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EDITORIAL

GOLDEN JOURNEY OF INSTRUMENTATION AT CSIR-CSIO

The origin of Instruments took place long ago even during the B. C. period indicating the need to express happenings bit more precisely. The study of celestial bodies, gravitational experiments, understanding the laws of matter, etc gave a strong desire to develop instruments to establish hypothesis, theories, laws, etc. The period during the last two centuries was mostly dominated by mechanical, pneumatic and hydro-dynamical principles until the invention of electricity which revolutionised the world. Chain of discoveries, inventions took place subsequently in studying the natural phenomena and particularly the electro-magnetic spectrum and the fascinating world of science it contained. This enriched our knowledge in understanding the eco-system with clarity and precision. Lord Kelvin, the father of measurement sciences rightly said "If we cannot express some entity in figures, we know very little about it".

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Measurement Sciences which required a suitable gadget to establish the facts gave a formal shape what is known today as Instrumentation. The earlier era of developments began with purely mechanical or thermo-mechanical systems which generated several derivatives like fluid-mechanical, electro-mechanical, etc dominating the scenario for long. Optics and opto-mechanical systems, however provided strong backup to the world of instrumentation. The real scenario changed after the invention of electronics which soon took the shape of micro-electronics and a host of devices emerged making a swift chain of developments from small scale to medium scale and finally to the very large scale integration in the Integrated Circuits Technology. This gave birth to several powerful devices such as microprocessors, micro-controllers and up to the present day's powerful Central Processing Units backed up by a matching growth in the memory devices, peripheral interface modules to interact and communicate with the outside world.

The communications field too grew at a faster rate from the conventional AM, FM, PCM to the present day Wi-Fi network giving a wide choice of communication protocols which are currently highly conducive to the computer controlled networks. The emergence of fiber optics led to the phenomenal growth in both communications and instrumentation design because of their inherent advantages such as high signal to noise ratio, low losses and manipulation of transmission characteristics by varying the refractive index of cladding by a suitable choice of materials.

The significant progress has also been witnessed in the field of computer science which provides many powerful computational platforms for high speed data processing. Powerful software packages for Supervisory Control and Data Acquisition (SCADA), LabVIEW,

MATLAB are frequently used for scientific and industrial applications. Soft-computing techniques for extracting features from the raw data employing Artificial Neural Networks (ANN), Fuzzy Logic (FL), Genetic Algorithm (GA) and their derivatives have made today's instrumentation systems much more powerful for prediction and forecasting. Sensor development has caught up tremendous awareness among researchers across the fields to evolve new methodologies involving trans-disciplinary areas. Several routes are being continuously followed to measure biological, chemical and physical parameters using nanotechnology, bio-photonics, opto-mechatronics, chemo-luminescence, etc. This has resulted in the integration of sensors at the front-end while computation platform with efficient communication protocolsing to come out with powerful sensor networks address as a backup support a host of applications.

Considering the growing importance of instrumentation and its timely induction in the Indian scenario to promote growth of industry in the country, a need was felt as early as in the year 1959 to set up a separate national laboratory. This led to the formation of CSIR-CSIO as per the vision of our sagacious and farsighted leaders like Pt. Jawahar Lal Nehru, Sardar Pratap Singh Kairon, Dr Zakir Hussain and many others who realised such a need to strengthen its capability to promote research as well as creating a base for the industrial growth. The Laboratory was initially started with a base station at Delhi and later moved on to its present location at Chandigarh in the year 1962.

Over these years, the Laboratory has undergone several stages of development with the initial phase mainly focused on self-reliance, capability building in R&D and providing specialised service support to the scientific instruments industry for its built-up and growth. Subsequently, there was a gradual shift towards building large and complex system design in a synergic mode to develop various scientific instruments and systems for a variety of application domains. Soon the laboratory entered into the strategic instrumentation sector and took-up challenging assignments when there was a phase of technology denial. The laboratory established its credentials by demonstrating its capabilities in the avionic instrumentation and its derivatives. During the later years, the laboratory restructured its R&D efforts in a 5 x 5 matrix giving emphasis on high end research (the Horizontals) and the Technology front (the Verticals). Focus was laid on areas of high science and innovative technology generation as per the national and global scenario. This opened-up many new areas of trans-disciplinary in nature backed up with creating several new R&D laboratories in the Institute.

Presently, the laboratory has created its visibility through its Verticals namely, Agrionics, Bio-medical Engineering, Optical Instrumentation, Photonics, Precision Mechanical Systems of relevance to the strategic requirements and meeting the societal needs. This required a strong base in high end research which was amply provided through the Horizontals namely; Computational Instrumentation and Virtualisation, Opto-mechatronics, ubiquitous analytical capabilities, knowledge network and MIS and Human Resource Development. The 50 years old Indo Swiss Training Center providing technical education at the shop floor level was fully modernized. Under the newly formulated Academy of Scientific and Innovative Research (AcSIR) young bright minds are being constantly inducted into the system to pursue their M.Tech in Advanced Instrumentation Engineering. An integrated Ph.D programme has also been initiated to strengthen high-end science.

