ISSN:0975-9646
Rekha Gautam et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 7 (3) , 2016, 1257-1262

To design an Architectural Model for On-Shore Oil Monitoring using Wireless Sensor Network System

[1]Rekha Gautam [2]Saurabh Shukla [3]Dr.G.N.Pandey
[1,]FGIET, Rae-Bareli, India, [2]PSIT, Kanpur, India,
[3] Vice-Chancellor, Arunachal University of Studies,
Arunachal Pradesh, India

Abstract- In recent times, oil exploration and monitoring in on-shore areas has gained much importance considering the fact that in India the oil import is 62 percent of the total imports.
Thus architectural model like wireless sensor network to monitor on-shore deep sea oil well is being developed to get better estimate of the oil prospects. The problem we are facing nowadays that we have very few restricted areas of oil left today. Countries like India don't have much large areas and resources for oil and this problem with most of the countries that's why it has become a major problem when we are talking about oil exploration in on-shore areas also the increase of oil prices has further ignited the problem. For this the use of wireless network system having relative simplicity, smallness in size and affordable cost of wireless sensor nodes permit heavy deployment in on-shore places for monitoring oil wells. Deployment of wireless sensor network in large areas will surely reduce the cost it will be very much cost effective. The objective of this system is to send real time information of oil monitoring to the regulatory and welfare authorities so that suitable action could be taken. This system architecture is composed of sensor network, processing/transmission unit and a server. This wireless sensor network system could remotely monitor the real time data of oil exploration and monitoring condition in the identified areas. For wireless sensor networks, the systems are wireless, have scarce power, are real-time, utilize sensors and actuators as interfaces, have dynamically changing sets of resources, aggregate behaviour is important and location is critical. In this system a communication is done between the server and remotely placed sensors. The server gives the real time oil exploration and monitoring conditions to the welfare authorities.

Keywords- Sensor, Wireless sensor network, oil, sensor and on -shore level.

I. INTRODUCTION

Oil import is 62% of total import in India. Hence, there is need to have more production of crude oil to the extent possible. The use of wireless sensor network system for oil exploration and monitoring is done due to cost of wireless sensor network is comparatively affordable and also the cost of wireless sensor network is continuously decreasing. It's simplicity in operation is also another major factor .Size of wireless sensor is decreasing and its applications more flexible. The total area for oil exploration in India on on-shore area is 23,944 sq.km. Area for shallow water oil exploration is 47,745 sq.km and the area for deep water oil exploration is 94,364 sq.km. India has 125 million metric ton of oil reserves or 5.62 billion barrels. It is second largest amount in Asia-Pacific behind China. Most of India's crude oil reserves are located in western coast (Mumbai), north east part, offshore Bay of Bengal and in the state of Rajasthan. India has 1,437 billion cubic metric of confirmed natural gas comes from western off-shore, Mumbai, onshore fields in Assam, Andhra Pradesh and Gujarat.

