THE IOT-BASED EARLY WARNING AND MITIGATION SYSTEM FOR ROB FLOOD DETECTION IN SEA WATERS AT KAMPUNG IKLIM, TAMBAK LOROK VILLAGE, SEMARANG

ABSTRACT

Background and Objectives: Background and Objectives: Tambaklorok is a coastal area located in Tanjung Mas Village, North Semarang District, Semarang City, Central Java Province, and is one of the largest fishing communities in the area. The Tambaklorok area is vulnerable to sea level subsidence, which often results in tidal flooding in the surrounding residential areas. This research program aims to implement a disaster mitigation system by installing an IoT-Based Early Warning and Mitigation System for Tidal Flood Detection. This system is intended to provide early warning to the community in order to reduce the risk of disasters and their impacts on the Tambaklorok village.**Methods**: The Rob Early Warning System is designed to identify floods using parameters such as seawater level, wind speed, wind direction, and air temperature. The device detects seawater levels using ultrasonic sensors, which are then read by a microprocessor. The data is then processed in a periodic series and sent to a real-time application. The technology may transmit evacuation notifications with predicted timings, allowing inhabitants to leave and reach safe zones.The IoT-Based Early Warning and Mitigation System for Rob Flood Detection will also include community outreach and empowerment activities as supporting activities such as mangrove planting, to support disaster mitigation efforts in the area.**Conclusion:**Conclusion: The installation of an IoT-based Early Warning and Mitigation System for Tidal Flood Detection in Sea Waters in Kampung Iklim, Tambak Lorok Village, Semarang has been successfully completed and has provided enormous benefits to the local community as a means of mitigation and early warning of rising sea water disasters.

Keywords: Tambak Lorok, Community Empowerment, Mangroves, Internet of Things, Rob Early Warning System

1. INTRODUCTION

Tambak Lorok Village is the largest fishing village in Semarang City, located along the coastline of the Java Sea. The village is situated in Tanjung Mas Subdistrict, North Semarang District. It lies at the northern edge of Semarang City, directly adjacent to the Java Sea, specifically along the banks of the Banger River. Administratively, this area is part of the Tanjung Mas neighborhood in North Semarang. The area covers approximately 84.48 hectares. Geographically, Tambak Lorok is bordered by the Java Sea to the north, Yos Sudarso Arterial Road to the south, PT. Indonesia Power Gas and Steam Power Plant Semarang to the west, and Banger River to the east. The Tambak Lorok area is characterized by low-lying land with an elevation of 0.5 meters above sea level. The soil in this region consists of weathered and sedimentary structures, making it prone to land subsidence at an estimated rate of 10 cm per year. [1]. Tambak Lorok is utilized for a variety of purposes in addition to housing, including trade and services, fish landing sites, warehouses, education, religious activities, and sociocultural events. The region is mostly used for fish farming activities. [2]. The primary potential of Tambak Lorok Village lies in its seafood production. The presence of Fish Landing Stations and Fish Auction Places plays a significant role in the local economic development of the coastal area and provides employment opportunities for the local community. The residents of Tambak Lorok utilize marine resources, such as shrimp and small fish, to produce shrimp paste (terasi). Additionally, the community also processes mangroves into snacks or chips, representing a form of utilizing natural resources for economic benefit.[3]

Tambak Lorok, as a climate village located in the coastal area of Semarang, is vulnerable to the threat of tidal flooding (rob). Land subsidence in the area exacerbates the occurrence of rob floods. With a population of approximately 9,000 people, the residents of Tambak Lorok face significant risks if tidal flooding occurs[4]Tidal flooding poses considerable concerns, including the possibility of loss of life and damage to residential structures. Given the probable future hazards posed by rob floods, coastal areas require an early warning system. This technology would let locals to plan ahead of time, lowering the risks and consequences of major floods, including as infrastructure damage, loss of life, economic losses in the fishery and tourist industries, and damage to personal and company properties.[5] Based on the occurrences of tidal flooding (rob) in Semarang City, particularly in the northern coastal areas, there is a need for effective and timely evacuation routes and early warning systems.[6]

Current advancements in technology enable the connection of water level monitoring with various devices. This technology is commonly referred to as IoT, which conceptually involves connecting surrounding objects through internet connections. The growing internet infrastructure allows for connectivity with computer networks and various other parameters. MySWL is an IoT service platform designed to facilitate the management and integration of IoT systems across various applications. Some key aspects of the development and features typically offered by platforms like MySWL include: Automatic Alerts: MySWL provides a customizable alert system that notifies users about abnormal conditions or significant eventsNotifications involve sending alerts through various channels such as email, WhatsApp, or mobile applications. The services used in this study include Real-Time Database and WebApp. The WebApp service allows data to be accessed through a web browser, making it easier for the community to monitor river water levels (ESP32)[7]In addition to being accessible via a web browser, the ESP32 also allows access to the Real-Time Database from Firebase over the internet. It includes a warning module that triggers alerts when the water level reaches a certain dangerous threshold.

