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INFLUENCE OF WEATHER CONDITIONS ON THE RELIABILITY OF ATMOSPHERIC OPTICAL COMMUNICATION

The article deals with the dependence of atmospheric optical communication link from the weather conditions. Analyze the impact of changing weather conditions on the reliability of the atmospheric optical link.

Key words: optical communication, atmosphere, lasers communication, bandwidth of channel, data transfer, meteorological factors.

Introduction

Atmospheric optical communication lines, or Free Space Optics (FSO) technology are becoming more common in the world [1]. However, the process of their implementation prevent some legends associated primarily with a biased estimate of the effect of weather on the reliability of this type of communication [2]. In this article, we would like to show that this impact could be accurately assessed. In addition, based on these estimates can be calculated with high certainty the reliability of the communication channel at a predetermined distance.

Main part

To correctly installed and configured the atmospheric optical lines determinant connection reliability are the weather conditions at the place of its location. Influence of atmospheric effect in weakening the beam meteorological factors: rain, snow, fog, sand storms, as well as man-made aerosols. Additional factors reducing the radiation power in the receiving plane are turbulent formation in the atmosphere and their interaction with the laser coherent radiation. This causes "jitter" the beam to its "gummy" in the detection plane.

The main parameter that describes the process of interaction of optical radiation with the atmosphere, is the meteorological visibility (MDA). This is the distance over which light with a wavelength of 0.55 microns is reduced by 50 times (17 dB). Weather conditions vary for the different geographical areas, and from year to year.

Statistical weather parameter for a particular geographic location, determining the reliability of communication, is a fraction of the time of year during which MDA less than a predetermined value.

Statistical meteorological data processing has allowed establishing the empirical dependence of this parameter on the distance. Value is true for MDAs less than 17 km away.

$$W(L) = \alpha_i L^{b_i} \quad (1)$$

Where:

W (L) – the probability of occurrence of the weather conditions in which MDA smaller distance L;

L – The distance (km);

a_i, b_i – constant for a particular geographic point.

In clear weather, the turbulence of the atmosphere determines the maximum distance communication. Influence of atmospheric turbulence and scintillation in a beam of laser light is significantly attenuated by the introduction of multiple laser transmitters, since their radiation substantially incoherent.

Analysis of the results of research set out in the early and later publications shows that the turbulence in the lower atmosphere is more complex, due to the development of various kinds of instabilities. Given the absence of complete theoretical studies evaluating the reliability of the communication parameters when using multiple lasers, as well as the effect of averaging the aperture of the receiver and the destruction of the coherence of the empirical relationship estimating these factors has been proposed to us the atmosphere aerosols.

$$I = \frac{2{,}5\cdot 10^{-3}\cdot V}{2^N}\left(\frac{QL}{D_r}\right)^{\frac{3}{4}} \quad (2)$$

Where:

I - The possible attenuation factor at a distance L (dB);

L – The distance from the transmitter to the receiver (m);

q – The total angle of divergence of the radiation transmitter (rad);

N – Number of transmitting lasers;

D_r – optical receiver aperture diameter of (m).

Using Bouguer's law expression (2), as well as geometric attenuation factor we obtain the expression for determining the maximum path length for a given MDA:

$$10log\left[\frac{P_t}{P_r}\frac{D_r^2}{\theta^2 L^2}\right] + 10log\left[e^{\frac{3{,}92L}{1{,}2V}}\right] - \frac{2{,}5\cdot 10^{-3}\cdot V}{2^N}\left[\frac{\theta L}{D_r}\right]^{\frac{3}{4}} = 0 \quad (3)$$

Where:

P_t - the impulse transmitter power (W);

P_r - receiver sensitivity with a signal: noise ratio of 10:1 (W);

V - MDA (m);

From the expressions, (3) and (1) can be prepared to determine the ratio of reliability of communication depending on the weather conditions and the distance to a particular location.

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$$W = a_i \cdot V^{bi} = a_i \left[\frac{1{,}42 \frac{L}{1000}}{log\left[\frac{P_t \; D_r^2}{P_r \theta^2 L^2}\right] - \frac{2{,}5 \cdot 10^{-3} \cdot V}{2^N} \left[\frac{\theta L}{D_r}\right]^{\frac{3}{4}}} \right]^{b^i} \quad (4)$$

Where:

L – Distance between transmitter and receiver.

The graph in Fig. 1 constructed in accordance with (4) and illustrates the level of reliability of the communication channel according to the selected due to a series of MOST 100/500.

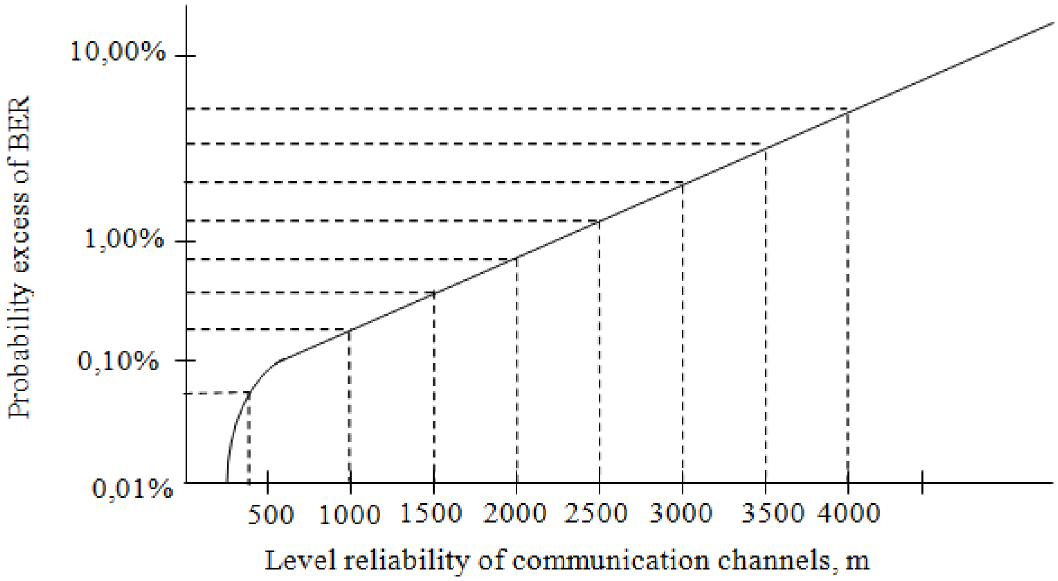

Fig. 1. The level of link reliability

Conclusion. As can be seen from calculating of reliability communication, the world does not exist FSO equipment, which can provide in the weather conditions in a particular Uzbekistan of bond with reliability above 99.8 %.

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