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Sediment Calcification Technique Using Single Beam Echo Sounder

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ABSTRACT: Sediment classification technique involve classification of different sediment. There are different types of technique exist like empirical method or model base approach. In this paper, it proposes a new technique in which single beam echo sounder are used to classify different sediment. Sediment is occurred because of processes of erosion and weathering on material. It is transported by water, force of gravity on particles or action of wind. Sediment can also be classifiedbased on its composition or its grain size. By measurement of echo from single beam echo sounder reflected from bottom surface of the sediment and calculation of the signal penetration in different sediment can result into classification of sediment. Study of experiment result can show effect of acoustic signal on different types of sediment. This study can eventually help us to speculate the exact ground area covered by water and amount of water present in the water bodies. It will also help us to determine water contamination because of different sediment present in it.

KEYWORDS: Sediment, Echo sounder, Erosion, Weathering.

I.INTRODUCTION

Classification of underwater object is one of the major challenging tasks due to constant changes in behaviour of sediment and its impact on the signals. By classifying different sediment and their impact on acoustic signal will result in the model of underwater situation. Design of single beam echo sounder can be used to detect underwater object. Echo sounder must work on different frequency because, in initial study it has been proved that when signal frequency reflects from ground surface. Some frequency penetrate through the different sediment and it is the big challenge to design echo sounder on frequency, which will give us exact reading of object distance. By accomplishing this result, we can speculate the ground area covered by water and amount of water in the water bodies. This will eventually help us for planning of water distribution in major city across in India. The result of the experiment is simulated using MATLAB simulator.

In 19th century, Hamon grabber technique used for measurement of ground area covered by water bodies. Hamon grabber is used for taking bottom grabs of water bodies. This technique uses bottom samples to calibrate the output of the single beam echo sounder and then it can also be used to classify a bigger area. But this technique has many disadvantages such as it has less accuracy, and because of large size of the machine it becomes less popular.It also takes more handling and harder to use in difficult condition. One of its major disadvantages is that this approach is expensive and it is also very slow process and also takes too much time. Now a day's echo sounding technique is used for measuring water depths by transmitting acoustic pulses from the water bodies surface and listening for reflection or echo from the bottom surface. This technique can be used for classification of different sediment, which ultimately pollute the water bodies as well as restrict the water storage capacity of the water bodies. Single beam echo sounder are also used for bathymetric mapping and for determining the sediment composition, core or grabs of the different sediment are needed. Only disadvantage of this technique is that it required extensive surveys and it might get little more expensive. This types of research is usefully to match modelled signal with different types of measurement done by a signal beam echo sounder, but we don't have to rely on ground truth for calibration. This research will also show how well it is able to discern between various sediments.

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II.SYSTEM MODEL AND RELATED WORK

There is very little work has been done on this topic. For decade hamon grabber technique has been used but is less accuracy an inability to work in harsh condition lead to new use of new technique which empirical method. In order to classify different sediment on the bases of their performance when they come into the contact with acoustic pulses, detail study of different parameters are required. So a test tank has set up in room temperature 21^0c to study those parameters. Size of this test tank is 2m x 2m. Layers of different types of sediment which has thickness of 20 cm is applied at the bottom of this test tank. Different material is used as sediment, such as sand with maximum diameter of particles is up to ½ mm and sedimentary rocks with maximum diameter of particle is up to 2 mm. then sound pulses are transmitted which will penetrate in the sediment. Beam width of this pulse is $1.5^0$and ping rate is 3-5 Hz for sand and 3 Hz for the sedimentary rocks. Direction of this beam will be near to normal axis. By studding the penetration of sound signal in different sediment, which has different particle size and varying different parameters regarding echo sounder like velocity of the pulse, transmission power of the pulse as well as frequency of the pulse will has various effect.

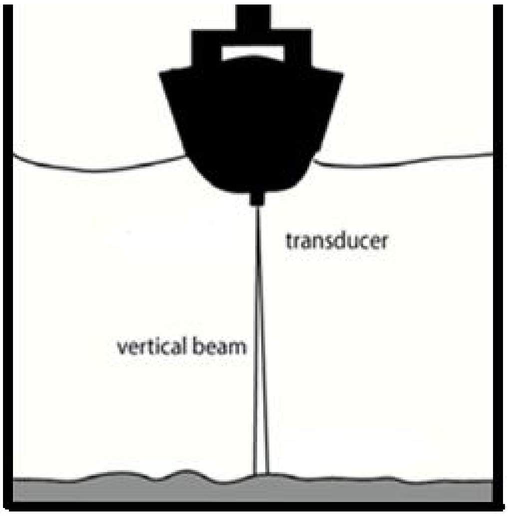

Fig. 1 test tank sketch

Different material is used as sediment, such as sand with maximum diameter of particles is up to ½ mm and sedimentary rocks with maximum diameter of particle is up to 2 mm. then sound pulses are transmitted which will penetrate in the sediment. Beam width of this pulse is 1.50 and ping rate is 3-5 Hz for sand and 3 Hz for the sedimentary rocks. Direction of this beam will be near to normal axis. By studding the penetration of sound signal in different sediment, which has different particle size and varying different parameters regarding echo sounder like velocity of the pulse, transmission power of the pulse as well as frequency of the pulse will has various effect.

