Accident Emergency Response And Routing Software (AERARS) using Genetic Algorithm

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Abstract

AERARS is a response and routing software for accident emergency requirement. A method has been proposed in this project for using a genetic algorithm to find the shortest route between a source and a destination. It make use of genetic algorithms ability to search the opt solution from the population helping to solve spatially addressed problem. The numbers of accident spots are plotted in ArcGIS environment and ten major accident spots are identified. The software package is designed with closest facility estimation and shortest route generation along with other basic software facilities in Visual Basic environment. Genetic algorithm provided a great optimality to the solutions. The closest facility tool helps to estimate the nearest hospital, ambulance, police station and fire station. The shortest route estimation tool generates shortest path between a locations to the hospital or ambulance spot. The various risk zones are assessed and more safety measures can be taken to reduce the frequency of accident. The software efficiency can be further increased by incorporating GPS and satellite technology.

***Keywords*: Genetic Algorithm; Mutation; Crossover; Fitness factor; Dijkstra's algorithm.**

1. Introduction

In a country like India with large population, the role of transport becomes immense. Over the last decade the growth in transportation sector have been rapid, with road transportation contributing its major shares. The advancement made in science and technologies have made drastic changes in the field of transportation from management, traffic control, fuel usage, and pollution control and accident response. With increase in number of vehicle overnight, chances of accidents are increasing day by day. The factors that might contribute to the cause of accidents are vehicle design, speed of operation, road design, drivers impatient. Independent of the reasons we need a response system which can react to the situation, since it can't be predicted. Project presented here comes to the problem of traffic accident response proposing a GIS based software approach for responding to the situation. It makes use of genetic algorithm to estimate the optimum route from the search space. It makes use of crossover and mutation operators which make it feasible for the job. It is also enriched with closest facility detection. The advantage of this software is that common man can use the system without any prior GIS software proficiency.

2. Study area and Data used

The study area chosen for the present study is KanyaKumari District in TamilNadu, India. The District is bound by Tirunelveli District on the North and the east. The South Eastern boundary is the Gulf of Mannar. On the South and the South West, the boundaries are the Indian Ocean and the Arabian Sea. On the West and North

West it is bound by Kerala. The headquarters (capital) of the District is Nagercoil, which is 22 km from KanyaKumari town.

2.1. Location of study area

KanyaKumari District in TamilNadu is chosen for the present study which is shown in the Figure 1

