

Sensor Network in Oil Search (SNOS)

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ABSTRACT

This proposal, prepared for the ONGC, will describe Sensor Network (SN) and assess its usability in oil field data collection. Working from literature and successful projects, we will describe SN technology and its possible use in Oil Exploration. We will assess:

- 1) If SN can be used profitably in oil field data collection?*
- 2) If SN can be used to gather data more accurately?*
- 3) How SN will impact on Exploration Process?*
- 4) How the coupling of two frontline technologies SN and MEMs works?*

The SN technology is emerging technology and turn out to be very successful in many projects. It is very much application specific hence one can not predict the impact of using it in general. Mainly it bridges the gap between empirical and formal world.

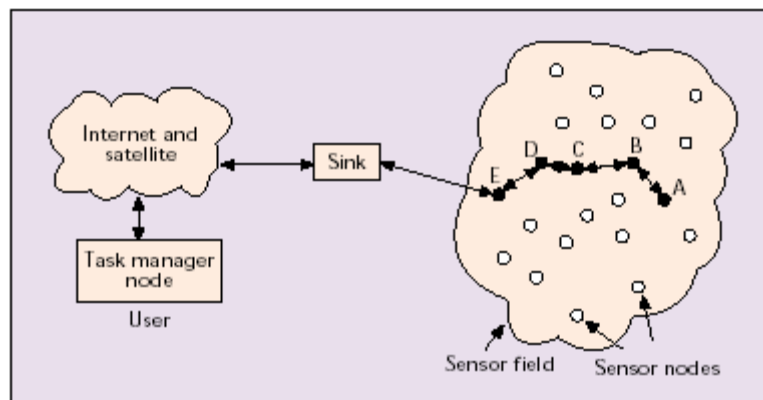
1. Sensor Network

1.1 Introduction

Recent advancement in wireless communications and electronics has enabled the development of low-cost sensor networks. The sensor networks can be used for various application areas (e.g., health, military, home). For different application areas, there are different technical issues that researchers are currently resolving. Let us take a look at the basics of this technology.

1.2 Sensor Network Communication Architecture

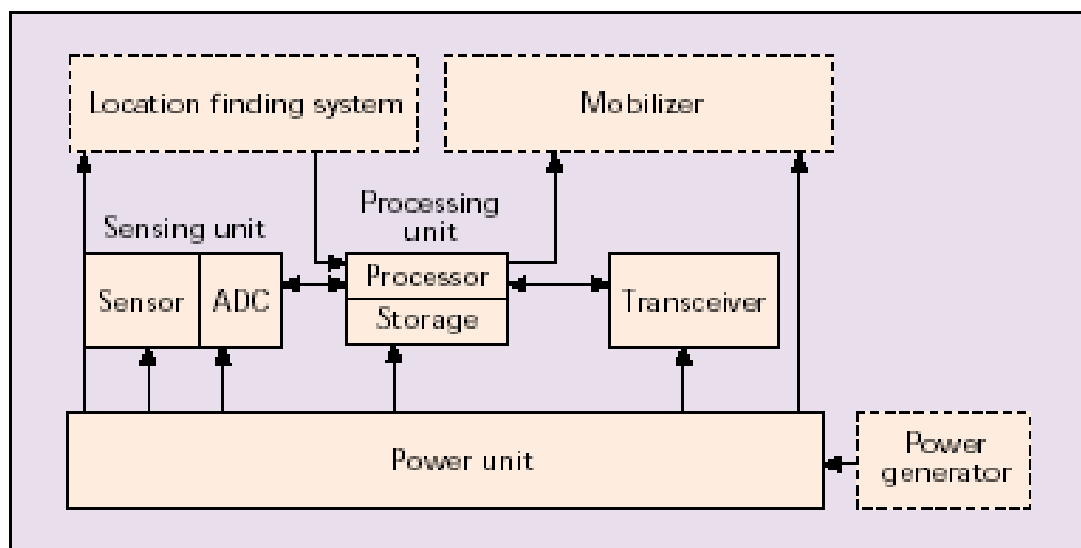
The sensor nodes are usually scattered in a sensor field as shown in Fig. 1. Each of these scattered sensor nodes has the capabilities to collect data and route data back to the sink. Data are routed back to the sink by a multihop infrastructureless architecture through the sink as shown in Fig. 1. The sink may communicate with the task manager node via Internet or satellite. The design of the sensor network as described by Fig. 1 is influenced by many factors, including fault tolerance, scalability, production costs, operating environment, sensor network topology, hardware constraints, transmission media, and power consumption.



