Development of Depth Measurement System and Wireless Transceiver using GPS and Echo Sounder for Survey Application

M. Selva Balan, Rohini Gaikar, Varsha Patil, Kartik Darade, Mustafa Tamboli
Chief Research Officer, CWPRS, Khadakwasla, Pune.
Faculty of Dept. of Elec. & Telecom., D.Y.Patil COE Akurdi, Pune
UG Scholar, Dept. of Elec. & Telecom., D.Y.Patil COE Akurdi, Pune

ABSTRACT
Estimation of water measurement is of high importance in hydrographic survey activity especially in reservoirs. Because in rainy season there is collection of slurry and mud at the bottom of dam. Because of this the depth of dam may get reduced and hence its capacity is reduced. There are number of techniques to measure the depth and each having its advantages and drawbacks. Here in this paperthe way of measurement of the depth by using dual beam echosounder is introduced as it has higher acquisition rate and the coordinates of position of actual slurry or mud is given by GPS. The data which is collected is wirelessly transmitted using the zigbee.

Keywords
Echo sounding, Zigbee

1. INTRODUCTION
For hydrographic survey depth measurement is an important parameter. So it need to have specific knowledge about the depth measurement techniques. There are number of techniques that are used for this purpose are listed below:[8]

- Single beam echo sounding (SBES)
- Multi beam echo sounding (MBES)
- Airborne laser system (ALS)
- Mechanic system (MS)

1.1 Basic principle of echo sounding
Here in echo sounding a transducer is place at the bottom of ship. Transducer transmit signal towards the bottom of sea or lack and this signal is reflected back. From the transmitted signal and received signal difference is measured to find out the depth. Distance is measured by multiplying half the time from the signals outgoing pulse to its return by the speed of sound in the water, which is approximately 1.5 kilometer per second. For precise application of echosounder, such as hydrography, the speed of sound must also be measure typically by deploying a sound velocity probe into the water. Echo sounding effectively a special purpose application for sonar used to locate the bottom. [6]

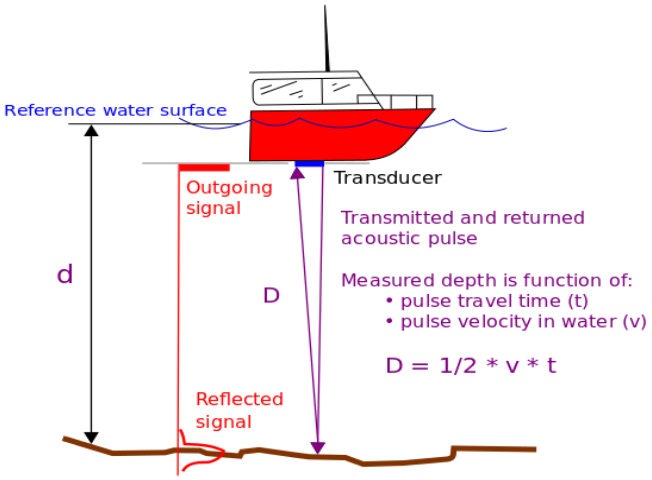

Figure 1. Principle of echo sounding

Table1- Difference between different depth measurement techniques

SBES	MBES	ALS	MS
1)Simple 2)Inexpensive 3)Not much accurate 4)No large number Of measurements 5)Limited acquisition rate	1)Higher mapping resolution 2)Data along single path 3)More accurate 4)Safe data collection	1)Very efficient 2)Higher speed 3)Good coverage 4)High cost	1)Time consuming 2)Insensitive to environment changes 3)Very old system 4)Less coverage 5)Limited measurements

2. MULTI BEAM ECHO SOUNDING
A precise echo sounder may be used for the work of hydrography. There are many considerations when evaluating such a system, not limited to the accuracy, resolution and the acoustic frequency of the transducer. This multi beam echo sounder having safe data collection and we get more accurate result about depth. [8]