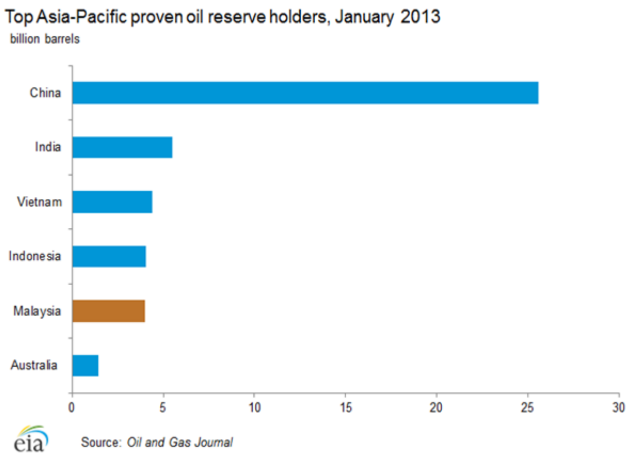

Figure 1: Countries with the biggest oil reserves

More than 80% of the world's proven oil reserves are concentrated in just 10 countries. Venezuela holds the world's biggest proven oil reserve followed by Saudi Arabia, while Canada and Russia hold the third and the eighth largest oil reserves.[16] Venezuela holds the world's largest proven oil reserves. The country's proven oil reserve as of January 2013 stood at 297.57 billion barrels accounting for about one fifth of the world's total proven oil reserve.[16] The country produced 2.8million barrels of crude oil per day in 2012 with 149 active rigs. Saudi Arabia ranks second biggest holding 265.4 billion barrels of proven oil reserve. The Middle East country held the world's largest oil reserve until 2009, until it was surpassed by Venezuela. [16] Saudi Arabia produced 9.763 million barrels of oil per day in 2012 with 148 active rigs. Canada's proven oil reserves stand at 173.1 billion barrels, which are the third largest in the world. Canada produced 1.308 million barrels of crude oil per day in 2012 with 353 active rigs. Iran possesses the fourth largest proven oil reserves in the world and the second largest among Middle East countries. Its proven oil reserves as of December 2012 were estimated at 157 billion barrels. The country produced 3.74 million barrels of crude oil per day in 2012 with 123 active rigs. Iraq, with 140.3 billion barrels of proven oil reserves, has the fifth largest oil reserves in the world and the third largest in the Middle East. The country produced 2.942 million barrels of crude oil per day in 2012 with 92 active rigs. Kuwait holds the sixth largest proven oil reserves in the world.[16] The country was estimated to contain 101.5 billion barrels of proven oil reserve as of December 2012. It produced 2.978 million barrels of crude oil in 2012 with 48 active rigs. United Arab Emirates (UAE) holds the world's seventh biggest oil reserve with 97.8 billion barrels of proven oil reserves. It produced 2.652 million barrels of crude oil per day in 2012 with 13 active rigs. The first commercial oil in UAE was discovered in 1958. Russia, with 80 billion barrels of proven oil reserves, has the eighth largest oil reserves in the world. The country's proven oil reserves increased by 3.4% in 2012.[16] It produced 10.043 million barrels of crude oil per day during the year with 320 active rigs. The North African country Libya ranks ninth, holding 48.47 billion barrels of proven oil reserve. It has the largest endowment (around 38%) of the total oil reserve in the African continent. The country produced 1.450 million barrels of crude oil per day in 2012 with 72 active rigs. Nigeria, a West African country located on the Gulf of Guinea, holds the tenth largest proven oil reserves in the world. The country's proven oil reserve as of December 2012 stood at 37.14 billion barrels. Nigeria produced 1.954 million barrels of crude oil per day in 2012 with 44 active rigs.[16]

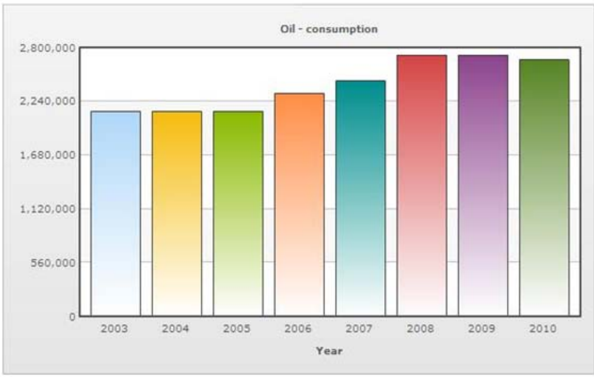

Figure 2

Rocks to contain oil and gas must have these important things like pores, porosity and permeability.

Oil on a commercial scale is usually found where the sedimentary rock in a sort of chamber or reservoir, in the highest possible situation e.g. crests of anticlines. Normally, oil is associated with water. Being lighter than water (specific gravity of 0.8 to 0.98), it collects in the anticlines or fault traps above the surface of water.

