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IMPROVING IMAGES AT RADIOVISION IN MILLIMETRIC WAVE LENGTH

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ABSTRACT

Illumination of the latent objects at formation images in millimetric and submillimetric (mm and smm) ranges of lengths of waves is necessary owing to small contrast, especially in the closed premises. Now importance of the decision of these questions has increased because of working out of technologies of multielement sensor controls of mm of a range, and also thanks to constantly increasing value practical use methods and systems of formation of images.

Index Terms **-** radiovision, millimetric wave, Gibbs effect

1. INTRODUCTION

Active illumination of observable objects allows to solve a problem of low contrast of passive (radiometric) images in mm range, and also provides transfer on an intake of the computer analysis (CA) essentially great volumes of the information about masked objects, than what can be received by means of use traditional radiometric CA.

Various approaches to reception of active (highlighted) images of sufficient visual quality and the information maintenance in various frequency ranges, beginning from microwave (30 GHz) and to smm a range (300 GHz), are described in variety of works [1-2].

On image distortion in mm and smm ranges considerable influence renders spatial effect of Gibbs.

2. CALCULATION OF MUTUAL SPECTRAL DENSITY

Theoretically also possibilities of synthesising of images high visual qualities in wide (mm and smm) a range of lengths of waves are experimentally shown.

By theoretical consideration of features formation images in partially-coherent radiation mm and smm ranges we will apply the approach stated in work [1], in view of that fact that effects of diffraction and an interference in systems of different function are full enough described by correlation functions of the second order [1-2]. For isoplanated quasioptical CA, having on frequency *h(ui — xi,* v), it is possible to write down the pulse response:

$$G(\boldsymbol{u}_1, \boldsymbol{u}_2, \nu) = \int_D \int_D \mathrm{d}^2\boldsymbol{x}_1 \mathrm{d}^2\boldsymbol{x}_2 h^*(\boldsymbol{u}_1 - \boldsymbol{x}_1, \nu) \times h(\boldsymbol{u}_2 - \boldsymbol{x}_2, \nu) G(\boldsymbol{x}_1, \boldsymbol{x}_2, \nu), \quad (1)$$

where *G(x1, x2, v)* and *G(u1, u2,* v) - functions mutual spectral radiation density in entrance and target planes CA accordingly; *xi* and *ui* - radiuses-vectors of points of the specified planes; *D x D* - a range of definition of function *G (x1, x2, v).* If CA has various distances from a plane of focusing system (FS) to an entrance plane d1 and from plane FS to a target plane d2 radiuses-vectors xi and ui in (1) should be replaced by the resulted radiuses-vectors xi/d1 and ui/d2 accordingly.

Generally for calculation of mutual spectral density of radiation on input CA it is necessary to consider characteristics of dispersion of radiation by object and angular distributions of radiation for each value of frequency. In mm a range of feature of reflexion of radiation from the majority of objects essentially influence possibilities of formation of spatially-not coherent quality images.

In the present work for realisation of separate research of results of influence of various destructive factors on quality formed in mm a range of images test objects passing radiation were used. In this case at uniform illumination of objects by quasimonochromatic radiation with average intensity and the central frequency ν_0 (for which $\delta\nu \ll \nu_0$ where $\delta\nu$ - width of a strip of frequencies) intensity distribution to exit CA can be written down in a kind

$$I(\boldsymbol{u}, \nu_0) = I_0 \int_D \int_D \mathrm{d}^2\boldsymbol{x}_1 \mathrm{d}^2\boldsymbol{x}_2 k^*(\boldsymbol{x}_1, \nu_0) k(\boldsymbol{x}_2, \nu_0) \times \gamma(\boldsymbol{x}_1, \boldsymbol{x}_2, \nu_0) h^*(\boldsymbol{u}_1 - \boldsymbol{x}_1, \nu_0) h(\boldsymbol{u}_2 - \boldsymbol{x}_2, \nu_0), \quad (2)$$

where $k(\boldsymbol{x}_i, \nu_0)$ - transmission peak factor of object;

$\gamma(\boldsymbol{x}_1, \boldsymbol{x}_2, \nu_0)$ - degree spatial coherent radiations in the entrance plane, defined from a parity

$$\gamma(\boldsymbol{x}_1, \boldsymbol{x}_2, \nu_0) = \frac{G(\boldsymbol{x}_1, \boldsymbol{x}_2, \nu_0)}{[G(\boldsymbol{x}_1, \boldsymbol{x}_1, \nu_0)G(\boldsymbol{x}_2, \boldsymbol{x}_2, \nu_0)]^{1/2}}. \qquad (3)$$

From (3) it is visible that intensity distribution to exit CA generally depends from spatial coherent highlighting radiation.

From (3) two limiting cases can be received. For completely spatially-coherent illumination $\gamma(\boldsymbol{x}_1, \boldsymbol{x}_2, \nu_0) = 1$ it is had

$$I(\boldsymbol{u}, \nu_0) = I_0 \left| \int_D k(\boldsymbol{x}, \nu_0) h(\boldsymbol{u} - \boldsymbol{x}, \nu_0) \mathrm{d}\boldsymbol{x} \right|^2$$

$$= I_0 |k(\boldsymbol{x}, \nu_0) \oslash h(\boldsymbol{x}, \nu_0)|^2 = I_0 |K_{\mathrm{coh}}(\boldsymbol{u}, \nu_0)|^2, \qquad (4)$$

3. EXPERIMENTAL RESEARCH

In the used scheme of multifrequency formation of images there are no devices for destruction spatial coherent radiations, and radiation changing on frequency directly shines objects in a subject plane P_1 (at normal falling of a flat shining wave on a planeP_1). Thus as a source of radiation changing on frequency the lamps of a return wave blocking a range of 52-119 GHz were used. Test objects masked the teflon plates homogeneous for a thickness, not allowing to observe objects in visible light.

The analysis of one-dimensional cross-section distributions of intensity in images of four-slot-hole periodic object with width of a crack 0.5 sm (close diffracted limit for used by the antenna system and a set of frequencies), its length 7.5 sm and the distance between cracks 0.6 see At comparison of results of numerical modelling at which finiteness of a pass-band of system of formation of the images was considered, different for different frequencies, reveals their coincidence with experimentally received results. For frequency of 58 GHz - the bottom frequency in a used discrete set of frequencies of radiation highlighting object, the image of four-slot-hole object intensity distribution has two maxima and can be interpreted as two-slot-hole object.

The image on frequency of 80 GHz also "visualises" the same "two-slot-hole" object with a little shifted positions of "false" cracks. For frequencies of 94 and 105 GHz "the three-slot-hole" object is observed, and only for frequency of 119 GHz distribution with four maxima that corresponds to real four-slot-hole object takes place, however these maxima in the image have various peak intensity for different cracks. Thus theoretical and experimental curves practically coincide.

Thus, at quasioptical formation in mm a range of images of periodic objects with the characteristic size of periodic structure, comparable with diffracted limit of used systems, occurrence of false periodic structures is possible, spatial and brightness which ·es depend on length of a wave of highlighting :ion. Thus it is necessary to notice that the size of details of an order of 3-10 mm is typical for the objects intended for supervision in systems of formation of mm of a range. Distinctive features of quasioptical display in mm a range of real objects with the considered spatial sizes are defined by fundamental bases of formation of coherent images which for range mm start to get the important practical value.

The synthesised image received as a result of total accumulation of signals of five unifrequent images adequately enough displays as spatial structure, and brightness distribution in observable object, though and with contrast decrease.

2. REFERENCES

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