lambor Kiri, Pulau Tiga, Kampung Gajah, Pasir Panjang Hulu, Pasir Salak, Bandar, Kota Setia, and Jaya Baru.

The study location for rural areas is on these 12 sub-district locations of Perak Tengah. However, due to time constraints and the vast area, the researcher decided to further focus the scope of study in Kampung Kuala Rasau, Slim River, Perak. The most common flood which occurred in Kampung Kuala Rasau, Slim River, Perak that received the worst hit from the 2014 flood. Due to its challenging task to access the area because of its rural environment, it will be a perfect location for the study location for the project, with it being a rural area that has a poor internet connection or none at all. It will help a lot to deploy the project here for the locals that were affected by the flood in 2014.

2.3. Importance of Flood Detection and Prevention

The importance of environmental monitoring is undoubted in this age. Knowledge of environmental monitoring is important to determine the quality of our environment. Information gathered through environmental monitoring is important to many different decision makers. So it is necessary to develop a system that monitors the environment conditions or the ambient conditions in real-time [14].

Disaster mitigation is very important in order to reduce the number of victims of both life and material. Alertness in disaster mitigation is urgently needed in every area in all countries of the world, especially in Indonesia. Embedded device technology specifically designed and programmed to detect disasters such as earthquakes, tsunamis, floods and landslides, storms and hurricanes [15].

Weather forecasting is important for individuals and organizations. Accuracy of weather forecasts can tell a resident in a coastal area of the impending danger when a hurricane might strike, an airport tower controller of what information should be sent to planes that are landing or taking off and a farmer of the best time to plant [16].

Internet of Things (IoT) is one of the most important technical trends which is utilized to monitor flood and human made resources to help in predicting and detecting essential events like flood, fire, gas and water leak that can position a threats to human life [6].

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2.4. Flood Detection and Prevention IoT System Block Diagram

Flood detection and prediction IoT systems use real-time sensors are one of the flood controls measures. This system will not only monitor the flood but also has an alert system to notify people. In the work of Kumari & Sailaja [17], it shows the block diagram of the riverside flood monitoring system. The project use two sensors to find out the two different parameters. One is ultrasonic sensor which is used to find the water level of a river and other is water flow sensor which is used to determine the flow rate of the river. For sending the SMS to local peoples to alert the situation during flood times they are using IFTTT web server. For monitoring the data of these two parameters they also use an external web server named as Thingspeak. The illustrated diagram is given in Figure 3.

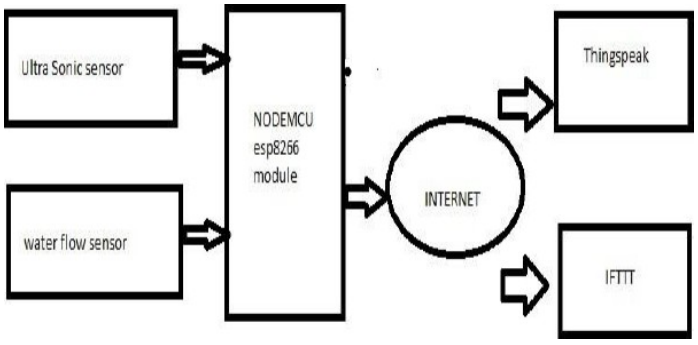

Figure 3. Block diagram of the system [17]

2.5. Hardware for IoT Flood Detection and Prevention System

Development board based on top of an ATmega328P microcontroller. It is an open-source hardware so the actual board can be manufactured by various manufacturers around the globe. The pin diagram for ATmega 168 and 328 are identical. Primarily works on Java programming language. The detailed specifications are given in Table 1 [18].

Table 1. Specification of Arduino Uno

Specifications	
Microcontroller	ATmega 328P
Operating Voltage	5V
Input Voltage	7-12V
Digital I/O pins	14 (labelled 0 - 13)
PWM pins	6 (Digital pins 3, 5, 6, 9, 10, 11)
Analog input pins	6 (A0 to A5)
Current in I/O pins	20mA
Flash Memory	32kB of which 0.5kB is for bootloader)
SRAM	2kB
Clock Speed	16MHz

It is a combination of both physical and easily programmed circuit board in addition to software (IDE) [19]. It will collect the data from all the sensors connected to it and display the data on the computer/mobile devices and that data will further be stored on cloud. It is easy to run the code and to collect data as it can be connected using USB cable and the IDE of Arduino is simpler version of C++.