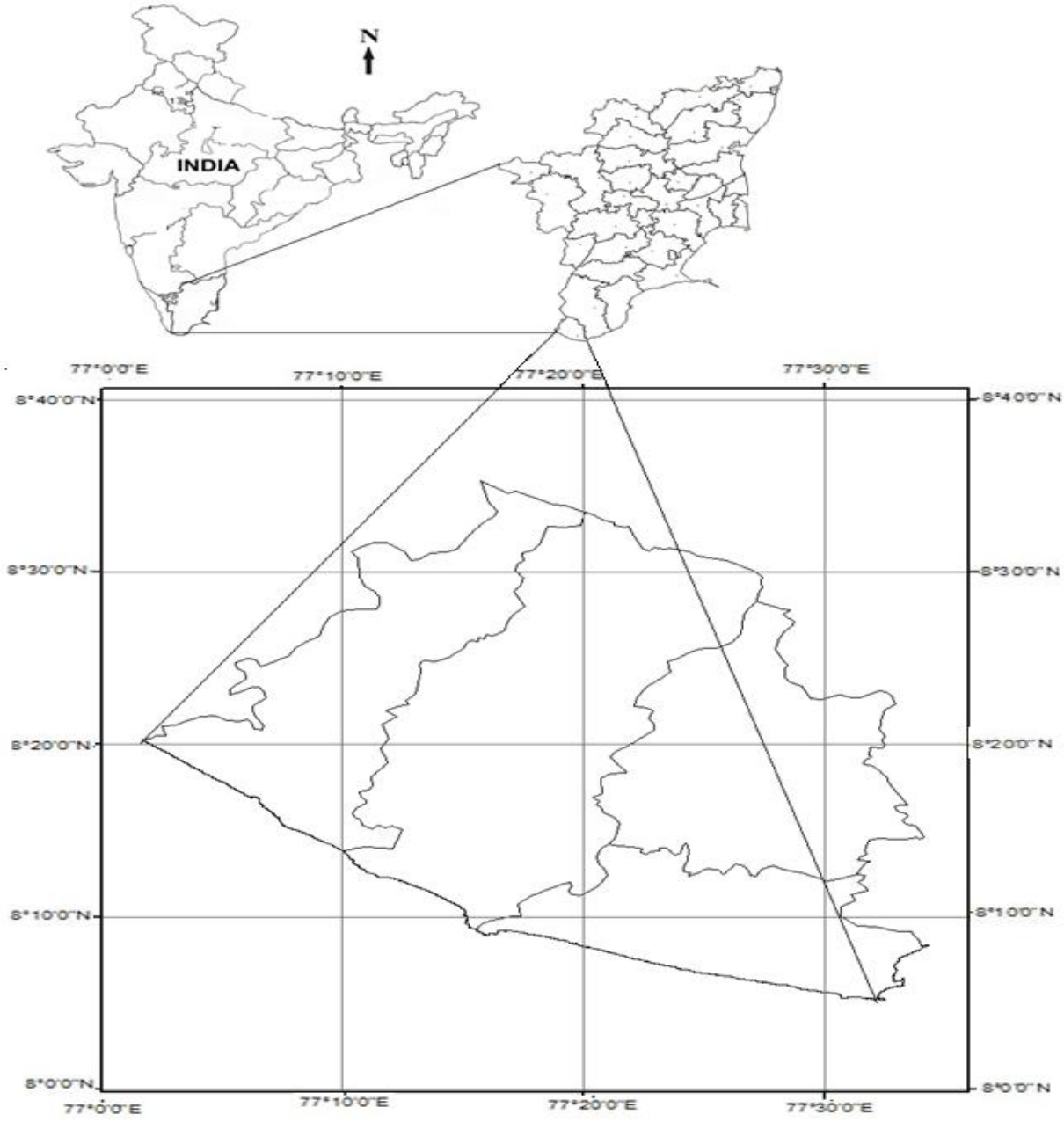

Figure 1: Geographic location of KanyaKumari District

- Area covered in the study region = 1672 sq.km
- Latitude $8^{o}00'00''N$ to $8^{o}40'00"N$
- Longitude $77^{o}05'00"E$ to $77^{o}35'00"E$

2.2. Data used

- Base Map of KanyaKumari District
- From Municipal of KanyaKumari
  - Transportation Network Map

    - Taluk boundary map
- From the SP office, KanyaKumari
    - Police station location
    - Accident records for the year 2008 to 2010
- From field Visit
    - Location of Ambulance services
    - Location of Hospitals
    - Information regarding Emergency services
- From Office of Divisional Fire Officer
    - Fire and Rescue station locations

2.3. Software used

- ArcGIS 9.3 is used for different layers generation which serves as input of the project. Measure Tool was used to estimate the distance between points.
- VB6 was used as Front end with Microsoft Access as database.
- Adobe Photoshop CS2 for animation and Designing.

3. Methodology

The aim of this present study is to develop a software package for accident emergency response and routing using Genetic Algorithm and Dijisktra Algorithm. Various studies of different researchers were analyzed. Based on the comparison, a method was proposed to select the optimized path and exact facility. Various data were collected and analyzed in GIS for creating a proper database of the study area. Figure 2 shows methodology of study.

3.1 GIS analysis

Monthly based analyses were carried out to ascertain more number of occurrence accident histories. The month based study dealt with month wise occurrence of accidents. From this the responder network may be get aware of accident prone month. Roads in the city are categorized as National highways, State highways, major roads and minor roads. This is done by giving a separate key number to each category in the database. Roads which are having names are identified and that data are stored in this database. Major Accident prone Zones were identified based on previous records and enlightened.

3.2 Database Design

GIS database is prepared as spatial and nonspatial data. Every accident spot is specifically located at their exact geographic positions, with their attributes. Road layer is digitized with more than 964 road segments and 729 locations. Measure tool is used to estimate the distance between two nodes (locations).The designed GIS database layers and their fields are

- ✓ Ambulance (Ambulance_ID, Ambulance Name, Ambulance_Phone_number).
- ✓ Firestation (FireStation_ID, FireStation_Name, FireStation_STD, FireStation_Phone_number).
- ✓ Hospital (HospitaI_ID, Hospital_Name, Hospital_Phone_Number, Hospital_STD).
- ✓ Location (Location_ID, Location_Name).
- ✓ Records (Accident_ID, Hotspots, Accident Date, Accident Time, Police Station, Ambulance, Hospital, Fire Station, Number of Causality, Vehicle Number, Victim Name, Type of Accident).
- ✓ Road (Road_ID, Road_SHAPE_Length, From Node, Distance, To Node, Road_Type).