■ Figure 1. Sensor nodes scattered in a sensor field.

1.3 Components of Sensor Network

Hardware Constraints A sensor node is made up of four basic components, as shown in Fig. 2: a sensing unit, a processing unit, a transceiver unit, and a power unit. They may also have additional application-dependent components such as a location finding system, power generator, and mobilizer. Sensing units are usually composed of two subunits: sensors and analog-to-digital converters (ADCs). The analog signals produced by the sensors based on the observed phenomenon are converted to digital signals by the ADC, and then fed into the processing unit. The processing unit, which is generally associated with a small storage unit, manages the procedures that make the sensor node collaborate with the other nodes to carry out the assigned sensing tasks. A transceiver unit connects the node to the network. One of the most important components of a sensor node is the power unit. Power units may be supported by power scavenging units such as solar cells. There are also other subunits that are application-dependent.



■ Figure 2. The components of a sensor node.

1.4 Design Factors & Advantages:

The design factors are addressed by many researchers. However, none of these studies has a fully integrated view of all the factors driving the design of sensor networks and sensor nodes. These factors are important because they serve as a guideline to design a protocol or an algorithm for sensor networks. In addition, these influencing factors can be used to compare different schemes. Some factors are

1. Fault Tolerant :

Some sensor nodes may fail or be blocked due to lack of power, or have physical damage or environmental interference. The failure of sensor nodes should not affect the overall task of the sensor network. This is the reliability or fault tolerance issue.

2. Scalability :

The average number of node may vary from application to application from few nodes to thousands of nodes.

3. Production Cost :

The production cost of each sensor node is important because cost of node is key cost in deciding the whole infrastructure cost.

4. Hardware Constraint :

Some applications bound to restrict various resources like RAM , CPU etc to be bounded may be because of power constraint ,cost constraint etc.

5. Environment :

The design of Sensor Network should be guided by the knowledge about the field where it will be deployed.

6. Power Consumption :

The sensor nodes being with low power microelectronic equipments require low power source.

Some of the above design factors are advantages from application viewpoint. Like low power consumption is clearly an advantage for Sensor Network that generates power from Sunlight.

2. Oil Exploration

2.1 introduction

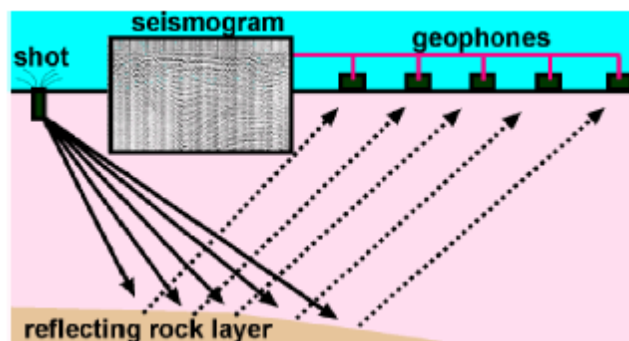
Oil is a very important commodity in our world. It is used in many industries that make our life easier including fuels, fabric, petrochemical industries, and the plastic industry.

Most people today are unaware of the giant petroleum industry. They use their products every day from gasoline to polyester fibers, but rarely think of what our society was like before many petroleum products were discovered. Finding petroleum throughout the world requires a knowledge of geology. The ability of oil and natural gas to migrate and get trapped into reservoir rocks make oil difficult to find. Three dimensional computer modeling from seismic stratigraphy aids in geologists' understanding.

There is no certainty that oil will be found by drillers using these techniques. The success or failure of a geologist's prediction will ultimately be whether the driller finds oil or not. Luck is also a factor.

