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Implementation of Communication Systems based on the Global System for Mobile Communications in Flood Monitoring Application with Web-Based Geospatial Information

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ABSTRACT
Flood disaster is a disaster that often occurs in various countries today. Indonesia is one of the countries that have frequent frequency of flood disasters. Based on these problems, the government encourages the role of government and private institutions to jointly reduce disaster victims by increasing research and development models to reduce disaster victims. This study aims to integrate disaster monitoring information systems with geospatial information systems for flood disaster locations. The prototype was developed in two systems namely a flood detector system and a flood monitoring information system with the addition of a geospatial information system. In the flood detector system using input components, namely ultrasonic sensors, temperature sensors, rain sensors. The processing component uses the Arduino Uno microcontroller and the output component is the GSM SIM900A module. the flood monitoring information system uses Apache Web Server, PHP, MySQL database, Gammu and Google Maps API. The results showed that the flood detector system was able to send sensor data to the flood monitoring information system server using the SMS Gateway service. Sensor data that has been processed by the server produces flood location information based on Google Maps accompanied by information on flood height, temperature and status of rain conditions at the location of the flood detector. The information is distributed to users in web form. And information is sent by the flood detector periodically and updated in real-time by the flood monitoring information system server.

Key words : Flooding, Geospatial, SMS Gateway, GSM, Information Systems, Google Maps.

1. INTRODUCTION

Indonesia is a country that has a geographical structure that is vulnerable to natural disasters. This can be seen from several experiences in recent years. In addition to the frequent earthquake in Indonesia, the flood disaster is one of the disasters that often occur in Indonesia. If an earthquake occurs due to the geographical structure that is in the location of the earth's plate shift, the flooding that occurs is caused by the effect of global warming.

The effect of global warming which is currently happening has given the influence of unstable weather. The influence of unstable weather results in extreme rainy weather in one area and drought in another location. Conditions during rainy weather in extreme conditions will cause flooding. Flood disaster is a disaster that is largely influenced by human actions. Human actions are a bad habit carried out by some people in disturbing the stability of nature such as forest exploitation without reforestation, littering, and the lack of rainwater uptake in urban areas.

Based on the lack of public attention to the environment that causes flooding, it is necessary for the government's concern in developing long-term and short-term programs in anticipating sustainable flood disasters. At present the long-term program carried out by the government, especially the Indonesian government, is to provide environmental education counseling, and an understanding of the influence of bad community habits that can lead to floods. In addition to the long-term program, a short-term program is needed, namely building a flood early warning system.

The Government of Indonesia in anticipating many victims of natural disasters has encouraged all government and private agencies to develop an early warning system using the latest information and telecommunications technology [1].

Based on the government's encouragement, this paper aims to describe the creation of a flood logging data system using the wireless sensor network model. The communication system used in the wireless sensor network-based data logging system model uses a GSM communication system [2].

Wireless Sensor Network is an embedded system based device consisting of a sensor module as a data input component, a microcontroller module as a data processor and a communication module as an output that will send data to a data processing center such as a server [3] [4]. The application of using Wireless Sensor Network has been used in various military products, manufacturing industries, education and disaster mitigation such as disaster early warning systems [5] [6].

Wireless sensor network communication systems in sending data remotely can be a type of local area network (LAN) or use a GSM communication system (Global System for Mobile Communications) [7]. GSM (Global System for Mobile Communications) communication system chosen in the creation of a flood monitoring system based on integrated data logging geospatial information system is the ease of getting a GSM provider network [8].

The flood logging data based monitoring system that was built aims to collect flood data continuously. The flood data is processed on the flood information system server. The results of data processing on the server produces a real-time list of water level data. A list of water levels is displayed during the flood.

2. LITERATURE SURVEY

Based on previous research by researchers, there are several jobs relating to flood sensor data logging systems based on wireless sensor networks that were built as supporting material for further system development ideas.

