Australian Journal of Basic and Applied Sciences, 4(11): 5550-5555, 2010
ISSN 1991-8178

Cooperation Among Agents at the Scene of Accident Using Combination of Fuzzy Logic and Genetic Algorithm

[1]Shahaboddin Shamshirband and [2]Hajar Siar, [2]Seyedeh Habibe Nabavi

[1]Young Researchers Club Islamic Azad University Chalous, Iran
[2]Young Reaserchers Club, Islamic Azad University

Abstract: there are many kinds of agents at the scene of an accident. The general purpose of these agents is to rescue more of the injured from the environment. Search agents and ambulance teams are among the most important agents present in the environment. In this article, we present a method for a more rapid provision of relief for the injured in an earthquake-hit environment through a combination of fuzzy logic and genetic algorithm. Through establishing cooperation between relief agent and ambulance teams in the environment, it becomes possible to provide relief for a larger number of the injured people.

Key words: earthquake-hit environment; cooperation; fuzzy logic; genetic algorithm

INTRODUCTION

In an earthquake-hit environment, there are many agents of various kinds. (Jang, *et al.,*) in general, this is not a problem that can be solved by using only robots; and a team of heterogeneous agents with different abilities and capabilities help to address the problem. (shen, *et al.,* 2009; Murphy, *et al.,* 2000) the main purpose of these agents is to search the area, find the injured and report their place and condition. (Jang, *et al.,* Alnajar, Nijhuis, 2009)

Each group of agents has its own weaknesses, but cooperation among agents makes it possible to overcome the problems to some extent and to achieve a more optimal result. (Alnajar, Nijhuis, 2009)

In this article, we have tried to present a composite method based on genetic algorithm and fuzzy logic in order to establish cooperation among groups of agents so that these agents can achieve their goal more quickly. Search agents and ambulance teams are among the most important kinds of agents present at scene of an accident. (Alnajar, Nijhuis, 2009)

The search agents have the responsibility of finding the injured people at the scene of the accident. The ambulance teams are responsible for providing relief and giving aid to the injured found by the search agents. The search agents search the area, find the locations of the injured, report the location and the condition of the injured to the ambulance teams, and request help. These ambulance teams also have the duty of providing relief for the injured whose locations have been found by the search agents. (Alnajar, Nijhuis, 2009)

Our purpose in writing this article is to present a method for the search agents and ambulance teams to be able to cooperate with each other in order to save a larger number of the injured in a shorter period of time. The article is organized as follows. In part two the overall proposed method is presented. The optimal way of finding the locations struck by the accident, where the ambulance teams have to reach, is explained. Finally, in part four, we describe how routing among locations is carried out by ambulance teams based on genetic algorithm.

The Proposed Method:

At the scene of an accident, the ambulance teams use two strategies in their decision-making (Nardi, A. Biagetti.) which are as follows:

a. The search agent asks the ambulance team to go to the specified location.
b. The ambulance team has arrived at the accident scene, and hence must perform optimal operations to save as many of the injured as possible.

The purpose in the first strategy is to find the optimal and shortest route so that the ambulance team can reach the injured in a short period of time. In this strategy, an appropriate routing algorithm is needed between

Corresponding Author: Shahaboddin Shamshirband, Young Researchers Club Islamic Azad University Chalous, Iran
E-mail: Shahab.sham@gmail.com

the starting point and the destination so that the time required to cover this distance is minimized.

In the second strategy, the aim is for the agent to choose the optimum stricken area, from among the requests received from search agents, as the destination to move to.

In our article, we use genetic algorithm for the first strategy as an appropriate method for routing by the agents, since genetic algorithms have the feature of directed random search which makes it possible to find the general optimal locations with acceptable precision. (Haupt and haupt, 2004)

To find the optimal stricken area as the destination of ambulance teams, we have used fuzzy logic: features of the area are fed as inputs of the fuzzy system and the output of the system specifies the degree of optimality of each area.

The Matrix of the Problem envinoment:

The problem environment is considered as a matrix so that search operations in the environment and the process of finding the locations of the injured is facilitated. The use of this matrix helps in solving the problem by employing the genetic algorithm and in creating a genetic environment.

Given the agents in the stricken area have a predetermined field of vision, the size of each element f this matrix is equal to the field of vision of the agents.

Determining the Optimality of Areas:

As was previously stated, in this article we use fuzzy logic to determine the priority of each of the areas reported by the search agents. In this method, the priority of each area is determined on the basis of a number of parameters which are considered as the input of the fuzzy system; and then areas are listed from the areas having the highest priority to those having the lowest priority, so that the ambulance teams can be dispatched to each area according to its priority.

