Introduction of JSPE PRIZES 2016

1. Hirokazu MATSUMOTO (University of Tokyo)

Dr. Hirokazu MATSUMOTO has long been engaged in length measurement research. To expand it to large-scale and practical metrology, he has researched on infrared laser metrology, high-accuracy metrology, non-linear optical metrology, and remote calibration with low-coherence interferometry. In the National Research Laboratory of Metrology, he enthusiastically studied various topics, such as the iodine-stabilized HeNe laser and national length standard using optical-frequency comb technology. In the field of length measurement, he has always led Japan's and the world's most advanced technology. His recent studies focus on frequency comb generation technology, absolute position measurement technology through optical comb, and new length-related measurement technology.

His research interest, which is length standard-related field, is considered the foundation of science and important for the manufacturing industry. For example, length measurement is an indispensable technology for semiconductor and a wide variety of optical or machinery products. Length measurement technology is essential in quality assurance using the geometric measurement in research fields of large-scale institutes and products. It is also important for remote calibration using optical fiber system to spread in industry and society. In addition, he worked to establish the efficient and reliable optical comb measurement technology that could operate in a real field environment. For his research, titled "Study on the frequency measurement of the communication band standard by the optical comb," he received the Commendation for Science and Technology by the Minister of Education. He was awarded the Japan Society for Precision Engineering (JSPE) Award for his research on infrared laser length measurements in 1984, and then the Ministry Award in 1988. In 1992, he was conferred the JSPE Numata Memorial Paper Award for his work titled "Two-Color Interferometric Sensor for Evaluating Processed Material" in which he used non-linear optics. His contribution to the optical measurement field is beneficial to not only the JSPE community but also society in general. He also served as deputy secretary general of the Japan Society of Applied Physics and the Optical Society of Japan. He has published over 180 academic journal articles and over 200 technical books and articles, which include "A Guide to Optical Measurement Device."

With his accomplishments described above, Dr. MATSUMOTO has greatly contributed to not only R&D in the fields of length and geometric measurement but also promotion of academic, educational, and industrial activities. He has made significant achievements in these fields, bringing further international fame to JSPE.

2. Sojiro TSUCHIYA (DENSO Corp.)

Mr. Sojiro TSUCHIYA joined Denso Corporation in 1975 and was involved in the development of precision processing technology and new production systems as an engineer in the production engineering department. Since 2003, he has been responsible for the overall production affairs in the Production Promotion Center as the Senior Managing Director and then Executive Vice President. During this time, he promoted the downsizing (1/N) of material processing equipment and the development of a compact, simple, and slim production system, and greatly contributed to increasing Denso Corporation's competitiveness in the automotive parts industry. Furthermore, he emphasized the importance of the use of information technology to meet market demands such as price, quality, and speed, and to compete in global markets. He also made efforts to become a pioneer of the Internet of Things.

In addition, based on the company's philosophy that the world's best technology and skills should be used to create the world's most competitive products, he actively contributed to the hosting of the WorldSkills competition (Skills Olympics) and developed skilled human resources. In addition to winning an award in 1998 for the Development of Adaptive Production System (APS) to Market Uncertainty, he has won the JSPE Technology Award seven times.

In this way, he has not only endeavored to facilitate the creation of novel manufacturing technologies but also to acquire world-class technology and skills, and has made significant technological, industrial, and educational contributions in the production processing area and the automotive industry.

Introduction of JSPE Technology Award 2016

1. Modeling of a Human Inspection Mechanism for Instrumentation of Visual Inspection in

Production Lines: Development of the "KIZKI" Consciousness Algorithm for Defects

Hiroyasu KOSHIMIZU, Kimiya AOKI and Takuma FUNAHASHI (Chukyo University), Yasuhiko MIWATA (The Institute of Physical and Chemical Research (RIKEN)), Hiroyuki ISHII (Toyota Motor Corporation)

The KIZKI consciousness algorithm for detecting defects is a smart image-processing technology inspired by the human visual inspection mechanism. Although several types of individually customized image-processing systems have already been used for individual inspection tasks, there is still no established general-purpose method for coping with the diversity of defects in various industrial fields.

