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Flood Detection System Using Ultrasonic Sensor with Fuzzy Logic Method

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ABSTRACT
Floods are one of the disasters that often occur in Indonesia. The problem that always arises when floods are the overflow of river water into residential areas that cannot be stopped and causes flooding. Therefore a problem arises, namely the flood detection system that makes flood warnings, which previously did not know whether the flood would overflow or not. With this system, residents will know the water level in the river, and residents will be ready before the flood comes. This system is supported by an ultrasonic sensor that will input water level data and is processed through Arduino which will output water level data through the Amazon web service which displays standby status via the website and calculates river water levels through fuzzy logic.

Keywords: *flood, fuzzy logic, Arduino, amazon web services.*

1. INTRODUCTION

Indonesian people are currently less concerned with the surrounding natural conditions that can cause natural damage in Indonesia. One of the disasters that occur is flooding. Flooding will always occur if the volume of water exceeds the capacity of the available waterways, resulting in flooding. Water will overflow in the river. Floods are one of the problems that always occur in Indonesia, especially during the rainy season, so that it will have a bad impact on the community, namely causing disruption of activities and resulting in material and psychological losses.

In Indonesia, especially in West Java Province, flooding is one of the disasters that often occurs, especially during the rainy season. Floods will always occur in the Citarum area, especially in the upper reaches of the river. Floods have occurred for decades, including in 1931, 1984, 1986, 2005, 2007, 2010, and 2020. One of the areas, namely Cieunteung Village, always floods from year to year, and the most severe floods often occur, especially during the rainy season. Floods in the Citarum River are caused by various problems such as deforestation in the Citarum River area and people around the Citarum River. They are not good at protecting the Citarum River area, especially the human behavior in throwing garbage into the river.

Therefore, one of the things that the Citarum River community needs are information about flooding. Among them is information by monitoring flood detection with flood limit heights directly and clearly. The system will carry out monitoring that can minimize the occurrence of flood disasters. Therefore, a flood monitoring tool is needed to directly determine and monitor the surrounding environment's condition by utilizing Internet of Things (IoT) technology. Internet of Things (IoT) is an object that is displayed virtually in cyberspace or the internet. The method used by the Internet of Things (IoT) is a wireless or automatic remote control. Its implementation requires a microcontroller-based ultrasonic sensor that uses amazon web services. One of the ways to calculate the river water level is through the fuzzy logic method, by utilizing Internet of Things (IoT) technology.

The limitation of the problem will only focus on developing a flood detection system using the Fuzzy method and designing a flood detection support system in the Citarum river. The aim and objective of this research are in the form of building a-based ultrasonic sensor system microcontroller that uses amazon web services. The development is carried out using the Fuzzy Logic method. Moreover, the research concerns designing, building, and testing a fuzzy method system for an early detection system for flood disasters as a tool for people living around the Citarum river.

2. BASIC THEORY

This section explains the Internet of Things (IoT), Amazon web service, Information-Centric Security (ICS), Real-time, Database, fuzzy logic. Internet of Things (IoT) is a structure or object that can control the development of a system that has been created remotely using the Internet of Things (IoT) internet media. Amazon web services are cloud computing services that can be accessed with a web service call. Information-Centric Security (ICS) is information security or describes the information that controls data access and cannot be accessed by others who can read or write the information. Real-Time is the time or events that are happening that are operated by hardware and software. Fuzzy logic is logic that has a similarity value between true or false. In logic, it is expressed in binary terms (0 or 1, black or white, yes or no), whereas fuzzy logic allows membership values between 0 and 1, levels of gray and black and white, and in linguistic terms, uncertain concepts, such as "a little," "enough" and "very." The following in table 1 and table 2 is an explanation of the stages of the Scrum method used:

a. Product Backlog

Table 1. Product Backlog

NO. PRODUCT BACKLOG	DESCRIPTION
ADMIN	
PB– 01	Follow
PB – 02	Login sent
PB - 03	go out
PB - 04	web access
PB – 05	web management
PB - 06	data entry
PB – 07	Edit data
PB – 08	Clear data
PB – 09	View data
PB – 10	Manage data
PB – 11	Save data
USER	
PB – 12	Follow
PB – 13	Login sent
PB – 14	go out
PB – 15	Website access
PB – 16	View data
PB – 17	Search data
CLOUD	
PB – 18	Fetch data
SENSOR	
PB – 19	Save data

b. Sprint Backlog

Table 2. Spirit Backlog

NO. SPIRIT BACKLOG	DESCRIPTION
SB – 001	This system is based on an android website and web view application
SB – 002	The system must be able to be opened via a web browser google chrome, firefox, safari, etc.
SB – 003	The system must be able to be opened via a smartphone with a minimum jelly bean operating system
SB – 004	This system is connected to the internet network and integrated with the database system

c. Scrum Meeting

The Daily Meeting or commonly referred to as the Daily Scrum is a conference of experts who hold a meeting to simply share information about the software development process that is being implemented. Opportunity for experts to show the progress they are working towards achieving desired goals. The use case of this explanation is shown in Figure 1.