The Proposed fuzzy system:

The fuzzy system used in our study is the Mamdani fuzzy system. The input linguistic variables of the proposed fuzzy system are as follows:

a. The number of the injured; the fuzzy range of this variable includes the interval [0-10], and shows that the maximum number of the injured in each area of the matrix of the environment is ten and the minimum is zero.
b. Extend of injured suffered; the fuzzy range of this variable is the interval [0-30].
c. The distance between the area requesting help and the ambulance team; the fuzzy range of this input linguistic variable is considered to be the interval [0-100].

The output linguistic variable shows the priority of each of the areas. The fuzzy range of the input linguistic variable of the number of the injured includes three fuzzy sets based on membership functions of the trimf type. This range shown in figure 1.

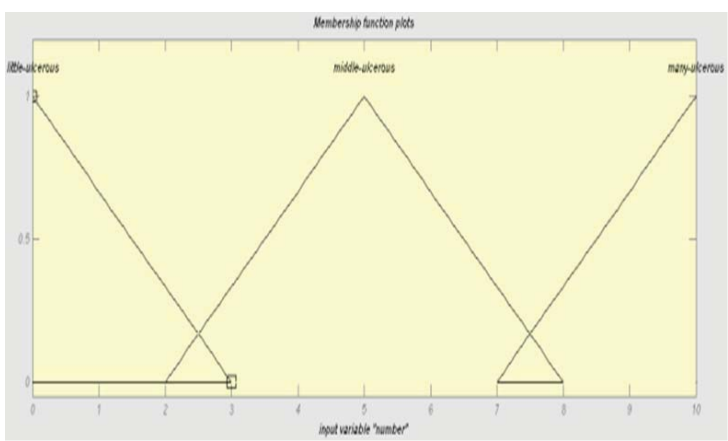

Fig. 1: The input fuzzy set of the number of injured.

The fuzzy range of the input linguistic variable of the extent of injured suffered by those injured is composed of three fuzzy sets based on membership functions of the type trimf . this range is shown in figure 2.

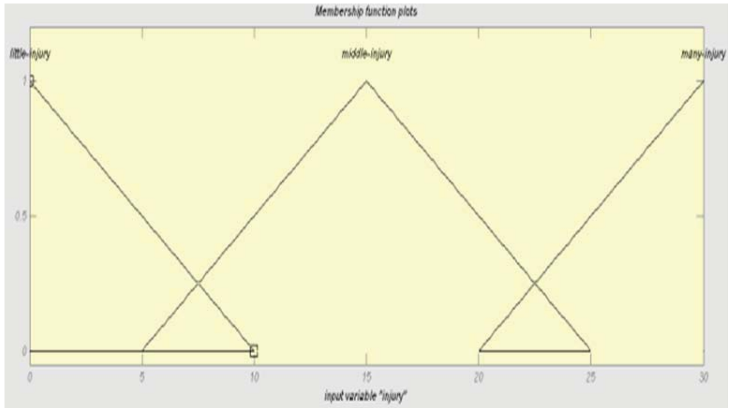

Fig. 2: The input fuzzy set of the extent of the injured suffered.

The fuzzy range of the input linguistic variable of the distance between the area requesting help and the ambulance team consists of three fuzzy sets based on membership functions of the type trimf. This range is shown in figure 3.

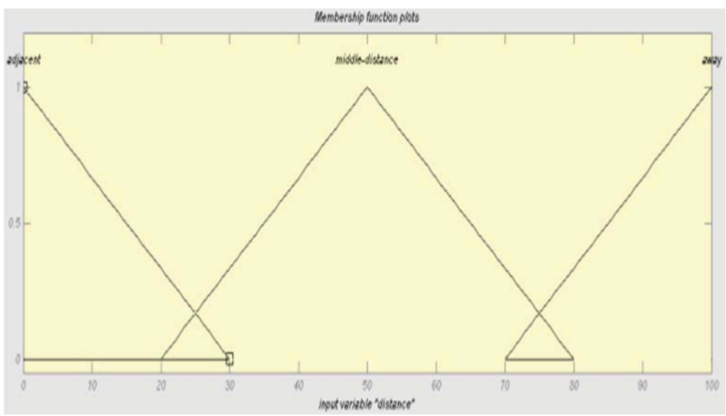

Fig. 3: The input fuzzy set of the distance between the area requesting help and the ambulance team.

The output linguistic variable is in the fuzzy range of [0-100] and consists of the five fuzzy sets each of the which is based on a membership function of the type trimf. The range is shown in the figure bellow.

