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An Enhanced Tsunami Detection System

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ABSTRACT: Investigation of an optimized model and the behavior of the properties of Tsunami waves and nature of the earthquake based on Accelerometer, float level sensor and Microcontroller is the main objective of the research paper. Models that describe different components of the Tsunami detector are addressed and their implementations into Proteus and PCB are described. Tsunami is hazards that threaten many countries. To protect people from this hazard, a warning system must rapidly and effectively provide critical information to those at risk to motivate them to take appropriate actions to save their lives. The proposed Tsunami detector model has a set of accelerometer, Float level sensor, microcontroller and buzzer which detects the Tsunami waves as well as earthquake. Simulation and practical implementation results show that the controllers can detect earthquake as well as Tsunami waves very precisely under the hazard conditions. The controllers show very good dynamic and transient performances.

KEYWORDS: *Tsunami, seismic energy, accelerometer, prototype, inverter.*

1 INTRODUCTION

Most tsunamis are generated by major earthquakes in the Pacific. Depending upon the location of the earthquake, tsunami waves can strike island coasts within minutes to hours. To protect people from these hazards an effective tsunami early warning system has to introduce. Early detection by the monitoring networks of tsunami warning centers (TWC) will trigger authoritative warnings that must immediately trigger emergency responses by emergency management and first responder agencies. The introduction of software decision support tools that can be used by stakeholder agencies involved in tsunami early warning. The training seminars will discuss PTWC and the country's tsunami warning and emergency response standard operating procedures and highlight considerations in effectively mitigating against tsunamis [1].

2 NATURE OF EARTH QUAKE & TSUNAMI

The main parts of the gearless WECS are the wind-turbine, the permanent magnet synchronous generator, the back to back converters with their control, and the pitch controller. A 3 MW direct drive wind turbine unit is considered for this analysis.

2.1 SEISMIC WAVE NATURE/ SEISMOLOGY

Seismic waves are the waves of energy caused by the sudden breaking of rock within the earth or an explosion. They are the energy that travels through the earth and is recorded on seismographs

There are several different kinds of seismic waves, and they all move in different ways. The two main types of waves are body waves and surface waves. Body waves can travel through the earth's inner layers, but surface waves can only move along the surface of the planet like ripples on water. Earthquakes radiate seismic energy as both body and surface waves [2].

2.2 Generation Mechanisms of Tsunami

The principal generation mechanism or cause of a tsunami is the displacement of a substantial volume of water or perturbation of the sea. This displacement of water is usually attributed to earthquakes, landslides, volcanic eruptions and glacier calving or more rarely by meteorites and nuclear tests. The waves formed in this way are then sustained by gravity. Tides do not play any part in the generation of tsunamis [2].

2.3 Seismicity

Tsunami can be generated when the sea floor abruptly deforms and vertically displaces the overlying water. Tectonic earthquakes are a particular kind of earthquake that are associated with the Earth's crustal deformation; when these earthquakes occur beneath the sea, the water above the deformed area is displaced from its equilibrium position. More specifically, a tsunami can be generated when thrust faults associated with convergent or destructive plate boundaries move abruptly, resulting in water displacement, owing to the vertical component of movement involved. Movement on normal faults will also cause displacement of the seabed, but the size of the largest of such events is normally too small to give rise to a significant tsunami [3].

Tsunamis have a small amplitude (wave height) offshore, and a very long wavelength (often hundreds of kilometres long, whereas normal ocean waves have a wavelength of only 30 or 40 meters),[4] which is why they generally pass unnoticed at sea, forming only a slight swell usually about 300 millimetres (12 inch) above the normal sea surface. In fig 1 to 4 they grow in height when they reach shallower water, in a wave shoaling process described below. A tsunami can occur in any tidal state and even at low tide can still inundate coastal areas.

