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ENHANCED PARTICLE SWARM OPTIMIZATION-BASED MODELS AND THEIR APPLICATION TO LICENSE PLATE RECOGNITION

HUSSEIN SALEM ALI BIN SAMMA

UNIVERSITI SAINS MALAYSIA

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by

HUSSEIN SALEM ALI BIN SAMMA

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LIST OF ABBREVIATIONS

ABC	Artificial Bee Colony
ACO	Ant Colony Optimization
AIS	Artificial Immune Systems
ANN	Artificial Neural Networks
CI	Computational Intelligence
CNN	Convolution Neural Network
EC	Evolutionary Computation
ERLMPSO	Enhanced Reinforcement Learning-based Memetic Particle Swarm Optimization
FPGA	Field Programmable Gate Array
FS	Fuzzy Systems
FSVM	Fuzzy Support Vector Machine
GA	Genetic Algorithm
GWO	Grey Wolf Optimizer
HOG	Histogram of Oriented Gradients
HS	Harmony Search

KNN	K-Nearest Neighbor
LBP	Local Binary Pattern
MLP	Multi-Layer Perceptron
MVO	Multi-Verse Optimizer
NBC	Naive Bayes Classifier
PCNN	Pulse-Coupled Neural Network
LPR	License Plate Recognition
PSO	Particle Swarm Optimization
RBF	Radial Basis Function
RL	Reinforcement Learning
RLMPSO	Reinforcement Learning-based Memetic Particle Swarm Optimization
SI	Swarm Intelligence
SIFT	Scale-Invariant Feature Transform
SOM	Self-Organization Map
SVM	Support Vector Machine
TDNN	Time-Delay Neural Network

MODEL BERASASKAN PENGOPTIMUMAN KAWANAN ZARAH YANG DITINGKATKAN DAN APLIKASI MEREKA UNTUK PENGECAMAN PLAT LESEN

ABSTRAK

Model pengecaman corak memainkan peranan yang penting dalam banyak aplikasi dunia sebenar seperti pengesanan teks dan pengecaman objek. Pelbagai kaedah termasuk model Kecerdikan Berkomputer (CI) telah dibangunkan untuk menangani masalah pengecaman corak berasaskan imej. Tertumpu kepada model CI, penyelidikan ini mempersembah model berasaskan pengoptimuman kawanan zarah (PSO) yang cekap serta aplikasinya untuk pengecaman lesen plat. Pertama, model Pengoptimuman Kawanan Zarah Memetik berasaskan pengukuhan pembelajaran yang baharu (RLMPSO) diperkenalkan. Masalah pengoptimuman penanda aras digunakan untuk menilai prestasi RLMPSO, dan kaedah *bootstarp* digunakan untuk menilai keputusan secara statistik. Kedua, RLMPSO disepadukan dengan mesin Penyokong Vektor Kabur (FSVM) untuk merumuskan model RLMPSO-FSVM yang cekap. Secara khusus, RLMPSO-FSVM terdiri daripada gabungan pengelas linear FSVM yang dibina menggunakan RLMPSO untuk melaksanakan penalaan parameter, pemilihan ciri, serta pemilihan contoh latihan. Untuk menilai prestasi model RLMPSO-FSVM yang dicadangkan, pangkalan data imej penanda aras digunakan. Ketiga, model dua-peringkat RLMPSO-FSVM dicipta untuk mempertingkatkan lagi kecekapan. Ia mengandungi peringkat pengecaman global dan peringkat pengesahan tempatan. Peningkatan model RLMPSO turut diperkenalkan dengan memasukkan operasi carian tambahan. Model RLMPSO yang (ERLMPSO) dipertingkatkan terdiri daripada tiga lapisan, iaitu lapisan global

dengan empat operasi carian, lapisan tempatan dengan satu operasi carian, dan lapisan berasaskan komponen dengan dua belas operasi carian. Akhir sekali, model dua-peringkat ERLMPSO-FSVM yang dicadangkan telah digunapakai dalam masalah Pengecaman Plat Lesen Kereta Malaysia (VLPR) yang sebenar. Kadar pengecaman setinggi 98.1% telah diperoleh. Keputusan ini mengesahkan keberkesanan model dua-peringkat ERLMPSO-FSVM yang dicadangkan dalam menangani masalah pengecaman plat lesen.

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ABSTRACT

Pattern recognition models play an important role in many real-world applications such as text detection and object recognition. Numerous methodologies including Computational Intelligence (CI) models have been developed in the literature to tackle image-based pattern recognition problems. Focused on CI models, this research presents efficient Particle Swarm Optimization (PSO)-based models and their application to license plate recognition. Firstly, a new Reinforcement Learning-based Memetic Particle Swarm Optimization (RLMPSO) model is introduced. To assess the performance of RLMPSO, benchmark optimization problems are employed, and the bootstrap method is used to quantify the results statistically. Secondly, RLMPSO is integrated with the Fuzzy Support Vector Machine (FSVM) to formulate an efficient RLMPSO-FSVM model. Specifically, RLMPSO-FSVM comprises an ensemble of linear FSVM classifiers that are constructed using RLMPSO to perform parameter tuning, feature selection, as well as training sample selection. To evaluate the performance of the proposed RLMPSO-FSVM model, a benchmark image database is employed. Thirdly, to further improve efficiency, a two-stage RLMPSO-FSVM model is devised. It consists of a global recognition stage and a local verification stage. In addition, enhancement of the RLMPSO model is introduced by incorporating additional search operations. The enhanced RLMPSO model (i.e. ERLMPSO) comprises three layers, namely, a global layer with four

search operations, a local layer with one search operation, and a component-based layer with twelve search operations. Finally, the proposed two-stage ERLMPSO-FSVM model is applied to a real-world Malaysian vehicle license plate recognition (VLPR) task. A high recognition rate of 98.1% has been achieved, confirming the effectiveness of the proposed two-stage ERLMPSO-FSVM model in tackling the license plate recognition problem.