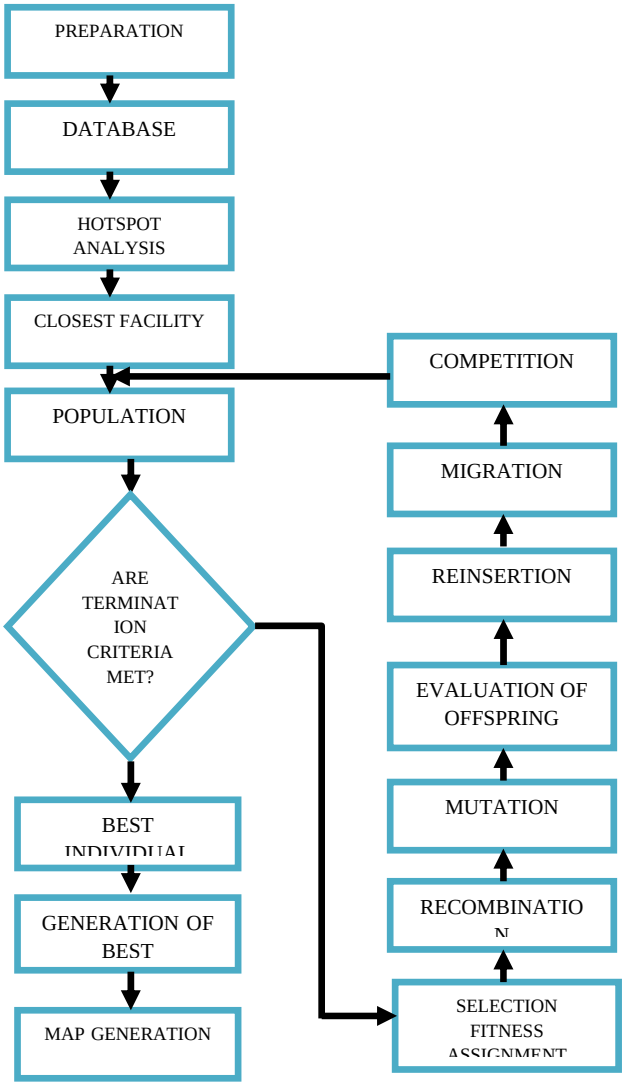

Figure 2: Methodology for the study

3.3 Software Overview

Design of software goes through following process

- Design
- Implementation
- Verification
- Maintaining

3.4 Software Designing

The main Objective of this project is to find the closest facility such as Hospital, Ambulance, Police station, and Fire Station and Shortest route estimation. The software also provides a facility to add the accident records and store it for later analysis. It can be handled even by the user who is unaware of GIS software. The main form of the software is given in figure 3 The main menu consist of menu bar legend field Route Field and Closest Facility field as shown in table 1.

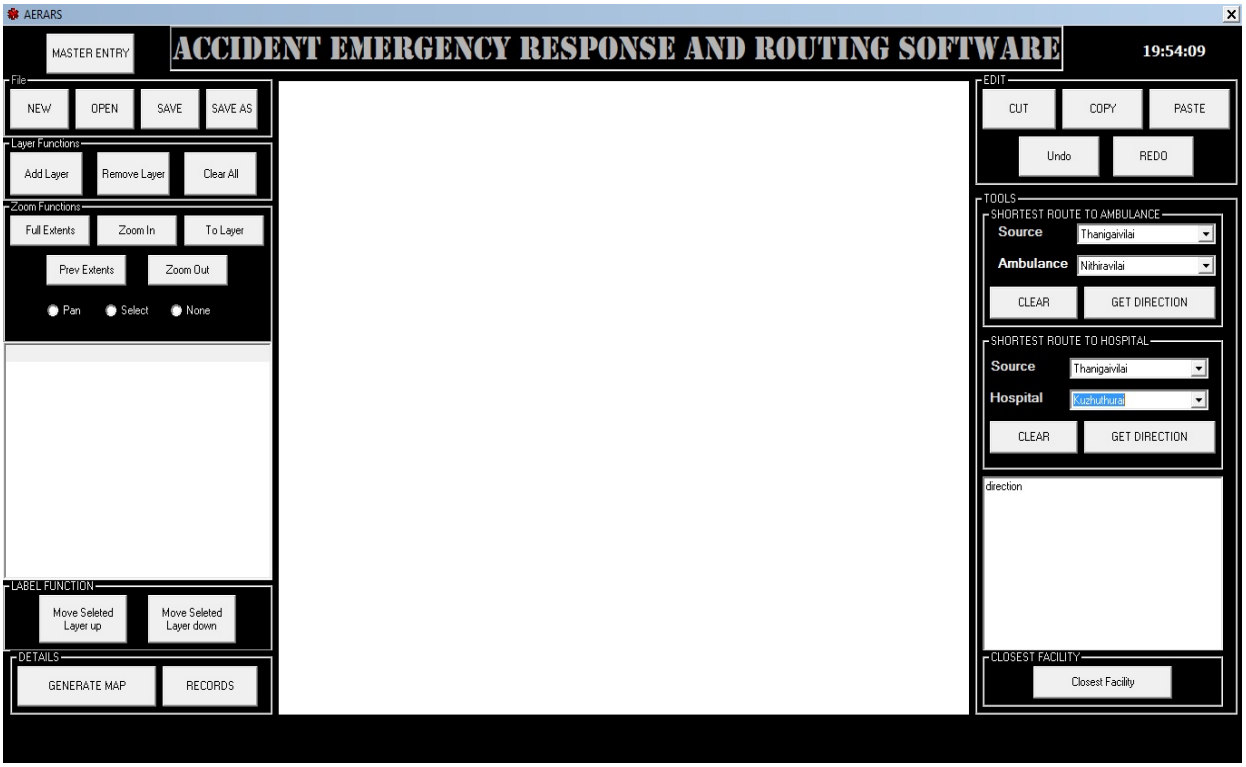

Figure 3: Main menu

3.5 Implementation

The implementation part mainly deals with two prospects that is estimation of Shortest Route using Genetic algorithm and finding the closest facility using Dijisktra Algorithm.

