XVIIth International Seminar/Workshop DIPED-2012

The XVIIth International Seminar/Workshop on Direct and Inverse Problems of Electromagnetic and Acoustic Wave Theory (DIPED-2012) was organized by the IEEE MTT/ED/AP Georgian and MTT/ED/AP/CPMT/SSC West Ukraine Chapters. This year, DIPED was held at the Tbilisi State University, Tbilisi, Georgia, on September 24-27. The Ivane Javakhishvili Tbilisi State University (TSU) and Pidstryhach Institute for Applied Problems in Mechanics and Mathematics, NASU, Ukraine, were the co-organizers of DIPED-2012. IEEE Antennas & Propagation Society, Electron Devices Society, and Microwave Theory & Techniques Society provided the Technical Co-Sponsorship for the Seminar/Workshop. The TSU provided the especial financial support for the event what made the possibility to extend the DIPED-2012 audience from outside of Georgia. Prof. Avtandil Chutlashvili, Vice-rector of TSU (Figure 1), gave the welcome address on the behalf of the TSU administration and wished the fruitful work and nice rest for the participants.

Figure 1. Prof. Avtandil Chutlashvili, Vice-rector of TSU, giving the welcome address from the TSU administration.

The IEEE Solid State Circuits Society and IEEE Section Ukraine were the supporting IEEE institutions.

Prof. Revaz S. Zaridze, Chairman of the Local Organizing Committee, and Dr. Giorgi Ghvedashvili, IEEE MTT/ED/AP Georgian Chapter Chairman, bended all efforts for the general and local organization of the event.

The DIPED-2012 technical program consisted of 43 papers, including 4 invited talks. Scientists from Bulgaria, China, Egypt, Georgia, Germany, India, Israel, Poland, Russia, USA and Ukraine brought forward their papers. The papers were arranged at the following sections:

- Theoretical Aspects of Electrodynamics
- Antenna Synthesis and Inverse Problems
- Complex Media
- Propagation and Scattering
- EM Field Applications
- Analytical and Numerical Methods
- Acoustics

The Plenary Session started with online presentation by Prof. Boris Z. Katsenelenbaum (Naharia, Israel) devoted to radar protection of impedance sphere and other nonplanar surfaces. It is known that the sphere is invisible for the radar if its surface has the unit impedance, similarly as the plane does not reflect the normally falling plane wave. The question was investigated which concerns the existence of other impedances which have the same property. Two other values of the complex impedance are obtained, which provide the radar invisibility of the sphere. These values have negative real parts, that is, the surface having such impedance is analogous to an active medium. Numerical examples demonstrate the essential frequency dependences of these impedances. For nonplanar surfaces of complicated shapes, the relation between the impedance tensor elements is found, what provide the protection, at least, for two orthogonal polarizations of the incident plane wave.

The next contribution "Validation of Loop-Star Basis Function Approach to Model EM/EMI Problems on Complicated Surface and Wire Geometries from Low to Microwave Frequencies" was given by Prof. Faik G. Bogdanov (Figure 2) and stimulated the active discussion after presentation and prolonged debate in lobby.

Figure 2. Prof. Faik G. Bogdanov presenting the plenary talk on the loop-star basic functions approach.

Such especial interest of attendees was explained by the pioneer application of loop-star and loop-tree approach to model of the EM/EMI problems on multiple, complicated and mixed surface and wire geometries. This approach has been also extended to considering printed geometries by modifying the previously developed hybrid MoM and multilayered Green's function approach. Such combination of the both approaches allowed to overcome low frequency breakdown

problem for multiple, complicated and mixed surface and wire geometries placed in free space, over ground plane or over/in layered medium. Specifically, it is extended to considering printed structures from low to microwave frequencies. The validation of the developed approach was demonstrated on semi-analytical and measurement data for various practical EM/EMI problems.

The new vision on the Rayleigh hypothesis based on series of the last results of computer simulations was discussed in the talk presented by Prof. Revaz S. Zaridze. In his presentation was accentuated that the study of the scattered field's singularities and its analyticity area represents one of the mathematical physic's fundamental problems and historically it is associated with a Rayleigh hypothesis. In this connection, possible or actual singularities in the analytic continuation of the scattering problem solutions for the two and tree dimensional Helmholtz equation were studied in order to investigate the Rayleigh hypothesis validity. The procedure uses computer simulations for the solution of particular problems, and relates to the several types of singularities, associated with the elementary source as well as boundary curve's singularities in the solution. The computational results have been provided confirmation of criteria for the validity of the Rayleigh hypothesis that have been criticized by several investigators, including the scientific school or reporter.

This year, the DIPED traditional topics were extended by presentations related to the antenna measurements, application of EM waves in medical investigations, technology of production of carbon nanoparticles, as well as to elaboration of tool for search of the UXO targets.

Prof. Moshe Porat discussed about the precise estimation of the amount of blood that leaks from the left ventricle to the left atrium. In this connection, it is necessary to assess the severity of the mitral regurgitation (MR). While the present gold standard to asses MR is by echocardiography, in discussed work was proposed a new approach to estimating MR using velocity values measured with magnetic resonance imaging (MRI). The volume estimation is based on the velocity of the blood through a number of slices. The proposed algorithm has been tested on MRI scans from patients with moderate-severe MR and compared to acoustic imaging results, providing results that are robust to parameters selection however underestimate the size of the leak. It was concluded that adjusted MRI could be an efficient robust tool to assess the severity of MR instead of acoustic imaging.

