

# Optimal Route Planning in Yangon Transportation Network

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## Abstract

*In recent year, the transportation networks are becoming more and more complex and navigation services are increasingly necessary for the people living in the modern society. One of the requirements in the cities of Myanmar is to fulfill the effective transportation and navigation service not only for the local people but also for the foreigner who are not familiar with Transportation System in Myanmar. In this proposed system, optimal path will be recommended for the person who will ride the bus from its location to nearest bus stop and suggest the shortest path to the destination bus stop. Modified Dijkstra Algorithm will be used to calculate the optimal path by creating the graph database for the Yangon transportation network on the mobile device.*

**Keywords:** *Dijkstra, Graph Database, Public Transportation Network, Bus Stops*

## 1. Introduction

Most of the citizens in Yangon area make use of public transportation type such as bus, taxi, train, planes and so on. Most of the people in Yangon are mainly depend on the public transportation bus line especially in Yangon region and there are nearly 2000 bus stops in Yangon downtown area. The effects of the traffic of urban area are the pollution in every aspect such as air, sound, the time wasting on the road and also hydrocarbon fuel. Even though the number of the roads is increasing, the traffic problem is still occurring in most of urban area. This system reports for providing bus information to passenger and commuter to encourage people to use public transportation systems. Providing

transfer information is another effective measure for promoting the public transportation system.

When planning the optimal path in the Yangon transportation network, lack of high quality dataset and lack of effective modeling are two common problems. Most of the geospatial industry has never before had no attention to it. The problem of the transportation network are identified and solved by various kind of method. Public transportation service is not very easy not only in Yangon, but also for the whole country Myanmar. The optimal path plannin is aimed to become open, more transparent access to geographic knowledge and increasing the value of the GIS professionals responsible for contributing the people in Yangon. Nowadays, the broad issue such as integration and access in the field of GIS is to assist the specialist in many fields ranging from Government Agency, academia and business organization. By integrating the GIS knowledge with the other fields and making accessible to the public or private organization in order to perform geocentric application, it can also support the mission critical applications that lead to more complex issue and more holistic decision making Sharing geographic knowledge in the Geo environment is also changing how we organize and communicate between different agencies and organizations. The Geo revolution will go far beyond simple visualization and mapping, embracing all types of knowledge and ultimately becoming a societal infrastructure for human behavior and human action. The system design including data collection work flow, system feature and data model will be seen in session 2 and the proposed system will be focused in session 3 and the theory will be focused in session 4 and the conclusion and future work will be discussed in session 5.

## 2. Related Works

Developing a spatial decision support system (SDSS) for emergency vehicle routing is based on integration of geospatial information system (GIS) and real time traffic condition. In this system, travel time which can vary over time is the problem in determining the shortest path for emergency routing. In order to solve the problem, GIS in emergency routing offers the efficient capability for network analysis, visualization.[1] The Fuzzy Inference Systems and conventional Geographic Information Systems on the shortest path problem is considered by studying on the graph theory and optimization areas. Each street segment is represented by an arc and each intersection by a dot. The fuzzy inference in GIS is used by implementing the fuzzy path planning inside an urban network. For performing data acquisition, fuzzy inference and GIS database updating in real time, a computational tool was developed. GIS module reads the input data from the online traffic monitoring system and then it generates the attributes via a fuzzy inference system. After getting input, it performs updates to the GIS database in real time and plans the fuzzy path in real time.[2] An Urban Traffic Information Portal based on WebGIS. An urban traffic information portal for dynamic information is developed for updating and responding, which is based on the fast growing rich internet application and WebGIS technology. In this regard, large population and heavy traffic load make traffic control hard but necessary and important. So, dynamic information publishing and enquiring becomes the main problem in traffic information service system. [11]

## 3. Optimal Route Planning Approach

### 3.1 Optimal Path Planning

When it comes to the optimal route planning, where the user stands near the bus stop become the source and where the user wants to go become the destination. There are over 2000 bus stops and 300 bus lines in the Yangon area. The optimal path planning system searches for the optimal route between the source and

