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1.
Abstract category: **System and antenna design**
Abstract title: **Non-destructive testing at microwaves using a vector network analyzer and a two-coordinate mechanical scanner**
Abstract Text: This paper describes a universal system for non-destructive testing of radio transparent samples at microwaves. The main components of the system are a vector network analyzer and a custom-built two-coordinate mechanical scanner that moves the target, all under remote control from the personal computer. The vector network analyzer is controlled directly through local area network connection using VISA interface, while the mechanical scanner is controlled by a microcontroller, which is connected to the personal computer over USB. The microcontroller is required to provide real-time performance required for the mechanical scanner driven by stepper motors. Additionally, the microcontroller sends synchronization signal to the VNA to start a frequency sweep of the VNA when the mechanical scanner reaches a preprogrammed sampling point. The limitations on the choice of sounding frequencies of the system are defined by the capabilities of the VNA and the antenna in use. Such parameters as sampling steps along coordinate axes, sounding frequency grid are programmable. The experimental setup can be used to establish technical requirements on a specifically designed system for non-destructive testing. The performance of the system is demonstrated on several samples with artificially made flows in their structure. Technical description of the setup, including hardware and software components, and signal processing technique is given and accomplished by the obtained radar images of the concealed flows. Some general problems relevant to the performance of the VNA in a system with the described architecture are given. Further improvements of the setup are suggested.
Presentation type: **Poster**

2.
Abstract category: **Security**
Abstract title: **ISAR-based microwave personnel screening system: preliminary experiments**
Abstract Text: This paper describes preliminary experiments supporting the idea of screening people in motion with a combination of a video sensor and a vertically distributed microwave antenna array. The system relies on the principle of inverse synthetic aperture: it uses subject's relative motion in the vicinity of a stationary antenna system to obtain detailed radar images. A video sensor is applied in the system to track the target, extract its trajectory, and use this information to coherently process the synchronously registered signal from the radar system. An experimental setup described in the paper is used to acquire radar signal samples for the two operating modes: mono-static and multi-static. The stop motion technique imitating experimentally electronically switched antenna arrays of different configurations is proposed. A joint calibration

technique for the video sensor and the radar system is given. The combined signal processing technique is presented. Sample radar images are obtained and demonstrated for mono-static and multi-static antenna configurations. Some improvements of the setup and the used experimental technique are given in the conclusion with the directions for the future work.
Presentation type: **Oral**

3.
Abstract category: **System and antenna design**
Abstract title: **Data acquisition, processing, and visualization in microwave holography with probe tracking and positioning on video**
Abstract Text: The research focuses on the development of the new holographic subsurface radar data acquisition technique in which the position and the polarization of the microwave probe is established by its tracking on video. This technique allows for adaptive interactive data acquisition when probe trajectory could not follow predefined trajectory or could not be equally dense in the areas with no target. The acquisition technique uses FFT-based data processing algorithm which allows interactive operation. The proposed technique also removes certain restrictions on the big scale curvature of the sounded surface because its profile can be determined from tracking the probe as a rigid body. The concept of data acquisition is demonstrated by a working prototype of the subsurface radar with the video positioning system. The probe has contrast markers which allow its fast detection and tracking. A reference point on the sounding surface is also marked by a sticker with a contrast marker. The signal processing algorithm is given, which uses three-dimensional topographic map of the surface and radar signal samples in a variety of points. A selection of radar images is given for various acquisition conditions. Further development of the system is suggested, including the use of modern 3D-sensors and augmented reality technique.
Presentation type: **Poster**

4.
Abstract category: **System and antenna design**
Abstract title: **High Resolution MW Holographic System for NDT of Dielectric Materials and Details**
Abstract Text: There is a burst of introduction of composite materials and structures in aerospace industry in last years. The composites have many advantages over traditional metal alloys. They have, as a rule, better strength/weight ratio, withstand to unfavorable weather conditions and aggressive environments. Corrosion also doesn't affect them. However, a few incidents, which include the Space Shuttle Columbia disaster occurred in 2003, killing all crew members, serious destruction of heat protection at a wing of the Russian space vehicle Buran and others, have aroused interest to new methods for non-destructive testing and evaluation of dielectric composite structures. Traditional methods of ultrasonic diagnostics are ineffective for porous composite such as polyurethane foam insulation, silicate fiber tiles as well as for honeycomb prepreg construction details due to high levels of acoustic wave's attenuation in them. In some cases, microwave holographic subsurface radars could be a reasonable alternative to ultrasonic testing. A specially designed installation, which uses a vector network analyzer for generating and receiving signals, was created. Operational frequency band of the installation gives opportunity to carry out experiments in the broad range of 0-24 GHz. The installation records complex multi-frequency holograms, and for their reconstruction the software was created. A few samples of polyurethane foam insulation that is used for shielding of rocket cryogenic fuel tanks were tested in the installation. All samples had preliminary produced defects. Comparison of the samples testing results and the defects maps showed that they are in a good coincidence.
Presentation type: **Oral**

5.
Abstract category: **System and antenna design**
Abstract title: **Influence of Frequency Band Choice for NDT diagnostics of Dielectric**

Materials

Abstract Text: The introduction of subsurface holographic radars into the practice of non-destructive testing of dielectric materials and structures requires the determination of optimal frequency range in each particular case that depends on materials' properties and defects' nature. Holographic subsurface radars are already used for the diagnostics of building structures; surveys of cultural heritage objects; the possible applications for the detection of antitank and antipersonnel mines in the soil are also investigated. In each specific case, the medium in which the object of interest is placed has unique properties that determine the level of attenuation of electromagnetic waves and its dependence on the emitted signal frequency range. These properties are determined not only by the composition of the medium, but, to a considerable extent, by its humidity. The last-mentioned parameter is often unknown a priori, and this is particularly challenging for processing the recorded data. The problem of nondestructive testing of dielectric materials, which are used in the aerospace industry, is relatively easier than mentioned above since the properties of these materials are known in advance and, furthermore, the attenuation of microwaves in them is extremely low, i.e. they can be classified as radioparent. The materials of space rocket fuel tank thermal insulation, intended for cryogenic fuel components: oxygen and hydrogen, are of particular interest for this research. The paper analyzes the impact of the frequency range on the quality of the registered microwave holograms and provides recommendations for its optimal choice. For experiments, the test samples of thermal insulation provided by enterprises of the aerospace industry were used. The experiments were performed on a specially designed experimental installation equipped with an electromechanical scanner and a vector network analyzer Rohde & Schwarz ZVA 24 used as the signal generator and receiver.

Presentation type: **Oral**