28th Saint Petersburg International Conference on Integrated Navigation Systems

On May 31 – June 2, 2021, Concern CSRI Elektropribor, JSC held the 28th Saint Petersburg International Conference on Integrated Navigation Systems (ICINS).

Every year this conference brings together scientists and researchers from different countries working in the field of navigation and motion control.

The conference was opened by the member of the Program Committee Prof. O.A. Stepanov, a Corresponding Member of the RAS (Concern CSRI Elektropribor, JSC). He noted that this year the ICINS was held in the mixed format combining in-person and virtual participation of the audience and speakers. He also noted that the conference is included in the agenda of the Year of Science and Technology of the Russian Federation. The Chinese Society of Inertial Technology was added to the organizations supporting the conference and provided the majority of speakers among the foreign participants. Prof. O.A. Stepanov wished success to both in-person and online participants.

Specialists from 8 countries took part in the conference: China, Egypt, France, Germany, Italy, Russia, Turkey, and Ukraine. The Russian participants represented 40 organizations from 10 Russian cities: Vladimir, Dolgoprudny, Izhevsk, Korolev, Kovrov, Moscow, Saint Petersburg, Samara, Yekaterinburg, and Zhukovskiy. In-person conferees, including two foreign participants from Egypt and China, were seated in the conference hall of the institute, keeping the distance between people. The employees from Concern CSRI Elektropribor could watch the sessions broadcasting and take part in the discussions from other rooms, which ensured safety of the event in the conditions of COVID-19 restrictions. Another 126 researchers, including 29 ones from abroad, took part in the conference online. The total amount of participants was about 270 people.

A total of 94 papers were heard at the Conference: two invited papers, 17 plenary and 70 poster ones, and 5 presentations were made at the Panel Discussion. Five young scientists with poster presentations were delegated to the ICINS by the Program Committee of the 23rd Conference of Young Scientists with International Participants "Navigation and Motion Control".

Since we celebrate the 60th anniversary of the first man-in-space flight this year, it was decided to open the conference with the invited paper “From the First Manned Mission into Space to the Permanently Manned Orbital Station” devoted to this event. It was presented by Prof. **M.Yu. Belyaev** (S.P. Korolev Rocket and Space Corporation Energia, Korolev) co-authored by a Corresponding Member of the RAS **G.P. Anshakov** (Space Rocket Centre Progress, Samara). The paper gave a brief history of preparations for and carrying out the world’s first manned mission onboard Vostok spacecraft, and discussed the key tasks and problems, the solution of which made this historic event possible. It described the history of the development and putting into orbit the world’s first orbital station Salyut. Much attention was given to the role of a human in carrying out a space mission. It described the in-orbit tasks which, when solved with participation of the crew, improve the reliability and efficiency of the space mission. To illustrate this, examples of crew activities during the missions of orbital stations Salyut, orbital complex Mir, and International Space Station were provided.

The second invited paper “Small Satellite Formations: Challenges in Navigation its Application Potential” was also dedicated to the problems of space research. It was presented by Prof. **K. Schilling** from the Center for Telematics (Würzburg, Germany).

According to the speaker, miniaturization enables the development of continuously smaller and smarter satellites

with the functionalities similar to conventional satellites. In particular, solutions are available to enable cost-efficient satellite formations even at the level of very small satellites with a few kilograms of mass. This opens the doors for realizing sensor networks in orbit to perform joint measurements. Sensor data fusion and post-processing result in innovative distributed Earth observation methods. Application aspects are illustrated by the nanosatellite missions NetSat, TOM and CloudCT already in orbit or in the preparation phase.

Besides the traditional conference sessions **Integrated Systems** and **Inertial Sensors and Systems**, new sessions were organized: **Motion Control** and **Relevant Issues of Theory**. The first of them joined the papers on aerospace topic, and the other one — the presentations focused on the development of methods and algorithms applied in the research of navigation systems and inertial sensors.

On the last day of the Conference, there was a Panel Discussion on **Motion Control of Moving Objects** chaired by Prof. O.A. Stepanov and Dr. **L.B. Rapoport** (V.A. Trapeznikov Institute of Control Sciences of RAS, Moscow). Five papers were presented, the topics of which covered a wide range of problems of navigation and motion control of various vehicles – from land vehicles, in particular, in the field of precision agriculture, to putting satellites into geostationary orbit and interplanetary missions.

In the opinion of the participants, the ICINS was a success and confirmed its status of the Russia's greatest scientific event in the field of gyroscopic and navigation technologies. During the conference, the specialists from different countries and institutions presented the results of their research and discussed the current state of scientific and technological development and challenges in the field of navigation and motion control, obtained new relevant information and exchanged the ideas. The mixed format of the conference has become quite usual; the Russian/English simultaneous interpretation of presentations was organized, which was available for both in-person and online participants of all sessions. One of the distinctions of this conference was the format of the poster papers discussion. After a three-minute presentation, the speaker answered one or two questions. Further discussions for in-person conferees took place at the posters, while the online audience could ask their questions to the author on the website.

Before the conference started, the preprints of the Conference Proceedings in Russian and English was prepared, including full texts of plenary and poster papers (with only Russian-speaking authors published in Russian). Abstracts, video presentations and preprints of the paper texts were available for the participants on the conference website from May 31 till June 11, 2021.

The texts of the presented papers will be uploaded in the electronic library IEEE Xplore, and indexed in Scopus, the International Scientific Citation Database. The proceedings in Russian (with only Russian-speaking authors published in Russian) will be registered in the Russian Science Citation Index (RSCI). The texts of papers selected by session chairs and the members of the Program Committee have been recommended for publication in the Russian and English versions of the *Gyroscopy and Navigation* journal.

The entertainment program included the excursion to one of the most beautiful and uniquely preserved palaces of Saint Petersburg, the House of Scientists on Dvortsovaya embankment (the Palace of Great Duke Vladimir Alexandrovich). The conference participants got a lot of pleasant impressions, left positive feedback and gave thanks to the Organizing Committee for the interesting and informative excursion.