3.5.1. The proposed Dijkstra's algorithm scheme for closest facility estimation

A Starting node is called a source node from which the distance of the node is Y. Dijkstra's algorithm will assign some initial distance values and will try to improve them step by step.

- Call the Facilities with Parameters I, J, K, L for Ambulance, Hospital, Police Station and Fire Station.
- Assume Source as starting Node.
- Assign to every node a distance value. Set it to zero for our source node and to infinity for all other nodes.
- Mark all nodes as unvisited. Set initial node as current.
- For current node, consider all its unvisited neighbors and calculate their tentative distance from the source node

Table 1: Menu Bar

MENU	**SUB-MENU**	**ACTIONS**
FILE	New	Creates a new workspace
	Open	Opens a file
	Save	Saves the file
	Save As	Saves the file in required format
Layer Functions	Add Layer	To add a new layer
	Remove layer	To remove a layer
	Clear layer	To remove all layers
Zoom Functions	Zoom IN	Zooms image in
	Zoom Out	Zooms outs the Image

	Full Extend	Zooms image to full extend
	Previous Extend	Take to previous zoom extend of image
	To layer	Zoom image to fit layer
	Pan	Move the image
	Select	Select the image or its portion
	None	Select nothing
	Exit	Exit the menu
Edit Functions	Copy	Copy an image on to clipboard
	Cut	Cuts an image on to clipboard
	Paste	Paste on to clipboard
	Undo	Cancels out last function
	Redo	Perform earlier done function
Closest Facility	Get Facility	Gets the Closest Facility
Shortest Route	Get Direction	Gets the Shortest route
Details	Generate Map	Generate output Map
	Records	Accident record storage
Label Function	Move Selected Layer Up	Move Selected Layer Up
	Move Selected Layer Down	Move a layer down over other
Master Entry Form		To enter the Details of data's
About		Version History
Help		To help user to understand Function

- When we are done considering all neighbors of the current node, mark it as visited. A visited node will not be checked ever again; its distance recorded now is final and minimal.
- If all nodes have been visited, finish. Otherwise, set the unvisited node with the smallest distance (from the source node) as the next "current node" and continue from step 3.
- Find the minimum value of each Facility and display in output

3.5.2. The proposed GA scheme for shortest route estimation design

Each location in the map is unique integer value index from 1……j, where, j is the number of location in the map. Each individual is designed to represent a solution for the problem and it should not contain repeated location indices. The length of the individual is chosen to be equal to the number of locations in the map. For a map with j number of cities the maximum gene length is equal to j, where Li is the ith location in the map.

3.5.2.1 Coding

Permutation encoding is used in this problem. In permutation encoding, every chromosome is a string of numbers, which represents the number of locations in a sequence Permutation encoding is useful when individual fitness depends on positions of genes in chromosome. Main difference between value and permutation encoding is that there are no genes with the same value in permutation encoding chromosomes. Useful in ordering problems such as shortest route estimation each of which represents a city to be visited.

3.5.2.2 ***Initial population***

The size of the population depends on the number of nodes in the graph and the length of each chromosome in the population. For a map with 125 towns it is better to have a population size around 100.

3.5.2.3 *Fitness function*

A fitness function evaluation is used to assigns a value to each Individual, noted as Fi. This Fi value is a figure of merit which is calculated by using any domain knowledge that applies. This is only points were the user knowledge is to be applied. Individual are chosen using the fitness value as a guide, where those with higher fitness values are chosen more often. Selecting Individual based on fitness value is a major factor in the strength of GAs as search algorithms. The method employed here is to calculate the total distance *Di* for each organism first, then compute *fi* by using the following equation (Buthainah Fahran Al-Dulaimi and Hamza A.ali et.al 2008)

$$F_i = D_{max} - D_{min} \qquad (1)$$

Where D_{max} is the longest distance over organisms in the population.

3.5.2.4 Selection

The basic part of the selection process is to clinically select from one generation to create the basis of the next generation. The requirement is that the fittest individuals have a greater chance of survival than weaker ones. This replicates nature in that fitter individuals will tend to have a better probability of survival and will go forward to form the mating pool for the next generation. Weaker individuals are not without a chance. In nature such individuals may have genetic coding that may prove useful to future generations.

The selection process applied here is Roulette Wheel Selection, which assigns a probability to each individual i, computed as the proportion using the following equation (Buthainah Fahran Al-Dulaimi and Hamza A.ali et.al 2008)

$$P_i = F_i / \sum F_j \qquad \text{Where: } j = 1, 2\ldots n! \qquad (2)$$

3.5.2.5 Crossover

To apply ordered crossover (OX), two random cross points are selected. Alleles from parent1 that fall between the two cross points are copied into the same positions of the offspring. The remaining allele order is determined by parent2. Nonduplicative alleles are copied from parent2 to the offspring beginning at the position following the second cross point. Both the parent2 and the offspring are traversed circularly from that point. A copy of the parent′s next no duplicative allele is placed in the next available child position.

