Doppler Sensor's Measuring Vehicle Speed and Traveled Distance Antennas

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Abstract – **The criteria of the microwave sensor of speed and traveled distance antenna choice are considered from the viewpoint of minimization of Doppler signal spectrum expansion.**

Keywords – **Doppler effect, speed and traveled distance sensor, Gaussian beam, antenna, mm-wave.**

I. INTRODUCTION

Non-contact microwave Doppler sensors measuring vehicle speed and traveled distance find the increasing application in the railway rolling-stock, wheel and track-type vehicle control systems [1]. They allow to lift accuracy of speed and travel measurement at the expense of exception of influence of sliding or tire scrubbing effects peculiar to contact gauges, that in turn allows to improve essentially parameters of control systems of movement and navigation.

II. MAIN PART

The Doppler displacement of frequency of a signal backscattered from a underlying terrain measurement lies in a basis of sensor principle of operation . Doppler frequency is determined by expression

$$f_d = f_0 (2v/c) \cos g$$

f_0 – microwave frequency; v – vehicle speed; c – speed of light; g – radiation angle.

The principle problem of a method lies in fact that the backscattered signal is not monochromatic. One of the basic reasons - final width of the sensor antenna pattern, that results in a variation of g value in illuminated spot area extent on an underlying surface. The effect can be essentially reduced by installation of the synphased antenna in immediate proximity to a underlying surface, when the last is in the near field of the aerial. However, in most cases it is unrealizable. In practice horn or lens-horn centimeter wave antennas are applied, placed so, that the underlying surface is located in their far field. The reduction of angular width of the antenna pattern is limited to that in process of increase of the aperture size the underlying surface moves in a Fresnel zone, that even more complicates the subsequent processing of the Doppler signal.

It seems promising to use focused Gaussian antennas.

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$$E(r)/E(0) = \exp[-(r/w(z))^2]$$

Electrical field amplitude in Gaussian antenna aperture is given by [2] w(z) is the radius at which the field amplitude and intensity drop to $1/e$ and $1/e^2$ of their axial values, respectively. It is defined by the equation

$$w(z) = w_0[1+(lz/pw_0^{2})^2]^{1/2}$$

w_0 - beam waist;
l - microwave wavelength;
z – distance from the waist to the aperture.

The radius of curvature of the wavefront comprising the beam is given by

$$R(z) = z[1+(pw_0^{2}/lz)^2]$$

In the waist radius of curvature aspires to infinity and it is possible to count, that the underlying terrain is irradiated with a plane wave area with Gaussian field distribution. The corner of an irradiation of a surface within the limits of an irradiating stain remains constant, that allows to narrow the width of a Doppler signal spectrum.

III. CONCLUSION

The use of focused Gaussian antennas allows to raise of speed and travel measurement accuracy. The efficiency of a method is increased with microwave frequency. The method is especially effective in the millimetre wave band.

REFERENCES

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