

Trip Planning System based on GIS (Case: ChanAyeTharZan Township)

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Abstract

GIS (Geographical Information System) maps are interactive. GIS gives the longitude and latitude of location points and attributes information from the using map. The travelers and tourists can know where the position they reach is by looking at the latitude and longitude of the location. Trip planning using GIS consists of a user selecting an origin and destination. It is intended to use by the user can retrieve the information by pointing to the desired location from the highlight map. This paper presents the output both textually and graphically, giving the user specific directions to get to their destination. This system is constructed for knowing the trip information of ChanAyeTharZan Township, Mandalay, and this information is stored in Relational Database. The administrator uses to add new information and to edit existing information. User retrieves the trip information by pointing and clicking the desired location from the map.

Keywords: Geographical Information System (GIS), Trip Planner, Latitude, Longitude, Spatial Database.

1. Introduction

GIS is a system of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling and display of spatially-referenced data for solving complex planning and management problems [13].

Trip planning system plays an important role for many travelers who depend on trip information. Trip information can give how many transfers along trip and the best route, and can know the place that they reach now, how to go to their destination and location's latitude and longitude. Trip planning system based on GIS (Geographical Information System) is more easily to use for many travelers because they can choose their original place and their destination place by doing click and point on the map even though they do not know the address.

ChanAyeTharZan Township is the downtown area of Mandalay, Myanmar. It is the main business zone of the city. So, many travelers and tourists visiting the city observe the many places within this township. When they are observing, they desire to know the trip information. If they haven't the trip information, they can't know how to travel, what transfer can use and

how many distances. As a result, it can waste time, money and energy.

To avoid such problems, travelers and tourists can use trip planning information system based on GIS. Now a day, GIS is a popular system in providing real world geographical information. GIS can apply for many areas such as transit, financial service, medical, disaster, forestry, etc. GIS also can provide coordinate system (latitude and longitude) of a location. Any locations on the earth have their own latitude and longitude. The travelers and tourists can know where the position they reach is by looking at the latitude and longitude of the location. So latitude and longitude of the location is very useful for travelers and tourists.

In trip planning system based on GIS, user can see the nearest marked places of the location that they are reaching. It is the best for trip planning system if the system can give the best route that reducing the walking distance and needing fewer transfers between the origin and destination. Moreover, it is also the best if the system can give the accurate and reliability of trip information. The accuracy and reliability of trip information is the most need of user.

This paper is intent to help the travelers and tourists for ChanAyeTharZan Township, Mandalay. In this paper, the user can choose their origin and destination location by text-based or map-based. In text-based, the user must enter the address into text fields and then the user will see that how to travel and how many transfers along their route. In map-based, the user must point and click their origin and destination on the map and then the user see the route, transfers and nearest marked place. Map-based can provide the user who unknown the exactly address. Moreover, the user sees the latitude and longitude of their origin and destination location.

Now a day, computers are the most familiar with human beings. Many users can use easily this system. As advantages the user can easily to use this system and can choose their origin and destination location on the map even though they cannot know exact their addresses. The user can know the location where they are reaching of the world by looking at the latitude and longitude of their location. The user also can choose right transfer and can know how many distance from origin to destination.

1.1 Objectives

Objectives of this system are:

- ❖ To use and understand the GIS for trip planning.

- ❖ To calculate latitude and longitude.
- ❖ To give information and location point of the relevant location of user desire.
- ❖ To recommend and retrieve information the user how much distance from origin point to destination point.
- ❖ To give the available trip.
- ❖ To represent the graphic entities of map's information along with relevant attributes store in the spatial database.

Next section, we describe the related works for this system. We also explain about the functions of trip planner: text-based and map-based trip planners. And then we calculate the latitude and longitude of ChanAyeTharZan Township. We explain about the system flow diagram. Finally we conclude with limitation and further extension.

2. Related Works

Trip planners can also provide a large amount of information to developers and planners related to the origins, destinations, and timing of trips, and on the use of the trip planner software. People using map-based trip planners employ a mixture of methods when determining their origins and destinations, including clicking on the map, entering a landmark or intersection, or any combination of those for both the origin and destination. The authors also demonstrate that users often plan more than one trip during their visit to the transit website. These are important considerations when developing an on-line trip planner [6].

Many times the input and output of the trip planner is a text-based interface. The user enters his/her address at the origin and destination and time requirements including day of travel in text fields. These time inputs can include the time at the origin or the time at the destination [2]. The information is sent to the web server, which sends it to a routing algorithm. The completed itinerary is returned to the web server and back to the browser. This has been the state-of-the-practice of on-line transit itinerary planners since their evolution from call centers [4].

