Foreword

Artificial intelligence (AI) is the core of the fourth industrial revolution. At the early stage of its development, expert knowledge was provided by the experts. Then, expert knowledge was formulated into the systems via rules. One common example of this type of expert system was fuzzy systems. With the development of data analysis technology such as data mining technology, decisions were made according to the characteristics of the training data. In particular, features were extracted from the training data. Then, statistical-based machine learning systems such as tree-based systems or deterministic-based machine learning systems such as neural networks were employed for formulating the relationship between the extracted features and decisions. Recently, with the development of fast computational devices, deep learning systems have been proposed. In particular, feature extraction is no longer required. The features are learned by the systems themselves.

With the development of AI technology, many applications have been developed in various industries including the transportation industry, the building industry, the machine manufacturing and health monitoring industry, etc. With the aid of AI in these industries, labour forces and maintenance costs have been significantly reduced.

The research innovation, engineering development and economic benefit derived from studies of AI for smart applications will attract more attention from researchers and engineering practitioners. In this connection, I am honoured and delighted to introduce six papers on this subject to the readers of HKIE Transactions issued on the theme of AI for smart applications.

The paper written by Suen et al. entitled "Application of artificial intelligence (AI) control system on chiller plant at MTR station" conducted a site trial and applied a fully automated AI system to control a chiller plant for optimisation of energy performance in real time. In particular, by performing the prediction via an AI system, the power consumption and cooling demand of the plant can be forecast based on the information of the actual chiller, the station and the weather conditions. Moreover, the optimal operational settings can be determined via performing real-time optimal control of the chiller plant. Furthermore, the paper presents the formulation of the design of the AI system using data-driven machine learning models. Then, the numerical optimisation approach was used to find the solution to the optimisation problem. A comparison of the effect of the proposed system and the rule-based optimal control system in conventional building management systems on the actual energy performance was conducted through a site trial. The results revealed that the proposed AI system achieved a better energy efficiency with annual energy savings of approximately 8.7%.

Another paper written by Chow et al. entitled "Artificial intelligence applications for proactive environmental monitoring and asset management" presents two studies conducted to explore the potential of applying AI in proactive environmental monitoring and asset management. In particular, maintenance works related to drainage services were performed in order to enhance the efficiency of environmental monitoring and structural inspection. In the environmental assessment project, AI technologies were explored to assist the observation of bird behaviour. In particular, a domain randomisation enhanced model was built to detect great egrets and little egrets. The model achieved a mean average precision of 87.65%. In a building information modelling project, AI technologies were used to facilitate the condition assessment of the concrete defects in sewage treatment facilities. Then, a supervised learning-based classifier was developed for the purpose of performing concrete defect detection. The proposed method could attain recalls of 86.2% and 89.9% for cracking and spalling classes, respectively. Besides, another concrete defect anomaly detector was built using the unsupervised learning approach. This method achieved the F_2 measures of 85.2% and 76.0% for cracking and spalling classes, respectively.

The paper written by Li et al. entitled "Development of an AI model for electronic board maintenance decision prediction for railway equipment" employed the RUS boost ensemble machine learning algorithm to make maintenance decisions on the railway electronic board based on the measurable component values. In particular, the paper developed a prognostic approach to considering the actual load conditions and life limiting factors as well as utilising machine learning algorithms to build the model. The model makes use of real-life test samples. It was found that the prediction accuracy achieves up to 95% for the correlation of the red urgent category and 94% for the correlation of the yellow medium urgency category.

The paper written by Ho et al. entitled "Effective real-time face mask detection on NVIDIA edge devices" proposes a robust automatic system based on Resnet-18 for performing face mask detection using the transfer learning kits provided by the NVIDIA edge accelerator. It found that the proposed system yields high accuracy in the classification of people wearing and not wearing masks. Since the proposed system can run in the real-time environments, it is applicable in various venues.

The paper written by Chow entitled "HRSG early tube leak detection with a transfer learning neural network and Gramian Angular Difference Field" employed a convolution neural network with the ResNet50 architecture to build a transfer learning model for detection of an early tube leak in a heat recovery

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steam generator. The goal of designing this model was to achieve a high classification accuracy with the minimal amount of leakage data. The model is user friendly as it consists of a minimal number of hyper-parameters for tuning. The proposed neural network was trained using the time series of the drum specific conductivity of the heat recovery steam generators encoded in the Gramian angular difference field. The model yielded an accuracy of 96.64%, a true positive rate of 93.28% and a precision rate of 100% for the data in the validation set. The paper also includes the computer numerical simulation results of the effects of different encoding algorithms such as the Markov transition field and a recurrence plot on the performance of the model. Besides, the paper also discusses the viability of adapting the design for other classification problems using other time series.

The paper written by Li et al. entitled "Multiple structural defect detection for reinforced concrete buildings using YOLOv5s" presents the employment of an object detector called the YOLOv5s to recognise the common structural defects including cracks, delamination, exposed reinforcement, rust stains, spalling, tile cracks, tile delamination and tile loss. Compared to other object detectors such as the YOLOv5m, YOLOv5l, YOLOv5x, YOLOv4, YOLOv3 and YOLOv5s, the proposed algorithm achieves higher accuracy when performing defect detection. In particular, the proposed algorithm achieved the mean average precision of 64.5% and 67.0% for the data in the training set and the testing set, respectively. Also, the proposed algorithm took less than 0.1 seconds to detect a defect in an image in the dataset. The small amounts of the weights and the high detection performance of the YOLOv5s algorithm demonstrate the effectiveness of applying the proposed algorithm to onboard inspection devices such as a droneUAV or a robot to achieve real-time structural inspection.

I would like to express my sincere gratitude to the HKIE Secretariat, the members of the HKIE Transactions Committee, the authors and the reviewers for their time and efforts in launching this interesting theme of the AI for smart applications for the benefit of the engineering profession in Hong Kong and the rest of the world.

Prof Wing-Kuen Ling
Guest Editor, Professor
The Guangdong University of Technology
yongquanling@gdut.edu.cn