Sensor System Design for Tsunami Early Warning System

Muhammad Ary Murti
Tel-U IoT Center, Telkom University
Jl. Telekomunikasi No. 1, Terusan Buah Batu, Bandung, 40257 INDONESIA
E-mail: *arymurti@telkomunievrsity.ac.id*

***Abstract*—Tsunami Early Warning System needs sensor system to detect symptoms of tsunami such as the earthquake, eruption of volcanoes in the sea, as well as the sudden reflux of sea water.**

This project focus on the sensor system to sensing of tsunami symptoms parameters and transfer the data to IoT Platform. The parameters are earthquake and sea wave condition such as waveform slope, sea water level.

***Index Terms*— tsunami, sensor system**

I. Introduction

Tsunami comes from the Japanese word that is, tsu means port and nami means wave. In some cases, tsunamis are equated with tidal waves. Tsunami waves are one of the natural disasters that have a huge destruction of land. Tsunamis occur due to sudden disturbances on the seabed, including earthquakes, undersea volcanic activity, and landslides near the coast.

The size of the tsunami wave is very much determined by the characteristics of the earthquake which triggers it with the characteristics of the wavelength produced by 1 to 1000 Km, with the time span of the disaster between 5 to 100 minutes, wave velocity ranging from 1 to 200 ms-1, and wave elevation can reach 10 to 30 meters in coastal areas [2].

According to the Japan Meteorogical Agency, tsunami warnings for a location can be detected altitude after 3 minutes of an earthquake. Where the height of the water surface is seen from changes in the average seal level. The height can be divided into two, namely "Huge" where the height reaches 5-10 meters, and "High" for altitudes above 3 meters. [7]

II. Sensor System

A. Sea Sensor System

Preliminary sensor system has been design using Gyroscope MPU-6050 to measure sea waveform slope and BMP-180 to measure sea level. Fig 1 and 2 shown the block diagram of tsunami sensor system and the hardware realization.

Penelitian ini didanai oleh LPDP RISPRO dengan judul PATRIOT-Net No. PRJ5/2018, 2018-2021.

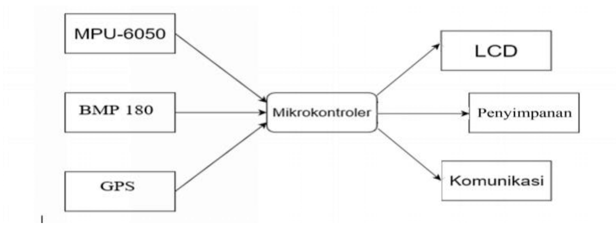

Fig. 1. Block Diagram of Tsunami Sensor System

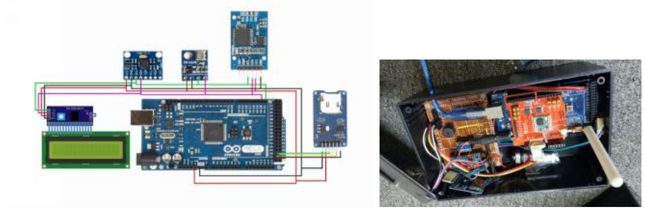

Fig. 2. Hardware Realization of Tsunami Sensor System

B. Earthquake Sensor

As preliminary design, we used accelerometer adxl 335 and vibration sensor LM393-801S . Fig 3 and 4 shown the block diagram of earthquake sensor system and the hardware realization.

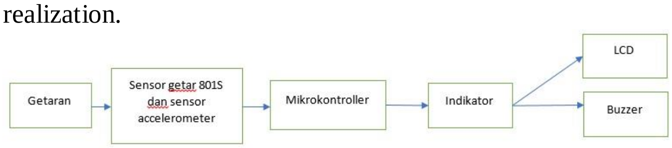

Fig. 3. Block Diagram of Earthquake Sensor

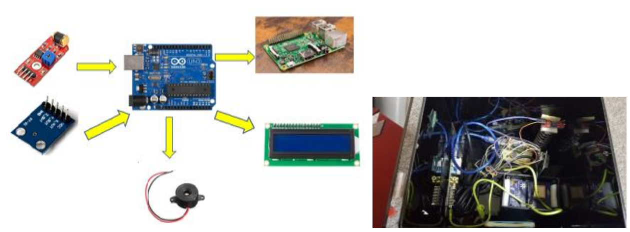

Fig. 4. Hardware Realization of Earthquake Sensor

III. Communication to IoT Platform

A. LPWAN : LoRa

Dragino LoRa Shield is a remote transceiver in Arduino Shield and uses the open source library. LoRa Shield allows users to send data and reach very long distances with low data consumption.

Dragino LoRa Shield is also compatible with Arduino Uno, Mega, Leonardo, and DUE. Dragino LoRa Shield uses a Semtech SX1276 / SX1278 chip that can emit a frequency band of 915 MHz. Dragino LoRa Shield can achieve a sensitivity of more than -148dBm. Compared to LoRa transceivers, other manufacturers such as Adafruit, Waspmote, and others is Dragino LoRa Shield far more practical to use because there is no need for additional cable or jumper connections to connect it to the microcontroller. The following Fig 5 is the complete appearance of the Dragino LoRa Shield 915 MHz

Fig 5. Dragino LoRa Shield 915 MHz

B. *Satellite Communication : Iridium*

Rockblock Mk2 is a communication module that is equipped with an Iridium SBD transceiver modem. With the modem the user can enjoy the Iridium SBD Satellite service. The service allows users to send and receive messages with a maximum size of 200 bytes. The reach of this service is all over the world. To send or receive messages, users only need to make sure Rockblock can get a direct view of the sky [6].

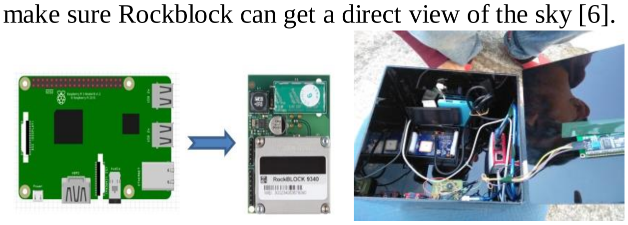

Fig 5. Satellite Communication

IV. Analysis

Earthquake detection devices based on vibration and accelerometer sensors is compared to Modified Mercalli Intensity (MMI) scale. Accuracy of the 801S sensor testing is 90%.

The accuracy test for MPU-6050 is 96.86%, and 76.54% for BMP-180 sensor.

The average delay of LoRa communication test is increased from 2.56 s for 1 meter to 3 s for 2 Km. It's caused by RSSI value, from -31.77 dBm to -95.88 dBm.

The disadvantage of satellite communication using Rockblock Mk2 is influenced by weather which is transmission delays rise up to 4 s when the weather is cloudy.

V. Conclusion

We expect more accurate sensor for tsunami and earthquake parameters with appropriate testing will be done for next term.

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