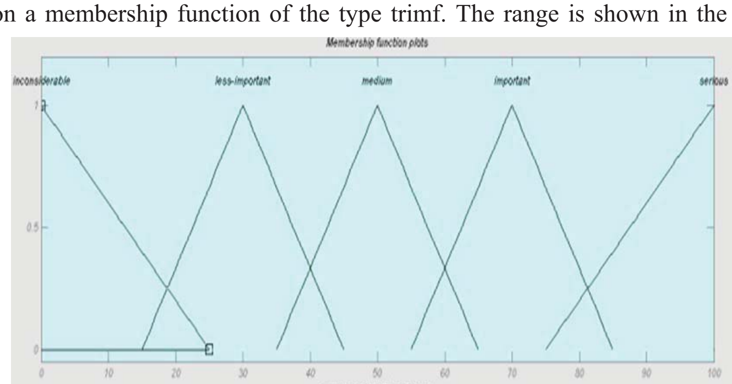

Fig. 4: The output fuzzy set of the priority of each stricken area requesting help.

Now that the linguistic variables and the input and output fuzzy sets have been determined, we use fuzzy rules to relate the input and output fuzzy variables to each other. In our proposed fuzzy system, 27 rules are used, some of which are shown bellow.

1. **if** (number is little-ulcerous) and (injury is littleinjury) and (distance is adjacent) **then** (importance is less-important)
2. **if** (number is many-ulcerous) and (injury is middleinjury) and (distance is away) **then** (importance is medium)
3. **if** number is middle-ulcerous) and (injury is manyinjury) and (distance is away) **then** (importance is important)

Fig. 5: Fuzzy rules for determining the priority of each area

Once the rules have been determined in fuzzy system, we can observe the priority of each area of the environment, based on the input parameters, in the output diagram of the fuzzy system. This diagram is based on the two parameters of the number of the injured and the extent of their injuries, while keeping the distance of the area requesting help from the ambulance team constant. The diagram is shown in figure 6.

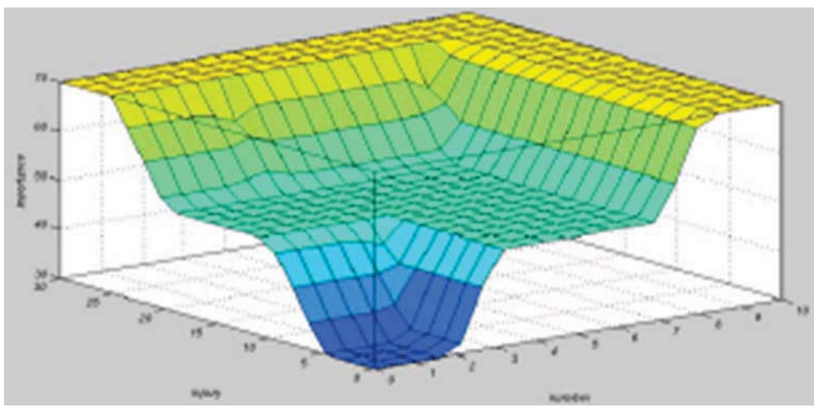

Fig. 6: The diagram of the output of the fuzzy system showing the priorities of the areas based on the parameters of the number of the injured and the extent of their injuries.

The areas reported by search agents are ordered on the basis of their priorities which are determined in the fuzzy system; and the ambulance teams provide help to the areas based on their priorities.

Routing by Agents:

As stated before, the ambulance team should be able to cover the optimal route to reach its destination in a short time period. In our study a genetic algorithm is used for optimal routing by the agent between two destination points, because genetic algorithms have a directed random search feature which helps the agent in finding the optimal route.

In the following parts, routing by agents through the use of genetic algorithms is explained.

Coding chromosomes:

Since the purpose is to find a route between the present point where the agent is and the destination point specified at the top of the priority list, each chromosome is considered as a set of matrix points. For example, an example of a chromosome is as follows:

[0, 10] , [10, 30] , [20, 30] , [10, 20]

This representation of chromosomes shows the order of the movements of ambulance teams in each area of the matrix.

The proposed genetic algorithm has this feature that the chromosomes present in a population have variable lengths, between every time the genetic algorithms is execute different starting and destination points will be involved; and hence the distance between the starting and the destination points will vary , and the use of chromosomes with variable lengths in population will help the proposed genetic algorithm to be efficient in routing between two points.

Proportionality function:

The shorter the route the agent covers, and the more secure the areas he covers, the more optimal the route can be. Therefore, we considered the two parameters of the length of the route and the security along the route in determining the proportionality of the chromosomes in the proposed genetic algorithm.

To each area in the matrix of the environment, depending on the extent of destruction taken place and on the extent of damage caused by fires in the environment and in the area adjacent to it, a number was assigned representing the security value of the area. These numbers are in the interval [0,10] : the more secure an area is, the higher its security value will be. This security value is depicted by the symbol W.

