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RF Based Tsunami Detection and Remote Alert System with Siren and Voice Module

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ABSTRACT:
Tsunami causes considerable destruction and loss of lives as well. In this paper, we present the implementation of a prototype of a tsunami detection system to detect the occurrences of tsunami, and also a warning system at a significantly smaller scale. The implementation of the system is based on the principle of variation in wind speed at the time of occurrence of tsunami. It consists of two sections namely transmitter and receiver section. The transmitter section consists of a flex sensor which detects the upcoming tsunami depending upon the abnormal rise in the wind speed. In receiver section this coming wind speed level is compared with the threshold level set in the Arduino Atmega328 microcontroller and if the value exceeds the threshold level, the abnormal condition is shown using a siren and an APR voice module for alerting about the coming tsunami.

Keywords: Flex Sensor, Arduino Atmega 328 microcontroller, Abnormal Condition, APR Voice module.

I. INTRODUCTION

A. MOTIVATION:

Tsunami is a natural calamity which is said to be generated by any disturbance that displaces a large mass of water. A tsunami is a very long-wavelength of water that is generated by earthquakes that cause displacement of the seafloor, but tsunami can also be generated by volcanic eruptions, landslides and underwater explosions that causes displacement of water column vertically upward. Tsunami occur suddenly, often without warning, and hence are extremely dangerous to the coastal communities.
Although we cannot prevent the nature from following its course, we can do a lot in terms of communication, early warnings. The resulting damage can be minimized and lives can be saved if the people living near the coastal areas are already prepared to survive the strike. This requires a warning system.

B. TSUNAMI DETECTION SYSTEM

The flex sensor works on the principle of resistance variation. Due to various wind speeds the flex sensor bends accordingly changing the output voltage every time. This analog voltage is first send to the microcontroller on the transmitter side where the built in ADC converts this analog value to a digital value. This digital value is send via RF transmitter and RF receiver to microcontroller on the receiver side which compares incoming value to the threshold value. If the incoming value exceeds the threshold value then this condition is declared as an abnormal condition.

C. TSUNAMI WARNING SYSTEM

Whenever the siren blows off it is case of an abnormal condition. Simultaneously an APR module plays the recorded message so that the coastal area can be evacuated at the earliest saving damage of lives and property.

II. TSUNAMI GENERATION:

Tsunamis are generated by earthquake, volcanic eruptions, landslides, underwater explosions, meteorite impacts. The tsunamis generated by landslides are tend to be relatively localised and do less damage than the ones that are caused by earthquakes.

A. EARTHQUAKE:

An earthquake is the perceptible shaking of the surface of the earth resulting from the sudden release of energy creating seismic waves. Earthquakes can be strong enough to toss people around and destroy entire cities. At earth's surface the earthquakes manifest themselves by shaking and displacement of the ground. When the epicentre of the earth is located offshore, the seabed maybe displaced sufficiently to cause a tsunami. Earthquakes can trigger landslides, and occasionally volcanic activity.[1]

B. VOLCANIC ERUPTIONS:

A volcanic eruptions occurs when hot materials are thrown out of the volcano, lava, dust, ash and gas are some of the materials. Eruptions can come from side branches or from the top of the branches. Some eruptions are terrible explosions that throw huge amount of rocks and kill many people. Seldom volcanic eruptions are accompanied by the tsunamis.

III. PHYSICAL CHARACTERISTICS OF TSUNAMI:

Tsunamis are not created by tides and are not related to it. As tsunami crosses the deep ocean its length form crest to crest may be hundred miles or more and its height form crest to trough will only be few feet or less. There are various physical characteristics of every wave including tsunami waves such as wave length, wave height, wave amplitude, wave frequency, wave velocity. But in this paper wind speed is our topic of interest. Wind Speed: Speed of the wind During normal conditions the wind speed generated waves travel at 90km/hr. However winds during tsunami are above this range. The wind speed vary from 115 to 320km/hr. Tsunami waves have a velocity of about 970km/hr (600 miles/hr) almost as fast as jet airplanes. When the waves enter the shoaling water the height of the waves eventually increases. It is in these shallow waters that the large tsunami can crest to heights exceeding 100 feet (30m) and strike with devastating force.[2]

IV. HARDWARE DESCRIPTION:

A. FLEX SENSOR:

Flex sensor also called as bend sensors measure the amount of deflection that is caused bending the sensor. When the substrate is bent, the sensor produces a resistance output correlated to bend radius- the higher the radius, the lower the resistance value.[3] The formula for resistance variation is:

$$R = \rho \times (L/A)$$

The resistance value depends upon resistivity, length and area of the sensor. Resistivity always depends upon the material of the sensor so resistance is now dependent only upon the length and the area of the sensor. Here we are using conductive–ink based flex sensor that are fabricated by laying a layer of resistive ink on the plastic substrate. When the sensor is bend the length between the ink spots changes and hence, the resistance changes and as a result the output voltage changes.