Arduino plays a big role in communicating the microcontroller with all the sensors that will be used in the project, such as the ultrasonic sensor, water flow sensor, and temperature and humidity sensor. It also helps communicate with other components such as the LCD and GSM modules. Its

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various pins will be integrated with different I/O functions that be used to program the functional capabilities of the component that will be used, as shown in Figure 4.

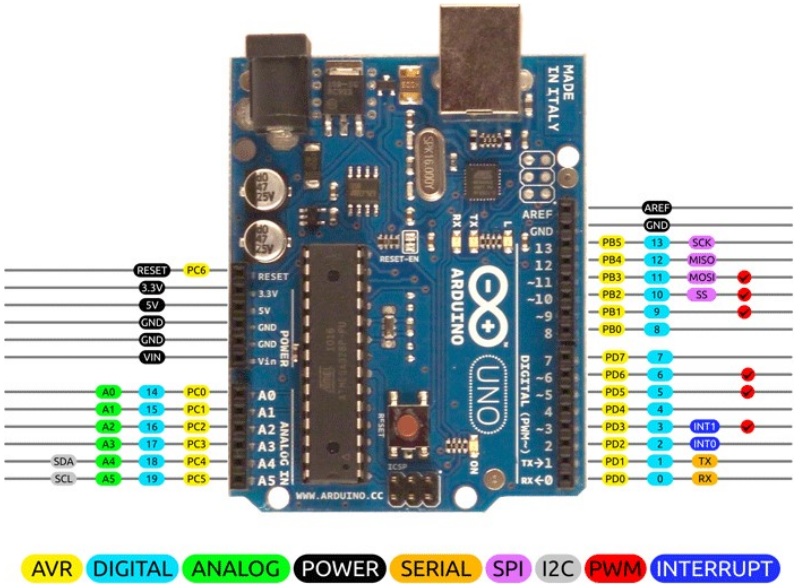

Figure 4. Arduino

3. Methodology

The development methodology used in this research is a Prototyping Model. The Prototyping Model is one of the most common models used to develop a system in the industrial field to help the product developers produce a quick and refined design [21] [22] [23] [24].

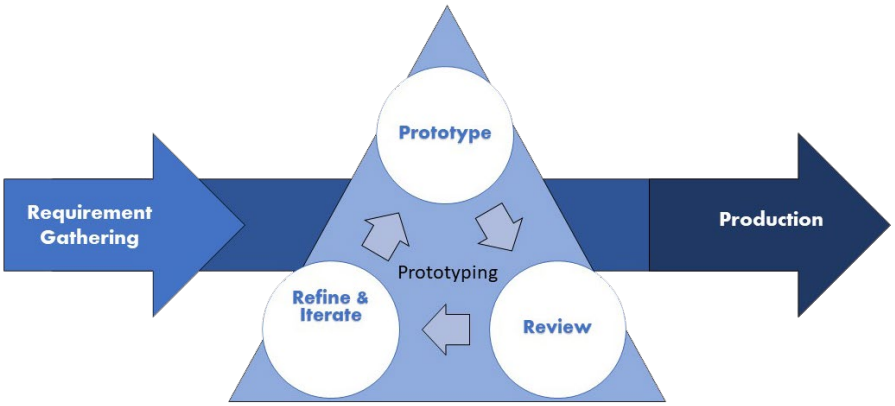

Figure 5. Rapid Prototyping Model

Rapid Prototyping applies an iterative approach to the design stage of an app or website [20] [21] [22]. The objective is to quickly improve the design using regularly updated prototypes and multiple short cycles. This saves time and money by solving common design issues before development begins, helps businesses to reach the market quicker and, puts the focus of development on the needs of the end-user. Rapid Prototyping originated in manufacturing, where it is used to build a physical design prototype (now often using 3D printing) to demonstrate and test a product's capabilities. When used in software development this prototype is either digital or on paper, but the concept is the same.

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Rapid Prototyping is normally associated with the Rapid Application Development (RAD) methodology, although you can also use it alongside an agile methodology.

To elicit information is probably the hardest part of this phase, where users sometimes do not know what they wanted. Thus, we use a quantitative data gathering from local respondent which use a close-ended question created beforehand by the developer. The question is determined by how long the user lives there, frequency of a flood, internet connectivity, devices that can receive messages, knowledge when a flood is happening, any other flood warning system, will a new flood warning system without internet connectivity will it be useful and a couples of functionalities question as shown on Figure 6.