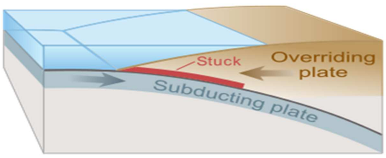

Fig. 1. Drawing of tectonic plate boundary before earthquake

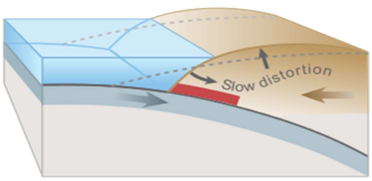

Fig. 2. Overriding plate bulges under strain, causing tectonic uplift

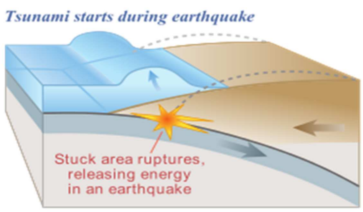

Fig. 3. Plate slips, causing subsidence and releasing energy into water

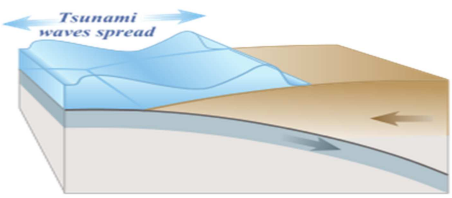

Fig. 4. The energy released produces tsunami waves

3 TSUNAMI WARNING AND PREDICTION

A tsunami cannot be precisely predicted, even if the magnitude and location of an earthquake is known. Geologists, oceanographers, and seismologists analyse each earthquake and based on many factors may or may not issue a tsunami warning. However, there are some warning signs of an impending tsunami, and automated systems can provide warnings immediately after an earthquake in time to save lives. One of the most successful systems uses bottom pressure sensors, attached to buoys, which constantly monitor the pressure of the overlying water column. Regions with a high tsunami risk typically use tsunami warning systems to warn the population before the wave reaches land [5].

Fig. 5. Tsunami warning sign

4 THREE AXIS ACCELEROMETER

Three axis digital accelerometer MMA7361LC is a low power, low profile capacitive micro machined accelerometer featuring signal conditioning, a 1-pole low pass filter, temperature compensation, self-test, 0g-Detect which detects linear free fall, and g-Select which allows for the selection between two sensitivities. Zero-g offset and sensitivity are factory set and require no external devices. The MMA7361LC includes a Sleep Mode that makes it ideal for handheld battery powered electronic [6].

The Free scale accelerometer is a surface-micro machined integrated-circuit accelerometer. The device consists of a surface micro machined capacitive sensing cell (g-cell) and a signal conditioning ASIC contained in a single package. The sensing element is sealed hermetically at the wafer level using a bulk micro machined cap wafer. The g-cell is a mechanical structure formed from semiconductor materials (polysilicon) using semiconductor processes (masking and etching). It can be modeled as a set of beams attached to a movable central mass that move between fixed beams. The movable beams can be deflected from their rest position by subjecting the system to acceleration. As the beams attached to the central mass move, the distance from them to the fixed beams on one side will increase by the same amount that the distance to the fixed beams on the other side decreases. The change in distance is a measure of acceleration. The g-cell beams form two back-to-back capacitors. As the center beam moves with acceleration, the distance between the beams changes and each capacitor's value will change,

$C = A\varepsilon/D$ (equation 4.1)

Where A is the area of the beam, ε is the dielectric constant, and D is the distance between the beams. The ASIC uses switched capacitor techniques to measure the g-cell capacitors and extract the acceleration data from the difference between the two capacitors. The ASIC also signal conditions and filters (switched capacitor) the signal, providing a high level output voltage that is radiometric and proportional to acceleration [7].

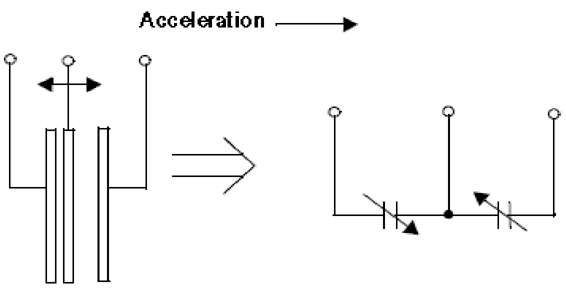

Fig. 6. Control structure for generator side frequency converter

5 Earthquake Detection Process

A water level sensor and an accelerometer MMA7361LC is connected with PIC16F876A. Microcontroller also connected with a buzzer. PIC16F876A interfaces with 16*2 LCD display in fig. 7 [8]. When a seismic shake occurs then the accelerometer senses the vibration. Vibration causes the change of g of accelerometer. The sensitivity of the accelerometer is 800 mV/g in 1.5g g-range setting. In this project setup g-range is selected in 1.5g.

