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Remote Identification of Liquids in a Dielectric Container Using Millimeter Waves. 4. Multifrequency Scanning

A. V. Pavlyuchenko[1*] and P. P. Loshitskiy[2]**
[1]*State Research Center "Iceberg", Kyiv, Ukraine*
[2]*National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine*
**ORCID: 0000-0003-4328-8385, e-mail: andy_pavluchenko@ukr.net*
***ORCID: 0000-0003-2349-0092*

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Abstract—Application of multi-frequency radiolocation allows to expand essentially received signals spectrum that increases amount of a target (object) classification identifiers including thermal portraits for radiometric measurements. In this paper it is represented a prototype of measuring radiometric unit allowing to carry out simultaneously contactless radiometric research of liquids in two wavelength ranges: 8-mm and 3-mm. It is developed the method of definition of parameters of capacity (container) where liquids are placed. It is estimated an influence of caustics appearing in case of waves reflections from internal wall of container and also on quality factor, attenuation coefficient and relative factor of container which are distantly measured. In two frequency ranges there are carried out researches of two water solutions and oil processing products (gasoline, dissolvents, diesel fuel). It is shown the liquids with close thermal portraits in identical frequency band due to close physical-chemical parameters, can have different thermal portraits obtained in different frequency bands reflecting dispersion properties of the liquids and they can be used for liquids identification visually or in case of received data processing.

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1. INTRODUCTION

In [1–3] it is shown a possibility of distance detection and identification of liquids placed in dielectric container with radiometric methods in the same frequency band. Radiometric systems are comparatively rarely applied in form of single-channel radiometer. For complex problems solution multi-channel devices are used as a rule.

Multi-channel systems dependently of their purpose use single or multiple frequency bands and/or receiver matrices, for example, matrices of scanning of traffic flow of Consortis-2 type, applied for hidden objects visualization in real time mode for provision of airports safety [4].

The second approach to the problem solution is following. At each channel its own frequency band is used. Such devices are applied for research of electromagnetic properties of dispersive media [5] and for detection of targets in urban conditions [6].

The wider is the spectrum of used signals the greater is amount of classification features of a target in a spectral area can be obtained by means of such systems. The greatest effect of multi-frequency radio location is achieved by means of application of statistically independent signals corresponding to different carrier frequencies.

Physically it is explained that correspondent maximums of the secondary radiation patterns of a target are displaced from each other [7].

In multi-channel systems combined variants are used dependently their on application. An example of such solution are methods of synthesis radiation patterns of active transmitting and receiving antenna arrays in case of reception of the signals reflected from radiolocation targets.

In case of application of multi-frequency orthogonal coherent signals in array elements and point-of-use access at their reception (MIMO radiolocation) we can provide low level of side lobes of spatial uncertainty function in definite observation sector by means of selection of type of inner calling modulation of partial signals [7]. Orthogonalization of antenna basis for transmitting and receiving antennas allows to solve technical problem of multi-dimensional observation space in multi-position systems of coherent

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ADDITIONAL INFORMATION

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