The IoT-Based Early Warning and Mitigation System for Rob Flood Detection in Sea Waters at Kampung Iklim, Tambak Lorok Village, Semarang is a technology-driven approach designed to address the challenges of Rob floods, which are caused by high tides, rising sea levels, or other coastal factors. The IoT-based system aims to enhance the resilience of Kampung Iklim and Tambak Lorok Village against Rob floods by providing timely information, enabling proactive measures, and ultimately protecting lives and property.

2. RESEARCH METHODS

This research was conducted using an experimental method to test the author's hypothesis, where ultrasonic sensors were employed for water level measurement and a MySQL platform was used to develop the Early Warning System.[8] The research process was carried out systematically, involving activities such as formulating ideas, reviewing literature, developing prototype design concepts, implementing the design in several phases, and then integrating all components into a complete system[9]

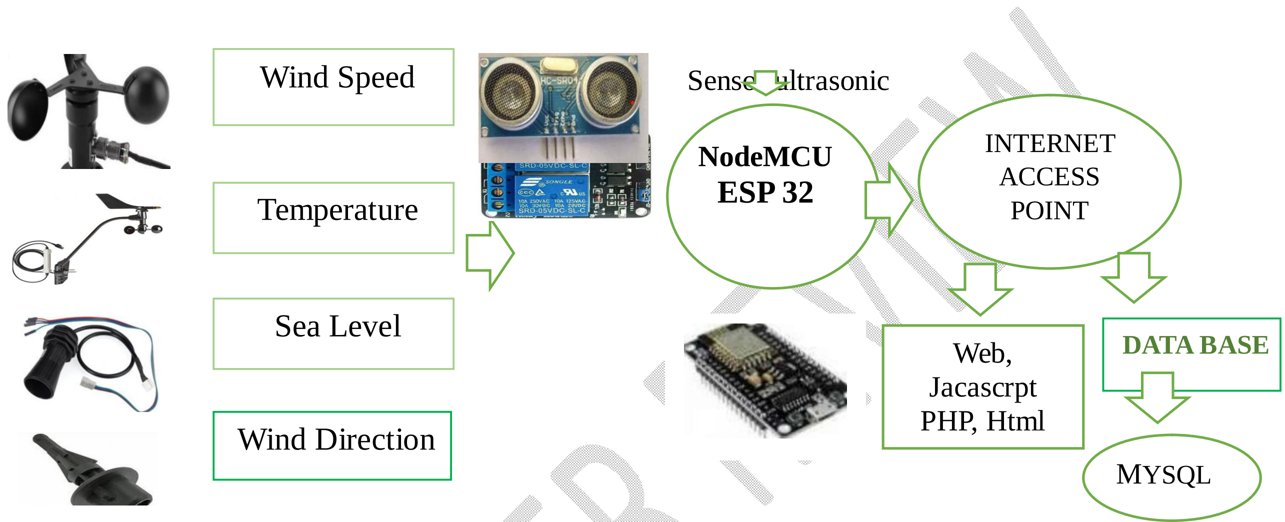


Fig 1. Diagram Rancangan Sistem

General System Flow Design is the process of designing how a system functions as a whole, from input to output, and how each component interacts with one another. Figure 1 illustrates the system flow design. It shows that the NodeMCU ESP32 microcontroller is used as an IoT device to process data with a custom program. The data is received based on input from an ultrasonic sensor that measures the distance to the water surface. Once the data is received, it is processed by the microcontroller according to the programmed distance thresholds. If the water level data meets the pre-defined conditions, it will be displayed on a website. Additionally, if the data falls within the Alert or Danger status, an alarm will sound to indicate the emergency.

3. RESULTS AND DISCUSSION

Database Design

Database design is crucial for creating systems that require data processing and management. For an early flood detection system using MySQL [10]database, the database design must support efficient data storage, retrieval, and processing to ensure accurate and timely flood monitoring

Table 1. Table Design

tb_sensor	Nama Field	Id	Sensor	Tanggal
	Tipe Data	Int	int	Timestamp

	Panjang ukuran	Auto increment	11	Auto

The tb_sensor table is used to store data collected from sensor devices. This data may include various types of information such as temperature, wind speed, wind direction, and sea water level as generated by the sensors. The tb_sensor table can be modified and customized based on the specific needs of the system or application being used. The table name follows a common naming convention, where tb is an abbreviation for "table," and sensor indicates that the table is related to sensor data.