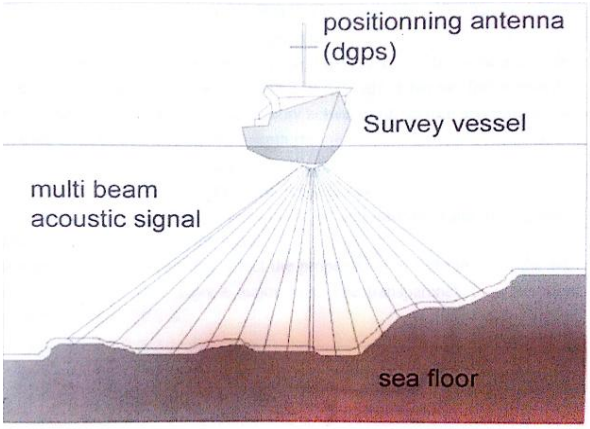

Figure 2. Echo sounding using a multibeam echosounder

2.1 Principle

The majority of hydrographic echosounders are dual frequency, meaning that a low frequency pulse can be transmitted at the same time as a high frequency pulse. As the two frequencies are discrete, the two return signals do not typically interfere with each other. There are many advantages of dual frequency echosounding, including the ability to identify a layer of soft mud on top of a layer of rock. Commonly used frequencies for deep water sounding are 33 kHz and 24 kHz. The beam width of the transducer is also a consideration for the hydrography, as to obtain the best resolution of the data gathered a narrow beam width is preferable. This is especially important when sounding in deep water, as the resulting footprint of the acoustic pulse can be very large once it reaches a distant sea floor. [4]

2.2 Limitations

It provide hydrographic data only along a single path directly beneath a track of a surveying ship. Moreover hydrographic survey ship can't operate safely in shallowwater.

3. BLOCK DIAGRAM

3.1 Transmitter Section

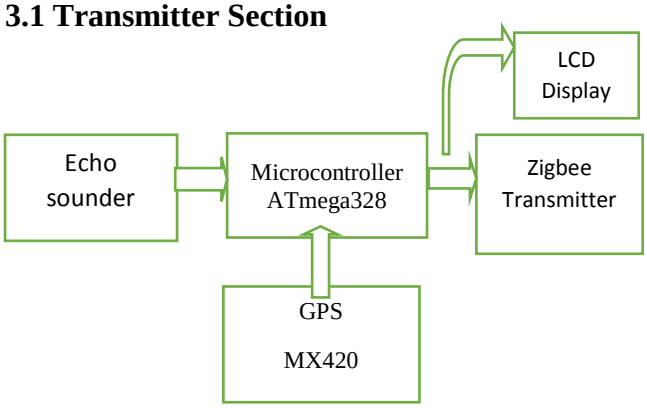

Figure 3 Transmitter section

3.2 Reciever Section

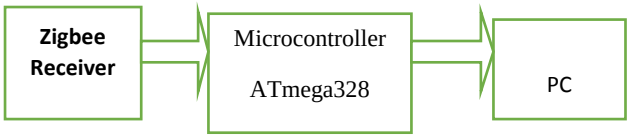

Figure 4 Receiver section

3.3 Block Diagram Description

The block diagram indicate the location of various components like GPS, DBES, Navisounder NS415, microcontroller and zigbee transceiver. The data from GPS in NMEA format is given to the Navisounder which has latitude and longitudinal information. The NMEA format from GPS is clubbed with another input data from DBES. The dual beam echo sounder is a sensor which calculates the depth at different point. So these Navisounder club the data of both GPS and DBES to form data string of DESO25 format. The DESO25 format contain the information of depth at certain point with its GPS coordinates. This data is given to the microcontroller. The microcontroller store this data into the SD card using the SPI interface. At the same time the microcontroller is interfaced with zigbee transceiver for wireless data transmission to the PC available into the office. Zigbee is an IEEE 802.15.4 standard for data communications with business and consumer devices. It is designed around low-power consumption allowing batteries to essentially last forever. The Zigbee standard provides network, security, and application support services operating on top of the IEEE 802.15.4 Medium Access Control (MAC) and Physical Layer (PHY) wireless standard. It employs a suite of technologies to enable scalable, self-organizing, self-healing networks that can manage various data traffic patterns. Zigbee is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range. Zigbee has been developed to meet the growing demand for capable wireless networking between numerous low power devices. In industry Zigbee is being used for next generation automated manufacturing, with small transmitters in every device on the floor, allowing for communication between devices to a central computer. This new level of communication permits finely-tuned remote monitoring and manipulation.

4. ZIGBEE

Wireless communication is the process of transferring of information in a distance without a physical medium. In this type of communication the information travels through the airs. The distance may be short (a few meters) or long (satellite communication).Wireless communication is generally considered to be a branch of telecommunications. The various examples of wireless transmission are GPS unit, Satellite television, wireless computer mice, cordless telephones, wireless keyboards, headsets etc. [2]

4.1 Zigbee vs other Technologies

Today's market is full of wireless technologies that aim the mid to high data rates for voice, PC LANs, video, etc. What is missing in all these technologies is the unique need for the sensors and control devices. Sensors and controls need very low energy consumption ability so as to have long battery lives even though high bandwidth is not required. Zigbee Alliance focuses on this part of the market and thus provides a standardized set of solutions for wireless communication for such devices. The main advantage of having a standard is that it provides a cost effective solution as compared to creating a new solution. [9]

