Development of UHF Band Communication Method under the Sea

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ABSTRACT

It is obviously known that radio wave is inefficient in the sea because of strong attenuation. On the other hand, high frequency radio wave has become the mainstream of wireless communication on the ground, and its instruments which certificate WiFi standard can be purchased inexpensively. Since radio wave is useful because of its connectivity, transmission late and price, communication like radio wave on the ground is desired in the water. In this paper, the method using high frequency radio wave communication in the water is developed. Characteristics of communication are verified when conditions are changed.

KEY WORDS: Communication; radio wave; UHF band; sea; short range; insulator; conductivity.

NOMENCLATURE

α : Attenuation constant[Np/m]
β : Phase constant[rad/m]
δs : Skin depth[m]
ε : Permittivity [F/m]
ε0 : Permittivity of Vacuum [F/m]
λ : Wavelength[m]
μ : Permeability [H/m]
σ : Conductivity [S/m]
ω : Frequency [Hz]
E : Electric Field[V/m]
E_r : Complex Notation of Electric Field of Radiation Field[V/m]
E_o : Complex Notation of Electric Field of Origin[V/m]
E_z : Complex Notation of Electric Field at Distance of Z[V/m]
H : Magnetic Field[A/m]
H_r : Complex Notation of Magnetic Field of Origin[A/m]
H_z : Complex Notation of Magnetic Field at Distance of Z[A/m]
\j : Imaginary Unit [-]
\r : Distance between antennas[m]
Wc : Transmission/reception power[W]
z : Distance[m]

INTRODUCTION

Underwater communication utilizing high frequency radio wave is inefficient because of high attenuation caused by the water, especially in high salinity water (Che, 2010; Moore, 1967; Ozawa, 2011). In order to communicate between long distance by radio wave in the sea, the low frequency radio wave such as VLF band (3-30[kHz]) has been applied. From recent progress of digital processing, the subsea communication device using LF band (30-300[kHz]) is commercialized (Edwards, 2009). On the other hand, possibility of HF band had been only discussed (Yoshida, 2007).

Comparing with radio wave, acoustic communication has been widely applied since it does not strongly attenuated by the water as radio wave. Therefore, acoustic communication is necessary technology to communicate between long distance in the sea. Even though acoustic wave is commonly applied, it has large disadvantage; slow communication speed, necessity of special microphone, etc. Furthermore, acoustic communication is not applicable around the coast because of reflection of acoustic wave by ground and surface of the sea.

On the other hand, radio wave is applied to large number of communication devices on the ground. Radio wave has high communication speed and connectivity if the medium has less attenuation characteristics, and these devices can be purchased easily and inexpensively. Since high frequency radio wave communication devices on the ground are highly progressed and accessible, high frequency band radio wave communication which applied higher than UHF band (300-3000[MHz]) for underwater is strongly desired.

In this paper, the method using high frequency radio wave communication under the sea is developed. The causation of radio wave attenuation in the water is the electromagnetic characteristic of the water. Therefore, high frequency radio wave communication will be realized when the path of radio wave is prepared between the transmitter and receiver by low attenuation material. The material is not required any special arrangement. The only requirement to establish the communication in the water is the contact of the material and the watertight case contained transmitter/receiver. It has large advantage comparing with other communication method. The proposed method does not require machining of watertight case to extract the signal to the outside from the case, and it realizes to apply high frequency radio wave communication device on the ground. As the first report,