3.5.2.6 Mutation

After recombination every offspring undergoes mutation. Offspring variables are mutated by small perturbations with low probability. The mutation operator induces a change in the solution, so as to maintain diversity in the population and prevent Premature Convergence. In this project, the string is mutated by randomly selecting any two cities and interchanging their positions in the solution, thus giving rise to a new path. A mutation operator that replaces the value of the chosen gene with a uniform random value selected between the user-specified upper and lower bounds for that gene. This mutation operator can only be used for integer and float genes.

$$\text{At random choose} i \in N. \text{ Select a value } x_i \sim U(x_i, x_j). \text{ Set . } X_i = x_i$$

4 Results and Discussions

The numbers of accident spots are plotted in ArcGIS and ten major accident spot are identified. The software package is designed with closest facility estimation and shortest route generation along with other basic software facilities. Genetic algorithm provided a great optimality to the solutions. The accident zone is plotted based on the previous year data from police crime department. The analysis is performed on monthly basis and it is found that most number of accident occurred in April-May time. The top ten major accident spot are also calculated based on its frequency of occurrences. The top ten Accident zone is Aralvamozhi, Pammam, Thovalai, Kaliyankadu, Villukuri, Sunkankadai, Parwathipuram, Krishnancoil, Puliyorkurchi, and Ottyadi. The figure 4 shows the top ten accident prone zones. Road accident records were stored in database. This Records Menu carries the following information regarding Road accidents. These are Station Name, Place of Accident, Date of Accident, Time of Accident, Type of accident, Victim name, Nearest Hospital, ambulance, Police station, Fire Station and Vehicle Number.

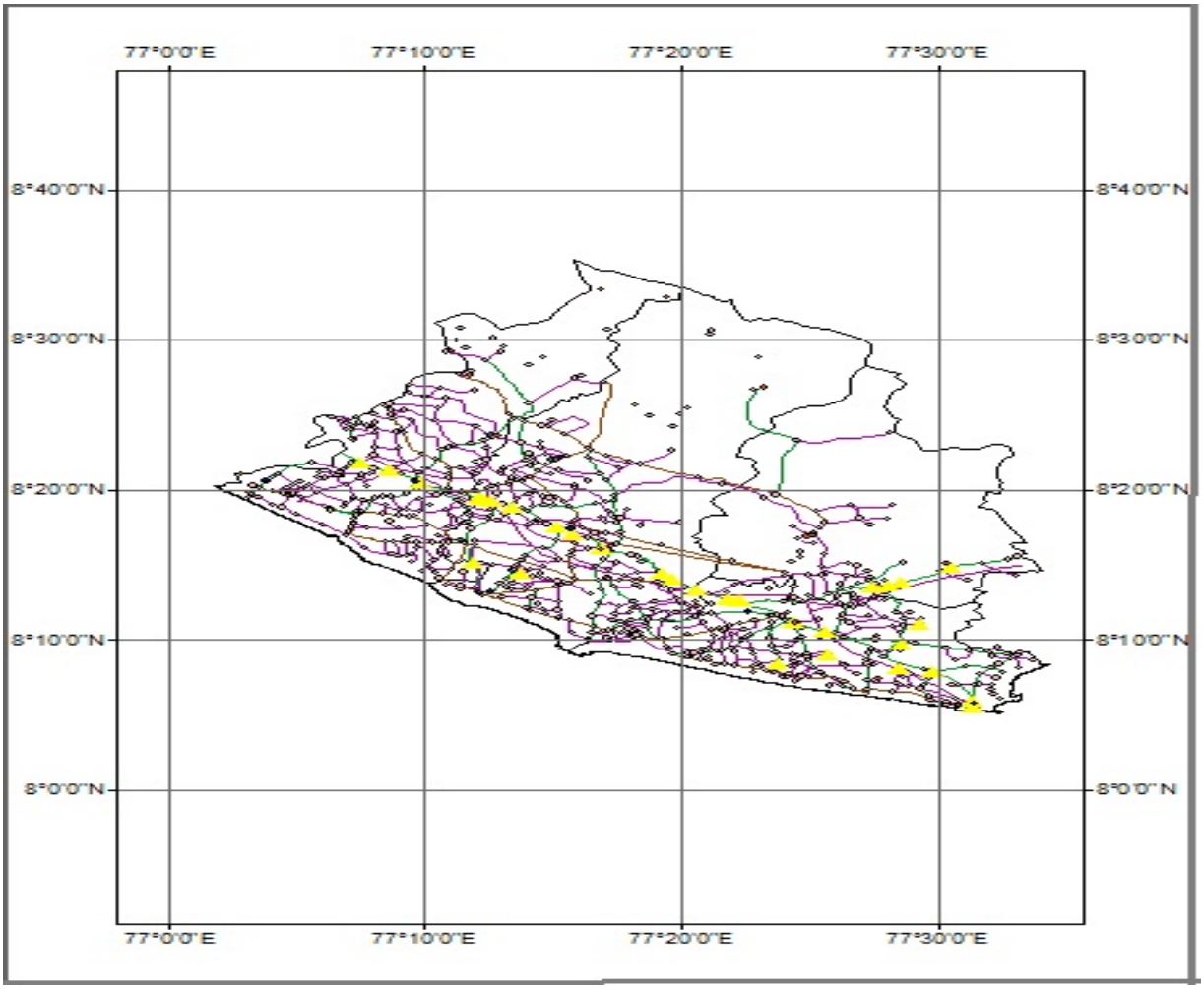

Figure 4: Top ten accident prone zones

The closest facility tool helps to estimate the closest facilities such as nearest hospital, ambulance, police station and fire station. This tool helps to estimate the nearest facility available for the location. This tool is tested for various location sets and outputs are found to be satisfactory. The figure 5 shows the closest facility tool showing the nearest facilities available for Painkulam village.

