Exploring OptimumRoute for Emergency Vehicles By Analyzing Road Network

EiSweHan[1]

Abstract

Computing optimum routes in road networks is one of the showpieces of real world applications. A critical problem of road network analysis is the computation of shortest paths between different locations on a real road network.Road network information is always changing when emergency vehicle travelling on the road network.Now roads are so congested that it is difficult for the emergency vehicles to travel and reach the hospital from the accident point.Emergency vehicle has to explore the new optimumroute when the current route is disturbance occur.Emergency Vehicle Transportation System (EVTS) isprovided to solve the both static and dynamic routing problems and to explore the optimumroute for emergency vehicle when an accident occurs on Yangon City road network.

Key words: road network, emergency vehicle

1. Introduction

Emergency services play a major role when accident occurs on the road network and need to save valuable human lives. Most of the emergency vehicles takethe patient to the hospital as fast as possible, even though they are unable to reach the hospital because of huge traffic at junctions.Once the emergency vehicle gets stuck in traffic, it takes more-time to reach the hospital.

This proposed system, the optimum routeis considered as finding a route between two specific points in both static and dynamic road network which needs minimum distance to traverse. When road conditions are changed, the algorithm finds the new route which is the optimum route.Exploring optimum route is often used for routing of emergency vehicles such as ambulance, fire engine and police car.

A critical problem in road network and transportation analysis is the computation of shortest paths between different locations on a real road network. A road network can easily berepresentedas a graph.Dijkstra's algorithm is the classic solution from graph theory.Several shortest path

[1]Dr., Lecturer, Department of Computer Studies, Dagon University

algorithms have been suggested by the researchers and Dijkstra's shortest path algorithm is the most appropriate one, which can be extended with a variety of modifications.Taking the real road networks into consideration, Dijkstra's algorithms have to be modified.

2. Objectives

Emergency VehicleTransportation System (EVTS) is presented to solve the both static and dynamic routing problems and to find the optimumroute for emergency vehicleswhen an accident occurs on Yangon City road network. The main objective of this study is EVTS to help the emergency vehicle travel to the nearest hospital or desired hospital as fast as possible without getting delay due to the congestion on road network for save the patient.

3. Creating Road Map and Road Network

The spatial data of the GIS are used for creating road network. The road and traffic data are the essential information of a city's transportation road network. Road network are needed to travel emergency vehicles. GIS information is supported by Google Map application.Google Maps servers deliver, upon processing the request from the client, calculate the parts of the world map at the specific zoom level.After sending the request, Google Maps servers can offer the required map.

3.1 Data Source of Google Mapsand OpenStreetMap (OSM)

Figure 1 Road Map of Yangon City

Google Maps freely support raster data format of road network only. Raster data is characterized by pixel values. Figure 1 represents a captured road map of Yangon City from Google Map as an example.

Geographical information of the road network is obtained from OpenStreetMap(OSM). OSM is freely supported for vector data format. Vector data is the spatial data represent as points, lines and polygons. A point is a single node, a line is two nodes with an arc between them and a polygon is a closed group of three or more arcs [3]. OSM data is clear and exact for calculating and processing shortest path.It is also easy to display for Yangon Road map. Figure 2 shows OSM layer is partly covered onto Yangon road map.

Figure 2Yangon Road Map of OSM

3.2 Addition of Resources on the Road Network

The road network serves as an underlying reference system for all resources that are part of an Emergency VehicleTransportation System(EVTS). The system is modeled by the following resources on the static road network.

Hospitals

Figure 3 Hospitals on the Yangon Road Map

Hospitals provide medical care to injured and sick people. To save a patient, the only way is to take the nearest hospital. In this system, locations

of some hospitals are placed on the map of Yangon City. Figure 3shows the hospitals are placed on the Yangon road map.

4. Database for System

Geographic information ofroads and junctions are needed for creating road network. This information is available by Google Maps and OSM that is saved in the SQLite database as their location of latitude and longitude coordinate with their names.

4.1 Google's Road Map of Yangon

Map of Yangon city are requested from the Google Map server and download the return file. Then the available map is saved to the database.

Table 1 SQLite database files of Google Road Map

sr no.	zoom_level	tile_column	tile_row
1	7	68	63
2	7	68	65
3	7	97	58
4	5	16	16

4.2 Names and Locations of Hospitals

Some Hospitals are placed on the road network. New hospital names can add and save to the SQLite database.