The first research that is known that making flood disaster mitigation systems in general using the main input components is an ultrasonic sensor in detecting flood levels [9]. In contrast to what the following researchers did that sensors to detect floods use infrared sensors combined with ultrasonic sensors [10]. While the microcontroller used in various flood disaster information system applications in collecting data from sensors is its ability in mono tasking systems [11]. Besides mono tasking, the use of small memory makes data easier to process [12]. The type of microcontroller that is often used in the manufacture of flood detection system products is currently the type of ATMEGA238 in the form of an Arduino minimum system. [1]. The Arduino minimum system is an open source based circuit board. Arduino minimum system board is a drinking system board that is easy to use in making prototypes of embedded system applications such as smart home applications, fire detectors and other automation products [13]. While the Arduino application in a flood disaster is the use of a flood detection system that is integrated with an ultrasonic sensor as a water level sensor and Arduino as a data processor [14].

From the research that has been done that some of them research flood detectors have used Arduino systems as data processing, ultrasonic sensors to detect water level or data input components, and GSM modem modules as output components [15][16][17]. Besides that, several communication systems in the flood detector system send their information through the Wireless Sensor Network concept [18][19].

From research conducted by previous researchers that the data output received by the flood information system server that is displayed in the form of text and numbers information for flood height parameters and other sensor parameters. From the research conducted, the research developed is a flood monitoring information system that can be integrated with spatial information systems such as flood detector location information.

3. METHOD

The research was conducted using the software development life cycle (SDLC) method. The initial stage of the research is to build a system analysis that aims to provide a description of the system to be built from the flood detector to the system that will be used by the user. While the second stage is the design stage. At the design stage it is the implementation stage of the analysis that is the design picture of the system begins with the flood detector system to the flood information system.

3.1. System Analysis

The system analysis stage is as shown in Figure 1. The description shown in Figure 1 is that a flood detector from location A or location B will detect the height of the flood, the ambient temperature and the presence of rain. Then the data is sent via a GSM modem module in text form using an SMS bebreceived by the server will be processed to produce web-based information that contains map-based flood location information accompanied by information on water level, temperature and rain in real time. This information can be accessed by users remotely via the web. While the admin function on the system is to input the initial data coordinates of the location of the flood detector installed.

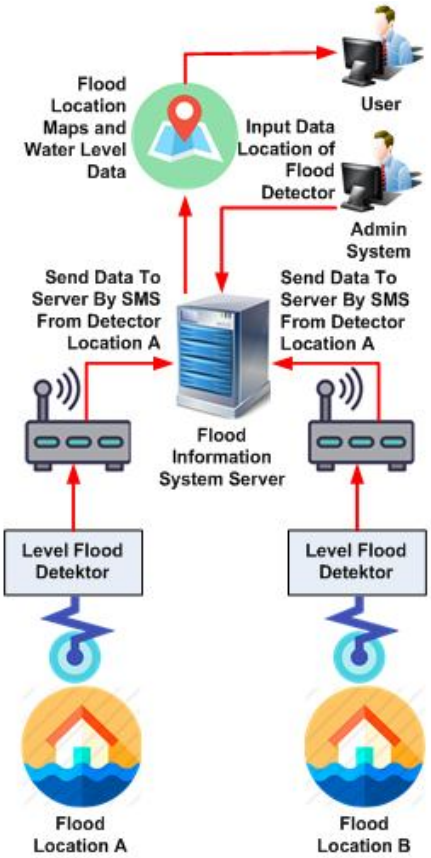

Figure 1: System Analysis

3.2. System Design

System design stage is the stage where the elaboration of the system analysis in the form of a series of system formers in more detail. The system design stage consists of integrating a series of detector systems with a flood information system. The series of flood detectors consists of hardware and flood information systems is software that consists of several supporting applications.

The hardware component of a flood detector system as shown in Figure 2 contains two blocks namely a flood detector block and a flood information system block. In the flood detector block there are several components such as system input components consisting of an ultrasonic sensor as a water level detector, a temperature sensor as a temperature detector and a rain sensor as a rain detector. The ultrasonic sensor used in this system is an HC-SR04 type ultrasonic sensor. While the temperature sensor used in the system is a DHT22 type temperature sensor. And the rain sensor used in the system is a standard rain sensor that uses a signal amplifier. The data generated by the sensor is processed by the processing component, the Arduino Uno microcontroller. While the output component is a GSM modem module with type SIM900A. The GSM module is tasked with sending data using an SMS service to the flood information system server.