User Table:
CREATE TABLE tb_users (id INT AUTO_INCREMENT PRIMARY KEY, username VARCHAR(50) NOT NULL, email VARCHAR(100), created_at TIMESTAMP DEFAULT CURRENT_TIMESTAMP);
Product Table
CREATE TABLE tb_products (id INT AUTO_INCREMENT PRIMARY KEY, product_nameVARCHAR(100) NOT NULL, price DECIMAL(10, 2) NOT NULL, stock_quantity INT DEFAULT 0);
Usage in Queries
Menambahkan Data: INSERT INTO tb_users (username, email) VALUES ('johndoe', 'john@example.com');
Retrieving Data By ID:
SELECT * FROM tb_users WHERE id = 1;
Updating Data By ID:
UPDATE tb_users SET email = 'john.doe@example.com' WHERE id = 1; DELETE FROM tb_users WHERE id = 1;

Water Surface Level Reading Hardware

The hardware for reading water surface levels consists of an ESP32 microprocessor integrated into an integrated board (Wemos D1 Mini). The water surface level is measured using an ultrasonic sensor, specifically a waterproof type known as JAVASCRIFT. [11]This JavaScript-based module emits ultrasonic waves after receiving a trigger pulse of at least 100 microseconds (μs). The echo pin will switch to High after the ultrasonic module completes sending the waves, and it will switch to Low after receiving the feedback or after 38 milliseconds (ms) if the object is at a certain distance. For ultrasonic sensors, 1 ms of travel time is equivalent to 0.0343 cm of distance (round trip), so 38 ms corresponds to approximately 650 cm (or 6.5 meters). The ultrasonic module uses sensors like the HC-SR04, which require a trigger signal to measure distance. Microcontrollers or development boards such as the ESP32 or Raspberry Pi can be used to interface with the ultrasonic sensor[12]JavaScript controls and processes the signals, particularly if using a server like Node.js or a Web Server on the ESP32[13]. IoT-Based Early Warning and Mitigation System for Rob Flood Detection in Sea Waters Using JavaScript and MySQL. In this IoT-based early warning and mitigation system for rob flood detection, various technologies are integrated to monitor, analyze, and respond to sea conditions that may lead to tidal flooding. The following are the general steps and components involved in the system:

1. System Components

a) IoT Hardware

a. **Water Level Sensor:** Measures sea water height in real-time. Examples include ultrasonic sensors or pressure sensors.
b. **Communication Module:** A module for sending data from the sensor to the server. Examples include ESP32 with Wi-Fi.
c. **Power Supply:** Provides power to the IoT devices.

b) Backend Software

a. **Server:** Handles data from sensors, stores data, and executes processing logic. Node.js can be used as the server.
b. **Database:** MySQL for storing sensor data and related information.

c) Frontend Software :User Interface: Web application for monitoring data and receiving alerts, using JavaScript.

2. System Design

a) Sensor and Development Board Connection

1. **Water Sensor:**
   a) Connect the water level sensor to a development board like ESP32.
   b) The sensor will measure water height in real-time and send data to the ESP32.
2. **ESP32:**
   a) Collects data from the sensor.
   b) Sends data to the server via Wi-Fi.

b) Server Setup

1. **Node.js Server:**
   a) Provides API endpoints to receive data from the sensor.
   b) Processes the data and stores it in the MySQL database.
   c) Provides APIs for the frontend application to display data and alerts.
2. **MySQL Database:**
   a) Stores sensor data, configuration, and related alert information.
   b) Possible table structures:

sql

Salin kode

```
CREATE TABLE sensor_data (
id INT AUTO_INCREMENT PRIMARY KEY,
sensor_idVARCHAR(50),
timestamp TIMESTAMP DEFAULT CURRENT_TIMESTAMP,
water_level FLOAT
);
CREATE TABLE flood_alerts (
id INT AUTO_INCREMENT PRIMARY KEY,
```

```
alert_time TIMESTAMP DEFAULT CURRENT_TIMESTAMP,
water_level FLOAT,
alert_message TEXT
);
```

c) Early Warning System Setup

1. **Flood Detection Logic:**
   a) Define a water level threshold that indicates a risk of rob flooding.
   b) Implement logic on the server to check incoming data and generate alerts if the water level exceeds the threshold.
2. **Alert Delivery:**Store alerts in the database and send notifications via email or SMS if required.