Dr. Tsismari Gavasheli (Figure 3) devoted her presentation to technological aspects of production of the carbon nanoparticles doped with magnetic clusters. The main technology on which the accent was made in this work is the technology, combining the ethanol vapor pyrolysis with the process of chemical vapor deposition. The original ethanol pyrolysis and chemical vapor deposition data speak on production of randomly distributed carbon nanoparticles aggregations doped with iron magnetic nanoclusters of 150 nm mean size. The data are supported by the results of magnetometry measurements. Some aspects of application of the produced materials in many EM fields were discussed too.

Figure 3. Dr. Tsismari Gavasheli giving the work granted by the Best Young Speaker Award.

Dr. Irma Shamatava (Figure 4) presented the joint investigation of two teams of scientists from Dartmouth College, Hanover, NH, USA and Tbilisi State University, Georgia, related to discrimination of challenging targets, such as small and deep targets in highly cluttered environments. This problem is still an enormous problem for UXO industry.

Figure 4. Prof. David D. Karkashadze (r) introducing the presentation of Dr. Irma Shamatava (l).

One way to improve target classification is to enhance the sensor hardware, while another way is to fully utilize the data provided by current EMI sensors, by deploying advanced signal processing approaches. To address the latter, a new ortho-normalized volume magnetic source (ONVMS) technique for representing subsurface targets responses, and for discriminating between UXO and non-UXO targets, was developed. The technique has been applied to live-site UXO data sets and demonstrated to be robust and tolerant to noise. In presented work, the ONVMS was applied to the data from a

small 20 mm projectile, acquired using an advanced, commercially available EMI system "MetalMapper" (MM). The target intrinsic parameters were first extracted from the data using both the ONVMS and simple dipole models, and then analyzed from library matching classification perspective.

Figure 5. Mr. Olexiy Sharabura received the Best Young Speaker Award for the contribution related to investigation of the circular aperture near field.

Figure 6. Mr. Ivan Petoev, one more Young Speaker Award recipient, talking about electromagnetic properties of the finite periodic lattice.

The following young participants were granted for the Best Young Speaker Award:

- Dr. Tsismari Gavasheli (Tbilisi State University, Tbilisi. Georgia) (Figure 3) for "Technology for Production of Carbon Nanoparticles Doped with Magnetic Clusters".
- Mr. Olexiy Sharabura (Physiko-Mechanical Institute, Lviv, Ukraine) (Figure 5) for "The Influence of the Probe on the Circular Aperture Near Field".
- Mr. Ivan Petoev (Tbilisi State University, Tbilisi. Georgia) (Figure 6) for "The Electromagnetic Properties of the Finite Periodic Lattice with "Cassini" Elements, Embedded in the Usual Dielectric".
- Ms. Lali Bibilashvili (Tbilisi State University, Tbilisi. Georgia) (Figure 16) for "Study of Antenna Matching Influence on the Results of RF Exposure Simulations".

Following the DIPED tradition, the time given up to the free lobby discussion taken a considerable part of total duration of DIPED-2012.

Figure 7. Prof. Guram Sh. Kevanishvili (l) discussing about the antennas near field properties with Olexiy Sharabura (l).

Figure 8. A group photo of the DIPED-2012 Committees after closing ceremony.

The big excursion tour in the framework of the Seminar/Workshop social events consisted of three parts. First of them was excursion in Tbilisi and acquainting with most interesting architectural sights.

The next point was visit to the Jvari church. The Jvari church, the church of the Holy Cross, is situated in Mtskheta, and stands on the rocky mountaintop at the confluence of the Mtkvari and Aragvi rivers. The beginning of Christianity in Georgia is closely connected to its history. After the conversion of Kartli, a large wooden cross was erected on the spot where the church was later constructed. The cross was able to work miracles and therefore drew pilgrims from all over Caucasus. The Jvari church was built between 586 and 605 by Ersimtavari Stepanoz I, upon the cross which it enclosed within its interior.

Figure 9. Monument of Vakhtang Gorgasali, Tbilisi founder, with Metekhi Church at the background.

A tour around Mtsheta - the oldest capital of Georgia, finished the excursion. Mtsheta is placed within 30 km from Tbilisi, this beautiful rare architectural ensemble of XIth century is unique in one's own way. Standing at the confluence of the Aragvi and Mtkvari rivers, one of the oldest towns in Georgia, Mtskheta has been populated since the second millennium BC. It was the capital of the Eastern Georgian kingdom of Iberia from the third century BC. It is thought that the name "Mtskheta" comes from the name for the "father of all Georgians, the son of Kartlos - Mtskhetos". Mtskheta is designated as a UNESCO World Heritage Site and is a living museum, with many architectural and historical monuments.

Figure 10. Monument of Taras Shevchenko, national Ukrainian poet, near the main TSU building.

Figure 11. New architecture of old Tbilisi: bridge over Mtkvari river.

Figure 12. Prof. M. Porat (r) and Prof. G. Georgiev (l) at the excursion tour to Jvari church.

Figure 13. Nice view to the oldest capital of Georgia Mtskheta from the Jvari church high.

Figure 14. A group of DIPED-2012 participants with Mtskheta capital at the background.

Figure 15. Prof. Revaz S. Zaridze (l) presenting the Best Young Speaker Award to Ivan Petoev (c) at the DIPED-2012 dinner.

Figure 16. The DIPED-2012 Young Speaker Award recipients: Tsismari Gavasheli, Olexiy Shsrabura, Lali Bibilashvili, and Ivan Petoev (from l to r).

It was announced by the organizers that the next Seminar/Workshop DIPED will be held at the Institute of Applied Problems of Mechanics and Mathematics, Lviv, Ukraine, in September 2013. The previous attendees and new participants are cordially invited.

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