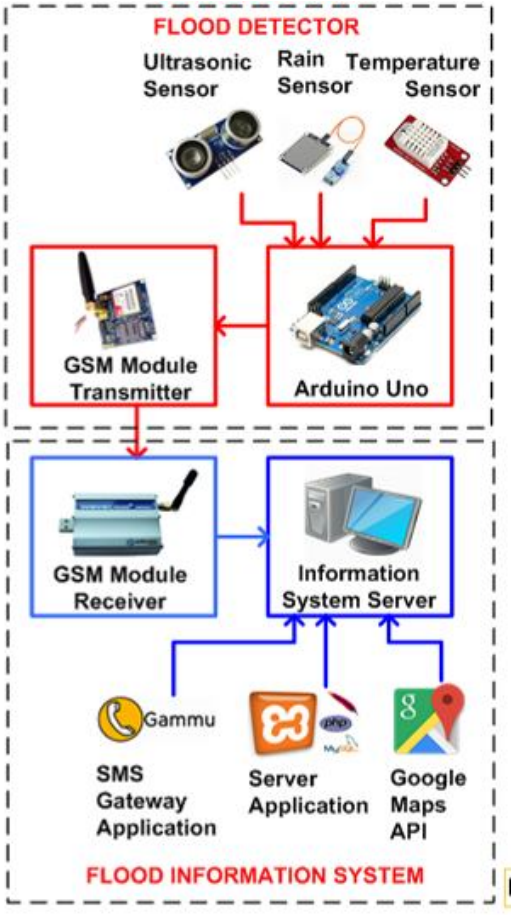

Figure 2: Banjir Deisgn of Flood Monitoring Information System

Furthermore, in Figure 2 there is also a flood information system block. In the block, there are several supporting system components, namely the component of the GSM modem receiver type Wavecom M1306B. The GSM modem functions as a data receiver modem. Data received by the modem will be processed on a Personal Computer that functions as a flood information system server with supporting application components such as the Gammu application functioning as an SMS Gateway application, Apache web server as a web server, PHP Engine and MySQL as a database management system and the Google Maps API as an API geospatial.

Design of flood information systems there are stages of context diagrams that aim to find out objects that are integrated with the system. Objects that are integrated here are the activities of interaction between objects and flood information systems. The integrated objects in the flood information system are the flood detector, admin and user. The object interacting with the flood information system is to send data on water levels, temperatures and rain conditions. While the admin interacts with the flood information system is the input data coordinates the location of the flood detector. And the user is accessing flood information consisting of information on flood location, water level, temperature and rain conditions. The diagram of the flood information system context can be seen in Figure 3.

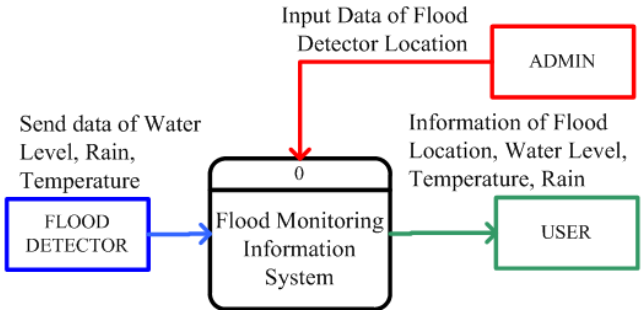

Figure 3: Context Diagram of Flood Information System

4. RESULT

Based on the design of a flood information system that is integrated with the spatial information system of flood locations, this research resulted in a prototype of a SMS Gateway based flood detector system as shown in Figure 4. The flood detector system was designed using a paralon pipe as a place where water is measured in height. This research uses a paralon with a length of 60cm. On the inner side of the pipe a float is installed as a water boundary that will provide reflections to the ultrasonic sensor to determine the height of the flood water. On the upper side of the pipe temperature and rain sensor components are placed. While the Arduino microcontroller as the data processor and the SIM900A GSM module component as the sender of data from the sensor to the flood information system server uses the SMS Gateway service.