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The institute recently celebrated its Golden Jubilee during which a number of scientific activities such as Conferences, Symposia, Seminars, etc were organised on various themes. Several special reports were published and a Compendium containing the reminiscences of its 5-decades of glorious journey was also brought out. This special issue of ***Science and Culture*** is yet another initiative to bring out issues on some of the key areas of research being carried out at various divisions of the laboratory.

Each topic focuses on research work done, specific technologies generated and the products which can be taken up for commercialisation. In line with the laboratory's R&D structure, broad areas covered begin with Agrionics - a

trans-disciplinary area of engineering intervention in addressing agriculture and food processing unit operations including pre-harvest, post-harvest, quantification of quality through machine intelligence. Measurement techniques established and the instrumentation developed are highlighted which has tremendous social impact. Dr C Ghanshyam and his colleagues make an overview of such developments.

Medical Instrumentation has been a strong area of research and applications in diagnostics, therapeutics and rehabilitation purposes. Biological signals generated in the body carry significant information which has been realised in prosthesis (EMG) and anaesthesia drug regulation (EEG), medical imaging employing soft-computing and ICT technology (National Knowledge Network Platform) which provide remote applications. These are highlighted in the next paper by Dr Amod Kumar and Dr HK Sardana.

High energy X-rays have almost replaced the earlier cobalt based technology which required handling of nuclear waste. The synergic efforts of CSIR-CSIO and DIT-SAMEER led to the indigenous development of a 6 MV Medical Linac System for cancer treatment which was commissioned at two major hospitals and four more such machines are under way under the Jai Vigyan Programme of the Government of India. Dr GS Singh highlights on the state of art machine converging the expertise on Linac tube and HV Systems, Precision mechanical and optical systems with an excellent blend of Opto-mechatronics.

Optics has been the strongest forte of the laboratory and a variety of optical instrumentation have been developed. Avionic displays in the fighter aircraft call for a total system design integrating precision mechanical modules, optical components and electronic systems to meet the stringent requirements of safety of flights. The article by Shri PP Bajpai and his team makes an overview of such developments which brought CSIR-CSIO on the world map.

The laboratory also took up a major leap in the area of photonics in developing fiber optics based sensors employing Fiber Bragg and Long Period Gratings. Special sensors for nano-scale measurements were also developed and demonstrated. The paper by Shri SC Jain gives an overview of such research activities carried out in the Photonics Division.

Monitoring of natural disasters such as earthquakes, landslides, snow avalanche, etc call for continuous recording of key seismic and related parameters. Geo-Seismic Instrumentation Group has developed a number of devices and systems which were deployed at field level for continuous acquisition and analysis of data. Dr SK Mittal gives an account of Disaster Mitigation through Geo-seismic Instrumentation developed in the laboratory.

This special issue has covered only a few key areas of technology development according to the laboratory's 5 x 5 matrix R&D structure with the verticals as the main application domains duly supported by the horizontals as per the details given above. Human Resource Development on trans-disciplinary areas has added new dimensions to the laboratory's research capabilities. The readers may get a fair idea of laboratory's R&D programmes and Human Resource Map where several young researchers are working towards advanced measurement techniques leading to innovative instrumentation design in meeting the strategic and societal requirements of the country (see Notes and News in the issue).

I am happy to write a few words as the Guest Editor on this important subject in this special issue on "Golden Journey of Measurement Sciences and Instrumentation Technology" which offers several exciting opportunities to pursue multi-disciplinary research associated with almost every broad area of physical and engineering sciences clusters. ❐

Pawan Kapur
Guest Editor

Dr. Pawan Kapur is currently the Director of CSIR-CSIO, Chandigarh. He did his M.Tech and Ph.D from the Institute of Radio Physics and Electronics, University of Calcutta with specialisaion in Control Systems and Digital Techniques and Bio-medical Engineering respectively. Earlier, he was at CSIR-CEERI, Pilani for about 30 years where he worked on Instrumentation and Control Systems for various agro-based industries. Dr. Kapur has been instrumental in restructuring the R&D road map of CSIR-CSIO and has set-up various state-of-art laboratories namely, Photonics, Advanced Optical Metrology, Virtual Instrumentation, Food Processing Instrumentation, GAIT Lab, Advanced Agri and Analytical Laboratory, etc. He is a recipient of several technology oriented awards and he has 17 products, 5 patents and more than one hundred research publications.

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