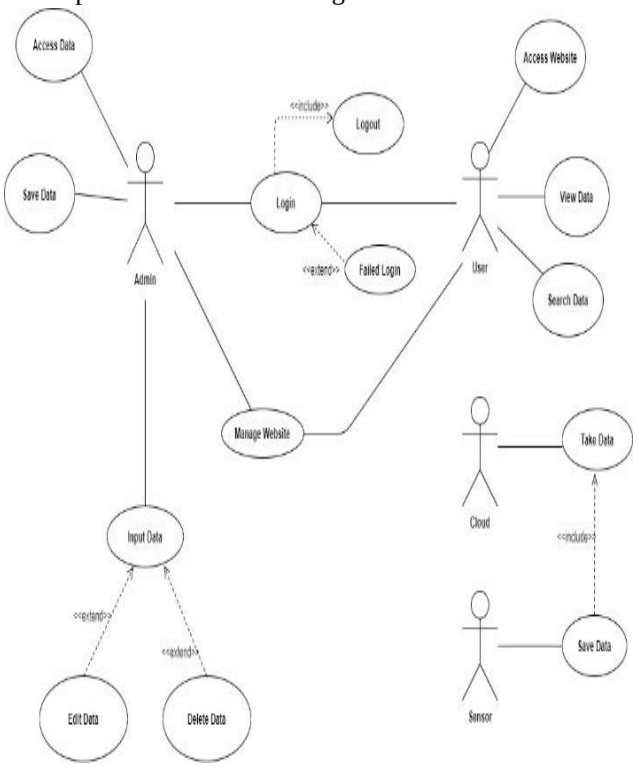

Figure 1 Scrum Method Design

d. Data source

From data information that has been processed to produce better information, it is necessary to have very accurate data because the information is processed and entered into the system. The data information in question is an information system for processing river water level calculations using the Tsukamoto fuzzy method so that the following data is needed: Data related to water level, Tsukamoto fuzzy data, namely: fuzzification, inference, defuzzification.

e. Information System Model

The information system model in calculating water level requires three stages, namely: fuzzification (forming fuzzy sets), inference (rules), and defuzzification (affirmation). A variable set of high, low moisture content, humidity.

1. Variable Identification

Table 3. Identification of Variables

Function	Variable Name	Reach
Enter	water content	>100
	low water	<20
Output	Humidity	>34

2. Variable Identification Flowchart

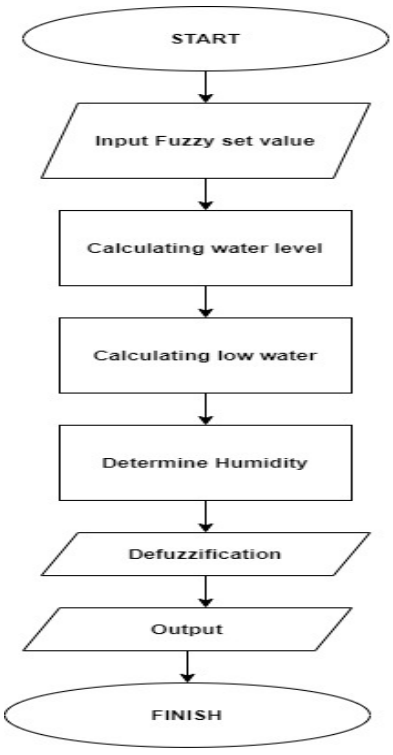

Figure 2 Variable Identification Flowchart

3. RELATED RESEARCH

In compiling this research, the authors refer to previous studies related to the title of this study. The following are previous references related to this research.

Research conducted by Kurnia Darmawan, Hani'ah, andri Suprayogi. "Analysis of Flood Vulnerability in Sampang Regency Using the Overlay Method with Scoring Based on Geographic Information Systems," the researchers use the overlay method with scoring with existing parameters. Each parameter performs a process scoring by providing a value based on the classification, which is then carried out by overlaying ArcsGis 10.2.1 software. The use of this software device utilizes an Information System that can represent flood-prone areas in digital form.[1]

Research conducted by Ike Fitriyaningsih, Yuniarta Basam, Lit Malem Ginting, "Application of Prediction of Rainfall, Water Discharge, and Web-Based Flood Occurrence Using Machine Learning in Deli Serdang" This research focuses on Machine Learning how to make intelligent decisions based on data. The result of this study is a web-based application that can produce predictions of rainfall and water discharge [2].

