A GSM BASED Real Time system TO MONITOR Underwater Noise Pollution

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1. Introduction

Coastal marine environment is permanently exposed to anthropogenic stress that damages its integrity and evolution. One of the most common anthropogenic perturbations of the marine environment is acoustic pollution. Maritime transport, oil and mineral extraction, and aquatic sports are just few examples of human activities that contribute to acoustic pollution of the sea. Because the intensity of these noise sources and long range propagation of the sound at sea, acoustic noise represents a risk for marine species. The effects on marine species are quite spread: neutralize the communication and detection systems of marine mammals [1], dispersion of fishes from their usual locations of nutrition and reproduction, and even injure their internal organs [2].

Monitoring underwater noise is a pre-requisite to control its impact on marine environment. There are a lot of monitoring systems that record the data acquired by a hydrophone, but to obtain real time monitoring system of underwater noise, we need to develop techniques to compress and codify the data to allow transmission by VHF or satellite communications.

The main objective of this project is to create a low-cost, user friendly, and real time monitoring system of underwater noise pollution at coastal area. Using real time monitoring should provide in the future the capability to adequately respond to underwater pollution. In order to achieve these points, we have developed a monitoring system that uses GSM (Global Systems for Mobile communications) technology to transmit acoustic data [4].

One reason to use GSM is its wide geographic expansion allowing high coverage far away from the coast (almost 35 km offshore) at almost all the coast of the Mediterranean Sea. The bandwidth needed to monitorize is below 3 kHz, which is lower than the frequencies used to transmit voice in GSM.

The codec used to transmit voice in GSM (defined at ETSI specification 06.10) is the Regular Pulse Excited Long Term Prediction (RPE-LTP), which is a lossy speech compression codec. This means that disturbs the signal and filters it. To solve this filtering problem we need to develop a switching frequency system to avoid losing of the most important frequencies of the signal.

2. Results and discussion

The spectrum of underwater noise [3] is divided in tree main windows located at (Figure 1):

-frequencies below 100 Hz, where the noise is dominated by oceanic traffic noise.

-frequencies below 1 KHz or so, where the results spread significantly, in function of the frequency-dependent attenuation part of the transmission loss. This noise is done by shipping movements near and far away (distant ships can still contribute significantly).

-frequencies of 3 KHz to 100 KHz, where there is a little variation of noise level. It is thought that this noise is generated by wind and surface wave's sources.

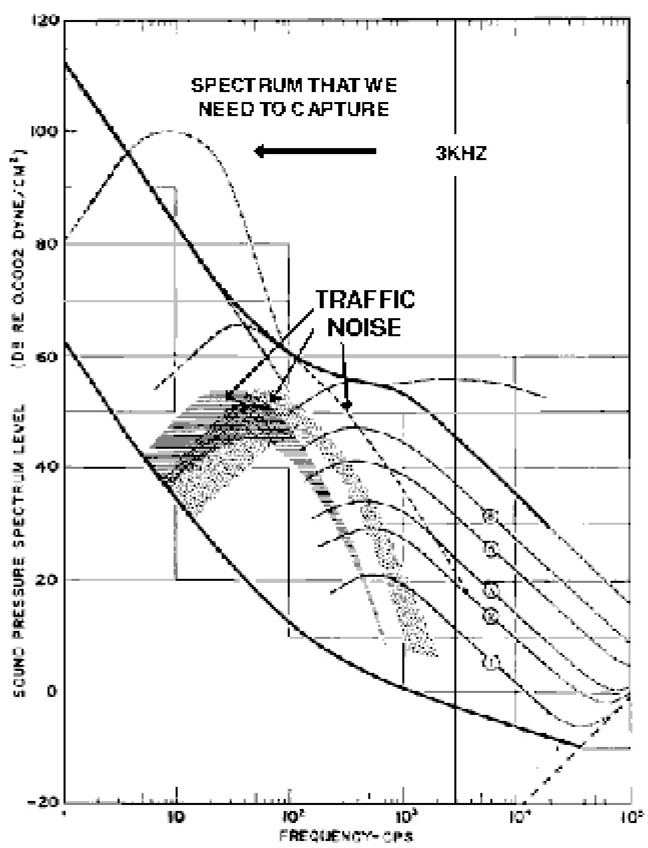

Figure 1. Curves of underwater noise [after 3]