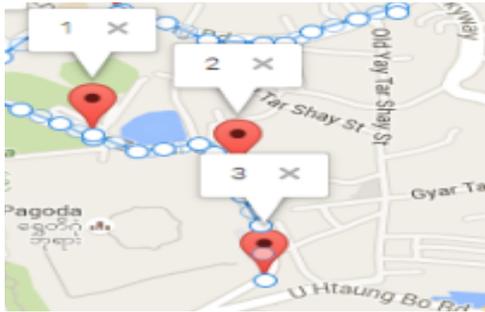
destination. In the public transportation network, the problems that will face for implementing the optimal route planning service have two aspects. The first one is the lack of a high-quality dataset and the other is the lack of effective modeling and optimal route planning approach. The problem that is usually found in finding the shortest path in the geospatial information system is generally categorized into three: time, distance and cost problems. The problem to be solved in this paper is the optimal path problem which is one of the problems for finding the path relating to distance as a cost. The cost of distance between bus stops will be focused due to the difficulties of getting data for time cost.

### 3.2 Representation of Road Network

A road network can be considered as a graph with positive weights. The nodes represent road junctions and each edge of the graph is associated with a road segment between two junctions. The weight of an edge may correspond to the length of the associated road segment, the time needed to traverse the segment or the cost of traversing the segment. Using directed edges it is also possible to model one-way streets. Such graphs are special in the sense that some edges are more important than others for long distance travel (e.g. highways).[4]

Public transportation network does not exist in practice. It's only the correlation record of point entity coordinates of bus stops data, bus links and bus lines. Then generate route network information, which records the topological relations of bus stops and routes. Therefore, it is stored in network element structure. Actually, the bus routes are overlapped by the road centerline. Therefore, in order to clearly display the uplink and downlink lines, migration processing has been done. In the process of line generation, the platform is mapped to the centerline sequentially. Then seeks the shortest path of the adjacent sites, connects the generated sites and then gets the route. [4]

Particularly consider that the network of the normal transportation is  $H=(V,E)$  in which  $V$  is the set of nodes and  $E$  is the set of links between the node. In the public transportation system, the set of nodes  $V$  is denoted by the  $\{v_n\}$  for  $n=1,2,3,\dots,N$  and a set of link is denoted by  $\{e_l\}$  for  $l=1,2,3,\dots,N$ . The following figure (1) represents the representation of the bus stop and the link between them.



**Figure(1) : Representation of Bus Stop and Links between them**

According to the figure (1), it portrays the bus stop and the link between them. The set of bus stop ' $V$ ' denoted by the  $\{v_n\}$  for  $n=1,2,3,\dots,N$  represent the number of node in the optimal route searching system and the set of link ' $E$ ' denoted by  $\{e_l\}$  for  $l=1,2,3,\dots,N$  represents the links between the bus stop.

### 3.3 Spherical Law of Cosines

Spherical law of cosine will be used in order to estimation of the distance between bus stop because it is very suitable in order to measure distance on earth surface.

$$d = \cos(\sin\phi_1 \cdot \sin\phi_2 + \cos\phi_1 \cdot \cos\phi_2 \cdot \cos \Delta\lambda) \cdot R$$

In the formula,  $\phi_1, \phi_2$  represent latitude, and  $\Delta\lambda = (\text{lon}_2 - \text{lon}_1)$  displays the longitude,  $R$  illustrate the earth's radius which means 6,371km of the earth radius.

The simple spherical law of cosines formula ( $\cos c = \cos a \cos b + \sin a \sin b \cos C$ ) gives well-conditioned results down to distances as small as a few metres on the earth's surface.

### 3.4 Requirement of the Optimal Route Planning Approach

The following requirement are needed to fulfill the optimal path searching system between the source and the destination. Firstly, the public transportation network need to built in advance as for the crucial requirement for the optimal route planning approach. Secondly, the implementation of optimal route planning for Yangon transportation network are require by basing on the theory existing for public transportation. As for the third requirement, the map operation are crucially important for the convenient of the user and the integration between the optimal path planning and the map operation are required. Finally, after finding the optimal shortest bus route in Yangon, the optimal path planning system will support the bus traveler by showing the optimal route in the map and by assisting the mobility of people by taking advantage of the transportation infrastructure.

## 4. Proposed System

### 4.1 Main Step of the Proposed System

The main step and the nature of the optimal route planning between the source and the destination are displayed in figure(5).

Step (1): Enter the source and the destination.

