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UNDERWATER WIRELESS SENSOR NETWORKS FOR DISASTER MANAGEMENT

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Abstract

About seventy one percent of the Earth consists of seas, oceans and lakes. Some of the violent natural disasters that have destroyed millions of lives over the centuries originate from the sea like tropical cyclones, hurricanes and tsunamis. Above 227,000 people died in the Indian Ocean tsunami of 2004. Since then, pre warning technologies are gradually emerging, which has significantly decreased the death toll. In this paper we propose an early warning for natural disasters originating from the sea. This system uses wireless communication.

Keywords: *wireless sensor networks, natural disasters, wireless communication, underwater*

INTRODUCTION

The high death toll caused by tsunamis, hurricanes etc. has underlined the need for proper, efficient pre-warning systems to be set up. This paper discusses a way to sort out this problem by placing a system which operates by wireless communication. Wireless communication is more advantageous than cabled connection as the latter faces problems such as breaking or fraying of wires, significant cost of installation, which is ineffective if the experiment is temporary and, most importantly, the inability to set up over long distances. In this paper, we put forward a completely wireless pre warning system to warn against tsunamis, hurricanes and cyclones. Sensors, both underwater and surface, are deployed in the sea to collect measurements which indicate toward a possible disaster. Different types of sensors are deployed such as temperature, humidity, pressure, depth, wind speed etc. as well as cameras. The surface sensors will be mounted on buoys whereas underwater ones will
be anchored to the sea bed. Wireless communication types are discussed further like optical, acoustic, radio frequency etc. and the best one is decided.

Types of Natural Disaster

1) Tsunamis

Tsunamis are formed when there is an earthquake, landside or volcanic eruption on the sea bed. This activity displaces a huge amount of water, where the energy travels in the form of huge waves at the speed of a jet plane. When a tsunami strikes the beach, the force and size of the waves carries the water inland, leading towards flooding, potential destruction of structures such as houses and objects like cars and human loss. There are signs which indicate the occurrence of a tsunami. Firstly, the coastal area mainly will experience a strong earthquake for more than 20 seconds. A more reliable sign is the abrupt and steep fall in the level of water - the water draws

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far back into the ocean, revealing the sea floor. On the sensor level, tsunami conditions are reached when seismometers detect heavy displacement of sea floor, sound sensors detect large noises and AI systems in underwater cameras detect a great shift in the sand. When this occurs, immediately a warning is issued which leads to evacuation of potentially threatened areas. Currently, there are hazard signs such as those shown in Fig. 1 in frequently impacted areas.

2) Hurricanes and cyclones

Both are the same phenomenon but are named on the basis of the places where they occur. Hurricanes form over the North Atlantic Ocean and Northeast Pacific whereas cyclones are formed over the South Pacific and Indian Ocean. Warm, moist air over the surface of the water, being less dense, rises up and creates an area of low pressure, where more high-pressure air comes in. This air again rises up. This cools the water in the surrounding air to form cloud as which along with the wind, spins and enlarged, eventually forming an 'eye' in the middle. The eye is very calm with very low pressure. This forms a cyclone or hurricane. During cyclones, the coastal areas experience heavy rains and strong winds. These lead to further disasters like landfalls, uprooting of trees and houses. Some of the traditional signs of approaching cyclones are: banana leaf stalks making eerie sounds; migratory birds leaving earlier than usual is a sure sign of approaching strong winds and cyclones; and if the winds blow in the southwest or northwest direction, then it is likely that a cyclone is on the
way. On the sensor level, pressure sensors detect sudden changes in pressure, temperature sensors measure a high temperature and wind direction and speed detect rotating and very high-speed winds. The sensors will then relay the information to the onshore disaster management systems which will issue necessary warning.

Types of Under water Wireless Communication systems

1) Acoustic

Acoustic waves are used as the primary carrier for underwater wireless communication systems due to the relatively low absorption in underwater environments.

2) RF

RF electromagnetic system provides noticeable advantages of radio waves over the acoustic and optical waves in shallow water conditions.

3) Optical

Optical system provides highest data transmission. However, the light can get deflected irregularly or absorbed by the water currents.

My System

The system proposed is relatively simple and will be theoretically efficient if put into place. The system works as follows: Offshore, there will be several clusters of underwater sensors as shown in Fig. 1 and Fig. 2. The underwater sensor types are temperature, pressure, depth and cameras. In the rough center of the cluster on the surface of the water a buoy will be present which will also be equipped with sensors like temperature, humidity, wind speed and cameras. The sensors will relay constant measurements to the buoy which will then transmit the data wirelessly through optical/acoustic communication to an onshore pickup station. If the conditions for natural disasters such as high temperature at the surface of the water, high wind speed, the buoy

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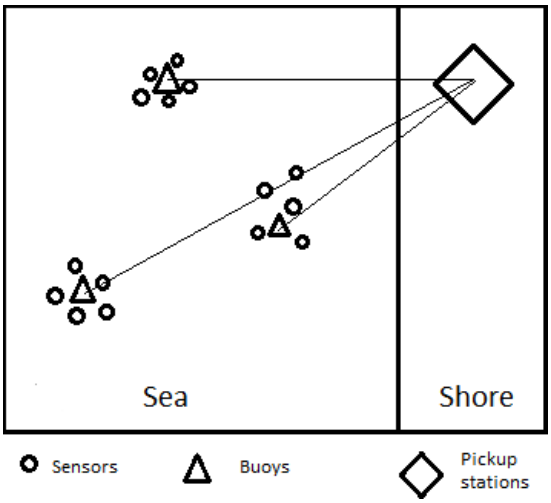
will issue a warning to the onshore station which will be connected to the municipal authorities of the city as well as the military. Once the municipal authorities get the alert, a disaster warning can then be announced for immediate evacuation. As the alert reaches the military, evacuation can be commenced. This will greatly reduce and hopefully eliminate human loss.

figure 1 – 2D model of tsunami and hurricane pre- warning system



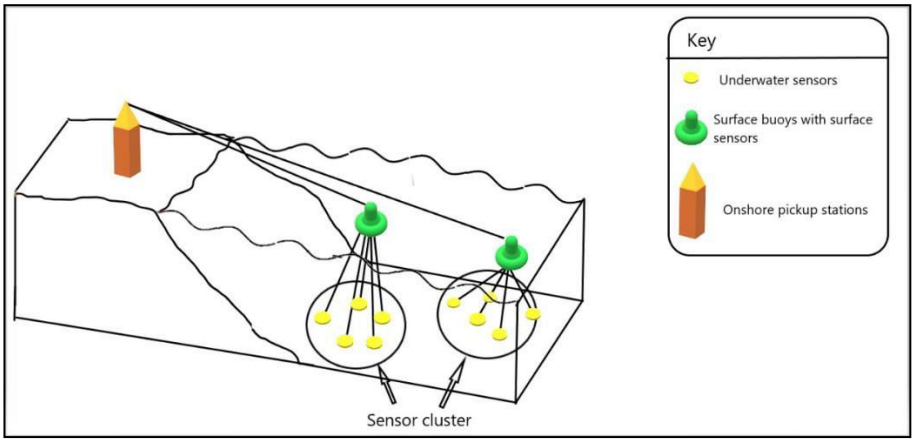


Figure 2 – 3D model of tsunami and hurricane pre warning system

CONCLUSION

The system proposed above not only will help in monitoring the offshore environment but will also be able to give us reliable forecasts. Possible to set up on large distances. Although prone to damage underwater, the equipment will need frequent maintenance. The upgradation of equipment can be done in stages, for example, sensors can be replaced in areas where they are most required.

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