The main objective of this model is to deploy wireless sensor network system in such a way that can monitor on-shore oil well. Deployment of network where sensors report the state of the environment and actuators set the state of the environment. For this selection or type of geophone sensors for deployment based on the properties like sensitivity, accuracy, cost, energy

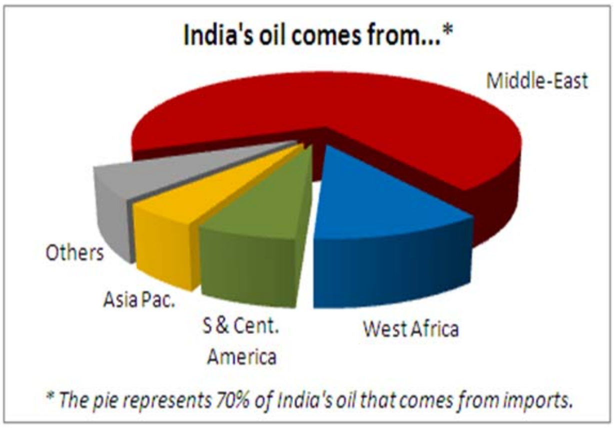

Figure 3

II. PROBLEM DEFINITION AND SCOPE

Till now we have gone upto 2000m (6561.6797ft) to detect oil under on-shore areas which is not sufficient to meet our requirement. Hence there is urgency to explore further to locate oil. Therefore an architecture model using wireless sensor network system is proposed and selecting a hydrophone sensor that has greater accuracy and sensitivity a good detection so that these sensors can be deployed easily and have good communication and coordination. And selecting a geophone sensor that has operating depth of 2500m (8202.09977 ft) with greater accuracy and sensitivity will surely solve the problem up to some extent, these sensors can be deployed easily and have good communication and coordination with actuators**.**

III. RELATED WORK

As already mentioned, oil as well as natural gas in India occur in sedimentary rocks. About 14.1 lakh sq km or about 42 per cent of the total area of the country is covered with sedimentary rocks out of which about 10 lakh sq km form marine basins of Mesozoic and Tertiary times. Besides, the country has offshore areas having Mesozoic and Tertiary rocks of marine origin covering an area of 2.5 lakh sq km upto a depth of 100 meter and another area of 0.7 lakh sq km upto a depth between 100 and 200 meter. Thus the total continental shelf of probable oil bearing rocks amounts to 3.2 lakh sq km