Table 2 Locations of Hospitals in the SQLite Database

sr no.	name	type	latitude	longitude
1	Yangon General Hospital	1	16.778616	96.150670
2	Bahosi Hospital	1	16.779715	96.140018
3	Military Hospital No 2	1	16.78787	96.148181
4	Paragu Hospital	1	16.776694	96.169295
5	Academy Hospital	1	16.790526	96.127995

5. Dijkstra's Shortest Path Algorithm for Network Analysis

Network Analysis for optimum routeis based on the well-known Dijkstra'sshortest path algorithm.Dijkstra's algorithm, conceived by computer scientistEdsgerDijkstra in 1956 and published in 1959,is a graph

search algorithm that solves the single-source shortest path problem for a graph with non-negative edge path costs, producing a shortest path tree [2].

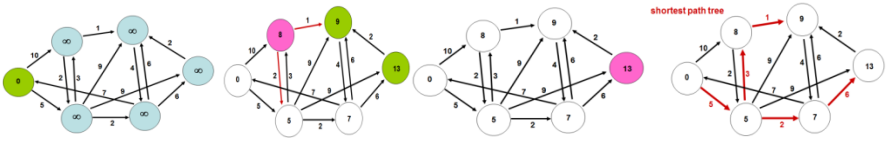

Figure 4Shortest Path Tree of Dijkstra's Algorithm

The classicalDijkstra's algorithm solves a shortest path problem directed and nonnegative weighted graph. Bidirectional dynamic shortest path algorithm is modified based on the original Dijkstra's algorithm for better performance of finding shortest path.This algorithm is modified to respect real time information such as blocked road segment congestion while finding shortest or optimal path.

6.ExploringOptimum Route by Analyzing Road Network

6.1 Optimum Route on Static Road Network

In static road network, the road network condition is a normal that means it has no blocked junctions and no blocked road segments. An accident location is identified on the road network. Figure 7 shows the accident name, accident type, location of accident point as latitude and longitude while the accident point is placed on the road network.

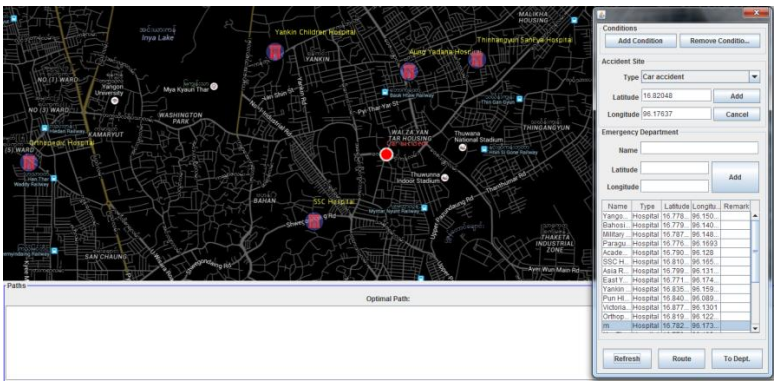

Figure 7Identified Accident Locations

After the accident point is placed on the road network, the system calculates and finds the optimal path by using bidirectional dynamic Dijkstra's shortest path algorithm. Figure 8 describes the optimal path routing from the accident pointto the nearest hospital and other hospitals.

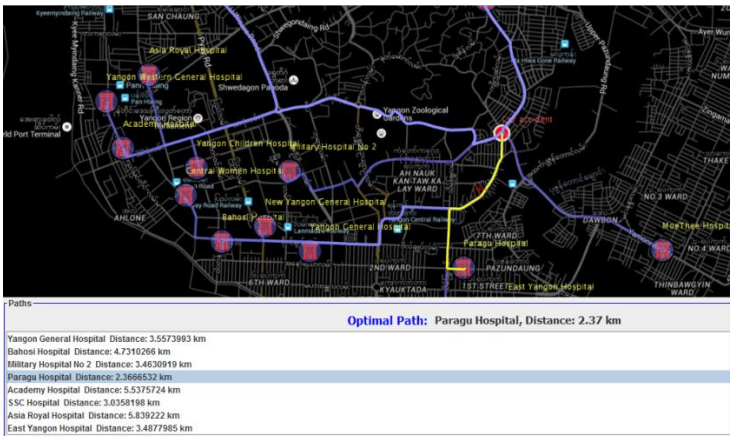

Figure 8 Optimum Route from the Accident Point to the Nearest Hospital and other Hospitals

Identified the Desired Hospital

Ifwant to go to desired hospital**,** the system allows to choose the desired hospital and shows the optimal path between accident point and this hospital.