Flood Prevention and Detection IoT System Questionnaire

Thank you for taking the time to answer these questions. The following questions are about eliciting information from our respondent regarding development of flood alert system.

1. How long have you lived here?
   a. A year
   b. 2 years
   c. Less than 10 years
   d. More than 10 years

2. How frequent floods occur in your area?
   a. Never
   b. Once a year
   c. More than once a year
   d. Not sure

3. Is there any internet connectivity in your area?
   a. Yes
   b. No

4. Do you have devices that can receive a message?
   a. Yes
   b. No

5. Do you know when a flood is happening?
   a. Yes
   b. No

6. Is there any flood warning alert from the government or other organizations?
   a. Yes
   b. No

7. If there is a flood warning system without the use of the internet will it be useful?
   a. Yes
   b. No

8. Should the product be less intimidating with compact design?
   a. Yes
   b. No

9. What kind of information did you want to see (Alert message will be sent when flood about to happen)?
   a. Water level
   b. Water level and water flow rate
   c. Water level, water flow rate and temperature of humidity level
   d. Water level, water flow rate, temperature or humidity level, and water height
   e. None only an alert message

10. Where would you feel safe for the product to be placed?
    a. 500 meters away from your house
    b. 1 km away from your house
    c. More than 1 km away from
    d. Safe anywhere

Figure 6. Flood Prevention and Detection IoT System Questionnaire

4. Result and Finding

4.1. Prototype

In developing the prototype, researcher has a few major's requirements that emphasize designing the system's architecture. The researcher could plan the necessary components for implementing the products by creating the hardware component according to software requirement specification to avoid unnecessary missing features. As shown in Figure 7, the input sensor will detect flood factors. The researcher set the system's condition to ensure that the Arduino process the information to align with flood occurrence. A message will be sent to the user as an alert on the probability of flood incoming. Simultaneously, the flood factors data will be stored to graph and get flood pattern for future analysis and the data displayed on FDAP Website.

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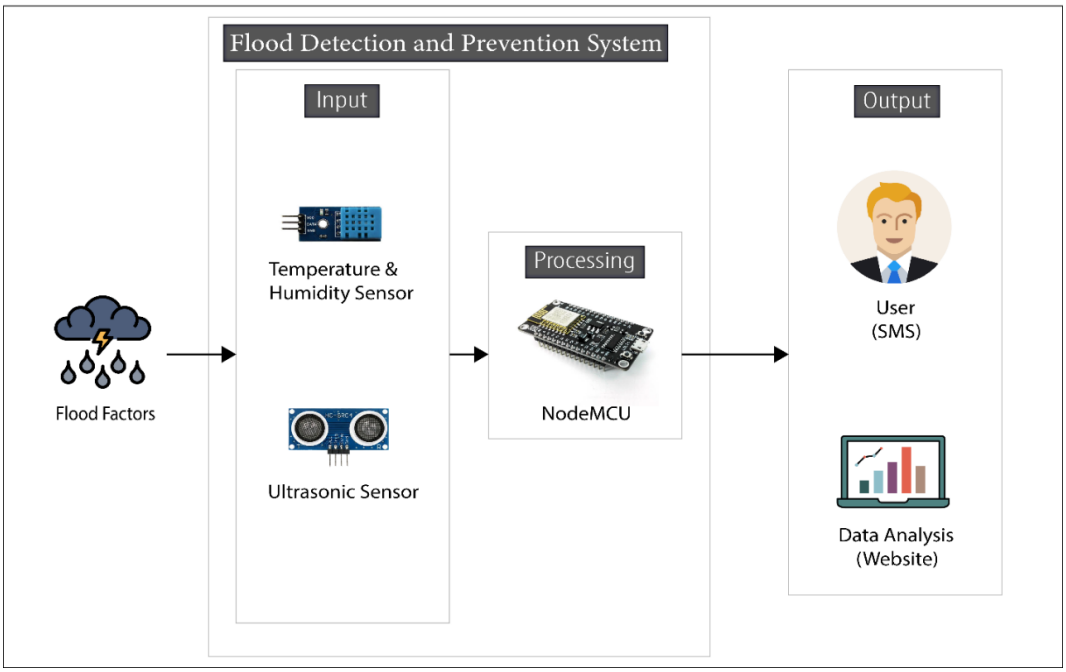

Figure 7. Flood Detection and Prevention System Architecture Design

Figure 8, shown the made to ensure that the researcher integrates the necessary components during the prototyping phase. The DHT11 sensor, Ultrasonic sensor, GSM Module, and the most important of all is the microcontroller, the nodeMCU. This design made is a rough sketch of the FDAP prototype, and further improvement may change how it looks in future implementation.

