Erasmus Mundus WAVES

Report

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Contents

1 Introduction

The following assignments were the main interest for exploration in order to progress the current state of the work:

- reconstruction of the bubble frequency response from the received signal
- simple version of the multiple scattering between bubbles
- research on the available mesurement procedures within the literature of the bubble experiments
- Wiener filter noise deconstruction
- sonar equation implementation

2 Theoretical part

Reconstruction of the bubble frequency response from the received signal

It will allow demonstrating the ability to invert the model to find individual bubble contributions from compund analysis. The following equation **??** was the base of the calculations:

$$R = T \times H + N \tag{1}$$

where R is a received signal, T is a transmitted signal by sonar, H is frequency response of the bubble, N is an added background noise.

Simple version of the multiple scattering

The concept lies in considering each bubble as a source when it scatters an incident wave. Therefore, each bubble will have an influence on another, and also receives a sum of all scatterrings from other bubbles.

Bubbles have to be sufficiently far from each other in order not to be dependent on each others bubble frequency response.

Research on the available mesurement procedures within the literature of the bubble experiments

- Sound signal: narrow band pulse, chirp, noise
- Sonar position: from top, vertical, horizontal
- Bubbles location: in the center of the experimental pool
- Bubble characteristics: emitting a single bubble of the specified radius; a row of bubbles; creating a bubble flare;

Other things which are important for taking into account are:

- Response of the transducer can influence the received signal
- Near field radiation implementation for measurements with a spherical radiation against the plane wave in a far field

Further set of things which are required to perform the experiment are the setup of the equipment required for performing our measurements. Essentially, it will include the sonar, a bubble generator, processing unit as a laptop/computer.

Wiener filter noise deconstruction

It is one o the signal processing filters which allow us to denoise the signal. Main feature of the Wiener filter is that unlike simpler filters that may only suppress noise or attenuate certain frequency components, the Wiener filter operates on a statistical model of the signal and noise, effectively balancing the trade-off between signal fidelity and noise reduction.

subsection*Sonar equation The Sonar equation is a fundamental tool in underwater acoustics used to predict the performance of sonar systems. The basic form of the Sonar equation is:

$$SNR = SL - TL + TS - NL \tag{2}$$

Where SNR is the signal-to-noise ratio, SL is the source level, TL is the transmission loss, TS is the target strength, and NL is the noise level.

To implement the Sonar equation, one needs to calculate or estimate each of these parameters. Source level (SL) represents the acoustic power radiated by the sonar system, which can be determined based on the characteristics of the sonar transducer and the electrical input power. Transmission loss (TL) accounts for the attenuation of sound energy as it propagates through the water, considering factors such as spreading loss, absorption,

and bottom and surface reflections. Target strength (TS) quantifies the amount of sound energy reflected or scattered by the target, which depends on its size, shape, and composition. Noise level (NL) encompasses all sources of ambient noise in the environment, including thermal noise, wind-generated noise, biological noise, and anthropogenic noise.

3 Calculation

Sonar equation implementation

1. Calculate the transmission loss from SONAR to 1m in front of target
2. Calculate TL from 1m in front of target to target
3. Calculate TS from filtering with frequency response of target
4. Add transmission loss from target to 1 m in front of target - Combine these for total target strength

4 Results

5 Interpretation

6 Conclusion