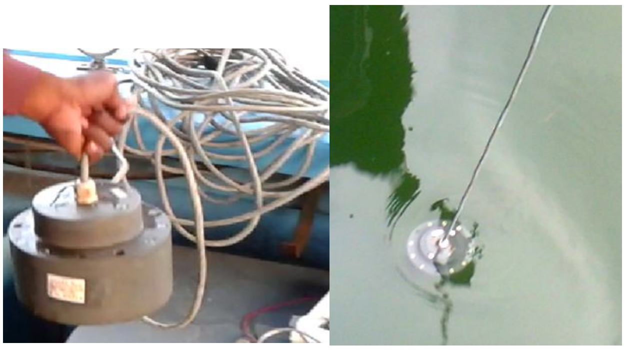

Fig. 2 Single beam Echo sounder

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III.EQUATION USED

Primary equation used for data calculation in acoustic theory is given below.

$$V = SL + G - 40 \log R - 2aR + TS + 2B\,(\Theta\phi) \qquad (1)$$

V = the received voltage of the echo in decibels (dB),

SL = the transmitted source level in dB @ 1m/ µpa,

G = the receiving gain of the system in dB per µpa at 1m.

40 log R = the two-way spreading loss in dB where R is the range in meters,

a = the sound attenuation coefficient in dB/m,

Ts = the acoustic target strength,

B (Θϕ) = the transducer directivity pattern function.

This is the equation which is used for acoustic signal processing. If the value of *V* in the given equation is greater than background noise signal penetration take place. Both transmitted sound and the return echo are greatest at the acoustic axis. And that will be perpendicular to the face of the transducer. R is the range which is unknown in this case, but all the other parameters are the known parameters in this equation. By calculating the distance we can easily calculate signal penetration in different sediments.

IV.RESULTS AND DISCUSSION

Experimental data on medium type sand with maximum diameter of particle is up to 1/2 mm, Beam width is 1.5^0 and Ping rate 3-5 Hz. Direction of beam is near to normal axis.

Velocity = 1480 M/s	Measured distance for 1W Power		Measured distance for 2W Power		Measured distance for 5W Power	
Actual Distance In meters	Channel 1= 200 KHz	Channel 2 = 33 KHz	Channel 1	Channel 2	Channel 1	Channel 2
1.7	1.54	1.62	1.53	1.61	1.52	0.52
1.6	1.44	1.52	1.42	1.52	1.41	0.52
1.5	1.34	2.45	1.32	1.39	1.32	0.52
1.4	1.28	2.39	1.23	1.30	1.23	0.52
1.3	1.13	2.30	1.14	1.20	1.13	0.52
1.2	1.05	1.11	1.03	1.09	1.03	0.52
1.1	0.95	1.01	0.92	0.52	0.93	0.52
1.0	0.83	0.91	0.83	0.52	0.82	0.52

There are several experiment has been performed and different parameter are use in this study. By varying this parameter we can study the effect on sound signal of this parameter. And we can easily classify different sediment.The experimental data table shown above is one of the case study that are performed in test tank on Medium sand with maximum diameter of particle is up to 1/2 mm, Beam width is 1.50 and Ping rate 3-5 Hz. Direction of beam is near to normal axis.

All case study took place in the same environment. Only difference in this case study is that parameter like transmission power are very in some cases from 1W, 2W, 5W while velocity is kept constant at 1480 m/s. Signal penetration is measured for both channel. Channel 1 operating frequency is 200 KHz and Channel 2 operating frequency is 33 KHz. Maximum distance which have measured is 1.7 meter in 2 meter test tank.

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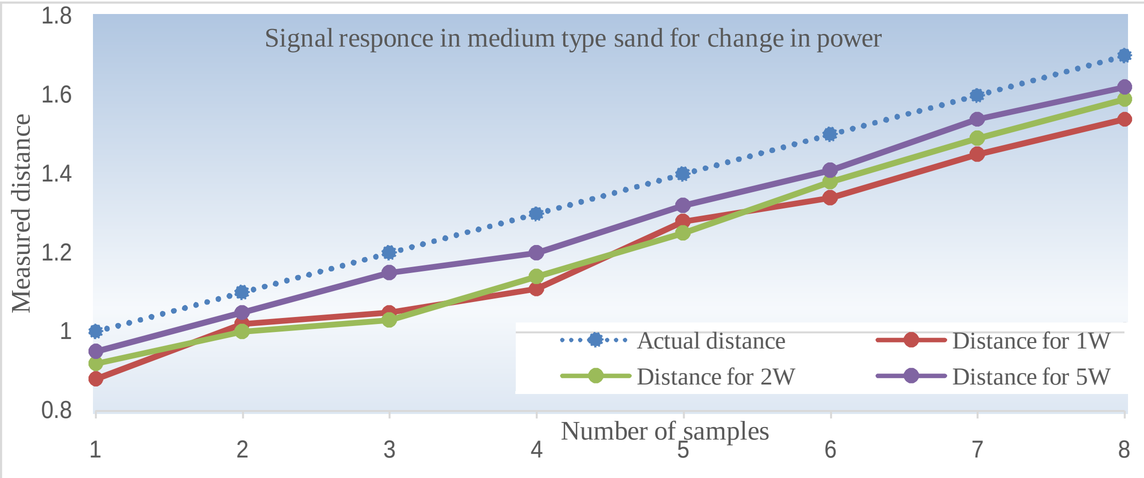

Fig. 3 Graph of the signal penetration in sediment

The graph clearly shows that change in signal parameter has saviour effect on penetration capability of the signal if different sediment.

V.CONCLUSION

Characteristic of acoustic signal has been studied.200 KHz with 2 Watt power transmission with 1480m/s sound speed detects the true bottom of the water column to 80 percent accuracy.Different parameter like transmission power, velocity of acoustic Signal, changing transmission frequency, time gate of the acoustic signal pulse and other parameter has severe effect on the signal behaviour as well as its penetration capacity completely depend on this parameter. Change in any of this parameter could change entire scenario of experiment. Above case study is the proof of this concept.

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