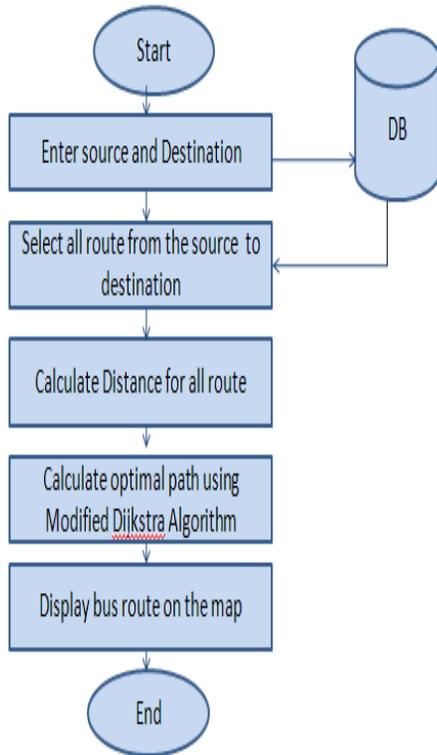
Step (2): Extract the possible from the source to the destination.

Step (3): Calculate distance for all route using the spherical law of Cosine.

Step(4): Calculate optimal path using modified Dijkstra Algorithm

Step(5): Display bus route on the map.

The illustration of system overview for optimal route planning between the source and the destination are displayed in figure(5).



**Figure (5) :Illustration of System Overview**

Before making any calculation, the graph database need to build in advance in order to calculate the path planning for the user including the implementation public transportation network, converting public transportation network to graph database.As for the first step, user current location and the desire destination location will put into the system. According to the figure (6), the demonstration of system overview can be seen. When the user would like to find the nearest bus stop according to the place(destination) that the user would like to visit, the system will suggest not only the nearest bus stop but also the optimal bus route including

the transit between them.The following figure(6) represents the demonstration of the system overview in which the system calculate the nearest bus stop basing on the the destination the user wants to go and then the optimal route searching system recommend the optimal path to the user by considering the transit between the bus stops.



**Figure(6): Demonstration of System Overview**

In other word , the system will calculate the nearest bus stop around the nearest area according to the user current location. Then, the nearest bus stop will be suggested to the user.

#### **4.2 Steps of the Optimal Route Planning Dijkstra Algorithm**

Step(1): Construct the public transportation bus network in the Yangon region by considering bus stops, transit and link between them.

Step(2): After constructing the bus transportation network, the starting bus stop which is nearest to the user location need to be labeled first .

Step(3): The next bus stop connecting to the first bus stop will need to consider and the least value (distance )of the bus stop will be chosen.

Step (4): All the bus stop connecting to the permanent labelled bus stop with their distance from the starting point need to be specified by labeling temporarily and chose the least value temporarily labeled bus stop.

Step(5): Repeat step 4 until the destination bus stop is reached

Step(6): Retrace shortest route backward through the public transportation network back to the starting source bus stop.

### 5. Database Design

The following table (1) represent the bus route data required for implementing the optimal route planning system.

**Table 1: Bus Route Table**

| i d | Route Id | Bus Route Link | Bus Id |
|-----|----------|----------------|--------|
| 1   | TR1      | 1-2-5-6        | B001   |
| 2   | TR2      | 2-4-6-7        | B002   |
| 3   | TR3      | 1-3-4-5-7      | B003   |

According to the bus route table, each and every bus line has a route which contains a specified number of bus stop. For row id one, the trip route TR1 contains four bus stop :bus stop 1, bus stop 2, bus stop 5 and bus stop 6 which was ran by the bus line namely B001. For example, north division 124 special (ywarma) bus line pass through a number of bus stop from Botahtaung Paya Bus Stop to Computer University Bus Stop in which it contain 75 bus stops in total. The following figure (2) portrays the northe division 124 special (Ywarma) bus line from Botahtaung bustop to Computer bus stop. The bus route of the North Division 124 Special (Ywarma) bus line include 72 bus stops in total. It pass through 11 townships in Yangon area.



**Figure(2) : North Division 124 Special (Ywarma) Bus Line**

The figure (2) illustrates the north division 124 special ywarma bus line which contains a number of bus stops. In other word, it include 75 bus stops in total which pass through 11 townships containing botahtaung township, pabedan township, latha township, lanmadaw township, alone township, kyeemindaing township, kamayut township, hlaing township, mayangone township, insein township and shwepyithar township. It has been a long trip and it takes nearly about two hours from the starting bus stop (Botahtaung bus stop) to final ( Computer bus stop) which pass through 75 bus stop within 11 townships. The following table (2) represents the information of the Bus Lines running in Yangon which contains nearly 300 bus line. The following table (2) shows the bus line in which the bus id and bus name are identified.