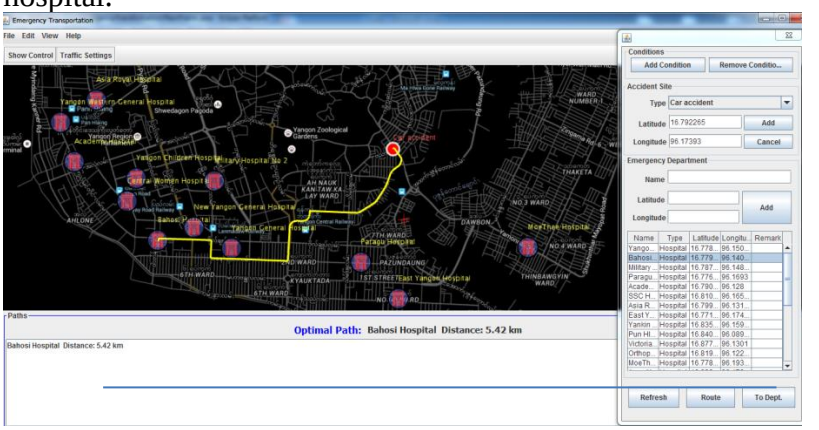

Figure 9Optimum Route from the Accident Point to the Desired Hospital

6.2Optimal Path Routing on Dynamic Road Network

The original path is changed when the road is congested during emergency vehicle travel to destination. For solving this dynamic problem, the algorithm recalculates the shortest path for the new optimal path.

Addition of Real Time Block Road Segment on the Selected Path

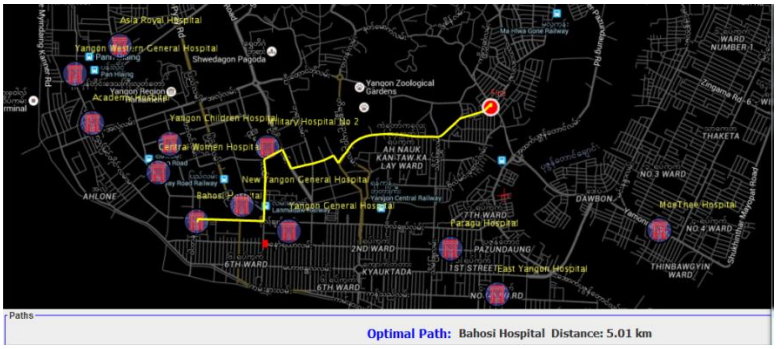

Figure 10 New Optimum Route When Adding Block on the Selected Path

If the road is congested on the selected path, the system allows by adding real time block road segment to selected path.

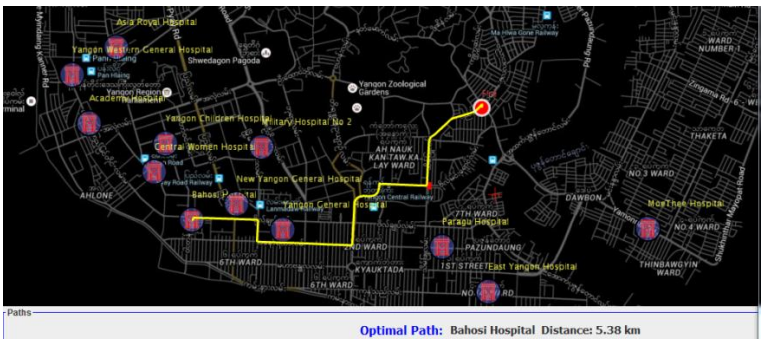

Figure 11New Optimum Route When Adding Block on the Selected Path

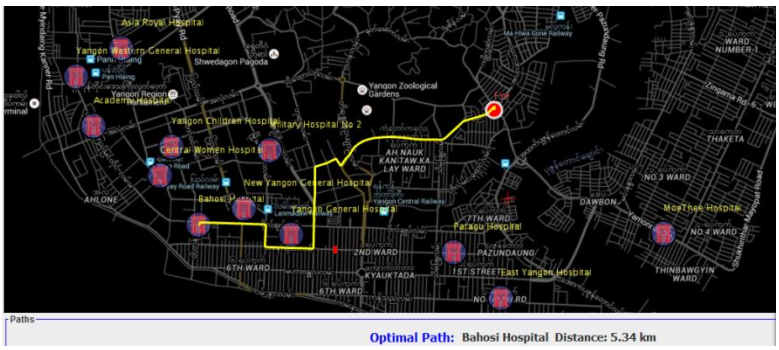

Figure 12New Optimum Route When Adding Block on the Selected Path

Algorithm finds the other optimum route avoiding that congested road and shows the new optimum route. In figure 10, 11 and 12 shows real time blocked on the selected route and shows the new optimal route.

7. Result and Discussion

The accident point is located in the corner of Banyardala Road and Set Yone Road in Tamwe Township. This location is latitude 16.810747 and longitude 96.142815. The emergency vehicle can travel from the accident point to the exposed hospitals.

