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Linkage Efficiency for Exterior Vehicle's Submerged Acoustic Modem

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Abstract: Due to the consistent change of indicate point submerged acoustic correspondence innovation, submerged acoustic correspondence arranges in seas will turn into a reality. Lately, unmanned vehicles for example, AUVs and Gliders have continuously developed and been culminated and can be utilized as a novel sort of submerged acoustic hub. In this study, a novel Unmanned Surface Vehicle (USV) incorporated submerged acoustic modem is presented. Because of the many-sided quality of submerged acoustic channels, the unforgiving marine condition and parts of the USV's control submerged acoustic correspondence that connections demonstrating and estimation is fundamental for USV interchanges and applications. Right off the bat, the submerged acoustic correspondence separate, USV running condition and the Marine condition are considered as the principle variables influencing a USV's acoustic correspondence. Comparing to the above variables, correspondence vitality misfortune display, USV movement model and marine natural effect model are set up separately. Besides, dissecting the connections among the three models, a USV submerged acoustic correspondence interface quality model is built.

Key words: Unmanned surface vehicle, underwater acoustic communication, link strength model, acoustic modem, acoustic signal intensity, correspondence

INTRODUCTION

Since, the number of unmanned platform rises and the related technology improves, the unmanned platform becomes a hotspot of ocean technique research and development which can provide technological support for an underwater acoustic network's mobile relay and topological optimization. Applications of marine robotic vehicles and investigation of underwater acoustic networking enabling the cooperative operation of multiple heterogeneous vehicles are explained by Yuh *et al*. (2011) and Cruz *et al*. (2013). In particular, a USV integrated underwater acoustic modem becomes an optional creative node in an underwater acoustic network because it has some advantages such as easy integration, quick positioning and low cost. Dynamic positioning of beacon vehicles for cooperative underwater navigation and is discussed by Bahr *et al*. (2012). It can also become a water and underwater communication relay. The USV 'ZARCO' was used to carry out a study of the communication and positioning between underwater AUVs and relative simulations and experiments of USV tracing and positioning of AUVs based on underwater acoustic communication was completed by the University of Porto researchers. Underwater acoustic communication channels: propagation models and statistical characterization and a high-frequency warm shallow water acoustic communications channel model and measurements are explained by Stojanovic and Preisig (2009) and Chitre (2007). The USV 'SCOUT' was researched and developed by Massachusetts Institute of Technology. It used an underwater acoustic modem to accomplish communication among many USVs with the aim developing a AUV communicating and positioning system based on a USV platform. Underwater vehicle for surveillance with navigation and swarm network communication and Biopreservation of value added Marine fishes under different storage conditions using Bacteriocin from *Lactobacillus* sp. (AMETLAB27) are discussed by Karthik (2014) and Wilson *et al*. (2016).

MATERIALS AND METHODS

System models: In underwater acoustic communication, seawater is a kind of non-ideal loss medium. The signal intensity will decline when transmitted in the medium. In the model of underwater acoustic communication link quality, the decline of this signal can cause energy loss. We consider that the link's energy loss is mainly due to the wave front expansion and the assimilation of the seafloor, the sea surface and the sea medium. By ignoring specific propagation, the acoustic signal loss can be estimated by the empirical formula as follows:

$$A(l, f) = (l/l_r)^k \, a(f)^{l-l_r}$$

Where:

$(l/l_r)^k$ = The engendering misfortune caused by augmentations. It is identified with the engendering style and separation

l = The genuine spread separation

l_r = The referential separation

k = The expansion misfortune file which is identified with the barrel shaped wave augmentations and round wave augmentations individually

We can see that the acoustic wave misfortune extends clearly with the expansion of recurrence. Thus, the explanations behind the loss of acoustic wave are engendering separation as well as the flag recurrence. The spread misfortune is appeared in Fig. 1 by the exact equation estimation at the recurrence of 20 kHz.

During the time spent submerged acoustic correspondence, USV movement status deteriorates the relative movement inside the flat plane and the relative movement in the vertical bearing. The USV is furnished with a Gyro disposition sensor and GPS to evaluate the parameters which are utilized to examination the

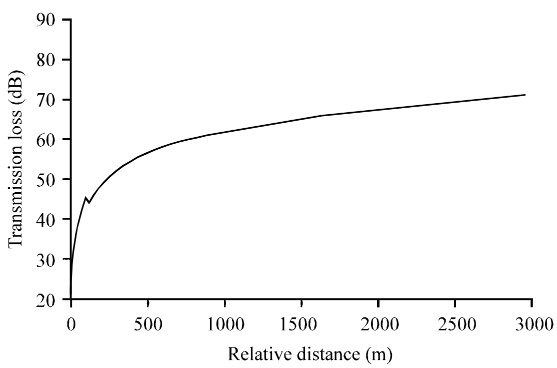

Fig. 1: Energy loss caused by extension

correspondence quality. Therefore, we can achieve a conclusion that these parameters for the most part have an impact on the model for example, contribute rate e the vertical course, roll precise speed ¢ and speed V inside flat plane.