Research conducted by Husneni Mukhtar, Doan Perdana, Perman Sukarno, Asep Mulyana, 2020 "IOT-Based Waste Capacity Monitoring System (SiKaSiT) for Flood Prevention in the Bojongsoang Citarum River Basin, Bandung Regency". The method used in this study is Sikasit with research results that can provide solutions to the surrounding community that can prevent a build-up of garbage through ultrasonic sensor devices. Then the sensor results are sent from the node MCU to the MQTT server and generated through the android appearance [3].

Research conducted by Respaningsih, Insani Abdi Bangsa, Arnisa Stefanie "Designing a Flood Monitoring and Detection System Using the Background Subtraction Method Based on the Internet of Things (IoT)." Researchers discuss the comparison between the two different systems, but the function is the same to track water levels and look for the error percentage [4].

The research conducted by Kukuh Prasetyaningtyas "Forecast of Potential Flood Areas for May - July 2021," discusses the prediction of several areas that will rain in July, where the data will be used to calculate the rainfall that occurs in an area, whether it will cause flooding or not.

Research conducted by Guntur Yusdi Purnomo, Christine Dewi, "Designing an Early Flood Detection System Using the Internet Of Things Concept." This

study uses the waterfall method, namely Design, System Design, Implementation and Testing, and Maintenance. The final result of this research is that the design of this early flood detection system was successful by doing it with the concept of the internet of things. This system can be accessed anywhere and anytime through the website in real-time [6].

Research conducted by Ilham Majid Rabbani, Purba Duru Kusuma, Randy Erfa Saputra 2018 "Development of a Fuzzy Method-Based Flood Detection Tool". This research designs a tool and implements software that can measure river water levels. The results of this study are in the form of notifications in the form of graphics that can be accessed publicly via the web [7].

Research conducted by Mohammad Ridwan. "Forecast Potential Flood Areas April-June 2021" discusses several areas that will be affected or not by flood disasters.[8].

The research was taken from the BMKG conducted by Mohammad Ridwan "Forecast of Potential Flood Areas in June, July, August 2021," discusses rainfall in several areas in June [9].

4. LITERATURE REVIEW

a. Definition of Flood

Floods are one of the natural disasters that often occur in Indonesia. A flood is an area that is exposed to large or high water puddles. Floods can be predicted or can be seen through information about rainfall. The factors that cause flooding, among others: Illegal logging, littering, high rainfall, land that is not able to absorb water, dams that do not function.

b. Understanding Ultrasonic Sensors

An ultrasonic sensor is a sensor used to detect the state of an object by using a distance count for the sensor and the object. The ultrasonic sensor functions are as a converter of sound magnitudes to electrical quantities.

c. Understanding the Fuzzy Tsukamoto Method

The fuzzy Tsukamoto method is a method whose usage rules are in the form of IF-THEN, representing a fuzzy set with their respective membership functions. There are also processes for implementing fuzzy Tsukamoto, namely: Fuzzification, Interference System, and Defuzzification.

d. Understanding the Internet of Things (IoT)

Internet of Things (IoT) is a structure or object that can control the development of a system that has been created remotely using the Internet of Things (IoT) internet media.

5. RESULTS AND DISCUSSION

a. Variable Water Level

If the water level has a value of less than 110 cm, this is included in the category of low water level. Meanwhile, the water level value exceeding 300 cm is included in the category of high water level.

Table 4. Membership Variables Water Level

No	Arrange	Domain
1	Tall	300cm
2	Low	110cm

b. Variable Humidity

If the humidity shows a value of less than 20, it is included in the low humidity category. Whereas if it has a value exceeding 30 it is included in the high category.

Table 5. Variables of Humidity

No	Arrange	Domain
1	Tall	30
2	Low	20

c. Knowledge in fuzzy based on the results and data analysis as follows:

Table 6. Membership

No	IF		THEN
1.	Low Water	Low Humidity	Not flood
2.	Low Water	High humidity	Not Flood
3.	High water	High humidity	Flood
4.	High water	High humidity	Flood

e. Defuzzification

Table 7. Prediction Results

No	Month	Water content		Humidity		Prediction Results	Information
		Tall	Low	Tall	Low		
1	April	300	102	38	19	Low	No Flood
2	Possible	500	100	200	100	Tall	Flood
3	June	221	78	118	114	Low	No Flood

6. RESEARCH METHODOLOGY

6.1 Type of Research

In data analysis research, qualitative data is used, which in this study is experimental, and the types of research carried out are: Library research is data collected by reading papers related to research, citing several expert opinions related to research. Meanwhile, correlational research is a change studied in a system and produces a product according to the required conditions.

