INTELLIGENT GIS BASED EMERGENCY VEHICLE MANAGEMENT

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Abstract

GIS provide critical support for decision makers during emergencies. Emergency management is a collaborative effort requiring coordination among specialists in planning, logistics, operations and etc [5]. The research reported in this paper attemps to reduce emergency projecting response times by an intelligent GPS-GIS based analyctical system. This system designed to choose the best path depending on different daily traffic conditions for emergency vehicles in order to pass them in the minimum time length. The system has two main components: 1) GIS base map and planning specific layers; 2) Graphical traffic analysis. This system provides for easy production of maps, reports, and analyses to develop and revise emergency response plans. The use of a GIS to support emergency management, both in response and planning, has become easier.

Introduction

Geographic Information Systems (GIS) are computer-based software programs that store geographic data and allow users to conduct spatial assessments for analytical and decisionmaking purposes. Geographic Information Systems are designed to collect, store, and provide data where geographic location is important [2].

The use of GIS by industry and governments, which includes collecting, and displaying spatial information for planning and functional analysis, has increased significantly over the last five years. This is mainly due to the greater computing power available to users at a much lower cost. New systems, both hardware and software have been developed that allow for the convenience and flexibility of use on laptop computers [2].

GIS is a very useful and progressive tool that provides a wide range of capabilities across various user groups. When responding to an incident, first responders can use GIS to identify the various resources required – police, ambulances, fire fighters, tow trucks, cranes, chemicals such as dispersants in order to help respond to an emergency in a timely and efficient manner [2].

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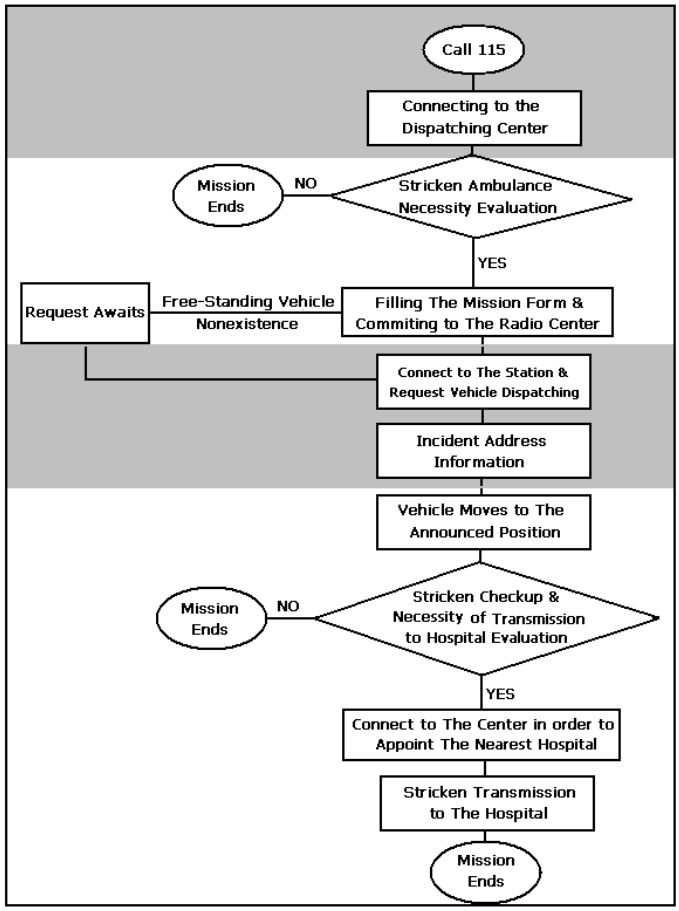
Emergency Operations Algorithm

Emergency operations chart operated by Iran emergency centers from incident occurrence and calling 115 untill stricken/traveler transmission to a hospital and emergency vehicle return to the center commonly likes Figure 1.

Figure 1. Emergency Operations Algorithm



Emergency Operations Algorithm Timely Evaluation

This chart can be devided into four sections.

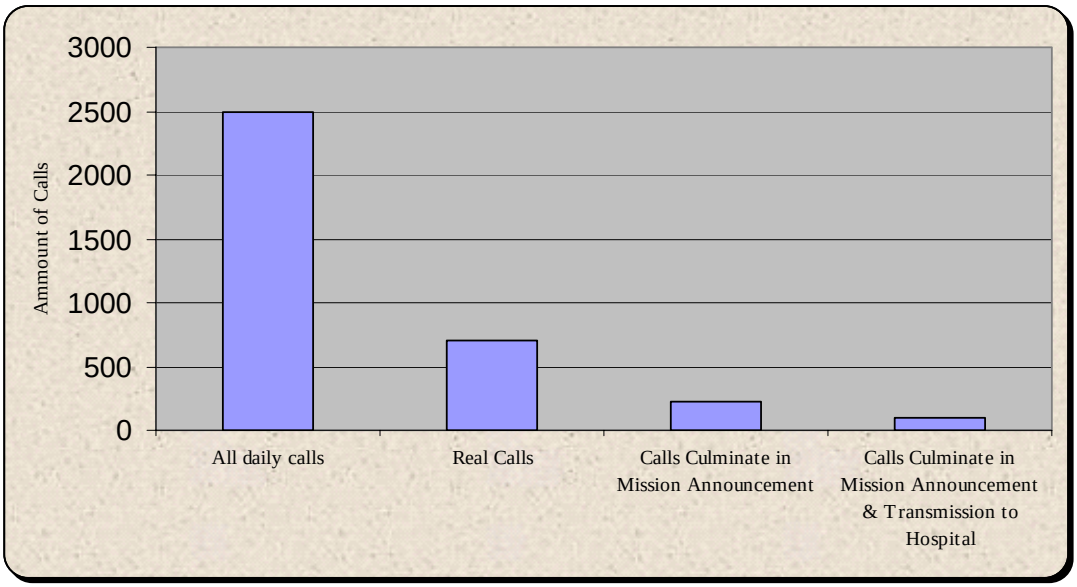
Section One: Notification

It is the time needed to establish a connection to the emergency center. Mashad Emergency Center has 6 phone lines and 4 dispatchers to answer calls. When all 4 operators are busy answering calls, there are still 2 other free lines. Therefore this system can answer 4 calls together and await 2 other calls. Thus the seventh call will be failed. Table 1 shows the moderate amount & variety of answered calls by Mashad Emergency Center in a day.

Table 1. Amount & variety of answered calls by Mashad Emergency Center

Type of Call	**Ammount**
All Daily Calls	2400-2500
Real Calls	600-700
Calls Culminate in Mission Announcement	200-230

Chart 1. Amount & variety of answered calls by Mashad Emergency Center



Only %40-43 of all calls culminate in mission announcement will conduce to transmission to hospital. Furthermore 9:00-11:00 A.M and 18:00-20:00 P.M are answering rush hours for Mashad Emergency Center.

Through more study on Mashad citizens' behavior after an incident happens and on their calls to 115, we understood that in the first five minutes after the incident occurrence no one calls 115 because of the accident shock. Multiplicity of similar parallel calls connects to the emergency center in the second five minutes. In order to track the emergency vehicle position large ammount of similar calls to 115 again are made to the emergency center in the third five minutes. However according to the existing statistics the emergency mission procedure in Iran big cities from start untill the "Vehicle Moves to The Announced Position" takes 8 to 10 minutes. Therefore there are so many unnecessary calls to emergency in the second and mostly the third five minutes after the accident. This people behavior makes emergency free connection lines busy inessentially. Overall this section takes atleast 10 seconds to atmost 4 minutes to answering a call.

Section Two: Dispatching

It is the time that dispatcher needs to evaluate the called situation that culminate in stricken ambulance necessity or unnecessity. This section mostly depends on dispatchers' skills and experience which takes atleast 1 minute to atmost 4 minutes.

Section Three: Positioning

It is one of the most important emergency operations steps. It starts with dispatching decision and continues untill "The Vehicle Moves to The Announced Position". In this section after making decision to dispatch an ambulance, filled mission form will be delivered to the Radio Center. This center connects to the nearest Emergency Stations and request an ambulance.

Through intelligent transportation systems the time of accurate positioning of the emergency vehicles during missions or in returning to the stations can reduce eminently. Employment of a satellite positioning system and a computerized mapping database in emergency vehicles afford an accurate (X, Y) coordinates positioning which greatly reduce positioning time versus traditional positioning systems [3].

Satellite Positioning System & Mapping Database

Today in Iran Emergency Centers, after the notification the Emergency Radio Center establishes radio connections to the emergency vehicles in the notified region in order to notices their position and mission's situation. They refer to a papery city map set on the wall to find out the nearest emergency vehicle and hospital. Installing a Satellite Positioning System (GPS) in each vehicle and a Control Center automated with a GIS Based mapping database beside the Radio Center allows emergency managers to locate all the emergency vehicles and proper hospitals in the region with no delay [1].

This system provides the following Benefits:

1. No need to establish a radio connection to each vehicle to locate its position
2. Easily select the nearest free emergency vehicle and a proper hospital to perform the mission
3. Reduce the positioning time
4. Relief emergency management

Section four: Transportation

It is the most important and most susceptible part of an emergency mission. It includes right path selection in order to pass to get to the incident location in the minmum time length. In Iran's current emergency systems this decision is made by the emergency vehicle driver and the dispatcher who is unaware of the urban traffic hourly conditions. With the following suggested designed software the best path can be chosen in a very short time.

Intelligent GIS Based Navigator System

Today GIS usage perquisites in transportation systems have been made clear to all the planners and managers. Through GIS based analysis many of the transportation problems have been solved. The "intelligent GIS based navigator system" which is designed and suggested in this paper is established on two main bases: 1) a GIS base map 2) Graphs Theory.

Because of the absence of a wide network traffic control system able to report the city main streets traffic condition momently in Iran cities, exploitation of an on-line system is effectively impossible. Therefore hourly traffic condition statistics can help mostly. Different traffic conditions can be partitioned into three cases: 1) Low 2) Moderate 3) Heavy. These hourly conditions will be defined as several layers on the city GIS based map. This system can draw all possible graphs which bridge the home and destination by determination of their coordinates. These graphs pass all the possible streets which lead to the destination. The total distance of each graph can be measured simply with eqn (1).

$$L = \sqrt{x^2 + y^2} \tag{1}$$

Above-mentioned hourly traffic conditions includes traffic volume and journey speed for each street. The time needed to pass each street can be measured easily by dividing the distance on its journey speed. A factor of safety dependent on different parameters such as street width, pedestrian traffic, number of traffic lights in a path and generally any speed reducer element can be multiplied by the measured time. By adding the streets pass time length in a path, the total time needed to get to the announced destination can be calculated. The Intelligent GIS Based Navigator System will choose the path with the minimum time length between all the drawn graphs in only a few seconds. To employ this system the objects below are essential:

1. Hourly traffic conditions informations

2. An on-line connection among the Emergency Center and the Traffic Control Center in order to control traffic points such as traffic lights.
3. Informations about traffic limitted streets because of constructions, repairments, etc.
4. A GIS base map and planning specific layers, including point locations for persons and facilities, hospitals, emergency stations, traffic signals, traffic control cameras and etc.

In addition other geographically referenced information about populations, potential events, resources, infrastructures can be advanageous too.

Results and Conclusions

These are the advatanges of using this system briefly:

1. No needs to set up a radio connection among the emergency vehicle and the Emergency Control Center in order to consult about the best path.
2. Accurate destination pinpoint.
3. Select the path with minimum time length
4. Reduce notification and response time and increase emergency management efficiency

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