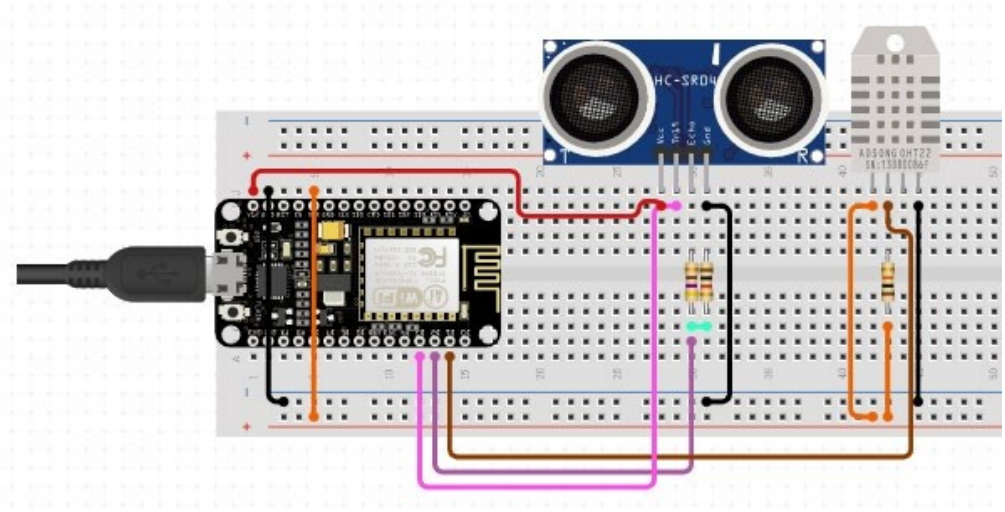

Figure 8. Flood Detection and Prevention System Prototype Design

The analysis of this study was carried out by using functionality test cases on the sensors and a survey on the product acceptance, functionality, and reliability. In order to verify the software performs its state functions in a way that the users expect. The functionality test needed to be done beforehand in the simulation and testing environment. This test help researcher to identify whether the product performs its objectives and is efficient to be used in the real-time environment. At the same

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time, to make sure the product performs its functional requirements perfectly, the test for the product sensor needs to be done.

In this research, there is also a product survey using formative evaluation that focuses on the acceptance, functionality, and reliability of the product. A survey was conducted at Kampung Kuala Rasau by using a questionnaire to gather the data needed for the analysis. To ensure that the system that is being built got the result it needed to function correctly and based on software specification requirement document.

4.2. Sensors Functionality Test Result

Sensor's functionality test results come from testing each sensor to make sure the accuracy aligns with its efficiency. Each sensor's test is categorized based on its functionality; for example, the DHT11 sensor could measure the humidity and temperature. So, there will be separate testing based on two different features of DHT11. One is for measuring the humidity, and the other is for the temperature. There is also the ultrasonic sensor to measure the water level using the simulated environment that the researcher created.

Table 2 shows the test result for DHT11 (humidity), Table 3 shows test result for DHT11 (temperature), while Table 4 shows the test result for ultrasonic sensor (water level).

Table 2. Result for DHT11 (Humidity) Test

Test Environment	DHT11 Sensors	First Reading (%)	Second Reading (%)	Third Reading (%)	Average Result (%)
DHT11 is placed in a non-raining simulation environment, and the reading is taken every 30 seconds.	A	78.4	78.6	77.9	78.3
	B	79.2	78.4	78.3	78.6
	C	78.9	79.1	78.6	78.8
	Total Average Sensor Value				78.5
	Efficiency = (Highest Sensor Value) – (Total Average Sensor Value)				0.7

Table 3. Result for DHT11 (Temperature) Test

Test Environment	DHT11 Sensors	First Reading (%)	Second Reading (%)	Third Reading (%)	Average Result (%)
DHT11 is placed in a non-raining simulation environment, and the reading is taken every 30 seconds.	A	28.2	27.9	28.0	28.0
	B	28.5	28.2	28.2	28.3
	C	28.7	28.9	28.5	28.7
	Total Average Sensor Value				28.3
	Efficiency = (Highest Sensor Value) – (Total Average Sensor Value)				0.6