Some problems are associated with text-based trip planners. One major problem is that, many times, the user either does not know the exact address of both the origin and the destination or the user does not enter the address correctly. Another problem is that sketch maps often do not provide enough detail or scale to be useful when attempting to plan a trip. A solution to this problem is to allow users to pick their origins and destinations from pull-down menus and provide interactive maps during the itinerary- planning process. This is reinforced by a large literature on human-computer interface design [1, 3, 5].

3. Geographic Information System

Geographic Information System (GIS) is defined as an information system that is used to input, store,

retrieve, manipulate, analyze and output geographically referenced data or geospatial data, in order to support decision making for planning and management of land use, natural resources, environment, transportation, urban facilities, health services and so on. GIS is a set of tools that allow for the processing of spatial data into information. This set of tools is open ended, but will include data input, data storage, data manipulation, and a reporting system [7].

The functions of GIS are data input, data storage and retrieval, manipulation and analysis, and data output [10].

3.1 Data Input

Data used in GIS come from many sources. It allows the user to capture, collect, and transform spatial and thematic data into digital form. The data inputs are usually derived from a combination of hard copy maps, aerial photographs, remotely sensed images, reports, survey documents, etc [10].

3.2 Data Storage and Retrieval

It organizes the spatial data and attributes data in a form which permits it to be quickly retrieved by the user for analysis, and permits rapid and accurate updates to be made to the database. This component usually involves use of a database management system (DBMS) for maintaining attribute data. Spatial data is usually encoded and maintained in a proprietary file format [10].

3.3 Data Manipulation and Analysis

It allows the user to define and execute spatial and attribute procedures to generate derived information. It is commonly thought of as the heart of a GIS, and usually distinguishes it from other database information systems and computer-aided drafting (CAD) systems [10].

3.4 Data Output

It allows the user to generate graphic displays, normally maps, and tabular reports representing derived information products [10].

4. Data Models and Data Layers

A GIS Database is a representation or model of the world and used to support many applications. A GIS database is used to extract specific information about objects and organize them in a way that is very useful.

4.1 Organizing GIS Database

- ❖ Group feature classes and types.

- ❖ Identify distinct layers.
- ❖ Identify relationships within and across layers.
- ❖ Group layers into data sets and databases [8].

The spatial data required for this system are predefined label types that associated with database files. The predefined label types are streets, bus stops, public trails, schools, shopping malls, hospitals, pagodas, markets, monasteries. In the Database, it contains Label Types, Labels that refer to the marked places and X, Y coordinate's values of the locations. Figure1 is showed the predefined label types for this system.

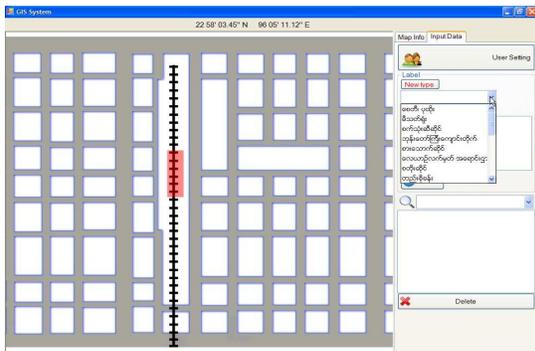


Figure1. Predefined Label Types

4.2 Geographic Data

The two important components of geographic data are spatial data and attribute data. The spatial data, also called geographic position, describes the features that have the known locations on the earth. To specify the position in an absolute way a coordinate system is used. The attribute data, also called non-spatial data, are the information that link to the geographic features for describing the spatial data.

4.3 Raster and Vector Data

All spatial data models are approaches for storing the spatial location of geographic features in a database. Locations are represented in a database as raster or vector positions. A raster based system displays locates and stores graphical data by using a matrix or grid of cells. A unique reference coordinate represents each pixel, which has attribute data assigned to it [9]. A raster is a tessellation of a surface. A tessellation is defined as the process to cover a surface through the repeated use of a single shape. Raster data resolution is dependent on the pixel or grid size and may vary from sub-meter to many kilometers. Generally, raster data requires less processing than vector data, but it consumes more computer storage space. Remote sensors on satellites store data in raster format. A raster can use any reasonable geometric shape, as long as it can be connected in such way as to create a continuous surface [7].