The shortest route is necessary to be estimated to find the easiest way either to ambulance or to Hospital. The shortest route estimated using genetic algorithm provided a great deal of accuracy. This helped to develop routing system for Accident emergency response. This tool is tested for various location routes. The estimation of shortest route to the nearest ambulance is estimated using genetic algorithm. This tool helps to estimate the shortest route between a location and nearest ambulance. This tool is tested for various combinations of routes. The figure 6 shows shortest route from ambulance at Nithiravilai to Painkulam Village.

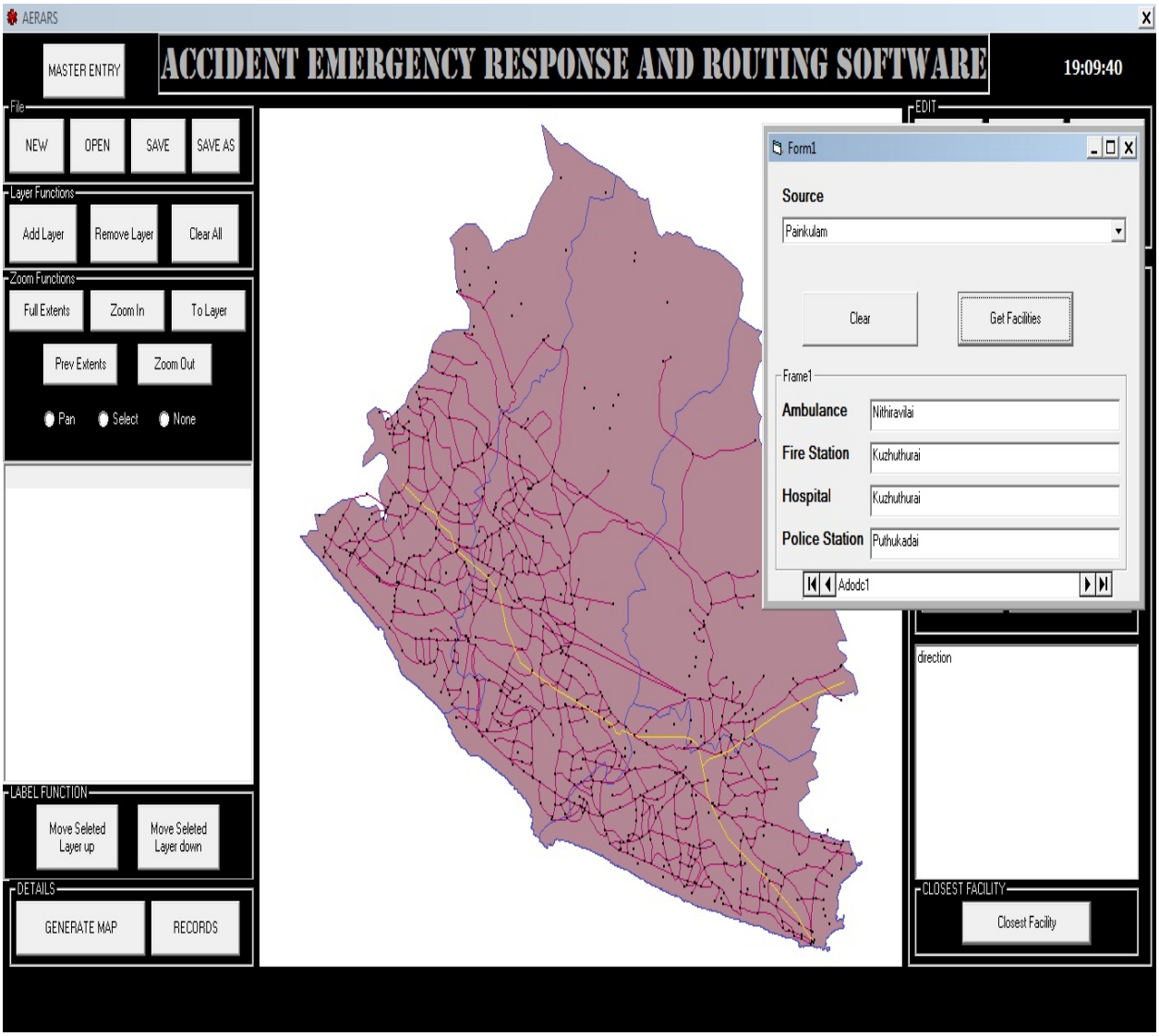

Figure 5: Closest facilities available for Painkulam village

The estimation of shortest route to the nearest Hospital is estimated using genetic algorithm. This tool helps to estimate the shortest route between a location and nearest Hospital is tested for various combinations of routes. The figure 7 shows shortest route from Painkulam Village to Kuzhuthurai Hospital.

