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4G - Electronic Prototype to Detect Tsunami and Similar Ocean Water Irregularities

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ABSTRACT

"Tsunami" Japanese meaning "harbor wave" is a natural disaster. Tsunami is a series of waves in ocean caused by an earthquake or volcanic eruption and landslide. Tsunami resembles sea waves having far longer wavelength. They resemble a rapidly rising tide, therefore tsunami are often referred to as 'tidal waves'. The Tsunami generates wave heights of tens of meters and their destructive power can be enormous and they can affect entire ocean basins. A typical wave period for a damaging tsunami is about twelve minutes. Meaning thereby the powerful and high velocity sea waves reaches the sea shore after twelve minutes from the instant when the under water earthquake occurs. At present there are 'tsunami warning systems' for the detection of tsunami before it arrives so that the loss of life and property could be minimized. The present systems that are solely dependent on satellite are very expensive, the satellite surveillance fails to detect the under water movement, the present systems are less reliable, also they are not a fully 4G systems for detection of tsunami or similar ocean water irregularities. So, efforts have been made here to put forth a 4G - Electronic prototype which is an embedded system using multi-sensors providing a real time output. This proposed system is a reliable and suitably sensitive system for continuous monitoring of tidal waves. It contains more than one sensor to provide redundancy in case one of the sensor units fails.

Keywords: Tidal waves, multi-sensor, communication, hardware, software

I. BACKGROUND

Tsunami is also termed as tidal waves. It is a series of waves in a water body caused by the displacement of a large volume of water, generally in an ocean. Tsunamis generally consist of a series of high velocity, increased height and powerful waves arriving on the sea shore in twelve to fifteen minutes. Tidal waves of tens of meters can be generated by large events causing enormous destruction of life and property. Although the impact of tsunamis is limited to coastal areas, their destructive power can be massive and they can affect entire ocean basins.

Era demands to serve a brief warning of tsunami to the people on the shore as well as to the entire world so that, the helping hands from the entire world can spread their wings immediately to save the victims of tsunami. The proposed system accomplishes this task of giving early warning. If people on the sea shore are served with a prior 10 to 15 minutes of brief warning then they can survive provided that they immediately run for high ground or seek the upper floors of nearby buildings.

In 2004, a tsunami was caused due to the earthquake in the Indian Ocean whose magnitude was around 9.2 ; it was the deadliest tsunami that killed roughly 2,30,000 people.

In 2006, a tsunami was caused in the java island due to an earthquake in the Indian Ocean whose magnitude was around 7.7.

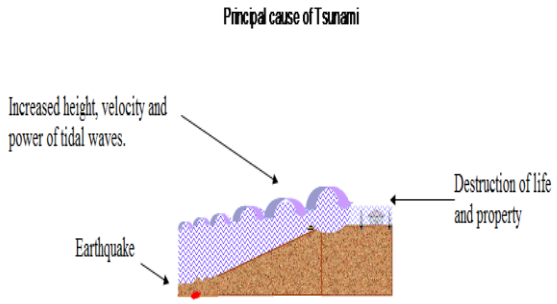

Figure 1

II. METHODOLOGY

Three methods of tidal observations are well known.

1) Placing number of sensors at appropriate depths and places in the ocean - This method is expensive.

2) Satellite Surveillance – This method is unable to detect the under water movement.

3) Therefore, installation of reliable and suitably sensitive system is preferred for continuous monitoring of tide waves. .The float system is the common form of level measuring system. It consists of a basic tide guage consisting of a stilling well with a float unit and a recording drum attachment. The float is attached to a chain. The chain in turn is attached to a counter weight which indicates the level as the float moves up and down.

The figure 2 shows the basic float type tide guage meter.

