



Editorial

Special Issue: Selected Papers from IEEE ICASI 2019

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1. Introduction

The fifth IEEE International Conference on Applied System Innovation 2019 (IEEE ICASI 2019, <https://2019.icas-conf.net/>), which was held in Fukuoka, Japan, on April 11–15, 2019, provided a unified communication platform for a wide range of topics. This Special Issue titled “Selected Papers from IEEE ICASI 2019” collected nine excellent papers presented on the applied sciences topic during the conference. Mechanical engineering and design innovations are academic and practical engineering fields that involve systematic technological materialization through scientific principles and engineering designs. Technological innovation by mechanical engineering includes information technology (IT)-based intelligent mechanical systems, mechanics and design innovations, and applied materials in nanoscience and nanotechnology. These new technologies, which implant intelligence in machine systems, represent an interdisciplinary area that combines conventional mechanical technology and new IT. The main goal of this Special Issue is to discover new scientific knowledge relevant to IT-based intelligent mechanical systems, mechanics and design innovations, and applied materials in nanoscience and nanotechnology.

2. Topics of Selected Papers

This Special Issue selected nine excellent papers from a total of 200 papers presented at IEEE ICASI 2019. The published papers are introduced as follows.

Dr. Lin [1] reported on the “Application of a Fuzzy Decision Model to the Design of a Pillbox for Medical Treatment of Chronic Diseases”. This study describes the importance of reducing waste from resources in medical systems. Patients with chronic diseases generate medical waste because they often forget to take their medications. Patients pay attention to the time and amount of medicine to take at different doses. This negligence often affects the schedule of taking medicines or preventive drugs. The amount of medicine also varies for different patients. The evaluation model in this study utilizes the fuzzy analytic hierarchy process to obtain the degree (weight) of each evaluation item determined by each patient. Thereafter, a more objective overall shape can be determined depending on the individual’s preference. In this study, the proposed package design serves as the case study. The results indicate that the evaluation model is feasible, and the findings of the case study are also valuable for follow-up designers. The design of a pillbox for patients with chronic diseases should consider the safety of taking the medicine; that is, the right person should take the right medicine at the right time at the right dose. Therefore, evaluating the feasibility of the pillbox for patients with chronic diseases is extremely important. The proposed evaluation model applies to products that

have different compositions. Follow-up researchers or designers can apply this approach to different case designs.

Dr. Ko [2] reported on the “Application of Fuzzy Theory to the Evaluation Model of Product Assembly Design and Usability Operation Complexity”. A product usually consists of more than one component to improve convenience and enhance living standards. However, a product is created by the joint efforts of people from various territories; therefore, an important consideration is enabling a product to merge into consumers’ daily lives rather than simply fulfilling its functions. Conflicts may arise in people’s life patterns or values, which should be considered during the manufacturing process. This study investigates the assembly process by considering the assembly operations and operating time. By determining the relationship between components, we analyzed the assembly concept of most components. A fuzzy comprehensive evaluation was conducted during the evaluation of the degree of complexity of user operations. Based on the ranking of membership, the most appropriate assembly was determined, which serves as a reference for designers to select the optimal product assembly. By recording the consumer usage models, we also proposed the optimal assembly and usage model of product design. The goal of this study is to find a balance between assembly evaluation and the usage model by allowing designers to determine the new assembly concepts that meet consumer usage models. A case study of four bedside stereos was conducted by implementing the proposed approach to determine the evaluation principle of assembly. The purpose is to enhance the balance between assembly design and user operation complexity for making efficient decisions. Thus, a product design can comply with the concept of concurrent engineering and the quality of a product design can be enhanced.

R. H. Hwang et al. [3] reported on “An LSTM-based Deep Learning Approach for Classifying Malicious Traffic at the Packet Level”. Recently, deep learning has been successfully applied to network security assessments and intrusion detection systems (IDSs) with various breakthroughs, such as using convolutional neural networks and long short-term memory (LSTM) to classify malicious traffic. However, these state-of-the-art systems also face tremendous challenges to satisfy real-time analysis requirements due to the major delay of flow-based data preprocessing, i.e., requiring time to accumulate packets into particular flows and then extracting features. If detecting malicious traffic can be performed at the packet level, then the detection time will be significantly reduced, thereby improving the potential of online real-time malicious traffic detection based on deep learning technologies. To accelerate the entire detection process by considering a packet-level classification, which has not been studied in the literature, we propose a novel approach in building the malicious classification system with the primary support of word embedding and an LSTM model. Specifically, we propose a novel word-embedding mechanism to extract packet semantic meanings and adopt LSTM to learn the temporal relation among fields in the packet header and further classify whether an incoming packet is normal or a part of malicious traffic. The evaluation results on ISCX2012, USTC-TFC2016, the IoT dataset from Robert Gordon University, and the IoT dataset collected on our Mirai botnet show that our approach is competitive to the prior literature, which detects malicious traffic at the flow level. As network traffic continues to grow every year, our first attempt can inspire the research community to exploit the advantages of deep learning to build effective IDSs without suffering significant detection delay.