5 Summary and Conclusion

The Accident emergency response and routing software proved to be efficient in accessing the closest facilities and determining the shortest route using genetic algorithm. Traffic control authorities, emergency service providers, policemen and any common man can use the system without any prior GIS software proficiency. The various risk zones are assessed which will serve as a reference of the accident spots and more safety measures can be taken to reduce the frequency of accident. The accuracy and care in creating database can be used to improve the result of the final output. Closest facility can be promptly obtained based on compromise between time and accuracy by Dijkstra's Algorithm. It proves to be time efficient. This helps one to estimate the facilities available with ease. The Genetic algorithm can be used to improve the accuracy of result on the basis of distance where other algorithm cannot be obtained. The search space can be utilized to its great extend. The shortest route tool provides the optimsed path with acceptable accuracy.

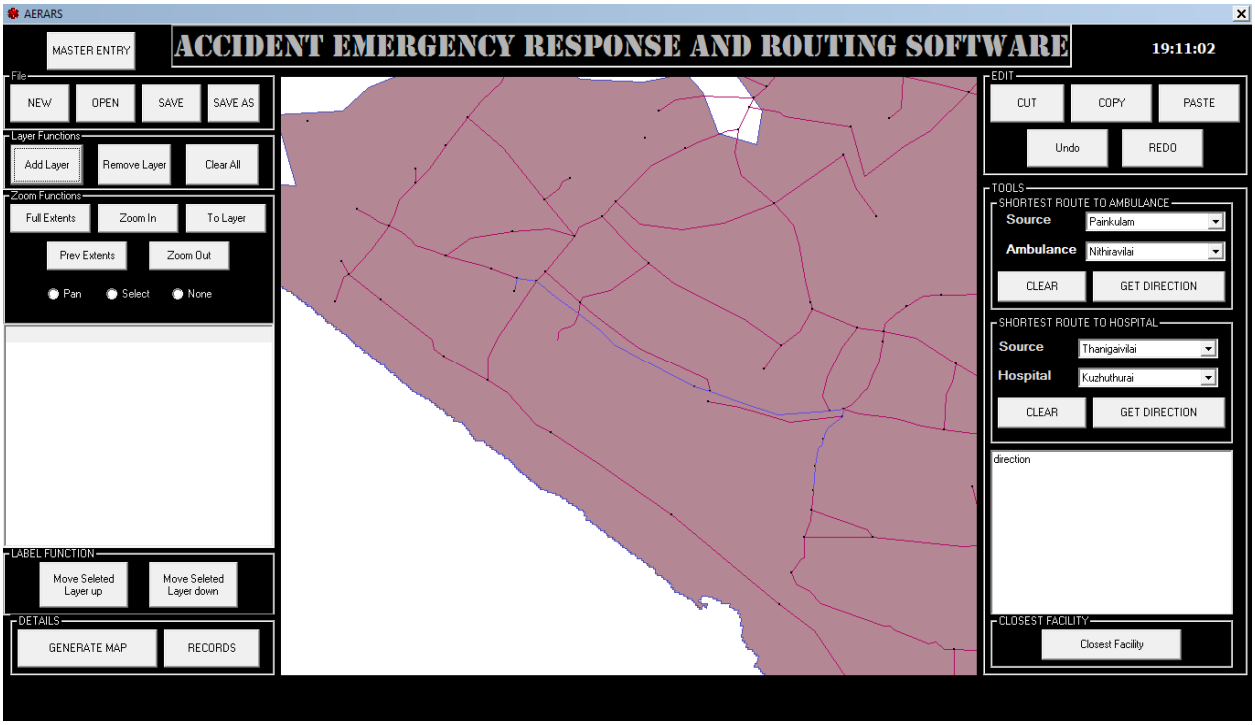

Figure 6: Shortest route from ambulance at Nithiravilai to Painkulam village

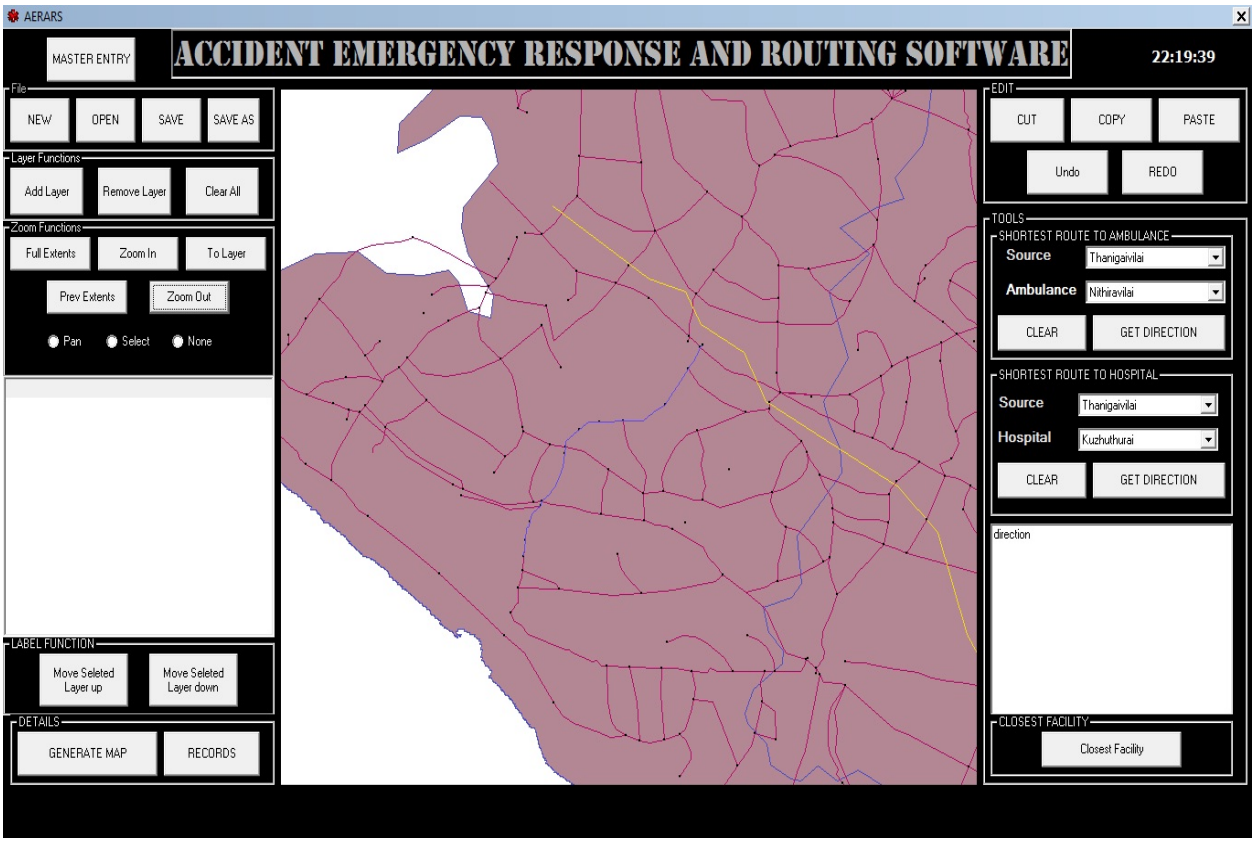

Figure 7: Shortest route from Painkulam village to Kuzhuthurai hospital

6 Recommendation

The software efficiency can be further increased by incorporating GPS technology in it. It provides a real time location condition which can be used to generate suitable route in case of traffic conditions. Also this software

can be also incorporated with satellite technology for automatic accident response with the help of online alert system will help to reduce the accident cases.

References

[1] A. John Sanjeev Kumar, J.Arunadevi, V.Mohan(2009), Intelligent Transport Route Planning Using Genetic Algorithms in Path Computation Algorithms, European journal of scientific research, vol.25 no.3 (2009), pp.463-468