Basic Tide Gauge

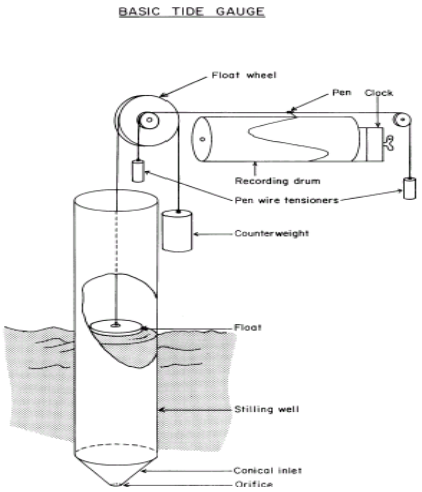

Figure 2

III. PROPOSED SYSTEM

The development tool preferred is Keil micro-vision which was acquired by Arm in the year 2005. It is a popular IDE – originated from Keil software. It is preferred as it includes project management, source code editing, program debugging and flash programming. Along with this it also possesses various other benefits too.

The domain knowledge required for embedded instrument of 4th generation tide guage meter is:

- Physics for sensors and actuators.
- Digital signal processing.
- Communication protocols (TCP/ IP).
- Instrumentation.
- Networking.
- Oceanography.

Figure 3 shows the basic concept of embedded instrument of 4th generation tide guage meter.

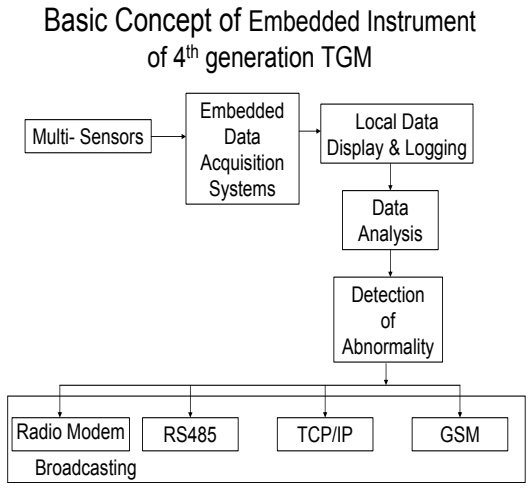

Figure 3

IV. Multi-sensor

Instead of using a single sensor for detection of ocean water irregularities multi-sensors are preferred. The idea behind using a multi-sensor is very genuine. Using more than one sensor provides redundancy in case one of the sensor units fails. Instrumentation is preferred for the measurement and control of the process variables. The process variables used are Level and Pressure.

The following sensors are preferred:

1. Ultrasound Sensor – The principal of operation includes time of flight proportional to the depth of water surface from sensor in air. Now-a-days even there are ultrasound sensors in existence which are capable to work underwater.

Figure 4 shows the ultrasonic sensor

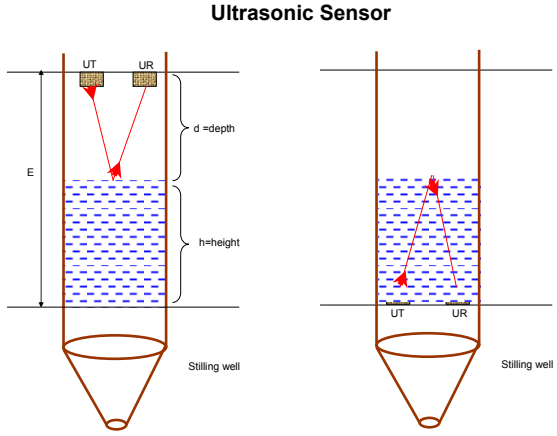

Figure 4

2. Pressure Sensor – The Strain guage type pressure sensor is preferred. The principal of operation includes the input pressure proportional to output voltage. This voltage in turn is proportional to tidal height. Pressure sensor is chosen as they are available in miniature size and high accuracy models capable of 0.05% accuracy. They measure differential pressure as well as extremely low or high pressures.

3. Float / Counter weight System: Absolute Encoding and Incremental encoder are preferred.

Communication

a) GPS

The Global Positioning Satellite enables tide guage for determining location. It provides information related to latitude, longitude and real time tracking.

b) Data transmission modes:

- **RS 485**

  It's works as an electrical interface. It is also known as TIA-485(-A), EIA-485. It is a standard defining the electrical characteristics of drivers and receivers for use in serial communications systems. Digital communications networks implementing this standard can be used effectively over long distances and in electrically noisy environments.

