Recent Technical Trend of Instrumentation and Measurement

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Instrumentation and measurements play a very important role for the research and development in the science and engineering fields. Recently the objectives of instrumentation have expanded to not only the industrial and scientific requirement, but also needs in all fields of social life including medical and welfare, environment, and disaster and security, etc. In recent years, intelligent and multifunctional measurements have been also studied in imitating the sensing functions of the human.

Keywords: instrumentation, measurements, precision, standards, space angles, multifunctional sensing

1. Introduction

The research and development of instrumentation and measurement face to manifold fields, and are deeply concerned with almost all science and engineering realms as the basic technology for solving the problems and finding new approaches. Therefore, it is quite difficult to focus our interest on some specific subjects. In this preview, the recent interesting technical trend of several kinds of professional fields deeply concerned with the instrumentation and measurement is presumptuously introduced.

2. Technical Topics surrounding Instrumentation

Life sciences, information technologies, nano-technologies and environment problems have been recently selected to promote energetically as four key national projects in the fields of science and technology of Japan. In these themes that are related each other in various aspects, the instrumentation and measurement have quite important parts to accomplish the objective. For examples, as the application of DNA detection and analysis, the abnormal condition of blood is expected to detect as the result of measurement using the magnetic minute particles and a micro magnetic sensing device injected into the blood. DNA chips are also planning to utilize for the stress measurement to recognize the stress reaction of gene in the blood. Actually, electronic and magnetic micro-chips are greatly contributed to develop the advanced measurement in the fields of medical and welfare, industrial and automatic control, environment and pollution, disaster relief and prediction, information and communication, security and surveillance, advanced robotics and so on. The new technique of instrumentation and measurement are needed in the fields of micro electronics, which are in the way of investigation. For the realization of ubiquitous society symbolized by IC tags, new measurement techniques are requested with high reliable and durable in any functioning conditions, and with tough for microwave noise in installed micro antenna. High-speed measurement and data processing are also expected. The instrumentation of signal exchanged between the IC tags and its reading machine in the management of physical distribution which is the most expecting market will have a heavy role in near future. In the robotics world, the instrumentation plays very important part as a basic technology. Precise and accurate measurements are

decisive to obtain excellent results for developing and investigating humanoid robots that spread toward vast objects all over the world. In the aging society, the care and assist of various kinds of partner robots or pet robots, that is, a smart robot that listens to his aged partner and nods to him, will be needed explosively. To understand the intention of human, it is necessary that various advanced sensors for five senses of human that are provided in the robot have to function actively. The instrumentation and measurement are the core technology for establishing the function in this process. In the fields of security, many kinds of biometrics technologies are now on the very important position of the society. The individual identification of a credit card, a driver's license and a passport is actually investigated. In the identification of the fingerprint, the iris, the palm and the features, the precise measurement and intelligent data processing are the point of the technology of detection. Traditionally, optical measurement based on CCD has been employed in this field, but other measurement way are recently adopted, which is one with infrared light, ultrasonic wave, thermal effect, electric capacitance and so on. In any methods, the instrumentation and measurement are one of the most careful portions. Intelligent automatic control housing is one of the attractive research fields in the instrumentation and measurement. In this architecture, smart sensors and advanced sensing systems are indispensable. In behalf of the human, the smart sensors and advanced sensing systems decide by themselves how to maintain the comfortable condition in the house. In this process, the integrated and fused solutions of extensive measurement results brought by a large number of smart sensors and advanced sensing systems that are installed throughout the house. In the lifesaving field, the instrumentation and measurement technology is one of the most important parts. For the rescue of victims in a lot of debris after the disaster, the information of a matter of life or death is the first and utmost demand. A microwave technology has often adopted for the purpose, but further unique technology in this field is earnestly expected. In the automatic sorting technique of good produce concerning agricultural fields, the information that results from instrumentation and measurement by the optical sensing system contributes to present sugar content, acid degree, and color and bloom on the fruit.

3. Actual Technical Categories in the Major International Conferences

In the main international conferences concerning the

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instrumentation and measurement, for example, IEEE Instrumentation and Measurement Technology Conference (IMTC), actual technical subjects are quite wide. The IMTC covers the academic aspects of measurement technology and instrumentation including the theory and practice of metrology, but related applications in industry and our daily life that are recently becoming more pervasive. In the IMTC, we can find not only traditional technical categories that embrace electrical, microwave, power, magnetic, temperature, acoustic, optical, kinematics, position, and flow measurements, machine testing, calibration and uncertainty problems, traceability systems, signal generators and noise problems, and signal processing, but also immediate items that are related to our life in society, that is, medical measurements and instrumentation, environmental monitoring, instrumentation and measurements for nanotechnologies, measurements in telecommunications, digital imaging techniques, robotics, chemical and biological measurements, smart sensors systems, tomography, transportation. The latter items indicate us that the recent study of academic fields emphasizes to direct toward the objective clearly more than ever. Various kinds of smart sensors are now very important tools in the fields of instrumentation and measurement. Uncharted science fields and extremely complicated engineering fields can be challenged by way of the creative trials of instrumentation and measurement with unique smart sensors or micro-sensors. The Conference on Precision Electromagnetic Measurements (CPEM), one of the traditional international conferences in the field of instrumentation and measurement, especially the establishment of basic electrical standards and precise measurements of electrical quantities concerning to the SI units also stands the important and leading position of instrumentation fields. Topics concerned in the CPEM is categorized as AC power, impedance, and AC voltage measurements, Josephson effect applications, quantized Hall effect, single electron counting, radio frequency and microwave measurements, magnetics, frequency standards, lasers, AC-DC transfer, time and frequency fountains, fundamental constants, and photonics. As one of the remarkable items in these fields, the establishment of AC voltage source applied by the DC Josephson voltage standards that is now adopted as the national voltage standard with high accuracy can be recommended. The persistent research of higher precision and accuracy of measurements is a prerequisite condition to break through the barrier toward the unknown fields of science and engineering.

4. Intelligent and Multifunctional Approach for Instrumentation, Measurement and Sensing

The measurement ability of the human is not so precise numerically, but his judgment of action and thinking followed by the results of measurement is usually appropriate. One of various novel approaches in the fields of measurements will head toward intelligent and multifunctional sensing like the human. Here is presented one of the recent examples concerned with the measurements of space angles, that is, azimuth and elevation angle, and also rotating speed using a multifunctional sensor constructed with a novel ball which is half filled with water⁽¹⁾. Figure 1 is a structure of the sensor with four electrodes on the surface of a ball. Three capacitances are measured between two of four electrodes arranged on the surface of the ball.

Fig. 1. Structure of the sensor

Fig. 2. Calculation results of C1 using finite element method with the corresponding surface-fit result

The calculation results of one of three capacitances C1 by finite element method are shown in Fig.2 with the corresponding surface-fit result. In this study, experimental and calculation results show that it is effective to measure space angle.

(Manuscript received Sept. 20, 2005)

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