6.2 Data Collection Method

In this study, one of the methods used in data collection is research data that can be obtained indirectly, or from existing sources, data used in the last 3 months through the BMKG (Meteorology, Climatology and Geophysics Agency).

A. Research methods

In the design of the system, the authors made one of the main objects, namely water, a water activity, namely the height and low water limit, which will be monitored automatically from ultrasonic sensors, personal computer (PC).

The ultrasonic sensor in this design is used as a water level detector and sends a signal via a microcontroller to send a signal to Amazon, the web service, in the form of a graph. In this system, it is a warning of water level, water level, and water humidity. This system has support in calculating water level, low water, and humidity. In calculations using Fuzzy Tsukamoto, calculation design through python programming language and implemented through jupyter notebook. The results of the correlation calculation will be displayed on the amazon web design service.

B. Test method

The test used in the fuzzification calculation is a programming language and is implemented through a jupyter notebook.

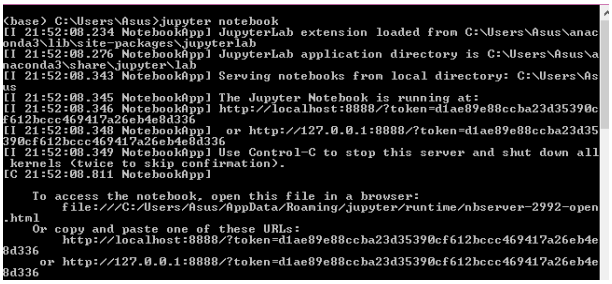

Figure 3 Python View

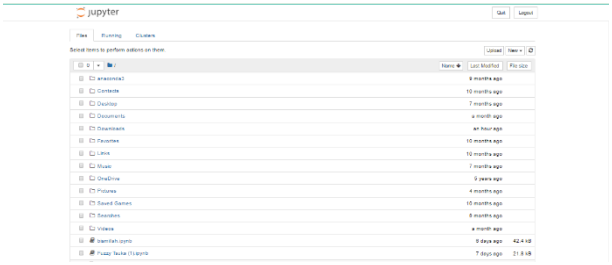

Figure 4 Jupyter View

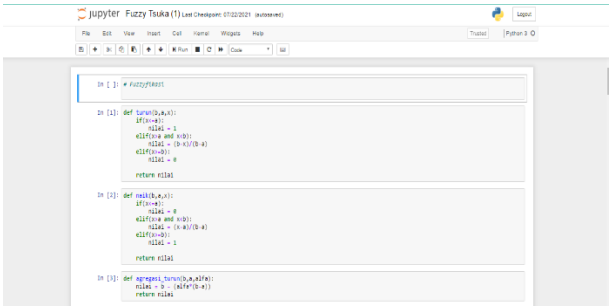

Figure 5 Folder View

6.3 Analysis

System analysis can be defined as a method for finding solutions to existing system problems by grouping existing components into smaller components so that the solutions found are under system requirements and system design.

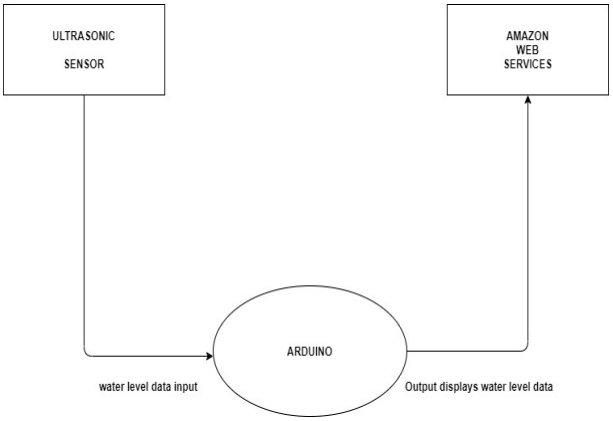

Figure 6 System Design.

Implementation of the development of Fuzzy Tsukamoto to detect flood disasters in the Citarum River and design a flood detection system in the Citarum River begins by collecting some data on the causes of flooding in the Citarum River. In Figure 6, it is explained that the ultrasonic sensor inputs water level data into the microcontroller and then, after inputting water level data through the microcontroller, it will output an output to display water level data via the Amazon web service. The essence of the above explanation is in Figure 6

7. CONCLUSION

The data information in question is an information system for processing river water level calculations using the Tsukamoto fuzzy method so that the following data is needed: Data related to water level, Tsukamoto fuzzy data, namely: fuzzification, inference, defuzzification starting from inputting the fuzzy set value, calculating the water level and low water then determining the humidity, defuzzification, and finally removing the data no flooding.

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