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Editorial

Applications of Fuzzy Multicriteria Decision Making to Complex Engineering Problems

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As a major research topic of decision making, multicriteria decision making (MCDM) has extensive applications in practical decision making. It is a modeling and methodological tool for dealing with complex engineering problems. Decision makers need to solve many issues with incomplete and uncertain information in the MCDM problems. The MCDM is dealing with structuring and solving decision and planning problems involving multiple criteria to support decision-makers. Typically, there does not exist a unique optimal solution for such problems, and the decision-maker usually differentiates the solutions based on their tools, in which fuzzy set theory plays an important role.

The fuzzy set theory is recognized as an important technique for problem modeling and solving. Fuzzy sets were introduced by Zadeh in 1965 as the extension of the classical notion of sets [1]. Almost all early interests in fuzzy set theory pertained to representing uncertainty in human cognitive processes, and now the fuzzy set theory has been extended to problems in engineering, business, medical and related health sciences, and the natural sciences [2, 3].

The MCDM has been broadly used in the world and more theories were proposed to solve the MCDM problems, such as the paper by R. Liao and H. Zheng et al. introduced an integrated model based on the fuzzy theory and evidential reasoning decision-making approach to the condition assessment of power transformers [4]. Their experimental results indicated that the integrated model could accurately assess the operating conditions of power transformers. Hence, this integrated method can be regarded as a radical innovation in the monitoring of electric devices. Another successful application of MCDM is in the face recognition. Ramalingam described an application of MCDM for multimodal fusion of features in a 3D face recognition system [5]. The fuzzy interval-valued TOPSIS (IVFT) approach for fusing multimodal features in a 3D face recognition system was proposed, which significantly improved recognition accuracy.

This special issue collects eight papers involved in the MCDM, which is in accordance well with the main features summarized above. Their investigations were applied to diverse disciplines (electrical engineering, computer science, economics, transportation, and gemstone identification) to assist the decision-makers to make the optimal choice.

First, the paper by N. A. Sedova et al. provides a neural-fuzzy approach to solve the problem of ship collision prevention in a heavy traffic zone. The authors presented the technique of using a maneuvering board to form the elements of learning samples by generating 192 different simulating models of neural fuzzy ship collision prevention systems through the lattice-free clustering method, as well as 288 neural-fuzzy ship collision prevention systems, where the network was generated through the subclustering method. Simulation studies show that the hybrid optimization method has the best performance. The testing of the most effective neural-fuzzy ship collision prevention systems proved that they can accurately determine the value of changing the ship-operator course to avoid the ship collision.

Next paper by B. Erdebilli et al. entitled "Using Intuitionistic Fuzzy TOPSIS in Site Selection of Wind Power Plants in Turkey" discussed how to select an appropriate site to build a wind power plant. They employed the TOPSIS method combined with the intuitionistic fuzzy numbers which are reflecting the judgments of decision makers and dealing with the complexity in the decision process, so that more accurate results can be achieved. Wind potential, location, cost, and social benefits were defined as the dimension of criterion, and the ten selected criteria were collected under these dimensions. The weights of the criterion importance were decided in the establishment of the wind power plant and the selection was made. Based on the calculated data, the most appropriate site for the wind farm was determined.

A. Guleria and R. K. Bajaj in the paper entitled "Pythagorean Fuzzy (R, S)-Norm Information Measure for Multicriteria Decision-Making Problem" propose a new parametric (R, S)-norm information measure for Pythagorean fuzzy set along with the proof of its validity and discuss its maximality and the monotonic behavior with respect to parameters under consideration. Further, an algorithm for the MCDM problem has been proposed and implemented with the help of two different kinds of numerical examples where weights are partially known or entirely unknown. Finally, the work has been concluded by providing the scope for future work.

The study by H. Hui et al. entitled "Ultra-Short-Term Prediction of Wind Power Based on Fuzzy Clustering and RBF Neural Network" shows that the precision of predicts wind generation by using fuzzy clustering and RBF neural networks. The power output of the wind farm is affected by, for example, wind speed, wind direction, the tail flow effect of units, and so on. Each unit's output has a certain influence on the others. According to the output of the wind turbines and the uncertain relationship between these factors, fuzzy clustering and RBF neural network are combined to establish a two-step prediction model. Different contributions of the wind turbines at different spatial positions to the power of wind farm and the correlation of wind power time series are also considered. Compared to the ARIMA forecast model and single RBF model, it was verified that the two-step forecasting method can effectively improve the precision in the ultra-short-term power prediction.

A. Janjic in the paper entitled "Distribution Network Risk Assessment Using Multicriteria Fuzzy Influence Diagram" proposes a new methodology for the multicriteria risk assessment of the distribution network assets, based on influence diagrams and fuzzy probabilities. The influence diagram has been used to determine all relevant factors concerning risks and their interdependencies. And the fuzzy probabilities are represented by triangular fuzzy numbers with constraints on the feasibility of elicited probabilities. This methodology enables the decision process in an uncertain environment, with the impact evaluation of each particular distribution asset or the asset component. The methodology was verified by the case study of selecting the maintenance strategy of distribution substation circuit breakers.

M. S. D. Putra et al. in the paper entitled "Fuzzy Analytical Hierarchy Process Method to Determine the Quality of Gemstones" utilized a fuzzy analytical hierarchy process (F-AHP) method to choose and assess the quality of gemstones to be traded. It is well known that the gemstone identification needs not only relevant professional knowledge but also abundant experience. By using the F-AHP method, the decision-maker can make more efficient, flexible, and realistic decisions based upon the available criteria and alternatives.

A. Basu and S. Ghosh in the paper entitled "Implementing Fuzzy TOPSIS in Cloud Type and Service Provider Selection" use multicriteria decision-making method to find out the best service provider among the top existing four companies and choose the deployment model as per requirement. As one of the leading-edge technological advances in the IT industry, cloud computing has been extensively applied to various industries. However, consumers often face difficulties in selecting the most suitable one from numerous cloud providers as per their requirements. This paper analyzes different criteria for choosing the suitable service provider along with the deployment model using the MCDM concept. The evaluation is carried out by using the technique for order preference by similarity to an ideal solution (TOPSIS) method. The MCDM method helps decision makers in integrating objective measurements with value judgments based on collective group ideas other than individual opinions. The best alternative is deduced based on the shortest distance from the fuzzy positive ideal solution and farthest distance from the fuzzy negative ideal solution.

The study by T. O. Fahad and A. A. Ali entitled "Multiobjective Optimized Routing Protocol for VANETs" adopts an optimized integrated multicast, multicriteria, adaptive route lifetime as a routing protocol for VANETs, whereby only an optimal subset of neighbor vehicles is chosen to relay route request (RREQ) messages based on distance, direction, speed, and future direction information in a combined sender-receiver manner. Fuzzy controllers were employed to assess routes' costs and their lifetimes. Furthermore, artificial bee colony (ABC) algorithm was used to concurrently optimize all used fuzzy systems and obtain the optimal highest rank of links' cost values within which the neighbors could be selected as relay nodes in a route discovery process. And the simulation results prove that the proposed routing scheme significantly improves the network performance in both urban and highway scenarios, under different situations of vehicle density.

Conflicts of Interest

The editors declare that they have no conflicts of interest regarding the publication of the special issue.

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