The frequencies of underwater sounds that we need to capture are below 3 KHz, to obtain the maximum noise information with the minimum bandwidth. Simulations made with the ETSI code of RPE-LTP and real probes done with the GSM codec, show that only the frequencies between 150 Hz to 3.4 KHz are transmitted. Figure 2 shows the frequency response of RPE-LTP for a senoidal signal with frequency changes from 0 to 4 KHz.

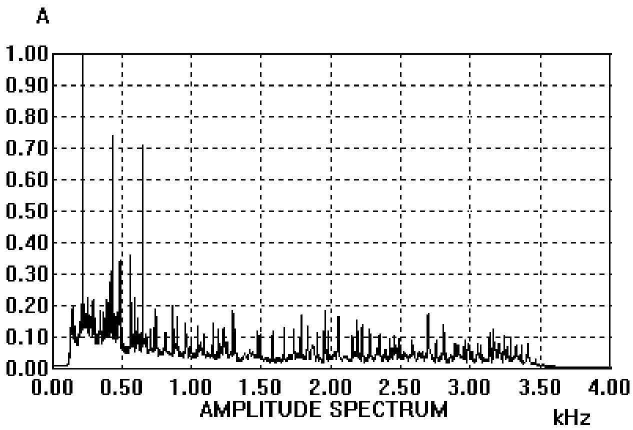

Figure 2. Response of GSM codec RPE-LTP to a modulated signal

The acoustic signal must be processed before its transmission due to filtering effects at frequencies of interest (below 150 Hz). In order to solve this problem, we have developed a circuit that filters those frequencies and shift them to a frequency of 3.4 KHz, using the inverse spectrum of the signal (Figure 3).

Tests made with this circuit show that the entirespectrum between 150 Hz and 3,4 KHz is transmitted, but with high losses. This is because of RPE-LTP is a lossy codec that simulates the speech with a Long Term Prediction filter. The average Explain Variance percentage for transmissions done with the codec is around 79%.

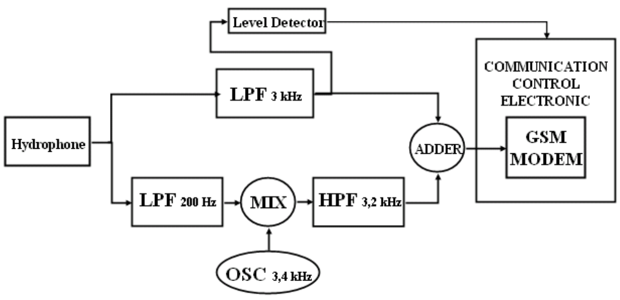

Figure 3. Diagram of frequency shift circuit.

In order to add more capabilities to our system, we have developed a electronic control that measures the GPS position of the monitoring system (for security reasons of the buoy), controls the GSM calling protocol and recognizes when there is a noise level upper than a configured value to initiate a transmission. This system is configurable by an SMS message and sends information messages of internal alarms and parameters (GPS position filtered with Kalman, battery levels, GSM signal level, QoS and BER, etc.).

3. Conclusions

The main problem of filtering with the RPE-LPT codec is solved by partial displacement in frequency of the acoustic signal, obtaining a simple and cost effective prototype for real time monitoring at coastal areas.

The use of a lossy codec like RPE-LTP generates at reception a signal that is similar to the original data, excepting slightly deviations. Thus the received data is on average the recorded data and so, our monitoring system can be only use to verify the average levels of noise.

4. References

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