A vector based system displays graphical data as points, lines or curves, or areas with attributes. The coordinates of vector based GIS can be in real world longitude-latitude or any given coordinate system (rectangular coordinate system) [9]. Vector storage implies the use of vectors to represent a geographic feature. Vector data is characterized by the use of sequential points or vertices to define a linear segment. Each vertex consists of an X coordinate and a Y coordinate [10]. Vector data represent geographic space that is intuitive and reminiscent of analog maps [7].

In this system, we use the two data models. Raster is used for displaying marked places and vector is used for displaying roads, rivers and blocks.

4.4 Organizing the Data Layers

Data Layers are the result of combining spatial and attribute data. Essentially, adding the attribute database to the spatial location. A layer type refers to the way spatial and attributes information are connected. Layers are functionally related map features. Two most common considerations for organizing data layers are feature types (point, line, or polygon) and feature themes (what the feature represents). Data layers are commonly defined based on the needs of the user and the availability of data [7].

In this system, four layers are divided. They are blocks, roads, rivers and marked places. Figure2 shows how to organizing the data layers for this system.

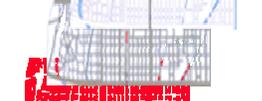
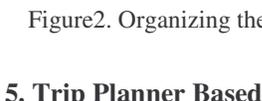
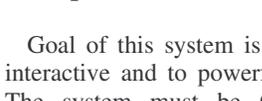
| | <u>Feature</u> | <u>File Type</u> |
|--|----------------|------------------|
|  | Point | Marked places |
|  | Region | Rivers |
|  | Line | Roads |
|  | Polygon | Blocks |
|  | Elevation | Tin |

Figure2. Organizing the Data Layers

5. Trip Planner Based on GIS

Goal of this system is to provide the user with an interactive and to powerful trip planning application. The system must be GIS map-based to provide interactivity and easy to use powerful GIS functions to perform the analysis.

Transit trip planning is a complicated activity. It involves finding information on the traveler's origin and destination. A transit user gives their origin and destination and then the representative will give the user an itinerary. Determine the optimum path based on the fastest itinerary, the itinerary involving the

fewest transfers, the cheapest itinerary, or the itinerary involving the least amount of walking [12].

5.1 The Functions of Trip Planners

The itinerary calculation process includes:

- ❖ origin, destination, and circumstance specification
- ❖ access and egress calculation
- ❖ path calculation

The important of trip planner is trip-planning options should include the minimum amount of transfers, and the least amount of walking. The output of the trip planner generally includes several of the following features: detailed directions, a route map link, distance, ride information [12].

5.2 Text-Based Trip Planner

In text-based trip planner, the input and output of the trip planner is a text-based interface. As input, the user must enter their address of the origin and the destination in text fields. The information will send to the routing. Then, the user will see how many transfers between origin and destination as output.

5.3 Map-Based Trip Planner

Interactive GIS map-based trip planners are provide user with an interactive map that provides search capabilities. The two initial steps are required to complete a successful map based trip calculation.

- ❖ to locate an origin and destination on a GIS map using address geo-coding.
- ❖ to identify the nearest transit stations to the origin and destination location [12]

In map-based trip planner, a spatial analysis finds all nearest marked places within a walking distance. The user can views the map and determines their origins and destination. As input, the user must be point and click on the map for their desire origin point and destination point. As output, the user can see available route on the map, nearest marked places and, latitude and longitude of area.

5.4 k-Shortest Path Algorithm

The k shortest paths problem is to list the k paths connecting a given source-destination pair in the digraph with minimum total length. It is a natural and long-studied generalization of the shortest path problem, in which not one but several paths in increasing order of length are sought. Given a directed graph G with nonnegative edge weights, a positive integer k, and two vertices s and t, the problem asks for the k shortest paths from s to t in increasing order of length. We require that the paths be simple (loop free). The k shortest paths problem in which paths are not required to be simple turns out to be significantly easier [11]. k-Shortest Path algorithm is used for path calculation in this system.