Table 4. Result for Ultrasonic Sensor (Water Level) Test

Test Environment	DHT11 Sensors	First Reading (%)	Second Reading (%)	Third Reading (%)	Average Result (%)
The ultrasonic sensor is placed on a 10-centimeter pole inside a 5-centimeter river simulation environment.	A	5.4	5.7	5.3	5.4
	B	5.8	5.7	5.7	5.7
	C	5.6	5.4	5.5	5.5
	Total Average Sensor Value				5.5
	Efficiency = (Highest Sensor Value) – (Total Average Sensor Value)				0.3

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After gathering all of the data from all of the sensors based on their reading, the Result for each sensor has minimal 0.5 differences reading, which proves the efficiencies of each sensor tested during the functionality testing process. In conclusion, the sensors from the test could be used in any FDAP product, which removes the benefit of the doubt when using FDAP Product.

4.3. Acceptance Test Survey

To summarize, the survey was conducted by using a questionnaire that was created by the researcher specifically to gather data about the acceptance of the FDAP system from the local user. The questionnaire is targeted to get feedback from the user about the acceptance, functionality, and reliability of the FDAP system. In this section, the Result and analysis of the survey are presented. All the data gathered from the questionnaire were transcribed and analyzed. As mentioned earlier, the questionnaire focuses on the three main themes. This is to get the highest acceptance among users. It is worth noting that the FDAP system was demonstrated to the user during its final prototyping phases.

Table 5 shows the Result of the participants' answer. There are two questions related to the reliability of the FDAP system. The reliability of the system is essential as the system responsible for the ability to continue to operate under predefined conditions that are set by the researcher to perform its functionality correctly. Nine out of ten participants agreed that the product is reliable to measure the water level accurately based on the demonstration video. On the second question, six of the participants agreed that by getting an early detection, they could prevent the flood from harming their valuable properties and life. Three of the participants not entirely sure whether the system could prevent a flood from harming them. One of the participants disagrees the system could prevent a flood from harming them.

It is noted that the majority of the participants feel that the FDAP is reliable to be used. It is reliable and able to detect the water level at an accurate measurement. Furthermore, half of the participants agreed the system could help them, and the other half either not sure or seem to be skeptical about it.

Table 5. Product Reliability

QUESTION	Yes	Maybe	No
Q1. Does FDAP able to detect water level accurately?	9	1	0
Q2. With early detection, can the user prevent aflood from further harming their life or properties?	6	3	1

Table 6 shows the Result of the functionality questions. There are two questions related to the system's functionality. On the first question, all of the participants agree that they prefer the SMS function rather than using the FDAP website. From the second question, all the participant has described their internet either to be extremely slow or moderately slow when using near their house.

The data gathered on the product functionality could be concluded that the majority of the participants are interested in the SMS feature more than the website because a majority of them have a slow internet connection, and harder to use the FDAP website.

Table 6. Product Acceptance

Question	Yes (Using SMS) / Extremely Slow	No (Using Website) / Moderately Slow	Moderate	Moderately Fast	Extremely Fast
Q1. Which features of the product interest you?	10	0	0	0	0
Q2. Please describe your internet connection speed near your house.	3	7	0	0	0

International Journal of Recent Technology and Applied Science, vol 4, no. 2, pp. 97-110, September 2022. **DOI: 10.36079/lamintang.ijortas-0402.398**

Table 7 shows the Result of the product acceptance question. On the first question, eight out of ten have been affected by the flood, and the other two have not been affected by the flood. On the second question, the majority of the participants wanted to install an FDAP system at their location. At the same time, the majority of the participants are also interested in the product itself.

From the data, most participants are interested and want to install the FDAP system at their location because a majority of the participants is affected by floods before. All the participants all living in Kampung Kuala Rasau, which have been affected by flood multiple times. Two of the participants that have not been involved live on higher ground than the other participants.