Results of the Optimum Route of the Same Accident Point and Different Hospitals

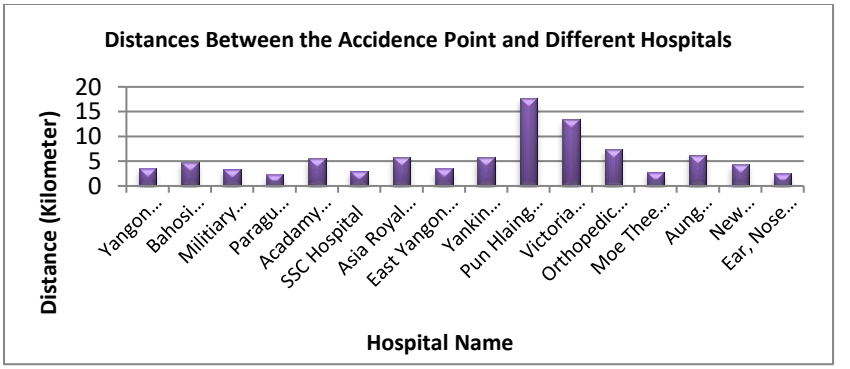

Figure 13Distances between Accident Point and Different Hospitals

Table 3 Distances of Routes Between the Same Accident Point and Different Hospitals

Sr No.	Accident Point	Route No.	Hospital Name	Distance (Kilometer)
1	Tamwe	1	Paragu Hospital	2.36665
2	Tamwe	2	Ear, Nose and Throad Hospital	2.46321
3	Tamwe	3	Moe Thee Hospital	2.83601
4	Tamwe	4	SSC Hospital	3.03581
5	Tamwe	5	Militiary Hospital No.2	3.46309
6	Tamwe	6	East Yangon General Hospital	3.48779
7	Tamwe	7	Yangon Central Hospital	3.55739
8	Tamwe	8	New Yangon General Hospital	4.31851

9	Tamwe	9	Bahosi Hospital	4.73102
10	Tamwe	10	Acadamy Hospital	5.53757
11	Tamwe	11	Yankin Children Hospital	5.73245
12	Tamwe	12	Asia Royal Hospital	5.83922
13	Tamwe	13	AungYadana Hospital	6.30003
14	Tamwe	14	Orthopedic Hospital	7.34969
15	Tamwe	15	Victoria Hospital	13.41333
16	Tamwe	16	Pun Hlaing Hospital	17.70637

According to the results, the nearest hospital is the Paragu Hospital and this route's distance is 2.36665 Kilometers. The road network condition is normal (static), the shortest route is the optimum route.

Results of the Optimum Route of the Same Accident Point and the Same Hospital

Table 4 showsthe result of the optimum route between the accident pointand the desired hospital (Bahosi Hospital). When adding the real time blocking on the current route, the result of the new optimum route shows avoiding this blocked road segment.

Table 4 Distances of Routes between the Same Accident Point and the Same Hospital

Sr No.	Accident Point	Route No.	Hospital Name	Distance (Kilometer)
1	Tamwe	1	Bahosi Hospital	5.01035
2	Tamwe	2	Bahosi Hospital	5.34451
3	Tamwe	3	Bahosi Hospital	5.38247
4	Tamwe	4	Bahosi Hospital	5.48349
5	Tamwe	5	Bahosi Hospital	5.42471
6	Tamwe	6	Bahosi Hospital	5.41683
7	Tamwe	7	Bahosi Hospital	5.28116
8	Tamwe	8	Bahosi Hospital	5.47265
9	Tamwe	9	Bahosi Hospital	5.49425
10	Tamwe	10	Bahosi Hospital	5.71329

In these results, the route 1 is shortest route between the accident point and Bahosi hospital among the other routes. The other routes are longer than the route 1, but these routes are optimum routes because the new route is the optimum route whenever the road condition is changed on the current route network.

8. Conclusion

The proposed system is exploring the optimum route for emergency vehicle by analyzing road network of Yangon City. In Yangon City, the vehicles are increasing daily, at the same time the congestions are caused on road networks. During taking a patient to the hospital, these problems are faced by the emergency vehicles. Emergency VehicleTransportation System (EVTS) is designed to the analysis of the road network of Yangon city by using Dijkstra's dynamic shortest path algorithm effectively.

EVTS provides the optimum route to the nearest hospital, desired hospital and other hospitals from the accident point. When road condition has changed with time more frequently, the system can find many optimum routes between the accident point and destination hospital. Therefore, EVTS is an efficient and interactive system for network analysis of optimal path routing on both static and dynamic road network.As a future work, EVTS will consider the multi parameters such as time taken to travel from the source to destination, real time road condition of blocked or unblocked junction, etc.

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