Algorithm: K-Shortest Path Algorithm

- ❖ Initialize the path branching structure T to contain a single node s, and put path(s; t) in the heap. There is one equivalence class C(s) initially, which corresponds to all the s-t paths.
- ❖ Repeat the following steps k times.
 1. Extract the minimum key from the heap. The key corresponds to some path P.
 2. If P belongs to an equivalence class C(u) for some node u then
 - a) Add a new branch (u; tP) to T that represents the suffix of P after u.
 - b) Remove from C(u) the paths that share at least one edge with P after u and put all of them except P into the newly created equivalence class C(u; tP).
 3. Else (P belongs to the equivalence class C(u; v) for some branch (u; v))
 - a) Let w be the vertex where P branches off from branchPath(u; v).
 - b) Insert a new node labeled w, and split the branch (u; v) into two new branches (u;w) and (w; v). Add a second branch (w; tP) that represents the suffix of P after w.
 - c) Redistribute the paths of C(u; v) n P among the four new equivalence classes C(u;w), C(w; v), C(w; tP), and C(w), depending on where they branch from branchPath(u; v) and/or P.
 - i. Paths branching off branchPath(u; v) before node w belong to C(u;w).
 - ii. Paths branching off branchPath(w; v) after node w belong to C(w; v).
 - iii. Paths branching off P after node w belong to C(w; tP).
 - iv. Paths branching off both P and branchPath(u; v) at node w belong to C(w).
 4. For each new or changed equivalence class (at most four), compute the shortest path from s to t that belongs to the class. Insert these paths into the heap [11].

5.5 Latitude and Longitude

Latitude and Longitude are spherical coordinates on the surface of the earth. Latitude is measured North or South of the Equator, resulting in a range of -90 (S pole) to +90 (N pole) degrees. Longitude is measured East or West of Greenwich, and can be expressed in different ways.

Diflat=endlatitude-startlatitude
 Diflong=endlongitude-startlongitude
 Lat=(diflat*(map resolution(H)-y)/H)+startlatitude
 Long=(x*DifLong/mapresolution(W))+ startlongitude

To receive the following information, this system uses the above equations. ChanAyeTharZan Township is located between $21^{\circ} 58' 0''N$ and $21^{\circ} 55' 14''N$ (North latitude), and between $96^{\circ} 5' 0''E$ and $96^{\circ} 6' 12''E$ (East longitude). Scale kilometer of ChanAyetharZan Township is 5.127km for West to East and 2.07km for South to North. According to these input data the system calculate the latitude and longitude between two points for computerized system.

6. System Design

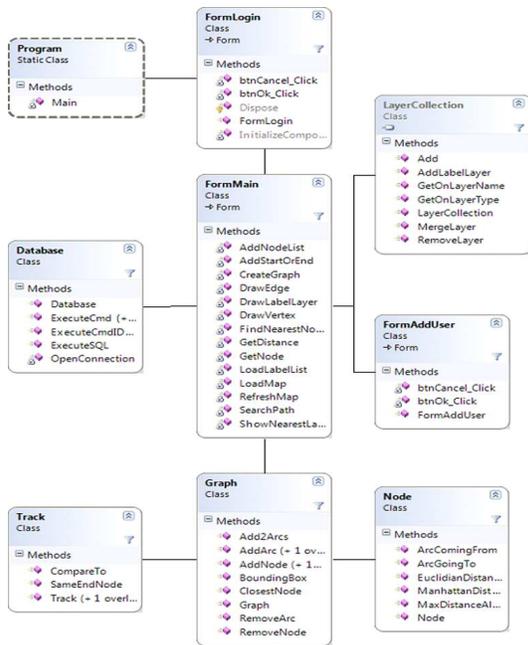


Figure3. Class Diagram of the System

In Figure 3, FormLogin class is used for checking the user or administrator and password to enter the system. FormMain class provides the main system that contains the streets and places, calculation for trip information and, latitude and longitude of the location. Database class is used for data retrieval and query from the database and to store the data into the database. LayerCollection class is used for administrator to adding the new labels and the new label types and deleting the existing labels. FormAddUser class is used for adding the new user and choosing their rights such as admin or user. Track class is used for calculating the route by using the k-Shortest path algorithm. Graph class is used for searching the nearest marked places of origin and destination locations. Node is used for the information of the arcs such as latitude and longitude of the locations.

Figure 4 provides two types of actors: Administrator and User. The administrator must login to edit and update new data for this GIS map. The user can search the trip information from the GIS system by choosing the source and destination location from text-based or

map-based. And then, calculate route information and latitude and longitude of the locations. Finally, the user knows the distance of the trip, how to go and the marked places from the source and destination places.