Zhu Chengtao et al. [4] reported on “Hierarchical Guided Image Filtering for Efficient Stereo Matching”. Stereo matching is complicated by the uneven distribution of textures on image pairs. We address this problem by applying edge-preserving guided image filtering (GIF) at different resolutions. In contrast to most multi-scale stereo-matching algorithms, the parameters of the proposed hierarchical GIF model are in an innovative weighted-combination scheme to generate an improved matching cost volume. Our method draws its strength from exploiting texture in various resolution levels and performing an effective mixture of the derived parameters. This novel approach advances our recently proposed algorithm, the pervasive GIF scheme, by equipping it with hierarchical filtering modules, thereby resulting in a disparity in images with a large number of details. The approach

ensures as many different-scale patterns as possible to be involved in the cost aggregation, thereby improving matching accuracy. The experimental results show that the proposed scheme achieves the best matching accuracy when compared with six well-recognized cutting-edge algorithms using version 3 of the Middlebury stereo evaluation data sets.

W. C. Lee et al. [5] reported on “Automatic Error Compensation for Free-form Surfaces by Using On-machine Measurement Data”. Currently, most computer numerical control controllers lack the function needed to compensate machining errors for free-form surfaces. The objective of this study is to enhance the accuracy and precision of the machined free-form surfaces of a workpiece using a mirror compensation method with on-measurement data. A new free-form surface for finishing machining can be automatically reconstructed by mirroring the points measured after semi-finishing. The surface can then be used to generate the cutting tool path to reduce errors during finishing. In this study, three types of surfaces were used to evaluate the proposed method. The results show that the proposed method reduced the standard deviations of the three surface geometries by 61%, 61%, and 32%. We also evaluated the tool radius modification method commonly used in the industry for error compensation and found no substantial reduction on standard deviation. Therefore, the effectiveness of the proposed error compensation method is evident.

Y. C. Hung et al. [6] reported on “3D and Boundary Effects on 2D Electrical Resistivity Tomography”. Electrical resistivity tomography (ERT) is one of the most widely used geophysical methods in geological, hydrogeological, and geo-environmental investigations. Although 3D ERT is now available, 2D ERT remains state-of-the-practice due to its simplicity in fieldwork and lower space requirements. Two-dimensional ERT assumes that the ground condition is perpendicular to the survey line and homogeneous outside the survey line. This assumption can often be violated in conditions such as geologic strikes not being perpendicular to the survey line and topographic changes or buried objects near the survey line. Possible errors or artifacts in the 2D resistivity tomogram arising from violating the 2D assumption are often overlooked. This study aimed to numerically investigate the boundary effects on 2D ERT under various simplified conditions. Potential factors including resistivity contrast, the depth and size of buried objects, and electrode spacing were considered for the parametric studies. The results reveal that offline geologic features may project onto the 2D tomogram to a certain extent, depending on the aforementioned factors. The mechanism and implications of boundary effects can be drawn from these parametric studies.

S. N. Tang et al. [7] reported on “Area-efficient FFT Kernel with Improved Use of GI for Multistandard MIMO-OFDM Applications”. This study presents a fast Fourier transform (FFT) kernel for multistandard applications, which employ multiple-input, multiple-output orthogonal frequency-division multiplexing (MIMO-OFDM). The proposed design uses a mixed-radix, mixed-multipath delay-feedback (MRM2DF) structure, which enables 4/5/6-stream 64/128-point FFT. This approach allows for the effective usage of guard intervals in conjunction with a novel resource-sharing scheme to improve area efficiency. An area-reduced constant multiplication unit and sorting buffer with minimal memory size further reduced an area overhead. A test chip was designed using UMC 90-nm technology and was evaluated through post-layout simulation. The proposed design outperformed previous works in terms of throughput per area.

M. C. Hwang et al. [8] reported on “The Design and Building of a Hexapod Robot with Biomimetic Legs”. A hexapod robot with biomimetic legs was built to implement a distributed control system, where a mechanism is proposed to serve as the central pattern generator and a computer to act as the brain stem, cooperating with the central pattern generator through wireless communication. The proposed mechanism consists of two modules, i.e., tripod gait generator and Jansen’s linkage. The tripod gait generator is a device that uses a single motor to generate a tripod gait, while Jansen’s linkage rhythmically executes the legged motion. In a sense, we are trying to implement the locomotion of a robot by means of a hybrid computational system, including the mechanism and electronic processor parts. The complex mathematical function of the foot movement is realized by the ensemble of links of the Jansen’s linkage to alleviate the computational burden. Furthermore, the proposed design,

based on non-located actuators, is intended to minimize the number of actuators while reducing the building cost of the robot.

C. M. Lin et al. [9] reported on “Heating, Ventilation, and Air Conditioning System Optimization Control Strategy Involving Fan Coil Unit Temperature Control”. The objective of this study was to develop a heating, ventilation, and air conditioning (HVAC) system optimization control strategy involving fan coil unit (FCU) temperature control for energy conservation in chilled water systems to enhance the operating efficiency of HVAC systems. The proposed control strategy involves three techniques, which are described as follows. The first technique is an algorithm for dynamic FCU temperature setting, which enables the FCU temperature to be set in accordance with changes in the outdoor temperature to satisfy the indoor thermal comfort of occupants. The second technique aims to determine the indoor cold air demand, which collects the set FCU temperature and converts it to the refrigeration ton required for the chilled water system, thereby serving as the control target for ensuring optimal HVAC operation. The third technique is a genetic algorithm for calculating the minimum energy consumption for an HVAC system. The genetic algorithm determines the pump operating frequency associated with minimum energy consumption per refrigeration ton to control energy conservation. A field experiment was conducted to demonstrate the effectiveness of the proposed HVAC system optimization control strategy combining FCU temperature control. The results show that the proposed strategy enabled the HVAC system to achieve 39.71% energy conservation compared with the system operating at full load.

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