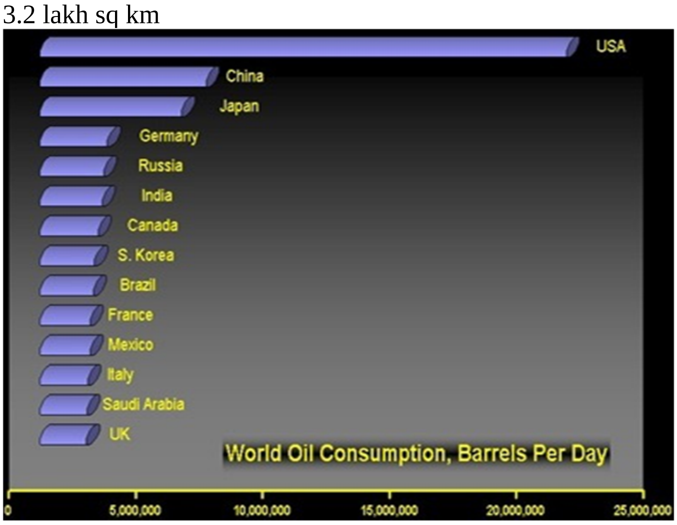

Figure 4

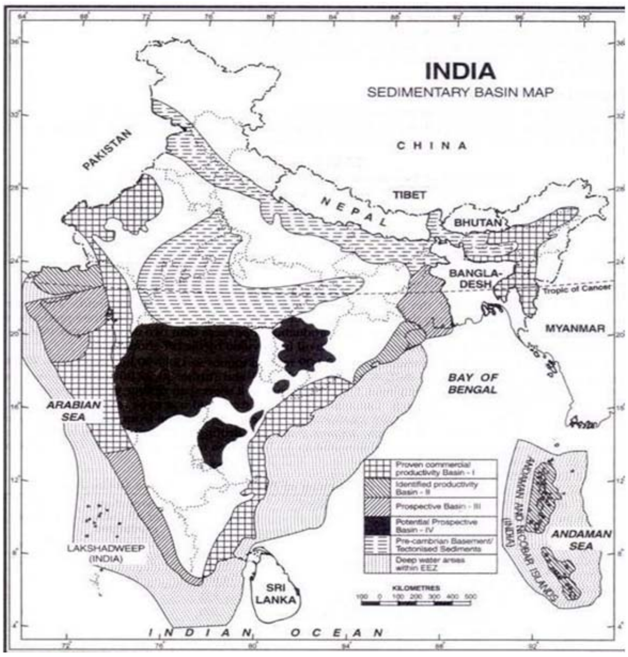

Figure 5: India sedimentary Basin map

The total sedimentary area including both on shore and offshore comprises 27 basins. The geological and geophysical studies have been conducted in 14 basins while exploratory drilling has been done in 9 basins. Mumbai High, the Khambhat Gulf and the Assam are the most productive areas.

Although India has vast areas covered by sedimentary rocks, structures containing oil are not in proportion to the expanses of these rocks and are found in limited situations. India has total reserve of crude oil is 581.43 million tones. Of this only about one-fourth i.e., 7.2 billion tons of in place hydrocarbon reserves have been established. About 70 per cent of the established hydrocarbon reserves is oil and rest is gas. The recoverable hydrocarbon reserves are of the order of 2.6 billion tones.

The history of **WSN** sensor networks has four phases, which is described as:-The Phase 1 includes Cold-War Era of Military Sensor Network 1960's and 1970's .During the cold war session extensive acoustic network were develop in the United States for the surveillance of submarine; some of these sensors are still use by the National Oceanographic and Atmospheric Administration to monitor seismic activities in the ocean. The another phase is Initiative in Defense Advanced Research Projects Agency 1970's and 1980'sThe major advancement to research on sensor networks has taken place in the early 1980s Distributed sensor networks (DSN) work aimed at determining of newly developed TCP–IP protocols and ARPAnet's approach to communication could be used in the sensor networks context. Next phase includes the development of Military Applications or Deployment in the 1980s and 1990s (These can basically be called as first-generation commercial products.) Based on the results generated by the DARPA–DSN researchers and the developments of test beds, military planners were set out in the 1980s and 1990s for the adoption of sensor network technology, to make it a key component of network-centric warfare's. Research in Present-Day Sensor Network 1990's and 2000's :(These can be called as second-generation commercial products.) Advancement in computational and communications that have been resulted in a new generated system of sensor network technology. Evolving sensor network represents critical significant improvements upon traditional sensors. Inexpensive compact form of sensors based on a numbers of highly-density technologies, including of MEMS and (will going to be in the next few years) nanoscale electromechanical systems (NEMS), are being appear.

Specification	First generation(1980's–1990)	Second generation(early2000's)	Third Generation(late 2000's)
Size	Larger	Small	Smaller
Weight	Pounds	Ounces	Grams
Deploy	Physically installed	Hand placed	Embedded
Node sense	Separate sensing	Integrated sensing	Fully
Protocols	Proprietary	Proprietary	Standard: Wi-Fi
Topology	Point-to-point, star	Client-server	Fully peer to peer
Power supply	Large batteries	AA batteries	Solar
Life span	Hours, day	Day to week	Month to years

Figure 6

IV. System Overview

We have first define the system architecture then followed by discussion of the sensor implementation network. After this data transmitting and processing unit implementation is done along with database and application server.