In our study, the proportionality function used in cited reference number seven was employed: in each chromosome, the distance between authorized (permissible) points is evaluated by the agent himself, and this distance, as can be seen in formula one shown bellow, is multiplied by the inverse of the security value of the area:

$$\frac{1}{W}\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \qquad (1)$$

The less the proportionality of the chromosomes in this relationship is, the more optimal the route will be. Reproductive operator

The combination operator used in this algorithm is of the single-point type: one point between parent chromosomes is selected at random, and the values between two points, which are in fact the features of the elements of the matrix, are replaced by each other.

The reproduction process among chromosomes present in a population will be carried out according to a reproduction probability represented by.

Mutation operator:

The mutation operator acts on each of the elements of the population with the probability of. In this algorithm, the mutation operator acts an each chromosome as follows:

a. A chromosome is chosen with the probability of.
b. A point in the chromosome is selected at random.
c. This point is replaced by another point chosen at random in another chromosome which lies around the staring or the destination point.

Through the action of the mutation operator, according to the method explained above, the speed of the convergence of the proposed genetic algorithm increases because it is very probable that the optimal route is around the starting or the destination point.

Simulation Results;

In this part, simulation of the proposed genetic algorithm is shown in an environment where the number of the elements in the matrix is 7×7.

The optimal route obtained by the proposed genetic algorithm is shown in figure 7.

Figure 8 shows how much it will cost the agent to cover the optimal distance obtained by using the genetic algorithm. As was stated in section 4 (B), this cost is based on the distance covered and the security of the route.

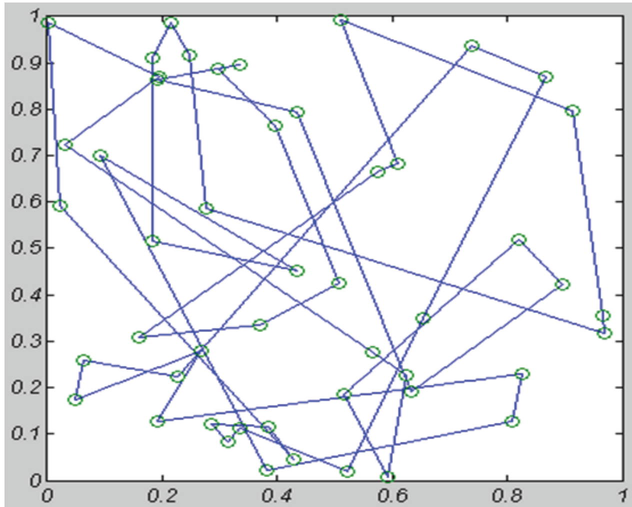

Fig. 7: The shortest route obtained by using the algorithm in an environment composed of 20 parts.

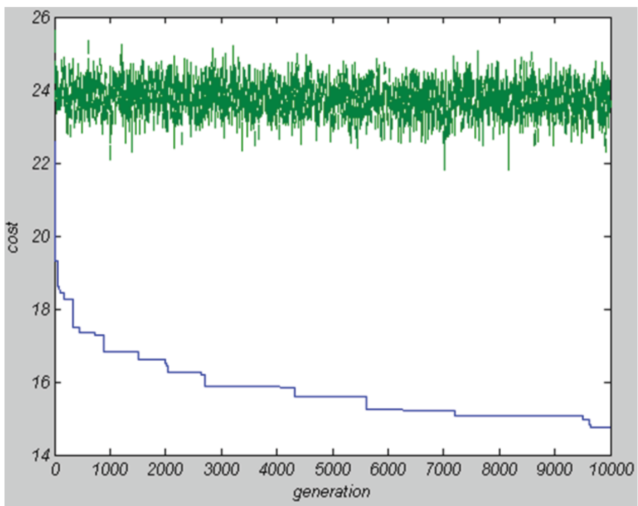

Fig. 8: the cost born by the agent in covering the optimal route.

As can be seen in figure 8, with an increase in the number of generations, the cost of covering the route by the agent will decrease, and in the end this cost will converge to the minimum amount specified in the figure.

REFERENCES

Jang, H.C., Y.N. Lien, T.C. Tsai, Rescue information system for earthquake disasters based on MANET emergency communication platform.

shen, H., Ch. Qian, X.L. Xu, 2009. Design decisions of the SEU-RedSun rescue 2009 team on the challenges of the virtual robot competition.

Murphy, R., J. Casper, M. Micire, J. Hyams, 2000. Mixed-initiative control of multiple heterogeneous robots for usar. Technical report, university of south Florida.

Alnajar F., H. Nijhuis, 2009. Improvements of a heterogeneous rescue team.

Nardi, D., A. Biagetti, Real-time planning and monitoring for search and rescue operations in large-scale disasters.

Haupt, R.l., S.E. haupt, 2004. Practical genetic algorithms. Wiley inter science publication. Second edition.