[2] B.Ganeshkumar, D.Ramesh, (2010), Emergency Response Management and Information System (ERMIS) – A GIS based software to resolve the emergency recovery challenges in Madurai city, Tamil Nadu, International Journal of geomatics and geosciences Volume 1, No 1, 2010

[3] Buthain Ah Fahran Al-Dulaimi, and Hamza A. Ali,Enhanced, (2002),Traveling Salesman Problem Solving by Genetic Algorithm Technique, World academy of science, engineering and technology , vol 38

[4] Dr Praveen kumar & Dhanunjaya Reddy Varun Singh(2003), Intelligent transport system using gis , In proceedings of Gisdevelopment Mapindia 2003,India

[5] Guolin Wang, Deyun Xiao and Jason Gu, (2008), Design and implementation on software platform of emergency management system for traffic incidents, The proceedings of 9th international conference IEEE may 5-7 2008, Niagara falls. Canada

[6] Hongjun Tian, Zhengjun Liua, Jixianzhang, Chengfengluo, Bin Liu, (2008), Design and development of emergency response geographic information platform based on web service, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B4. Beijing2008

[7] Mei-Po Kwan & Jiyeong Lee (2005) Emergency response after 9/11: The potential of real-time 3D GIS for quick emergency response in micro-spatial environments, Elsevier, computers, environment and urban systems, vol 29 pp:93–113

[8] Saeed BehzadI, and Ali A. Alesheikh(2008), Developing a genetic algorithm for solving shortest path problem wseas International Conference on urban planning and transportation (UPT'07), Heraklion, Crete Island, Greece, July 22-24, 2008

[9] Sachith Abeysundara, Baladasan Giritharan, Saluka Kodithuwakku (2005), A Genetic Algorithm Approach to Solve the Shortest Path Problem for Road Maps, Proceedings of the International Conference on Information and Automation, December 15-18, 2005, Colombo, Sri Lanka.

[10] S. Behzadi , Ali A. Alesheikh (2008), A pseudo genetic algorithm for solving best path problem , The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B2. Beijing 2008