2.2 Basic Oil Exploration Technique

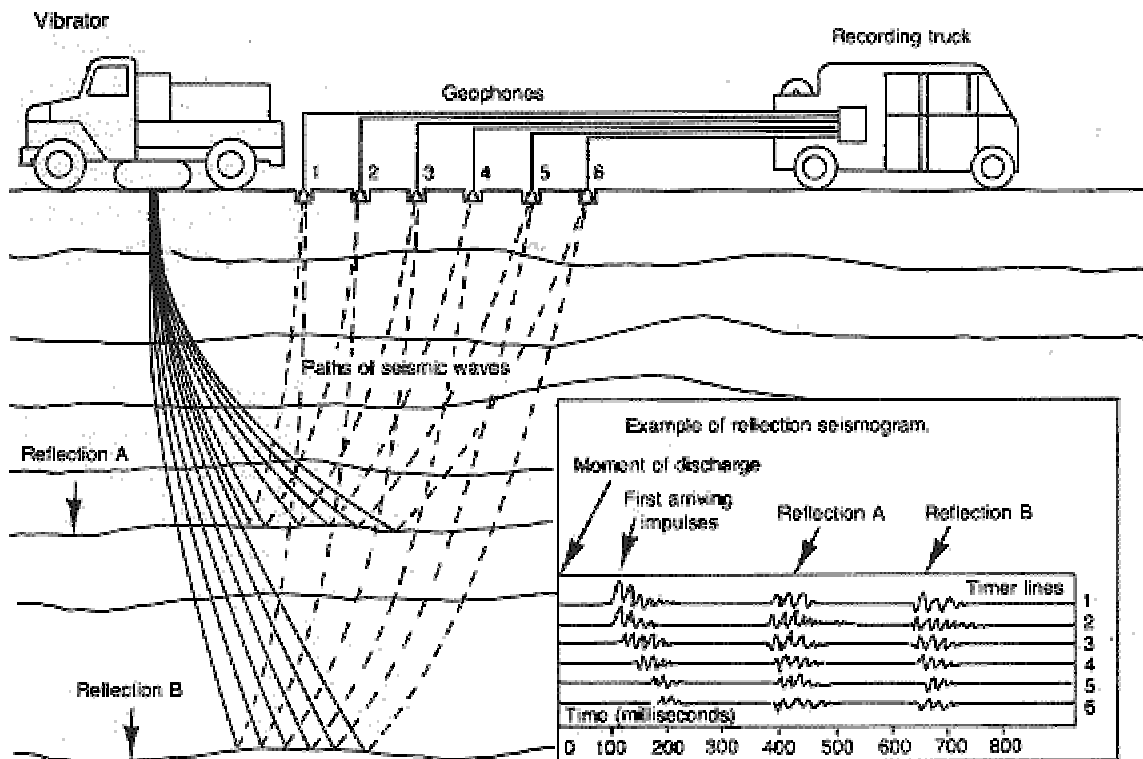
Geology is important in finding oil. Surface and subsurface geology provides clues to where oil is hiding. As the crust moves because of subsidence, faulting,



and other plate tectonic mechanisms, oil can get stuck in “traps.” To “see” these structures, seismic stratigraphy provides us data to interpret what the strata looks like. Creating seismic profiles in a suspected oil field, a charge or “shot” is set off that produces waves. The waves will then reflect differently on diverse rock strata. The waves are reflected back to the surface and recorded using geophones, which then translates the information into seismograms.

Today, computers are used to create three-dimensional models which can recreate the subsurface features.

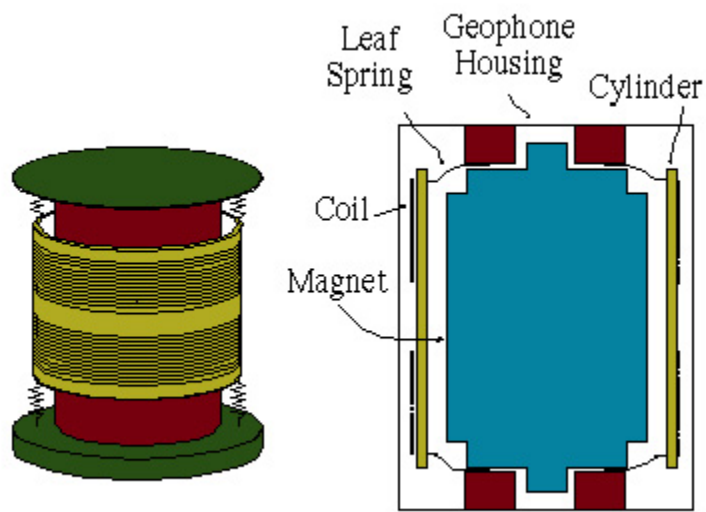
Acquisition of seismic exploration data involves the synthetic generation of seismic waves, and their subsequent detection after passing through or reflecting off the region of interest (i.e., the "target"). The most frequently practiced form of seismic acquisition is the reflection seismic survey. A reflection seismic survey typically involves generating hundreds to tens of thousands of seismic source events, or shots, at different locations in the survey area. The seismic energy generated by each shot is detected and recorded at a variety of distances from the source location. The detectors used to transform ground movement into an electrical voltage that can be recorded are geophones and hydrophones, generically referred to as receivers. For every source event, each receiver generates a seismogram or trace, which is a time series representing the earth movement at the receiver location. Each trace has a reference time zero corresponding to the time of its source event. A record of all traces for each shot is usually written to a medium such as magnetic tape for subsequent study, including processing, display and interpretation.