A. System Architecture

Under this section we have described our proposed on-shore oil monitoring system that uses sensors which are remotely placed

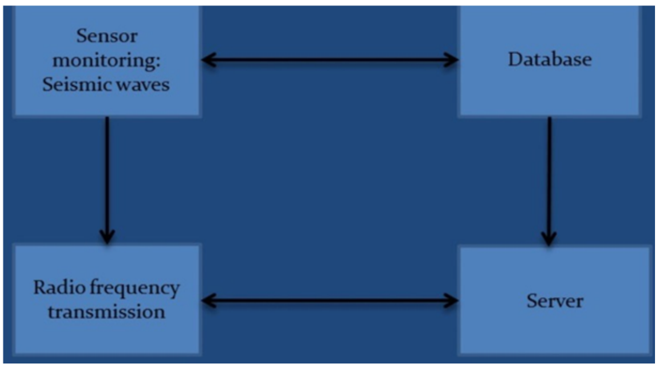

Figure 7 :

To support the data acquisition in a real time environment, system consists of four major modules. The first module consists of sensors for measuring seismic waves. The module second is used for transmitting and processing of data of which is located on remote sites. Sensors forms a cluster to send the required data to the cluster head and after this the cluster head send the data to the routers and then routers send the data to the server. This is our third and fourth module. The third module run as a data base which stores the data then the data is compared to the values of comparator and after this data is accessed by the application server which gives the required data by plotting the seismograph.

Monitoring sensor

Figure 8: SM-24 ST Upright Geophone Sensor[19][18]

Features

The SM-24 ST Upright geophone element is designed to offer cost effective performance in seismic exploration based upon field-proven I/O Sensor technology. Low distortion, combined with durable specifications, provide high-fidelity data in 2-D and 3-D surveys. The extended bandwidth allows the full potential of 2-ms/24-bit recording systems to be realized. Applications: 2-D & 3-D seismic exploration with bandwidth from 10 Hz up to 240 Hz.[18]

Implementation: Can be installed in a variety of I/O Sensor geophone cases.

Specification: SM 24 ST Upright Geophone [18][19]

Frequency

Natural Frequency 10Hz

Tolerance +/- 5

Maximum tilt angle for specified fn 10 degree

Typical spurious frequency > 240Hz

Distortion

Distortion measurement velocity 12 Hz

Sensitivity

Sensitivity 28.8 v/m/s

Tolerance +/-5 %

Physical Characteristics

Diameter 25.4 mm

Height 32 mm

Weight 74 g

Operating Temperature Range -40 degree Celsius to + 100 degree Celsius

Data Transmission and Processing along with data transfer to application server

The algorithm we are using here for data transmission is LEACH algorithm. Basically it is a low energy adaptive clustering hierarchy.[8] In this nodes are organized into different set of groups called clusters which is a property of cluster based hierarchy protocol. By selecting a cluster head among various nodes communication inside a cluster among the nodes is done. Then the communication is done between cluster head and base station. The data is sent to the cluster head by the nodes present in the cluster then the data is sent to the base station by cluster head. In two hops the data is communicated to the sink node. All this reduces the energy consumption while transmission of data and increase the lifetime of the network.