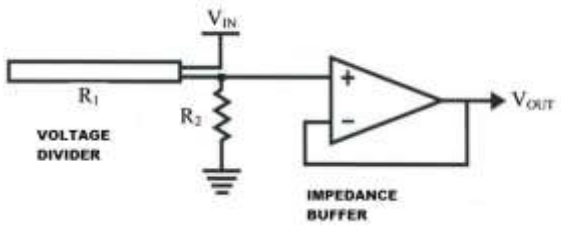

Fig.1 Basic Flex Sensor Circuit

The output voltage V_{out}, is given by the below formula:

$$V_{out} = V_{in} \left[\frac{R_1}{R_1+R_2} \right]$$

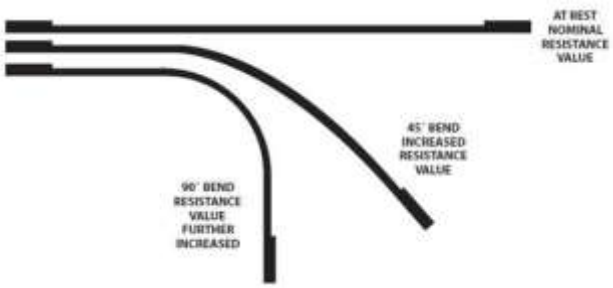

Fig.2 Flex Sensor Bending

B. ARDUINO ATMEGA328 MICROCONTROLLER:

AVR is a series of microcontroller family which is designed by Atmel. ATmega 328 is one of the microcontroller chip that is used with the popular arduino board. Arduino board comes with 1 or 2 microcontroller chips ATmega 168/ATmega 328, ATmega 328 is an upgraded one. It is a 8 bit controller consisting of 28 pins having an in built ADC.

C. HT12E ENCODER:

HT12E is an encoder IC of 2^{12} series of encoders. They are paired with 2^{12} series of decoders for use in remote control system applications. It is mainly used in interfacing RF and infrared circuits. HT12E converts the parallel inputs into serial output. It encodes the 12 bit parallel data into serial for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits.

D. HT12D DECODER:

HT12D is a decoder IC of 2^{12} series of decoders. They are paired with 2^{12} series of encoders and are used in applications like burglar alarms, car door controller, security system etc. In simple words, the decoder converts the serial input into parallel output. It decodes the serial addresses and data received by the RF receiver, into parallel data and sends them to output data pins. The input data code is decoded when no error or unmatched codes are found.

D. RF TRANSMITTER TWS434A AND RF RECEIVER RWS 434:

These wireless transmitters work with our 434 Mhz receivers. They can easily fit into breadboard and work well with microcontrollers to create a very simple wireless link. Since the transmitters communicate data only one way, they must be paired with the receiver.[4] Following are its features:

- 434Mhz
- 500ft range(proper conditions)
- 5V supply range

V. MODULE:

A. TRANSMITTER MODULE:

The transmitter module consists of a flex sensor, a microcontroller, HT12E encoder, RF transmitter and an LCD which displays the various levels of wind speeds. The analog data from flex sensor goes to the 23rd pin of microcontroller which converts this analog data into digital data through an inbuilt ADC and this 4-bit digital data is given to the pin 10,11,12 and 13 of the encoder from the pin 16,17,18 and 19 respectively of the controller. The encoder converts the parallel data into serial data and this serial data is given as the input to RF transmitter.

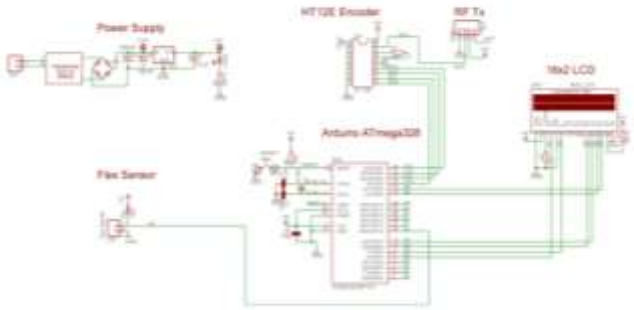

Fig.3 Circuit Diagram-Transmitter Module

B. RECEIVER MODULE:

The receiver module consists of a microcontroller, HT12D decoder, RF receiver, buzzer and an APR voice module. The serial data is received by the RF receiver and this data goes as an input to the decoder at pin no 14. The decoder converts the serial data into parallel data and this 4-bit data is given as an input to pin no 16,17,18 and 19 of the controller from the pin no 10,11,12 and 13 respectively of the decoder. The controller on the receiver side compares the incoming data to the threshold value, and if the value exceeds the threshold value then it sends a high signal to the buzzer which is connected to pin no 23 of the controller and the buzzer blows off and simultaneously an APR module which is connected to pin no 24 of the controller plays a recorded message of "Tsunami Alert".

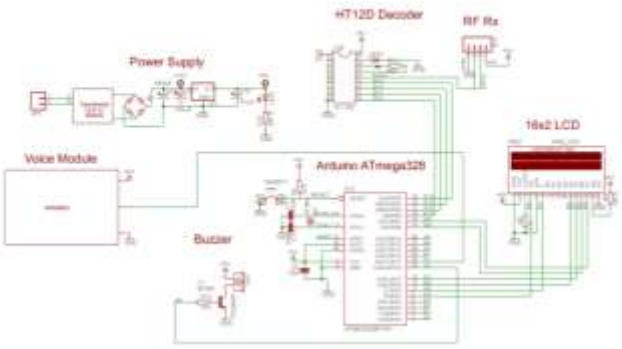

Fig.4 Circuit Diagram-Receiver Module

VI. CONCLUSION:

Hence, as discussed above we conclude fabrication of a system which can detect the coming tsunami using a flex sensor and alert the remote areas of the same. The early warning of tsunami can give sufficient time for the people living in the coastal areas to evacuate the area in turn avoiding loss of hundreds or even thousands of human lives. Despite the improvements in detection and forecasting, some

fundamental issues remain concerning gaps in coverage, the value of individual components of the network, and the risk to the warning capability due to the gaps and from individual component failures, or failures of groups of components.

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