Flood detector work system when sending data to the flood information system server then use the SMS format "LOCATION # VSENSOR1 # VSENSOR2 # VSENSOR3". With this pattern, it is easy for the information system to break the SMS text received by the server into separate data for location data, water level values, temperature values and the status of rain conditions. The data transmission time system uses a scheduled delivery system that is every height value changes in multiples of 5cm.

Figure 4: Flood Detector System

While the server system that is built is a personal computer that is designed as a server by integrating the Wavecom M1306B modem via a computer USB port. In Figure 5. It appears that the server displays the XAMPP application as a web server and MySQL database control panel. And besides that it also displays flood information as a substitute for simulations on the user side.

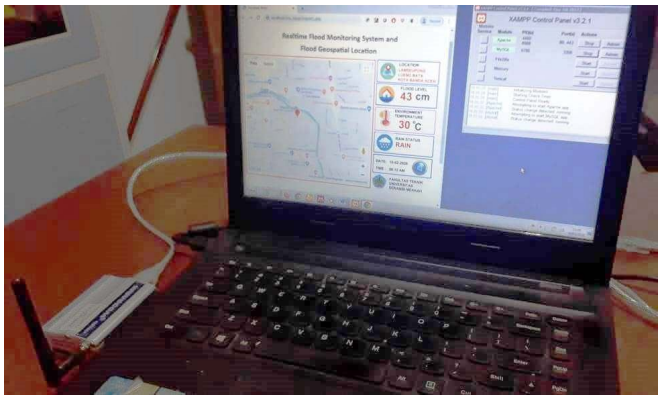

Figure 5: Server with GSM Modem

In general, the display of flood information systems accessed by users can be seen in Figure 6. On the flood information system display that is integrated with the geospatial information system, it appears that the information is updated in real time. Flood information displayed on the information system is pertaman, location map of flood detector based on Google Maps, second is the text of the location where the flood detector is located, third is the height of the flood or water, fourth is the temperature, fifth is the status of the rain condition and the last is the date and time .

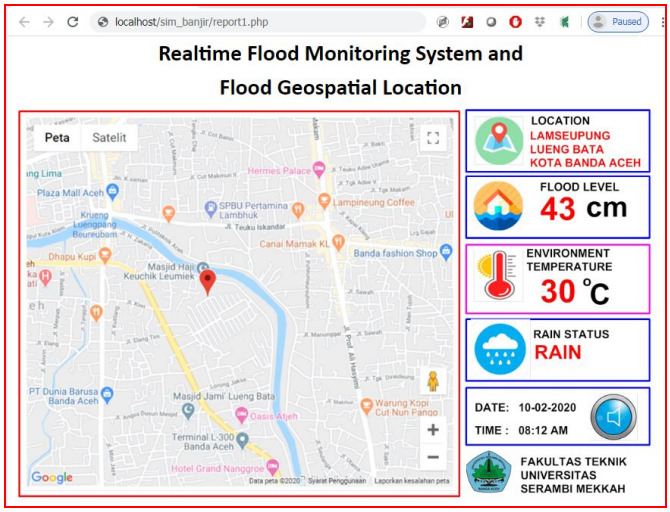

Figure 6: The flood information system interface is integrated with the geospasil information system for flood location

5. CONCLUSION

From the prototype of the flood detector system and the integrated flood information system with the geospatial information system of the flood site that has been built, it can be concluded that the system in general has been running in accordance with the description of the analysis that has been designed. Likewise, the prototype product of the flood detector system and the flood information system were accordingly built according to the design that had been built before.

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The Ministry of Research and Higher Education (Ristekdikti) of the Republic of Indonesia through the Higher Education Collaboration Research Scheme (PKPT) with contract number 119 / SP2H / LT / DRPM / 2019. This research was conducted jointly by a research team from Universitas Serambi Mekkah and a team from Syiah Kuala University as a Research Partner Team.

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