The change of g provides a voltage change in microcontroller. The microcontroller is selected in Timer0 and Timer1. When the change of voltage occurs in microcontroller, it is transmitted to LCD display for providing visualization facility. Again when water reaches to a float level of water level sensor buzzer comes out to perform and LCD show the result as float detect through the microcontroller. If water level reaches high and touch the point tsunami alert of the sensor then buzzer gets alarm notification through microcontroller and also LCD shows the result as Tsunami Alert.

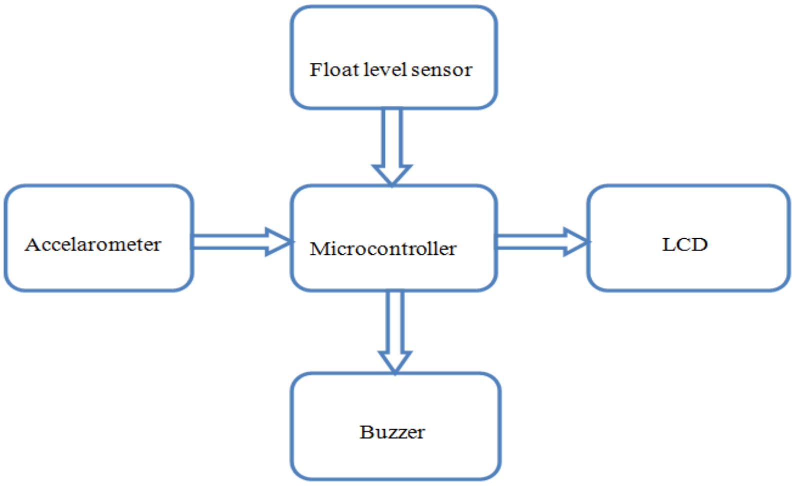

Fig. 7. Block Diagram of Earthquake Detection Process

6 Prototype Of Tsunami Detector

This thesis works mainly based on the detection process of accelerometer MMA7361LC and water level sensor which is connected with PIC16F876A. PIC16F876A interfaces with 16*2 LCD display for showing the generated signal. Fig. 8 shows the circuit arrangement of the water level sensor. This circuit contains two parts, one is low level sensing and another is high level sensing. There operational amplifier is used to sense the water level of flood causes by Tsunami.

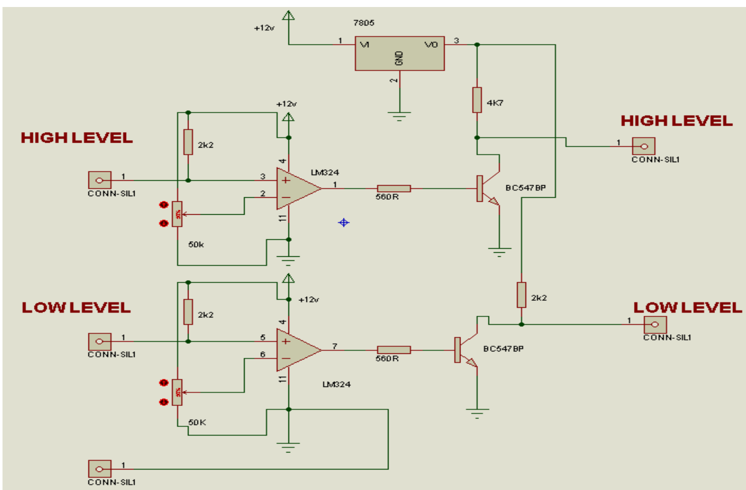

Fig. 8. Water Level Sensor Diagram

In Fig. 9 different parts of the Tsunami detector has been shown. There two sensor parts is shown to detect earthquake and tsunami. A microcontroller used for logical performance, LCD used to visualize the information; a real time clock is used to provide time information. The circuit is drawn by Proteus.