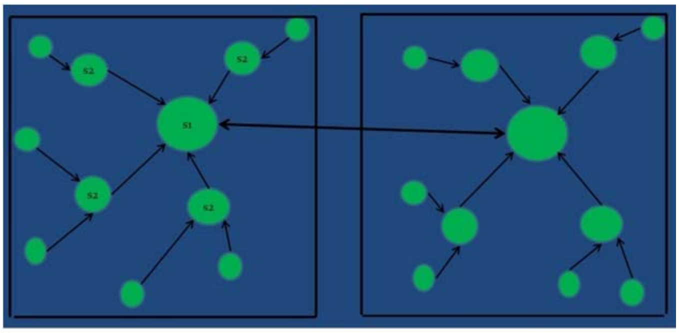

Figure 9

LEACH is hierarchical routing approach for sensors networks. By multi hop communication sensor nodes are involved to maintain the energy consumption as it is main function of hierarchical routing. In this data aggregation and data fusion is done with in a cluster in order to decrease the number of messages transmitted to the sink. Sensor proximity to the cluster head and the energy reserve of sensors are the two main reason for cluster formation. In cluster hierarchical routing low energy sensor nodes used to perform sensing and high energy sensor nodes performs the processing of data. By assigning special tasks to the cluster head and creating cluster increase the cluster life time and energy efficiency. Through this energy consumption can be reduced by in a cluster by performing data aggregation and data fusion. As it reduces the number of messages transmitted to the sink node. [7].

The goal of the on-shore oil monitoring system is to maintain a reliable communication between the sensors so that real-time information can be accessed. This algorithm has three phase first phase is cluster localization phase, second phase is cluster optimization phase and third phase is cluster transformation phase. Here time synchronization is important for routing and power conservation In this network sensors form a clusters and having a radio frequency wave communication after this they form a cluster network architecture having inter cluster and intra cluster communication. Here in a cluster each node sends its data to the cluster head in aggregated form by the use of directed diffusion algorithm. The sensor communicates among them by the use of sensor network query processing algorithm. After this cluster head transfers its data to the routers and routers after processing, sends the data through gateways to the application server. Here the sensor can be in sleep mode in round robin fashion. In this algorithm network services includes data compression and data aggregation. Since it is a real time system so we will follow Trace-Driven simulation which is also low in cost and the simulation tool will be OMNET++ which operate on Tiny OS and support MAC which help in energy conservation.

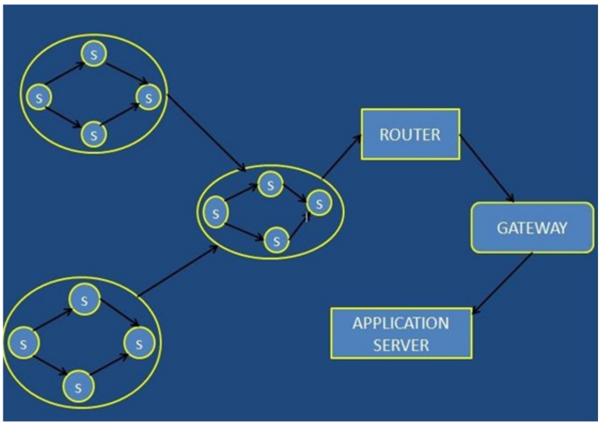

Figure 10

Here the role of the sensor is to measure the seismic waves. This technology is cluster based. In the above figure sensors displayed in small circles are called as ordinary bottom nodes and the ones in large circle are cluster heads. Here data fusion and data packet transmission is done. Data information can be transmitted to routers by wireless communication. When receiving data, routers establish a local database and then transmit the data to the application server.

V. CONCLUSION AND FUTURE PERSPECTIVE

Here large numbers of sensors are deployed over an area of 1 km. These sensors form clusters to measure seismic waves generated by vibrator after being reflected from rocks at different angles. Sensors are placed at a distance of 200 to 300m distance. These seismic waves are recorded by geophone sensor. These sensors will transmit the recorded data through radio frequency wave to gateways which gain transmit the data to servers. The server plots the seismograph to get different values at different angles generated by seismic waves and recorded by geophone sensor. On the basis of data recorded by geophone sensor the whole area is divided into three regions

1. Green region : Where there is every possibility of oil exists
2. Yellow region : where there is little possibility of oil exists
3. Red region: Where there is no possibility of oil exists.

