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# Implementation of Mems Based Low-Cost Directional Wave Sensing in the Sea *Buoy* Using Wireless Sensor Networks

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**Abstract:** Collections of the real-time sensing of the waves are necessary in deciding the process in the coastal areas. Due to the recent developments in the semiconductor technology, accurate and very reliable sensors are designed and developed. A current technique in the monitoring of waves only uses the point based measurements and commercially the implementation cost is high which is not practical with huge applications. This study proposes the low-cost sensing of the directional waves in the sea *Buoy* by implementing the MEMS based sensors on it. The system is employed with Inertial Measurement Unit (IMU's) which contains the accelerometer, gyroscope and magnetometer for wave sensing. These low-cost MEMS sensors for direction wave sensing mainly helps in weather and also in several other applications in oceanography.

**Key words**: MEMS inertial measurement unit, wave *Buoy*s, magnetometer, IMU's, commercially, monitoring

## INTRODUCTION

One of the necessary tasks in the daily life is monitoring the waves because the information about the structure of the waves helps in protection of the environment from hazards, marine scientist, authorities of the harbor, fishers and surfers in beach (Tedd and Kofoed, 2009). At starting stage the effort of MEMS based accelerometers are identified the sensing of the waves based on sea *Buoy* as a function area (Prudell *et al*., 2010). But the accelerometers that are used at starting stage were restricted due to float and imprecision. This imprecision required the several important changes for getting feasible wave information as cited by many National Data *Buoy* Center (NDBC) (Langhamer and Wilhelmsson, 2009). It requires the additional developments in the consumption of the power, accuracy and in reliability.

Due to the evolution in the technologies, MEMS (Micro Electro Mechanical System) had become gradually more important because of its small size, low cost and its precise measurement (Langhamer, 2008). Inertial measurement unit contains the accelerometer, magnetometer and gyroscope which are interfaced with the micro controller. As the advancement in the technology for magnetometers and accelerometers results in various application uses this features. Hence, several limitations in the performance and accuracy have been improved (Leijon *et al*., 2008). The result of this advancement shows the large area of potential for the employing MEMS sensors in various applications like sensing the wave position using *Buoy* and propose the feasibility of major enhancement in applications of the wave sensing when evaluated with the sensors which are used at starting stage of wave sensing. These systems are used to measure the state of a floating body in the sea through sensing the waves and these data is transmitted through wireless sensor networks.

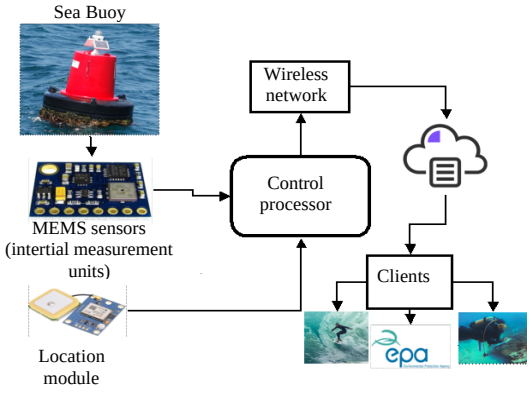


Fig. 1: System architecture for low-cost directional wave sensing in the sea *Buoy* with wireless sensor network

**System archiecture:** Figure 1 shows the system architecture for low-cost directional wave sensing in the sea *Buoy* with wireless sensor network.

## MATERIALS AND METHODS

**Hardware description:** The primary objective of our proposed system sense the directional waves along with

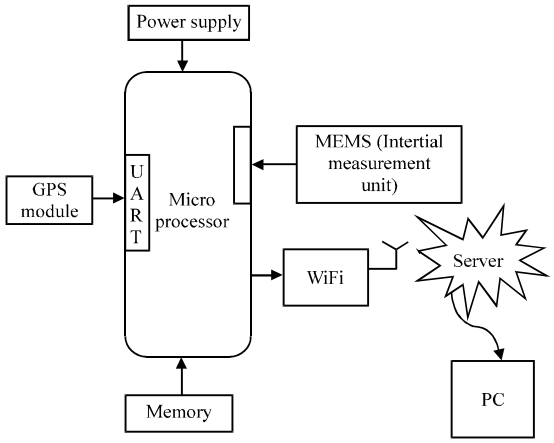


Fig. 2: Block diagram of low-cost directional wave sensing in the sea *Buoy* with wireless sensor network