Table 7. Data Gathered

	Yes	No	Extremely Interested	Very Interested	Moderately Interested	Not Very Interested	Not at all Interested
Q1. Does flood hadaffected you before?	8	2	/	/	/	/	/
Q2. How likely would you like thisproduct installed at your location?	/	/	2	7	1	0	0
Q3. After watching the video, how interested are you in this product?	/	/	3	2	5	0	0

Based on the survey conducted with the local participants of Kampung Kuala Rasau, the majority of the participants living in that area have trouble with an internet connection to get any information from any online news website. Thus, participants are more interested in using the SMS functionality of the FDAP system because of its simplicity in accessing the flood alert message. At the same time, because of the typical flood that occurred in Kampung Kuala Rasau, the participants are invested in having FDAP products install at their home location because of the system's reliability. In a part of it, the FDAP system still needs space to improve its capability to detect flooding in the real environment because there are multiples factors that could affect the flood detection feature, such as the product location placement and external natural factors. Therefore, a location placement study could be conducted to improvise the product.

5. Conclusions

This study aimed to analyze whether the usage of the system is possible in the detection and prevention of flood disasters. The system currently focuses on the rural location that has a non-internet connection or poor internet connection. Besides, the objective also to develop a fully functional system that focuses on the detection of flood and sending an SMS alert to the local area that will be affected by it. In the development process, the researcher also focuses on the FDAP website to make it easier for the future researcher or government organization to analyze the flood phenomenon from the researcher's FDAP website. Furthermore, the system was also developed to test the system's functionality and reliability in the simulated flood environment.

The researcher analyzes thirty-three articles to identify the components needed to develop the system. Each article is analyzed individually to ensure the essential components can be built and used in this system. Through the study, the researcher was able to identify the components needed to ensure the system could function as stated in the SRS document. Picking the right component such as a NodeMCU to as the microcontroller to process the input and output information at the same time as a WIFI module to upload data to ThingSpeak, Ultrasonic sensor to measure the water level, DHT11 to measure the humidity and temperature of the surrounding area and the GSM Sim900a module to send offline alert SMS.

The development process is very challenging as it consists of offline and online system integration. The development process is based on the Rapid Prototyping model as a reference for developing the FDAP System. This model was chosen because it is a flexible model widely used in the development of an IoT system. To implement the system, the researcher must choose an Integrated Development Environment (IDE) that is suited for the development of the system. IDE chosen needs to accommodate the offline system's development, which used Arduino IDE, and online system, which used Visual Studio Code. Once selected, the researcher focused on coding for the product first using

International Journal of Recent Technology and Applied Science, vol 4, no. 2, pp. 97-110, September 2022. **DOI: 10.36079/lamintang.ijortas-0402.398**

C++. Each feature added to FDAP product need to be verified according to the Software Requirement Specification document. Each feature added also is tested using a test case derived from Software Test Plan. The next implementation is for the online web system, which focuses on using HTML, CSS, JS, React.js, and ThingSpeak as the main programming languages and frameworks. FDAP website focuses on displaying the data retrieved from FDAP product implemented at the flood location; thus, the website needs to be easy to navigate and follow the Human-Computer Interaction design principle as the designing guideline.

The researcher tests the functionality and reliability of the system. Functionality test uses the Sensors Functionality test to ensure each sensor aligns with the right efficiency to validate against its software requirements. There are two different sensors tested with three different functionalities involved. The data gathered conclude that each sensor has minimal 0.5 differences reading, which proves each sensor's efficiencies according to its functionality and could be used on different FDAP products and provide the same accurate data. The reliability test for the system uses the Acceptance Test Survey technique. The survey focused on ten respondents from the local area (Kampung Kuala Rasau) previously affected by the flood. Simultaneously, the site has a poor internet connection, which is suitable for the survey. The questions are divided into three themes: the reliability theme, functionality theme, and acceptance theme. From the analysis, the respondents are interested in the SMS functionality of the FDAP system because of its simplicity in accessing the flood alert message. The respondents are also invested in having FDAP products install at their home location because of their reliability.

Future work of Flood Detection and Prevention System focuses on adding extra functionalities to improve the prevention of flood. This improvement will focus on mitigating the flood water by transferring them to a reserve retention basin as alternative flood prevention. There is also a future improvement for the FDAP website, not only focused on researcher and government organization as their use for analyzing flood phenomenon but also on the user interested in getting more information regarding flood alert in their current location. With this improvement, the FDAP system will attract new users living in the central city and suburban area to consider using the FDAP system services. Flood Detection and Prevention system could contribute to society's safety and property. FDAP system could save human life and prevent financial loss from the affected local or government bodies. At the same time, it supports the emergency services to be prepared for flooding by allowing people to get the information early. Furthermore, the FDAP website could contribute to future research by providing a trend graph and raw information gather from FDAP product placement in the local flood-affected areas.

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