In this proposed KIZKI algorithm (Japanese Patent No. 5821708), the research group developed a simple iterative and simultaneous scheme using multiple image-processing processes realized by both coarse-to-fine spatial resolution processing similar to human peripheral vision and spatial tremor-phase processing similar to human micro-saccadic vision. The basis of the KIZKI algorithm is characterized by both eye-camera investigation by human inspectors and knowledge of ocular physiology.

It has already been experimentally certified that the KIZKI algorithm can be applied to several different types of defects such as cracks and dents on mechanical and electronic parts by simply tuning a few parameters. Moreover, the proposed KIZKI technology has already been fabricated in a real production line for motor vehicle electronic devices, and is currently starting to be applied to mechanical parts in car production lines. Thus, it is industrially significant that the proposed KIZKI technology provides a unique key solution for instrumenting the automated inspection process, which is the last problem facing full automation of production.

2. Development of a Real-time Thermal Displacement Compensation Systems

Hideki IWAI, Yoshio WAKAZONO, Yuji SASAKI, Yasumasa SAKURAI, Yuji OKA (JTEKT Corporation)

Thermal displacement caused by environmental temperature changes affects the machining accuracy of machine tools. To compensate for thermal displacement, the research group has developed a fast and compact method for estimating thermal deformation based on the finite element method (FEM).

For a given temperature condition in structural analysis, an FEM model is divided into multiple blocks, and temperatures in each block are set to uniform values obtained from sensors. Thus, thermal displacement can be estimated by simple multiplication of the thermal displacement coefficient matrix and the temperature vector. Therefore, real-time compensation for thermal displacement is realized in CNC of machine tools.

The developed system achieved a reduction of more than 80% in machining error caused by thermal displacement at a temperature change of 20 degrees.

3. An Image Restoration and Minute Defects Detection Technique Using Ultrasonic Image for Highly-integrated Electronic Devices

Kaoru SAKAI and Kenji NAKAHIRA (Hitachi, Ltd.) Kaoru KITAMI and Masamichi UMEDA (Hitachi Power Solutions Co., Ltd.)

With the development of an information-oriented society, electronic devices, which are key devices for smart phones, digital cameras, cars, etc., have become complicated and miniaturized. To ensure reliability, the need for internal inspection of these electronic devices that have high sensitivity using scanning acoustic tomography are increasing in production lines. To meet these needs, techniques for improving measurement image definition and automatically detecting minute defects have been applied to ultrasonic images of electronic devices that have been attained by increased miniaturization and complexity.

High-definition ultrasonic images can be acquired by focusing an ultrasonic beam and irradiating a sample. However, the ultrasonic beam at the focal point is diffraction-limited. This causes the image to blur, and thus, minute defects can be missed. To address this problem, the research group proposed to utilize an image restoration technique that generates a clearer internal image from an image acquired with a probe that has the full spread of the beam. The technique first estimates the intensity distribution of the beam from the specification of the ultrasonic probe used for imaging and then performs deconvolution of the estimated intensity distribution on the blurred image to obtain the ideal image. Optimal restoration is performed on each image acquired by approximately 100 types of probes with different specifications, achieving a defect visibility improvement of 1.6 times. Furthermore, through statistical image processing using the periodicity of circuit patterns, statistical outliers are detected as defect candidates. By separating candidates caused by manufacturing tolerance, minute defects where the pixel value is equal to the manufacturing tolerance can be detected automatically from the interfaces of stacked wafers with complicated structures. This technique of ensuring detection of minute defects hidden inside of highly-integrated electronic devices has been incorporated in ultrasonic inspection tools and released on the market in 2015.