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Analysis of underwater noise into Gaussian/Non-gaussian category

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Abstract – *Underwater communication is done by acoustic wave .In communication, noise is important factor. It is the contribution of many sources. Inside the water different types of noise is occur at different frequency and it affect the signal differently. Combination of all noise called as ambient noise which divide in two group like man-made and natural noise. In this paper, analysis is done on bathymetry data which consist signal with noise. We focus on statistical analysis of individual noise, doing the simulation and on the basis of that define it is Gaussian or not. Again we focus on types of noise. Here at low frequency different noise is occur and at high frequency different noise is occur. So we find which noise occur at different frequency. An algorithm is based on non-gaussian approach allow to generate number of sequence of samples for noise realization and on the basis of kurtosis level decide the gaussanity.*

***Key Words*: Noise, Types of Noise, Statistical parameter**

1. INTRODUCTION

Underwater communication is the recent topic in communication. Today world is so fast. In this world science and technology go beyond the human expectation. Such technology is used in underwater communication. Instead of electromagnetic signal we use acoustic signal for underwater communication. Because this is used for long distance with less attenuation. This wave provide the number of advantages like less attenuation, high reliability, travel long distance with low frequency only the lack of bandwidth is big issue with that signal. Acoustic signal is a sound signal. When underwater object vibrate they create sound presser wave that alternatively compressed & decompressed water molecule as the sound wave travel through sea. The compression and decompression associated with sound wave are detected as change in pressure. The velocity of acoustic wave is 1500m /s. It require elastic material for propagation (i.e.solid, liquid & gas). This speed is depend on three factors temperature, salinity and depth. Speed can be calculated by

$$C=1449.2+4.6T-0.055T^{2}+0.00029T^{3}+(1.34-0.01T)(S-35)+0.016z \quad (1)$$

Where, c is the sound velocity in m/s; T is temperature in ^{0}C; S is salinity in p.s.u. and z is depth in m.

2. UNDERWATER NOISE

Underwater noise is the most challenging subject. Day to day increase the industrial interest in offshore oil and gas extraction will affect the diversity in seawater. Anthropic activity is the most dominant source in underwater. Different part of ship produce the different noise. In that most dominant is noise generated by propeller. This environment, create very complex noise in water called as ambient noise. It is the combination of natural and anthropic noise. Here data is to be collected from bathymetry which consist mixture of noise. Practical is to done in khdkwasla dam Pune on 10th September 2018 with single beam echo sounder having frequency 16khz and depth is 200m. Show in fig1.Data is to be recorded and simulate through matlab. Therefore the different noise is givien as

$$Nt(f) = 17 - 30\log(f) \quad (2)$$

$$Ns(f) = 40+20(S-5)+26\log(f)-60\log(f+0.03) \quad (3)$$

$$Nw(f) = 50+7.5w+20\log(f)-40\log(f+0.4) \quad (4)$$

$$Nth(f) = -15+20\log(f) \quad (5)$$

Where f is the frequency in kHz. Therefore total noise PSD is

$$Sxx(f) = Nt(f)+Ns(f)+Nw(f)+Nth(f) \quad (6)$$

Here each noise is occur at different frequency. At low frequency turbulent noise is occur with having frequency is from 0.1 to 10 hz. Ship noise occur at frequency 10hz to 100hz.Wind noise occur at frequency 100hz to 100khz.This is generally occur on sea surface and it effect is depend upon wind speed.. And the last is thermal noise which occur at frequency above the 100khz.This is generated because of movement of water molecule. It is occur at very high frequency. But for underwater we use low frequency so that's way this is not to be consider much. See fig 1. Which indicate result of simulation of PSD of different noises.

A. Turbulence noise:

Obstacle is come in flowing of river water and steam and create the turbulence as well as air bubble formation which produce the specific sound. This is nothing but background noise. In such condition signal to noise ratio is low and then difficulty is occur during the analysis the capture data. Second one is because of turbulence change in pressure is occur inside the turbulence region. This dynamically varying pressure is picked by pressure sensitive hydrophone located in turbulent region. If the turbulent component of the flow is written as u, then the associated dynamic pressure is qu2 where q is fluid density

B. Ship noise:

Noise generated by ship is radiated by different part of ship. However the underwater noise spectrum is dominated by two main principal sources i.e. machinery and propeller. Propeller noise is the most dominating source which generate the noise on surface of sea. Because of rotating the propeller, it create positive and negative pressure on water. This negative pressure create bubbles and produce the sound. Producing force on water is depend on propeller blade. The propeller blades are rotating twisted wigs that produce the strong hydrodynamic force. This noise occur at low frequency.

C. Wind Noise:

Wind noise is depend upon wind speed. If wind speed is high then breaking of wave is occur and produce the sound. If we consider on shallow water then it is the combination of different noise. Generally this noise occur on surface of sea. And so because of that it is somewhat difficult to model. Wind blowing at a certain speed and behavioue of that source level (SL) can be obtained. Noise level by wind is given by

$$NL = A\ 10n \log 10\ u \qquad (7)$$

Where A & n are variable that may vary with frequency and location of measurement and u is wind speed.