- **Radio Modem**

  Radio modems transfer data wirelessly across a range of up to tens of kilometers. Radio modems is a modern way and it creates Private Radio Networks (PRN). Private radio networks are used to provide real-time data communication. The advantage of radio modems is that it enables the user to be independent of telecommunication or satellite network operators.

- **GSM Mobile**

  A GSM modem acts as a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. The brief warning becomes available on GSM mobile.

- **Hardware and software TCP/IP stack**

  The TCP/IP Internet protocol suite provides end-to-end data communication specifying how data should be packetized, addressed, transmitted, routed, and received on internet.

  A data network is used as a digital telecommunications network. It allows nodes to share resources. The connections between nodes are established using cable media and wireless media.

Hardware requirements

- **ISAC**

  Intelligent Sensor Actuator Controller from ADI provides a 'system on chip' (SOC). It is programmable. ISAC is also termed as "micro-converter". These components from Analog Devices combine a powerful 8051-family microcontroller core, including flash program and data memory, with a multi-channel 12-bit analogue interface which includes an A/D as well as a D/A converter. ADuC831 is preferred as it has its major features on one silicon chip. Its size is very small around 14.15 mm pin-pin.

- **Wiznet Ethernet module**

  WIZnet is the trend leader of Open Source Hardware. Its unique solution, Hardwired TCP/IP technology, in Arduino's Ethernet Shield has been recognized as standard for IoT. WIZnet is the IoT Device Platform Company. Its unique technology – Hardwired TCP/IP provides better performance and stability than any other software Internet connectivity solutions.

Software Requirements

- Software development in embedded C.
- LabVIEW based GUI

  Laboratory Virtual Instrument Engineering Workbench (LabVIEW) provides a system-design platform and development environment for a visual programming language from National Instruments.

Graph

At the instant tide waves increase in height and start reaching the shore it takes around few minutes to reach the shore. Figure 5 shows the plot of tidal height in centimeter versus time in seconds.

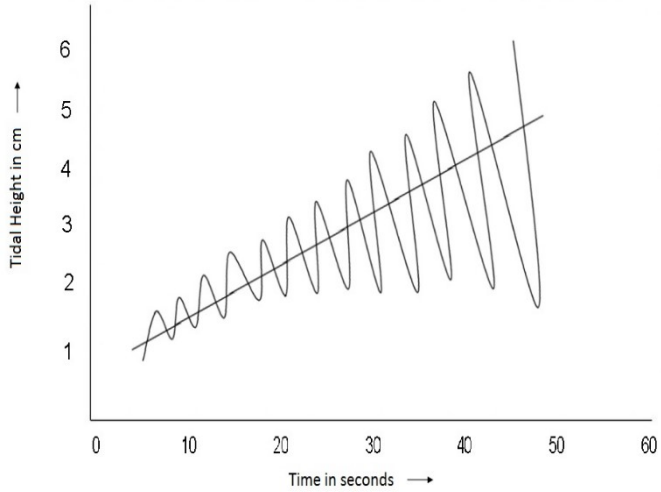

Figure 5

V. CONCLUSION

With the increase in the number of occurrences of the tsunami all over the world, it has become quite essential to develop an efficient tsunami warning system for the detection of tsunami before it arrives. This will ultimately minimize the loss of life and property. As any of the system cannot be hundred percent efficient, so there is always scope to improve the tsunami warning system in terms of speed or accuracy or power consumption, etc. When an earthquake under sea or volcano eruption with landslide is occurring in the sea, then the tsunami warning system can provide sufficient time before the arrival of the tsunami. This proposed work is a step taken to get knowledge of the existing tsunami detection 'the basic tide guage' and to implement a reliable, cost effective and 4th generation technology for detection of Tsunami and similar Ocean water irregularities.

VI. REFERENCES

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