Distance Evaluated Simulated Kalman Filter with State Encoding for Combinatorial Optimization Problems

Zulkifli Md Yusof 1, Zuwairie Ibrahim 2, Asrul Adam 3, Kamil Zakwan Mohd Azmi 3, Tasiransurini Ab Rahman ,Badaruddin Muhammad 3, Nor Azlina Ab Aziz 3, Nor Hidayati Abd Aziz 3, Norrima Mokhtar 3, Mohd Ibrahim Shapiai 3, Mohd Saberi Muhammad 3*

1 Faculty of Manufacturing, Universiti Malaysia Pahang, Malaysia.
2 Faculty of Electrical and Electronics Engineering, Universiti Malaysia Pahang, Malaysia.
3 Faculty of Engineering and Technology, Multimedia University, Malaysia
4 Faculty of Engineering, University Malaya, Malaysia
5 Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Malaysia.
6 Institute for Artificial Intelligence and Big Data, Faculty of Bioengineering and Technology, Universiti Malaysia Kelantan, Malaysia. zuwairie@ump.edu.my

Abstract.
Simulated Kalman Filter (SKF) is a population-based optimization algorithm which exploits the estimation capability of Kalman filter to search for a solution in a continuous search space. The SKF algorithm only capable to solve numerical optimization problems which involve continuous search space. Some problems, such as routing and scheduling, involve binary or discrete search space. At present, there are three modifications to the original SKF algorithm in solving combinatorial optimization problems. Those modified algorithms are binary SKF (BSKF), angle modulated SKF (AMSKF), and distance evaluated SKF (DESKF). These three combinatorial SKF algorithms use binary encoding to represent the solution to a combinatorial optimization problem. This paper introduces the latest version of distance evaluated SKF which uses state encoding, instead of binary encoding, to represent the solution to a combinatorial problem. The algorithm proposed in this paper is called state-encoded distance evaluated SKF (SEDESKF) algorithm. Since the original SKF algorithm tends to converge prematurely, the distance is handled differently in this study. To control and exploration and exploitation of the SEDESKF algorithm, the distance is normalized. The performance of the SEDESKF algorithm is compared against the existing combinatorial SKF algorithm based on a set of Traveling Salesman Problem (TSP)

Keywords: combinatorial optimization; distance evaluated; simulated Kalman filter; state encoding; travelling salesman problem