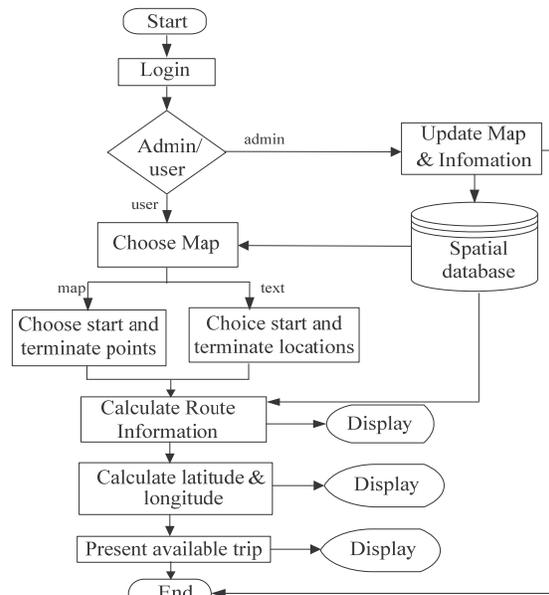


Figure4. System Flow Diagram

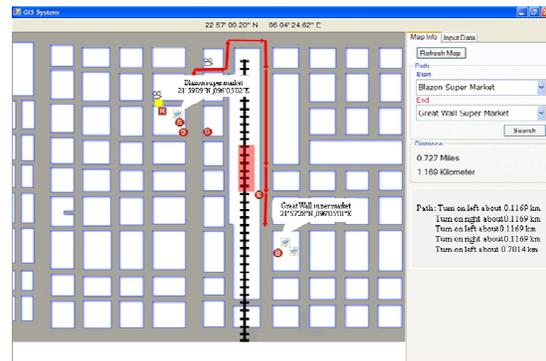


Figure5. Trip Planner between Blazon Super Market and Great Wall Super Market By Text-Based

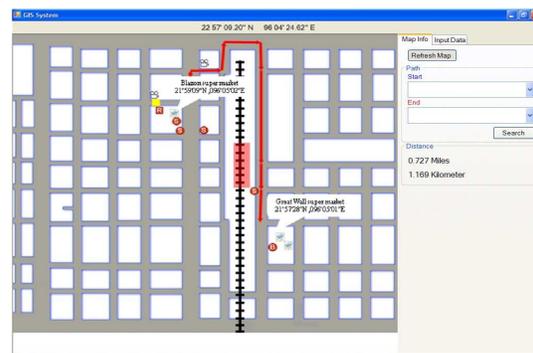


Figure6. Trip Planner between Blazon Super Market and Great Wall Super Market By Map-Based

Figure 5 describes a Trip Planner between Blazon Super Market and Great Wall Super Market by text-based. Figure 6 describes a Trip Planner between Blazon Super Market and Great Wall Super Market by map-based. By pointing the mouse on the map, the user can now street's numbers, latitude and longitude of any locations, river's names and name of marked places.

The origin location is Blazon Super Market and the destination location is Great Wall Super Market. The latitude and longitude are 21°59'09"N, 96°05'02"E and 21°57'28"N, 96°05'01"E. The distance between these locations is 0.727miles or 1.169 kilometers. The distances are calculated based on Mandalay units, pja that called by Mandalay citizens. In that unit, unit of distance measure based on distance between two adjacent turrets on the palace walls (approximately one furlong). In this system, pja changed as kilometer and mile to know any user. One pja has 0.1169 kilometers. Figure 7 shows the detailed distance information between Blazon Super Market and Great Wall Super Market.

| Movement | Distance (pja) | Distance (kilometer) |
|---------------|----------------|----------------------|
| Turn on Left | 1 | 0.1169 |
| Turn on Right | 1 | 0.1169 |
| Turn on Left | 1 | 0.1169 |
| Turn on Right | 1 | 0.1169 |
| Turn on Left | 6 | 0.7014 |

Figure7. Detailed Distance Information between Blazon Super Market and Great Wall Super Market

7. Conclusion

This system is constructed to retrieve information of the trip based on GIS. The user can know trip information of the ChanAyeTharZan Township and the particular information effectively. GIS is developed to help the users to look for location effectively. GIS software can be easily updated and the users can easily access the application. In this system, standard query language is used for data integration and retrieving. In this system, trip information from the map can be retrieved easily. The x, y coordinates system is used for the storage points, lines, and areas. The user can use the latitude and longitude to know the location where they are reaching. This system gives the trip plan for the user who wants to know about the trip information of ChanAyeTharZan Township, Mandalay. This paper is intended to develop geographic information system for trip planning system.

8. Limitation and Further Extension

This system is only use for ChanAyeTharZan Township and can be run only with .Net Framework 3.5 and Windows XP Service Pack 2. It can be extended to let more users into online system and can

be made available for other townships. