Integration of GPS and GIS for Railway Accident Management

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Abstract

To make better decisions in railway accident management, a well-organized, up-to-date, reliable, on-line and accurate spatial database is required. Global positioning system (GPS) is used in spatial data acquisition and geospatial information system (GIS) is implemented for processing, managing and integrating geospatial data. Integration of GPS and GIS provides a new horizon in management of equipment, manpower, traffic, operation, time and rail accident. Identifying the format and type of data used in rescue operation, a customized GIS for railway accident management has been designed and executed in which trains timetable, district specifications, block feature,…are included. The system, in ACAD environment, displays train movement in the network in real time and starts alarming if any incident/accident such as arrival of train into an obstructed block, any defect of track, personnel working and any accident-induced factors raised. In addition, in case of any accident such as trains collision, derailment, train running,…the accident will be simulated and managed on time. To manage accidents properly, the traditional man-operated system does not work well, therefore, GIS-GPS system is applied to step towards automation, enabling better quality for data processing, speed, accuracy and security. It is attempted in this paper to identify forms and types of required data while setting up a proper database. In this connection a software package in VB language has been developed in which train positional data and railway-related accident information have been integrated. The developed system has successfully undergone a test using real data(off-line GPS measurements ,map as well as accident and train timetable,…), then through simulation and comparison of the results, proved to be a successful accident management and alarming system.

1. INTRODUCTION

Railway industry has a valuable role in economic development of each country. Considering several parameters such as transferring huge amount of goods and passengers with a high level of security and saving of fuel as well as less environmental impacts have been considered by decision makers and transportation experts. Cost balance in railway in every country represents huge amount of loss due to accidents, therefore, it is of prime importance to investigate quantitative and qualitative ways of reducing the impact of accidents [1].

Accident management in railway decision making has to consider the following two issues to avoid or mitigate the damages:

(i) accident prevention and development of an alarming system to predict and alarm before the occurrence of accidents.

(ii) reduction of negative effects of accidents after its occurrence through proper emergency and management services.

To achieve the above-mentioned objectives, necessary steps have been taken to simulate train movement, accidents and rail accident management system. The major problems in the simulation include, (i)the lack of appropriate information, (ii)the problem of making real accident scene environment due to human and cost issues and (iii) problems in performing a comprehensive test on the system.

Preparing the proper environment similar to the real case in the test, a simulation has been performed for rail accident alarming and management.

A number of investigations have been done on the impacts of railway accidents (see e.g.[8],[9]) Figure 1. represents some statistics of accidents in Iran to highlight the importance of accident management.

![Figure 1: Some statistics of accidents in Iranian railway](image-url)

Iran’s railway is going to increase its efficiency, speed cargo tonnage, … which obviously could lead to more accidents.

Designing and developing the proposed alarming and managing system can be used to identify the sources of accident, personnel involved, establishment of a reliable
database of accidents, determination of the damages in railway infrastructures, reduction of human interference, documentation of needs according to the available facilities to have a comprehensive database of the accidents.

2. **FUNDAMENTAL CONCEPTS IN RAILWAY ACCIDENT MANAGEMENT**

A number of locating and positioning sciences and technologies have been employed to efficiently handle railway accidents. Among them geospatial information system (GIS) as a locating and global positioning system (GPS) as a positioning system have been highly considered in geomatic engineering.

GIS includes a set of software, hardware, geospatial data, models (algorithms) and expert to be used in the process of collection, storage, retrieval, updating, processing, displaying and transferring the data to support a decision making process [2],[3]. GIS is the science and technology of spatial and attribute information integration and can be efficiently used to monitor and manage railway accidents [4].

GPS has been developed as a series of 24 positioning satellites by US having period of 12 hours which provides the location, time, velocity, … of objects with a range of locational accuracy. GPS system contains three sections including space, ground control and user.

In this research, Garmin GPS receiver has been used to collect locational information of Tehran-Mashad railway in 2001 by Iranian Railway Research Center.

GPS and GIS integration have also been widely used for a number of applications to name but a few, they have been implemented to manage ambulances in Greece[5], management of security of drivers and preparing better services to passenger in Norway, design of geographical railway safety assessment system (GRASAS) in Japan[6] and creation of the complete radio coverages in AMTRACK system in Canada [7].

3. **DEVELOPED SIMULATIONS**

In this section the track simulation, accident simulation and simulation of the functionality of GIS-based railway accident management system are discussed.

3.1 **Track Simulations**

A Visual Basic (VB) program has been developed to investigate trains movement in real case in the railway track. The simulation was intended to be used for studying the locations of trains and usage conditions based on the train time table.

The developed system can predict and alarm any possible accident and also can be used to support and manage relief operations.

Therefore it was necessary to simulate the real situation of a train before accident as well as locate the position of the train after accident for relief management (Figures 2 & 3).

3.2 **Accidents Simulation**

To recognize the real accident environment due to confronting two trains, derailment, … a software package in VB environment has been developed and successfully tested in this research (Figures 4 & 5).
3.3 Simulation of Functionality of The GIS-Based Railway Accident Management System

At this stage the functionalities of some nearby trains have been simulated. GPS has been used to monitor the position of the trains with high accuracy and GIS has been implemented to handle attribute and spatial data of emergency services and the trains, enabling experts in control center to have a proper reaction against the railway accidents (Figure 6).

The collected positional data has been edited using a developed program in VB environment. A base map at a scale of 1:2500000 covering necessary locational data of the track and emergency services nearby of the area has been digitized and made GIS ready for further analysis [9].

Autocad has been used as a graphical software in this research. In addition, a comprehensive database of the trains, emergency services and other required attribute data have been linked to the graphical data [9] which have been illustrated in Figure 7.

A multimedia system has been designed for some query functions to have a better usage of available data in this research (Figures 8 & 9).

4. PRACTICAL WORK

To develop the proposed system, simulation of trains movement and the accident have been done. The input of the system include maps and other locations of trains in addition to the database of relevant features and emergency service provider centers. The Tehran-Mashad railway track in the north west of Iran has been selected for this research.

The real information regarding the position of a train obtained through an off-line GPS measurements in 2001 has been achieved. To collect the data, the GPS receiver has been installed in the train and the positional data has been ported to an industrial computer in the train. The selected track is important due to huge cargo and passenger traffic which is a part of international transit track of Mashad-Sarakhs-Tajan in east of Iran.
5. CONCLUSIONS

Railway has long been considered as the safest transportation media. Recognizing the need to improve the efficiency of the transportation systems, it is necessary to investigate the accidents and find out speed, cargo tonnage, ... It is necessary to investigate the accidents and find out the essential methodologies for optimum management of information and resources available in railway rescue operations.

The statistics show a huge number of accidents are due to human errors. Therefore, having a systematic way for railway operation management and reduction of human intervention or controlling activities and performances could play a significant role in reducing the number and impact of accidents.

Reliable, accurate, precise, up-to-date and structured geospatial data is the key for decision making. Integration of GIS as a system for optimum acquisition and management of geospatial data and GPS as a reliable means of positioning and navigation could pave the way for an intelligent decision making in railway organizations to prevent or mitigate huge amount of human and economic losses.

The developed system has proved to be successful in a number of issues like determination of the best path to get to the accident location and perform emergency services. The system could be installed on a PC or laptop with minimum 64 Mbyte RAM with an AutoCad system which is used as a graphical media.

The system has been implemented in a real traffic environment with the ability to answer a number of spatial, non spatial and integrated queries.

The system has been developed in a completely operational mode and is ready to accept any real information in management and executive parts of railways.

REFERENCES

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