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Summary Sheet

Simulation Analysis of Multi-hop HF Radio

Summary

HF radio propagation plays an extremely important role in communication at sea and mountains. It may be influenced by various factors, resulting in great loss of signal transmission. In this paper we focus on transmission and reflection loss of HF radio propagation in reflecting surface changes.

First, according to the PM wave spectrum and random wave theory, we establish a **three-dimensional random wave model** to simulate the motion of waves. On this basis, we analyze the reflection of electromagnetic waves on the sea surface. We consider the influence of wave height caused by different wind levels on the reflection coefficient and obtain the reflection loss of electromagnetic wave under different conditions successfully. Then we get the sum of the lossin the transmission and the The first reflection intensity of the turbulent ocean and the calm one. At last we analyze the signal electric-field and atmospheric noise electric field of the receiving point, get the relation between SNR, transmission distance and hops, and the maximum number of hops should be 6 when SNR attenuates to 10 dB.

Second, we analyze the transmission on the ground on the basis of the wave model. We simulate the **topography** with the wave fluctuation. Because the electromagnetic characteristics of the earth are different from the sea surface, we correct the relative dielectric constant and conductivity. Since there are more obstacles on the ground than on the sea, so we also analyze the diffraction phenomenon of electromagnetic wave propagation on the ground. We calculate and compare the first reflection intensity between mountainous or rugged terrain and smooth terrain. Surprisingly, the effective distance of sky-wave transmission is shorter than that of sea surface reflection. Under the same conditions, the maximum number of hops of HF radio propagation is 4.

Finally, we consider the wind and waves that the ship may encounter on the sea surface, and calculate the longest distance that the received signal can propagate at a given wind level (i.e., SNR not less than 10 dB). Because ships usually travel longer, we also analyze the **periodic variation of the ionosphere** with time, and obtain the influence of the periodic variation of the ionosphere on the propagation of sky wave. On the basis of this, we get the optimal radio frequency under different conditions. After taking the ship speed into account, we amend the original model and obtain the maximum time for the ship to maintain the same multi-hop path.