**Table(2) Bus Line Table**

| Bus Id | Bus Name                            |
|--------|-------------------------------------|
| B001   | North Division 124 Special (Ywarma) |
| B002   | 39 City Bus(Nga Moe Yeik)           |
| B003   | 39 City Bus(Taung Dagon)            |
| B004   | 40 Bus Green                        |
| B005   | 40 Bus Yellow                       |

The following table (3) represents the geocaching of the two bus stop and. the link between them with the spatial data. According to the bus graph table, it can save the geospatial data between the two bus stop so we can calculate the distance between them very efficiently.

**Table(3): Bus Graph Table**

| Id  | Start Bus Stop | End Bus Stop | Geodata     | Distance(km ) |
|-----|----------------|--------------|-------------|---------------|
| G 1 | 001            | 002          | Coordinat e | 200           |

|        |     |     |            |     |
|--------|-----|-----|------------|-----|
| G<br>2 | 005 | 097 | Coordinate | 234 |
| G<br>3 | 033 | 301 | Coordinate | 432 |
| G<br>4 | 223 | 234 | Coordinate | 224 |

The sample of the data from the Geo Data Column are as shown in the following figures. Bus stop (1) and (2) are connected by plotting the latitude and longitude between them in order to calculate the distance between them and the format of the data can be seen in the following figure(3) and (4) .

```
{ "busstop": [ "1-2" ], "coordinates": [[16.851041002406742,
96.1245346069336],[16.847755163496934,
96.12504959106445],[16.8428262981377,
96.12625122070312],[16.837404397983427,
96.1274528503418],[16.833296794489215,
96.12899780273438],[16.826888755136178,
96.13019943237305]], "distance_metres":
[2761.002718505373]}
```

**Figure(3) : Sample of Geo JSON Data in the Bus Graph Table**

After marking the bus stop and bus line, the geographic data for the public transportation bus line network is generated according to the following format in the JSON file.

```
{"BusStop": ["startId-endid"], "geoCoordinates":
[[latitude,longitude],*], "distance_metres":
[distancemetre in figure]}
```

**Figure(4) : Bus Line JSON Format**

By using the generated JSON file, the problem of measuring distances on earth can be solved because the nature of the road and street on the road network are not straight line. As for example, assuming that Euclidean distance formula are used for the distance between two points (two bus stops) will not come out the result correctly because these points are

connected with curve line(road) rather than straight line.

## 6. Experimental Result

The experimental results from Hlaingtharyar Township to North Dagon Township with different bus stops are portrayed in table (4). Due to the limitation of bus types and less running bus line from Thama Kone bus stop to 8 Thama bus stops make transfer five transit points as shown in table (4).

**Table (4) Experimental results of Transit Algorithm**

| Source to destination Bus Stops | Possible point in real area | Transfer point by Transit Algorithm | Reduce unnecessary point |
|---------------------------------|-----------------------------|-------------------------------------|--------------------------|
| Computer/Saung2                 | 23                          | Direct way                          | 96%                      |
| Computer/Sule Pan Chan          | 60                          | Direct way                          | 98%                      |
| Computer/8mile                  | 35                          | Two transfer point                  | 94%                      |
| Aungmingalar highway/108taung   | 39                          | Three Transfer point                | 92%                      |
| Mayni/Hledan                    | 22                          | Two Transfer Point                  | 95%                      |
| Thit saing kwae/Computer        | 64                          | Five transfer point                 | 92%                      |

Only the Special Bus and Big Bus type apply for bus transportation in this system. If all of the currently running bus lines apply to this system, the performance of the transit algorithm is more efficient and can give more useful detail information.

## 7. Conclusion

In this paper, the proposed system is tested on Yangon down town region, road network. Collect the bus routes information, bus stops, road name and their related geographical information data such as latitude/longitude and position in Yangon downtown area are collected from Google earth and use GPS GARMIN etrex-10 device.

Yangon down town region is limited from left latitude 17°03' 56.63" N to right longitude 96°19' 04.15"E. These collecting data are stored in spatial database which will use to develop the modified Dijkstra algorithm of graph theory to calculate the shortest route. The system will be able to show the data to the user to select the optimal route and bus number with information of public bus transport for downtown region in Yangon.

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