Group Configuration for Evacuation Route Guidance in MANET-based Building Evacuation System

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1. Introduction

In emergency cases such as a fire, there is the possibility that the cellular networks do not work smoothly due to the traffic congestion. Therefore, we have developed the MANET-based building evacuation system [1]. This paper proposes a group configuration scheme for evacuation route guidance in the MANET-based system. The proposed scheme classifies users into multiple groups and exchanges messages between the groups, resulting in the flexible route guidance adaptive to the change of the situation and the lower network overhead.

2. MANET-based building evacuation system

In the MANET-based building evacuation system, the floor is divided into multiple sections. Each section is equipped with at least one beacon, and it transmits the strongest RSSI signal at regular intervals. A user looks for the beacon and derives the current section. It is assumed that the building structure is given to users. The system calculates the length of the line connecting the center points of between the current section to exit i when it needs distance to exit i. The parameters used for the building systems are as follows. qt_i is the exit time when it takes for one user passing through exit door. ps is the number of sections from the exit that users can evacuate smoothly. c_i is a set of critical sections contained in the evacuation route to exit i.

3. Group configuration scheme for evacuation route guidance

The MANET-based system configures groups to provide efficient evacuation route guidance in the following four steps.

1) Step 1

Each user selects exit i with the shortest route and the ID of the exit section is assigned as a group ID. It transmits its user information to all users by flooding. When a user receives the information from the user with the same group ID, it recognizes the user as the same group. The user with the lowest user ID in the group becomes a group leader. Then, the group leader transmits the group information by flooding so that all leaders can obtain all groups' information and confirm the number of evacuees to each exit.

2) Step2

If the number of evacuees to each exit is unbalanced, the leader selects a user who changes the exit to exit j and then transmits a *change_exit* message. The user who receives the message calculates the estimated time to move to exit i and j (that is, et_i and et_j) according to Algorithm 1. If $et_i > et_j$, the user selects exit j, and then the group ID becomes j and transmits the new user information by flooding.

In Algorithm 1, movingTime(*sectionID*) is a time from a section specified by *sectionID* to exit i. The moving time is calculated by '*the distance between sectionID and exit i per moving speed of a user*'. waitingTime(*sectionID*) is calculated by '(*the number of users moving to exit i in sectionID*) × qt_i'.

3) Step 3

If the number of sections passing from the current section to exit i is more than ps for a user, the group ID of the user is assigned as (i, c_i) and then it is transmitted by flooding. As a result, multiple small groups are configured.

4) Step 4

The group leader selects a new leader from the group members for each small group and the new leader list is transmitted by flooding. If a user is included in the new leader list, the user becomes the new leader, otherwise the leader abandons the role of the leader.

Algorithm 1:

```
Input: r_i // section list of the route from current section to exit i of a user
Result: estimatedTime
begin
set estimatedTime to 0
for(n ← 0 to | r_i|)
   sectionID = r_i [n]
   if ( etstimatedTime > movingTime( sectionID ) )
      estimatedTime += waitingTime( sectionID )
   else
      estimatedTime = movingTime(sectionID) + watingTime(sectionID)
return estimatedTime
```

3. Conclusion

This paper proposes a group configuration scheme for the evacuation route guidance in the MANET-based system. In future works, we are planning to evaluate the proposed scheme through the simulation experiment.

References

[1] T. Yamazaki, and T. Ohta, "A MANET-based building evacuation system considering user characteristics," Proc. 2021 IEEE CyberSciTech/ PICom/ DASC/ CDBCom, pp.124-129, Oct 2021.

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