3. Implementation

Code node.js to collect and process data

javascript

Salin kode

```
const express = require('express');
const mysql = require('mysql');
const app = express();
const port = 3000;
app.use(express.json());
// MySQL connection
const connection = mysql.createConnection({
host: 'localhost',
user: 'root',
password: ",
database: 'flood_detection'
});
connection.connect();
// Endpoint to receive sensor data
app.post('/api/sensor', (req, res) => {
const { sensor_id, water_level } = req.body;
const timestamp = new Date().toISOString();
 // Save data to MySQL
const query = 'INSERT INTO sensor_data (sensor_id, water_level, timestamp) VALUES (?, ?, ?)';
connection.query(query, [sensor_id, water_level, timestamp], (err, results) => {
if (err) throw err;
// Check for flood alert
if (water_level> 100) { // Example threshold
const alertMessage = 'Flood warning: water level is too high!';
const alertQuery = 'INSERT INTO flood_alerts (water_level, alert_message) VALUES (?, ?)';
connection.query(alertQuery, [water_level, alertMessage], (err, results) => {
if (err) throw err;
console.log('Flood alert saved to database.');
```

```
});
}
res.send('Data received');
});
});
app.listen(port, () => {
console.log(`Server running on http://localhost:${port}`);
});
```

Kode JavaScript untuk Frontend

Gunakan framework seperti React atau Vue.js untukmembangunantarmukapengguna.:

html

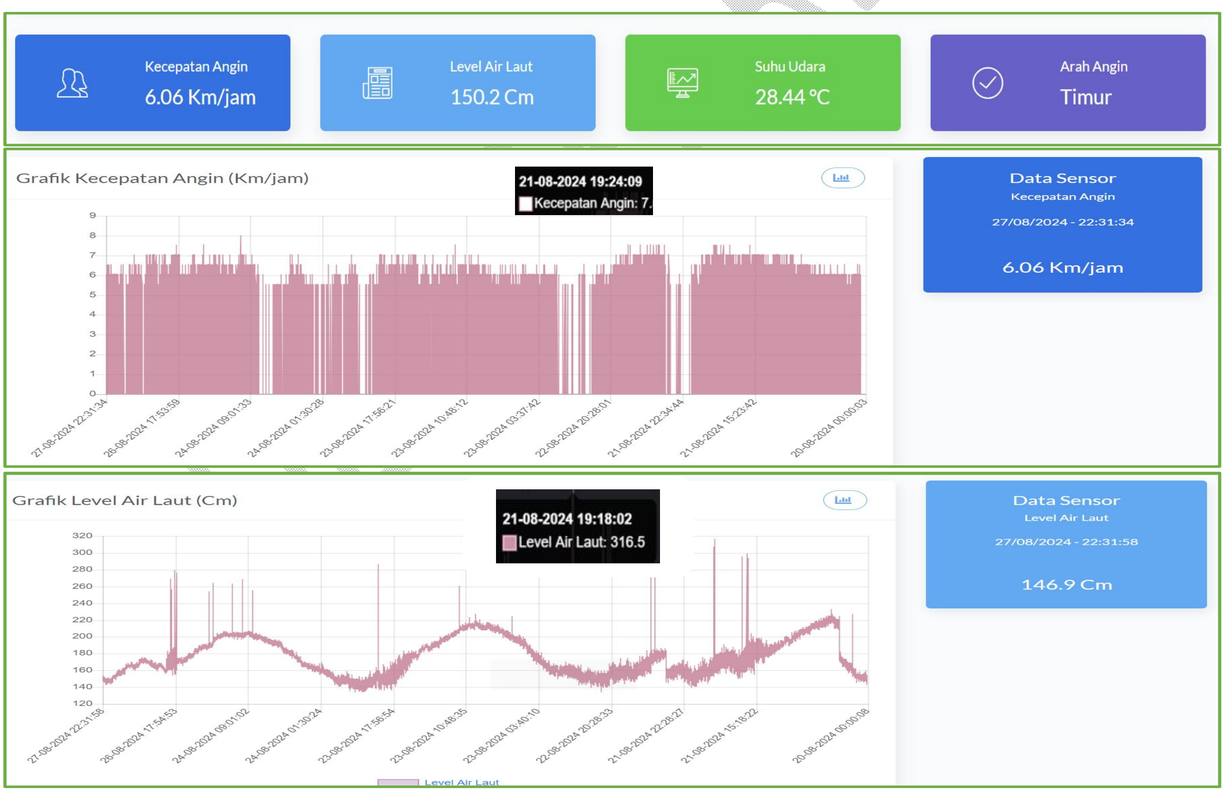
Salin kode

```
<!DOCTYPE html>
<html lang="en">
<head>
<meta charset="UTF-8">
<meta name="viewport" content="width=device-width, initial-scale=1.0">
<title>Flood Detection Dashboard</title>
</head>
<body>
<h1>Flood Detection Dashboard</h1>
<div id="alerts"></div>
<script>
async function fetchAlerts() {
const response = await fetch('http://localhost:3000/api/alerts');
const data = await response.json();
const alertsDiv = document.getElementById('alerts');
alertsDiv.innerHTML = '';
data.forEach(alert => {
const alertElement = document.createElement('div');
alertElement.textContent = `Alert at ${alert.alert_time}: ${alert.alert_message}`;
alertsDiv.appendChild(alertElement);
});
}
fetchAlerts();
setInterval(fetchAlerts, 10000); // Refresh alerts every 10 seconds
</script>
</body>
</html>
```