4.2 Characteristics of zigbee

1. Dual PHY (2.4GHz and 868/915 MHz) , Data rates of 250 kbps (@2.4 GHz), 40 kbps (@ 915 MHz), and 20 kbps (@868 MHz)

2. Yields high throughput for low duty cycle devices like sensors and controls

3. Low power (battery life multi-month to years)
4. Multiple topologies: star, peer-to-peer, mesh
5. Addressing space upto:18,450,000,000,000,000,000 devices (64 bit IEEE address) and 65,535 networks
6. Requiring low latency
7. Fully hand-shacked protocol for transfer reliability
8. Range: 50m typical (5-500m based on environment)[9]

Table2. Comparison between different wireless techniques

FEATURES	Wi-Fi (IEEE 802.11b)	BLUETOOTH (IEEE 802.15.1)	ZIGBEE (IEEE 802.15.4)
Power Profile/Battery life	Hours	Days	Years
Network Size	32	7	64000
Operating Frequency	2.4 and 5 GHz	2.4 GHz	868 MHz (Europe) 900-928 MHz (NA), 2.4 GHz (worldwide)
Complexity	Very Complex	Complex	Simple
Range	50-100m	10m	70m-300m
Data rate	11Mbps	1Mbps	250Kbps
Application Focus	Web, Email	Cable Replacement	Monitor and control
Success Metrics	Speed	Cost	Power, Cost

4.3 Advantages

1. Low power consumption.
2. Simply implemented.
3. Users expect batteries to last many months to years.
4. Bluetooth has many different modes and states.
5. Secure networking

5. CONCLUSION

From last few years, major techniques are searched for the depth measurement. So today there are lot of techniques which make the work easier and simplify the task of hydrograph. Using this system the engineers on site don't need to carry bulky computer with their batteries thus reducing their effort. Also it replaces the current system which is proprietary, thus our system can be made flexible as need be, and also is cost effective to a very large extent.Wireless module using zigbee established a communication link with on-site computer in the office. Also the development of wireless system i.e. zigbee make easy transmission of the depth measurement data and coordinate's data to the PC which is best thing. So in future this system is also used in mining for metal detection purpose.

6. REFERENCES

[1] Tien-Wen Sung, Ting-Ting Wu, Chu-Sing Yang, Yueh-Min Huang, Reliable Data Broadcast for Zigbee Wireless Sensor Networks, international journal on smart sensing and intelligent systems, vol. 3, no. 3, September 2010.

[2] P.Rohitha1 ,P. Ranjeet Kumar2 Prof.N.Adinarayana3, Prof.T.Venkat Narayana Rao4, Wireless Networking Through Zigbee Technology, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 7, July 2012

[3] Professor & Head, Dept. of Computer Applications, Mohamed Sathak Engg. College,Kilakarai & Principal, The Role of Zigbee Technology in Future Data Communication System, Journal of Theoretical and Applied Information Technology 2005 - 2009 JATIT.

[4] S. Omar, A. Liu, P. Techateerawat, "Navigation Wireless LAN Device", The 2004 International Symposium on GNSS/GPS, Sydney, Australia, 6-8 December 2004.

[5] "Reservoir Survey and Data Analysis" U.S.Department of the interior, Bureau of Reclamation, Nov 5, 2012

[6] Sharma Etemadi Borujeni, "Ultrasonic Underwater Depth Measurement" 2'nd IEEE International Symposium on

[7] Underwater Technology, April 2002, JapanMobile Adhoc Networks are the networks whose topology changes randomly with time.

[8] Doug Lockhart, Peter Canter, Corey Collins, "Case study on Hydrographic Survey Processing with Ellipsoidal Altitude" 2007 MTS

[9] Erina Ferro and Francesco Potorti, "Bluetooth and Wi-Fi Wireless Protocols: a survey and a comparison" IEEE Wireless Communication, February 2005

[10] Neil W. Bergmann and Jarrod Trevathan, "Wireless Underwater Power and Data Transfer", Eight IEEE Workshop on Practical Issues in Building Sensor Network Applications 2013

[11] Xiaobo Yu, Pirabakaran Navratnam and Klaus Moessner, "Resource Reservation Schemes for IEEE 802.11- Based Wireless Networks: A Survey", IEEE Communication survey and Tutorial, Third Quarter 2013

[12] Nickolas J. LaSorte, Sameer A. Rajab and Hazem H. refai, "Experimental Assessment of Wireless Coexistence for 802.15.4 in the Presence of 802.11g/n", IEEE 2012

[13] Pankaj Varma and J.S.Bhatila, "design and Development of GPS-GSM Based Tracking System with Google Map Based Monitoring", IJCSEA Vol 3, No3, June 2013

[14] Dr.K.R.R.Mohanrao and T.Nandini, "Zigbee Based Location System for Forest Search and Rescue missions", IJETT-Vol 11, No4-May 2014

[15] Prachi Sharma, "Wireless Sensor Network for Environmental Monitoring", IJSRET, 3-4 November, 2014