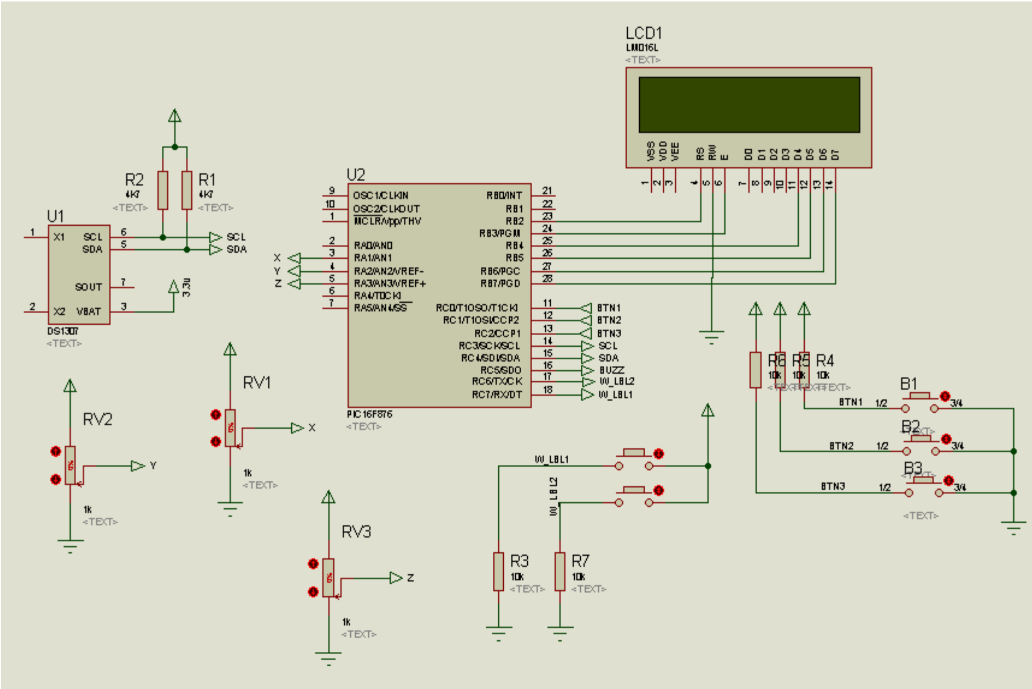

Fig. 9. Schematic Circuit Diagram of Tsunami Detector

A voltage regulator is used to convert the voltage from an upper level to a lower level. A switching regulator converts the dc input voltage to a switched voltage applied to a power MOSFET or BJT switch. The voltage regulator generates a fixed output voltage of a preset magnitude that remains constant regardless of changes to its input voltage or load conditions. The device accelerometer used to detect seismic motion. When GS pin connected with ground it can detect seismic motion up to 1.5 g. The sensitivity of the accelerometer is 800 mV/g in 1.5g g-range setting. Accelerometer gives signal of vibration as voltage to a microcontroller. A water level sensor is used to detect tsunami. It gives two alarm notifications, one in low level and another in high level of flood. Here used an operational amplifier LM324 for sensing the water level. The microcontroller interfaces with a LCD by 4bit mode. The LCD shows the information of vibration as magnitude, date, month and year and the information flood as Float detect for low level alarm and as Tsunami Alert for high level of water. An internal EEPROM of micron roller used to record previous data. Also a real time clock are used to run the clock .When a seismic motion occurs above predetermined threshold value or flood cross its predetermined level, the buzzer comes to performance. It started to ring for awakening people.

7 Result And Discussion

The project has been implemented at our laboratory. The output of the project was run according to the prescribed condition. Here two points have been considered to discuss.

Point 1: Practical implementation

Control means ability to turn on, turn off a machine whenever we want to and in this project it is done. Fig. 10 shows the whole arrangement of the project. In this project 12V power supply, wiring cables, voltage regulators, Buzzer Alarm, operational amplifier and microcontroller IC are used. Connecting all the components according to the circuit diagram desired output is achieved clearly.