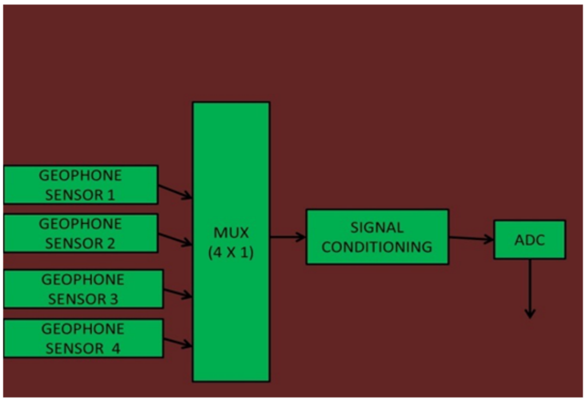

Figure 11: Wireless sensor network architecture

We are using LEACH algorithm which randomly selects a few sensors nodes as cluster heads (CH) and rotates this role to evenly distribute the energy load among the sensors in the network[8]. Data arriving from various nodes of a cluster are compressed by the cluster head node, to reduce the amount of information that must be transmitted to the base station by sending an aggregated packet through data aggregation by finding the min., max and average values of the data sensed. To reduce the inter-cluster and intra-cluster collision this algorithm uses TDMA/CDMA MAC when there is an urgency to monitor the sensor network constantly this algorithm is most appropriate. The limited energy of the sensor node could be drained by the periodic data transmission which is unnecessary. Therefore user does not need data immediately. A randomized rotation of the cluster head is conducted after certain interval of time to obtain a uniform energy dissipated in the sensor network. There are two phases in the LEACH operation the set up phase and the steady phase [9]. In the setup phase CHs are selected and the clusters are organized. In the steady phase the transfer of data takes place to the base station. The steady state has longer duration than the duration of the setup phase in order to minimize overhead.

T (N) =P/1-P (rmod1/p)

P is the priority probability of a node being elected as a cluster head. Here r is current round number and G is the set of nodes that have not been elected as cluster heads in the last 1/p rounds. Each node during cluster head selection will generate a random number between 0 and 1. If the number is less than the T (N). Here T (n) is the Threshold, the node will become a cluster head, and T (n) is the Threshold function [7]. After receiving this advertisement all the non-cluster head nodes decide on the cluster to which they want to belong. The signal strength of the advertisement is the main reason on which the decision is based. The cluster heads are informed by the non –cluster heads that they will be a member of the cluster. Then by receiving the messages a time slot is given to each node by TDMA Scheduling by cluster head node so that it can transmit the message at a given time period. This schedule is broadcast to all the nodes in the cluster. Sensing and transmitting of data to the cluster heads is done in the steady phase \by the cluster nodes. After receiving all the data the cluster head aggregates all the data before sending it to the base station. Communication of cluster is done using different CDMA codes to reduce interference from nodes belonging to other clusters.