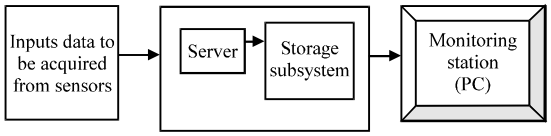


Fig. 3: Architecture of wireless network

the location in the sea by placing the low cost sensors on the sea *Buoy*. The status of the waves can be collected and locations of the *Buoy* are sending to the cloud. Then the data from the cloud can be monitored wirelessly through the PC. Figure 2 shows the block diagram of low-cost directional wave sensing in the sea *Buoy* with wireless sensor network.

**Wireless network arcitecture:** The data about the waves that are collected by Inertial Measurement Unit (IMU's) like the vertical acceleration tilt angle and also, the location of the *Buoy* from the GPS module are managed and send to the cloud. The architecture of supports in supervises the resources of IoT and gives cost-effective means to the produced services. Architecture of server is shown in Fig. 3.

The server contains a feature of storage which is made with MySQL database. The data is acquired by the server and move to the database by using various protocols like HTTP protocol server and MQTT server. The HTTP server is based on the request-response mechanism, the HTTP server accepts the user's request and responds quickly and enables the data to access the server and helps in storing the data in MySQL.

## RESULTS AND DISCUSSION

**Measurements of the wave:** Micro Electro Mechanical System (MEMS) can be developed by using the methood

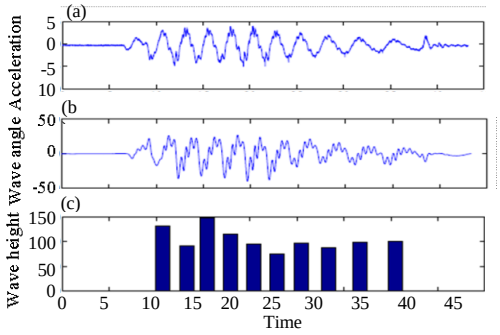


Fig. 4: Acceleration of the wave, wave angle from the Gyroscope and height of waves

of micro fabrication. Inertial Measurement Unit (IMU's) comprises of accelerometer, gyroscope and magnetometer. These sensors are interfaced with the central processor and placed in the sea *Buoy*. *Buoy* is always in the floating state. Accelerometer is employed for acquiring the vertical acceleration of the waves and also, obtining the force of the waves. Gyroscope and magnetometer employed for acquiring the tilt angle of the oceanic waves related with the earth plane, i.e. by the side of orientation with the gravity. The predicted acceleration is successivly undergoes the double time integration to acquire the height of the waves. The main process of the accelerometer is to sense the peak of the waves. This information of peak can be employed in deciding the period of waves and also, employed for reseting the process of integration occasionally. Figure 4 shows the acceleration of the wave, wave angle from the gyroscope and height of waves in the sea through sea *Buoy*.

## CONCLUSION

This study proposes a solution for monitoring the waves in sea based on WSNs along with the location of the sea *Buoy*. Several parameters of waves like wave height, wave direction and force of the wave can be monitored by employing this technology. Solution of this study acquires information of parameters by using MEMS-based sensors such as Inertial Measurement Unit (IMU's). The main advantage of employing the MEMS based sensor is to use the lower to sense the waves and its overall implementation cost is low due to its small size. The interfacing of the sensors with the onboard processor provides the enhanced result in the discussed parameters.

## RECOMMENDATIONS

In future research, we are planning to enhance the system accuracy by doing a real-time compensation of error in the accelerometer and gyroscope in real time and by fusing data from multiple sensor nodes.

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Tedd, J. and J.P. Kofoed, 2009. Measurements of overtopping flow time series on the Wave Dragon, wave energy converter. Renewable Energy, 34: 711-717. Figure 1 System architecture for low-cost directional wave sensing in the sea *Buoy* with wireless sensor network Figure 2 Block diagram of low-cost directional wave sensing in the sea *Buoy* with wireless sensor network.