D. Thermal Noise:

This noise occur at very high frequency i.e. the frequency above the 100kHz.It is generated because of movement of water molecule. See the figure 1 which indicate different noise occur at different frequency. At low frequency turbulent noise occur which indicate by green. At medium frequency ship and wind noise occur. And at high frequency thermal noise occur.

3. STATISTIC

Here we do the statistical analysis of all types of noises and calculate the all parameter. Acoustic noise is the sequence of samples which having random charactertics. Since the simulating the noise based on Gaussian process. Normal distribution characterized the mean is zero, variance is one and level of kurtosis is 3. This level of kurtosis indicate the gaussianity and any shift from this value indicate the non-gaussian shape. Below table1. Indicate the how kurtosis value is change which indicate noise which occur in water is non gaussian. As well as low kurtosis value occur with sinusoidal source. Here we use input signal is sine wave. Skewness value is indicate the symmetry property. If skewness value is 0 then it is more symmetry. If its value is negative then signal is shift negative side. And if its value is positive then signal is shift toward positive side. Its value should be less than 1.9.

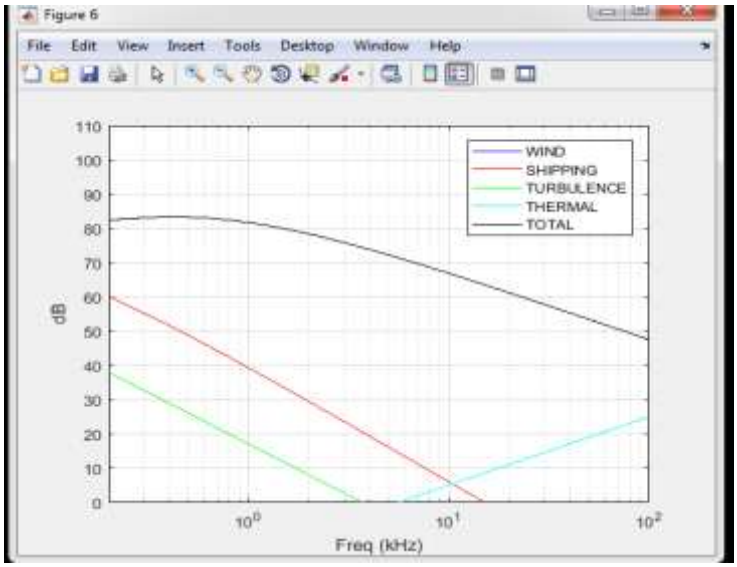

Fig 1. Indicate different noises occur at different frequency.

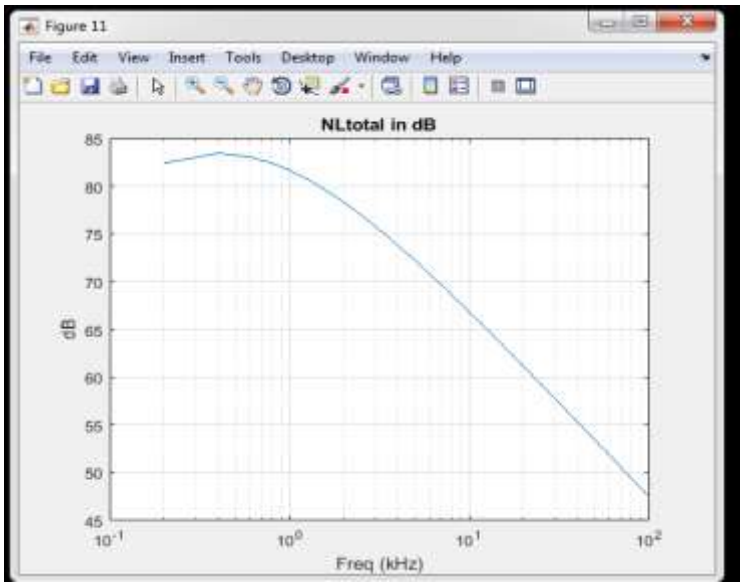

Fig2.Total noise signal in db

Table 1. Statistical parameter of signal and noises

Parameter	Input signal	Input+ Multipath noise	Input+ thermal noise	Input+ wind noise	Input+ Ship noise	Input+ Turbulent Noise
Mean	0.309546	-0.001309	0.006225	55.707983	13.40509	-30.07608
SD	35.357267	0.212213	0.711845	7.661346	14.28574	12.715423
Variance	1252.966	0.045034	0.506723	58.696224	204.0825	161.681994
Kurtosis	1.500	3.670681	1.500924	4.560780	6.663944	6.993309
Skewness	-0.013136	0.187012	0.013136	1.369534	1.739109	1.786266

4. CONCLUSION

In this paper we focus on underwater noises. In every communication noise play an important role. Acoustic noise in the sea come from many sources. Surface agitation and ship noise is the most dominant source of ambient noise. Here we have done some analysis and on the basis of that basically from kurtosis value we find noise is non gaussian. Again we see types of noise and its frequency.

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