Setting the sensor reading interval, water level change data can be obtained periodically. In this study, the interval used is one minute, which means the data reflects the change in water level per minute. With this interval, data is also sent to MYSQL Realtime Database. To send data to Realtime Database, ESP32 requires internet access, which requires an internet access point.The

Realtime Database is set up to hold four sorts of data: water level, temperature, wind speed, and wind direction. As previously stated, the Rate of Change is the change in water level measured in centimeters per minute. With data on the rate of change per minute, both the online monitoring gadget and the warning gear can forecast the likelihood and time of floods. To access the Realtime Database, a communication configuration in JavaScript format must be constructed.

Warning Hardware. The warning hardware also requires a microprocessor with internet connectivity. The device used in this study is the ESP32, which reads data from the JavaScript Realtime Database. A siren was chosen to provide varying warning signals. When the water level approaches critical levels and the rate of change is still increasing, the microprocessor issues early warnings with a siren under two critical conditions: approximately 15 minutes and 5 minutes before flooding occurs (210 cm-250 cm and > 250 cm).Testing Results :The web monitoring prototype built in this study includes a system for monitoring sea surface water levels that can be accessed publicly through a web browser. The data displayed in the browser is updated in real-time according to the data in the Realtime Database. The monitoring system is used to observe changes in the Realtime Database simultaneously. The display, accessible through a web browser, is as follows:



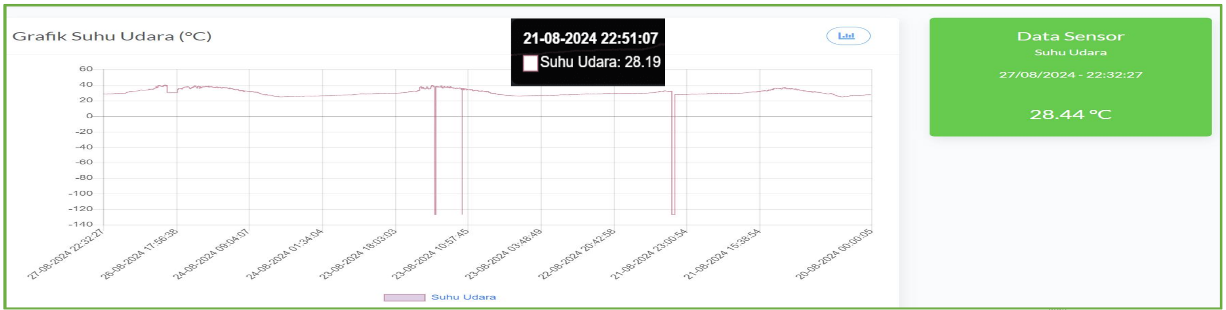


Figure 2. Parameter display on Web SensorKu

Figure 3. Condition of R-EWS installation location

CONCLUSION

Rob-EWS has become an effective tool in reducing the risk of tidal flood disasters in Tambak Lorok Village in Semarang City. Early detection capabilities, combined with robust data analysis and timely notification, have made a significant contribution to reducing the impact of tidal floods. Continued improvement and expansion will further enhance the effectiveness and resilience to future flood events.

DATA AVAILABILITY

All necessary data has been assembled along with accompanying documentation. This study will help researchers identify crucial areas of the Web-Based ROB Disaster Mitigation Information System in Tambak Lorok Village, Semarang, Central Java.

CONSENT

The author(s) have gathered and archived respondents' written consent in accordance with international or university standards.

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