

UNIVERSITI TEKNOLOGI MARA

**FLASH FLOOD EVACUATION WITH DISCRETE
PARTICLE SWARM OPTIMIZATION**

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ABSTRACT

During flash flood evacuation processes, the most challenging task is to move people to safer locations. Uneven distributions of transport, untimely assistance and poor coordination at the operation level have always been the major problem in evacuation process. Currently, no proper procedure is available in managing the evacuation vehicle assignment problem (EVAP) and evacuation vehicle routing problem (EVRP). A discrete particle swarm optimization (DPSO) algorithm is proposed to solve the EVAP and the EVRP. Discrete particle position is proposed to support the implementation of the DPSO known as myVAP-A for the EVAP. Particle positions are initially calculated based on the average passenger capacity of evacuation vehicle. Computational experiments were done with different numbers of PFA using two types of sequences for vehicle capacity: random and sort ascending order. Both of these sequences were tested with inertia weight and constriction factor (CF). Performance of each vehicle allocation was analyzed in four variations namely myVAP-A using inertia weight with random vehicle capacity, myVAP-A using inertia weight with sort ascending order of vehicle capacity, myVAP-A using CF with random vehicle capacity, and myVAP-A using CF with sort ascending of vehicle capacity. Flash flood evacuation datasets from Malaysia were used in the experiment. myVAP-A using inertia weight with random capacity was found to give the best results compared to the other variations of experiment and outperformed a genetic algorithm (GA) with random vehicle capacity and a GA with sort ascending of vehicle capacity in solving the EVAP. However, the problem of local minimum was determined, and this algorithm was enhanced to overcome this problem with the use of velocity clamping procedure known as myVAP-AVL. This procedure had shown some improvement, but nevertheless it failed to give an optimal solution, particularly for large dataset. Thus, a modification of this algorithm was done by applying a min-max approach and named as myVAP-MM. myVAP-MM was tested and analyzed using the same variations of experiment as in myVAP-A, and myVAP-AVL. myVAP-MMVL-WR outperformed all variations of experiment and the VAP-A and VAP-MM in fitness value and processing time for all datasets. It achieved an optimum solution and successfully avoided the local minimum problem for the EVAP. For EVRP, the step for finding the solution starts with the investigation of the solution for the shortest path problem (SPP). DPSO_SPP algorithm was proposed using a new solution representation for SPP. The solution representation was incorporated with a search strategy and random selection of priority value. The purpose of this representation is to reduce the searching space of the particles, which has led to a better solution. This solution representation was modified to accommodate the EVRP and embedded in the myVRP_2 algorithm. The algorithm was tested using the EVRP dataset of road network for flash flood evacuation in Johor, Malaysia and compared with myVRP_1 from the previous solution. Comparative analyses were carried on both myVRP_2 and myVRP_1 with the GA. The results indicate that the proposed myVRP_2 are highly competitive and showed good performance in both fitness value (total travelling time) and processing time. The validation processes confirmed that myVAP-MMVL-WR showed good performance in maximizing the number of people to vehicles while myVRP_2 gave good performance in minimizing the total travelling time from vehicle location to PFA. These algorithms have successfully solved the evacuation planning with a better solution quality (fitness value) and less processing time.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Emergency management has received significant attention with respect to various types of disasters (Geroliminis et al., 2006; Ranganathan et al., 2007; Herzog, 2007) such as terrorist attacks (Johnson, 2005), hazardous material (Zografos & Androutsopoulos, 2005), hurricanes (Barrett et al., 2000), and flash floods (Simonovic & Ahmad, 2005; Chiu et al., 2005). Evacuation operation, which is a process of evacuating residents from any dangerous sites to safer destination in the shortest possible time (Kim & Shekhar, 2005) is of prime importance in emergency management (Goldblatt, 2004). In the event of emergency, various mechanisms of evacuation planning have been adopted by different levels of management of the various coordinating agencies. Much effort has been done in producing manual evacuation guidelines (Hoffman, 2008; Magiswary et al., 2010), developing an evacuation system (Simonovic & Ahmad, 2005), simulation (Chiu, 2004; Johnson, 2005), and a wide variety of algorithms (Kongsomsaksakul, 2005; George et al., 2007; Özdamar & Yi, 2008; Xie & Turnquist, 2011) to facilitate the evacuation operation for different types of disaster.

Flash floods which are considered as natural disasters have become catastrophic events across the world. Flash floods can be defined as the event resulting from heavy rainfall over a small area within a short period of time that can cause water to rise and fall quite rapidly (Barredo, 2007). Among the recent flash floods events occur in Australia (Davies, 2011), Thailand (Hancocks, 2011) and