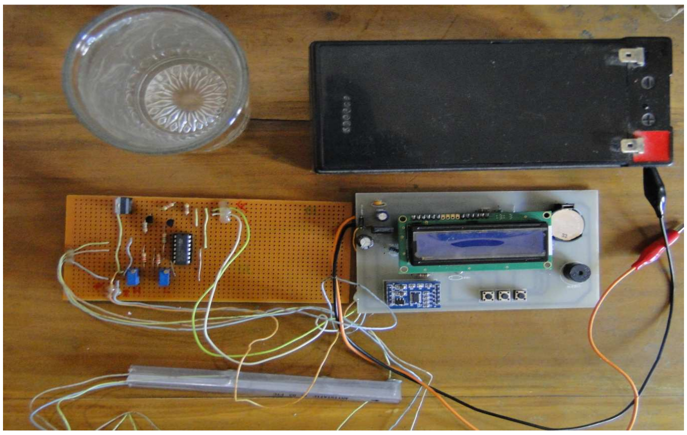

Fig. 10. Whole Arrangement of the Project

POINT 2: OUTPUT OF THE PROJECT

Microcontroller is the heart of this system, which controls the overall operation of the system & always alert for receiving data & that data can be displayed on the LCD (Liquid Crystal Display) through the LCD driver as output in fig. 11 and 12 and 13. When an earthquake occurs accelerometer senses it by the g-cell in capacitive form & convert this signal to voltage by the capacitive-voltage converter and send this signal to buzzer & LCD for alarm notification through microcontroller.

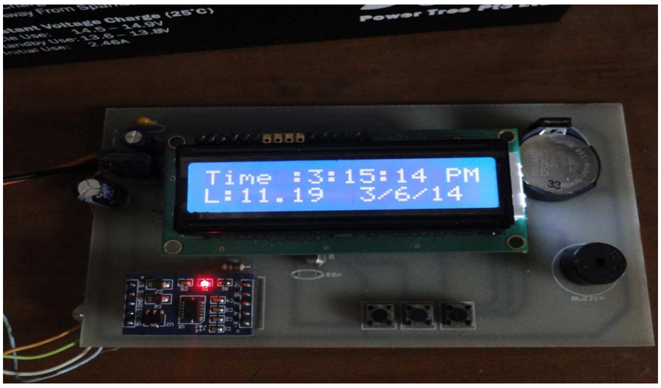

Fig. 11. Earthquake Detected by the Accelerometer

When water level of sea rises water level sensor will sink by the water, after reaching water to the second level of sensor buzzer do alarm & LCD shows float detected shown in fig. 12.This alarm counted as primary warning.

If gradually water level of sea rises high to high the 3rd level of sensor will flood, buzzer will get voltage signal through microcontroller & will continuously ringing. This will detect as final warning of tsunami & LCD will show tsunami alert show in fig. 12.

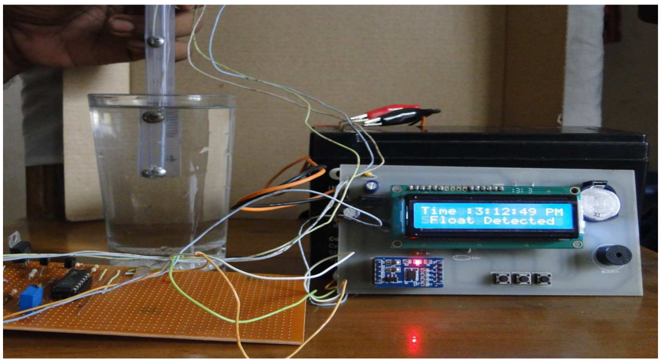

Fig. 12. Float Detected By The Water Level Sensor

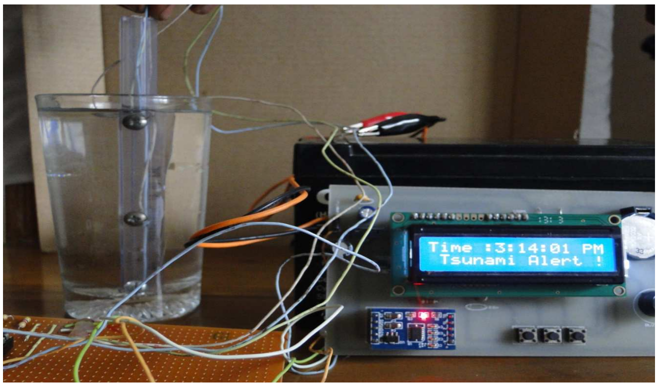

Fig. 13. Detect Tsunami Alarm by the Water level Sensor

8 CONCLUSION

Now-a-days many researches are going on to invent a device which may forecast tsunami. Our project aids a small step over it. Our set up cannot predict tsunami but it can detect it faster than previous set ups. In this project LCD shows the time, date & magnitude of earthquake detection and Tsunami alarm notification as well as show the last recorded data. Further research over this project may attribute a huge improvement of existing facility. The success of this project will save many human lives by awaking them in time of earthquake and tsunami before it hits tremendously.

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