The acoustic signal propagation speed is an important parameter in the marine environment. The variation of acoustic speed influences the sound wave's propagation route. Temperature, salinity and depth are the main parameters that influence sound speed. We can conclude the empirical formula by many measurements on the sea as follows (Stojanovic and Preisig, 2009; Chitre, 2007; Karthik, 2014; Wilson *et al*., 2016):

$$c = 1449.2+4.6T-0.555T^2+0.00029T^3+ (1.34-0.01)(S-35)+0.16Z$$

RESULTS AND DISCUSSION

Experimental verification: Keeping in mind the end goal to check the submerged acoustic correspondence connect quality model in this study, a lake examination was led utilizing our USV in Qingdao Jihongtan Reservoir on July 15, 2015. The edge of the repository is 14.3 km and the profundity is around 10 m. Two EvoLogics submerged correspondence modems have been utilized as a part of this trial, one is plunged underneath the water around 2 m close to the shore stage; the other is situated under the USV as a portable hub which is 3 m from the water surface. An independent hydrophone with 256 kHz testing recurrence is settled around one meter under the USV and is utilized to record and screen correspondence signals. The USV likewise has other gear for example, CTD, a climate station, GPS, electronic compass, single bar profundity sounder et cetera (Fig. 2 and 3).

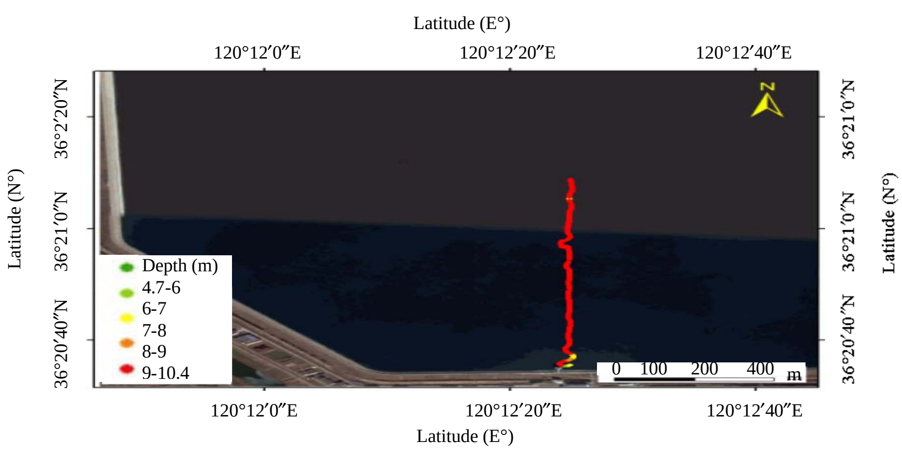

Fig. 2: Mobile route map

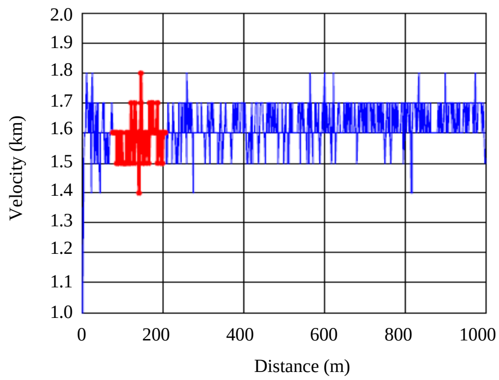

Fig. 3: Velocity changing with the distance

The marine environment and the sailing state of USV have effects on the communication link strength. In order to test the impact, we take a mobile experiment. We define that the desired trajectory is a straight line along North direction, the starting point is 36°20′35″N, 120°12′25″E and the ending point is 36°21′12″N, 120°12′25″E. USV sails automatically straight line 1 km in mobile communication experiment using path following automatic control.

In Fig. 2 and 3, we can see that the three parameters change slowly. They change within certain limits and conform to the regulation. However, they fluctuate violently between the distances of 100 and 200 m. Compared with the above fixed communication experiment within 1 krn, the signal strength attenuates by about 5 db more which is mainly due to the USV running condition and the ocean environment.

CONCLUSION

In this study, the submerged acoustic correspondence separate, USV running condition and the Marine condition are considered as the fundamental variables influencing a USV's acoustic correspondence. Comparing to the above variables, a correspondence vitality misfortune demonstrate, USV movement model and marine natural effect model are built up individually.

From the above tests, it is presumed that the USV is extremely viable as a versatile transfer hub and the models can legitimately be received to portray its correspondence capacity. The proposed models, not exclusively can be utilized for USV submerged acoustic hubs to frame a system, additionally for other versatile hubs for example, AUV and ROV, thus give the premise to building systems.

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