Recent advances in acquisition technology are improving the quality and economics of 3-D acquisition. *In land acquisition, the logistics of deploying receiver stations and cables are a significant expense, severely limiting the number of receivers that can be deployed per shot*

2.3 Geophones :

Geophones are highly sensitive ground motion transducers that have been used by seismologists and geophysicists for decades. Figure shows both an isometric and cross-sectional view of a geophone, which uses the motion of a spring-supported coil in the field of a permanent magnet to generate an output signal.



Electro Mechanical Geophone

3. Microelectronic Mechanical Devices

3.1 Introduction

Micro-Electro-Mechanical Systems (MEMS) is the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through microfabrication technology. While the electronics are fabricated using integrated circuit (IC) process sequences (e.g., CMOS, Bipolar, or BICMOS processes), the micromechanical components are fabricated using compatible "micromachining" processes that selectively etch away parts of the silicon wafer or add new structural layers to form the mechanical and electromechanical devices.

Microelectronic integrated circuits can be thought of as the "brains" of a system and MEMS augments this decision-making capability with "eyes" and "arms", to allow microsystems to sense and control the environment. Sensors gather information from the environment through measuring mechanical, thermal, biological, chemical, optical, and magnetic phenomena.

3.2 Advantages of MEMs Devices

1. High accuracy
 2. Small size
 3. Fast response time
 4. High precision
 5. Systems integration
 6. Lower costs
-

4. SNOS

4.1 Overview:

This project is intended to be research based. Considerable emphasis is placed on discussing the techniques and exploring the problems involved in oil field data collection. Then we will exploit the flexibilities provided by the Sensor Network to make data collection easier. Further we will use MEMs coupled with SN and will see pros and cons.

4.2 Background:

As described earlier cable based data acquisition offers cost as well as some other problems. Most important is Cabling Effect while data acquisition.

The use of traditional Electromechanical Devices further augments the problem because of their difficulties in deployment and high power requirement. The next subsection discusses the alternative wireless data transfer & using MEMs thereby composing sensor network

4.3 MEMs Geophone

Mems geophones have revolutionize the seismic data collection. We are giving here comparison of Electro Mechanical and MEMs Sensor



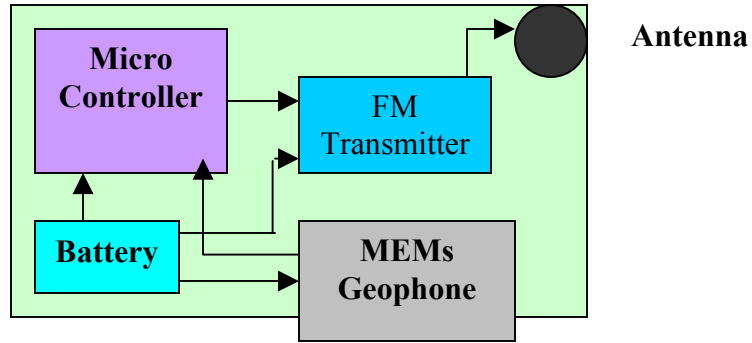
Figure 2: Electromagnetic and MEMS geophone

Comparison (Specifications from www.tronics-mst.com)

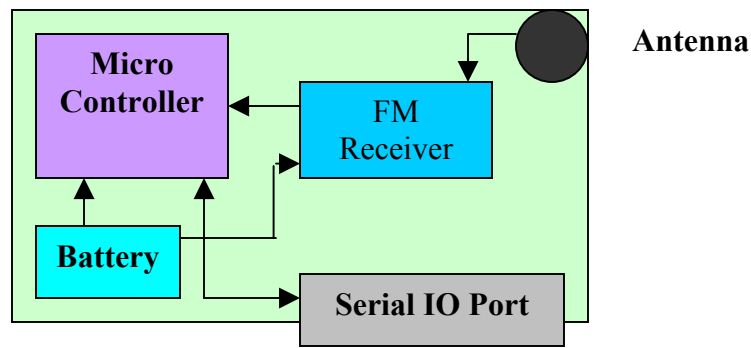
	MEMs Geophone	Electromagnetic Geophone
Size	.5 cm ²	17 cm ²
Weight	1gm	76gm
Linearity BW	0-800 Hz	10-250 Hz
Distortion	-90dB	-70dB
Inclination Tolerance	27 degrees	10 degrees
Power Consumption	400mW	420mW

Table suggests that MEMs wins in all respects including size, weight and inclination tolerance.

4.4 Proposed Block Diagram of Sensor and Receiver:



Sensor



Receiver