References

1. K. M. Sivalingam, M.B. and P. Agrawal, "Low Power Link and Access Protocols for Wireless MultimediaNetworks", *Proceedings IEEE Vehicular Technology Conference VTC'97, May 1997.*
2. http://en.wikipedia.org
3. W. Mangione-Smith and P.S. Ghang, "A Low Power Medium Access Control Protocol for Portable Multimedia Systems", *In Proceeding 3rd Intl. Workshop on Mobile Multimedia Communications, Princeton, NJ, Sept. 25-27, 1996.*
4. A. A. Ahmed, H. Shi, and Y. Shang, "Sharp: A new approach to relative localization in wirelesssensor networks," in *Proceedings of IEEE ICDCS*, 2005.
5. www.petrostrategies.org/Learning_Center/exploration.htm#How Do Scientists Find Oil and Gas? Retrieve on Jan, 2010
6. www.globalspec.com/industrial-directory/reson hydrophone year 1999-2010 Global Spec . Retrieve on Feb, 2010.
7. Rashmi jain, Manali kshirasagar "Study of Different Communication Protocols for Wireless Sensor Network" National Conference on Innovative Paradigms in Engineering & Technology, 2012, Proceedings International Journal of Computer Applications.
8. Parul Kansal, Deepali Kansal, Arun Balodi "Compression of various Routing Protocol in Wireless Sensor Network", International Journal Journal of Computer Applications (0975-8887) Volume 5-No.11, August 2010.
9. Ameer Ahmed Abbasi, Mohamed Younis "A Survey on clustering algorithms for wireless sensor networks" , Computer Communications 30 (2007) 2826-2841.
10. "Wireless Ad Hoc Networks: Basic Concepts", High Frequency Electronics, March 2007.
11. Saurabh shukla, G.N.Pandey "To Design an Architectural Model for Deploying Wireless Sesnor Network to Prevent Forest Fire". Issue 84 December 2013 in International Conference of Computer Science and Software Engineering (ICCSSE 1217-1221.
12. Saurabh Shukla. "Deployment of Wireless Senor Actuator Network System to Monitor Off-Shore Deep Sea Oil well". Vol1, No.1, September 2013 in International Journal of Computer Science Applications and Information Technologies (IJCSAIT). 23-31.
13. ChalermekIntanagonwiwat, Ramesh Govindan, and Deborah Estrin. Directed diffusion: A scalable and robust communication paradigm for sensor networks. Technical Report 00-732, University of Southern California,March 2000.
14. Chong, C., Kumar, S.: Sensor Networks: Evolution, Opportunities and Challenges. In: Proceedings of the IEEE, Vol.91, No.8, pp. 1247--1256. IEEE Press, New York (2003.).
15. R. Bekkerman, R. El-Yaniv, Y. Winter, and N. Tishby. On feature distributional clustering for text categorization. In ACM SIGIR, pages 146–153, 2001.
16. http://www.hydrocarbons-technology.com/features/feature-countries-with-the-biggest-oil-reserves.
17. http://www.hydrocarbons-technology.com/features/feature-the-10-biggest-oil-and-gas-companies-in-the-world
18. Sensor Nederland b.v. An I/O subsidiary
19. www.geophone.com
20. www.i-o.com

AUTHORS

Mrs. **Rekha Gautam** has done his B.Tech from Dr. A.P.J Abdul Kalam Technical University, Lucknow. She is currently pursuing her M.Tech from Ramswaroop University, Lucknow in computer science. She has an experience of more thaN 6 years as an Assistant Professor in Computer Science in FGIET,Rae-Bareli,U.P.,India.

Saurabh Shukla was born in Bulandshahr, India on 14 June 1985 . He has done his M.Tech from Indian Institute of Information Technology, Allahabad, India in 2010 and completed his B.Tech from U.P.T.U; Lucknow, India in 2008.He has an experience of more than 3 yrs. working as a faculty of Computer Science Department of Rajiv Gandhi Institute of Petroleum Technology, Rae Bareli, India. He has received scholarship as stipend from MHRD for 2 years during M.Tech. He has been selected in Tata Consultancy Services during campus placement in M.Tech. He has qualified Graduate Aptitude Test of Engineering. His two papers are published in international journal and one in international conference.

Prof.GN.Pandey has done his Ph.D. in 1966 from Banaras Hindu University, Varanasi, India. He has done his Post –doctoral Research from University of Michigan, USA and completed his M.Tech in Chemical Engineering in 1963 from Indian Institute of Technology, kharagpur, India.He has done his B.Sc in Chemical Engineering in 1962 from Banaras Hindu University, Varanasi, India.

He has been awarded with "Distinguished Service Award", "Distinguished Alumnus Award" and with Rastriya Gaurav Award. He has supervised 27 research schemes, guided about 27 Ph.Ds written about 14 books, and published 225 research and technical papers. Currently he is working as a Vice-Chancellor of Arunachal University of Studies, Namsai, Arunachal Pradesh, India. He is also the Visiting Professor of Indian Institute of Information Technology, Allahabad, India.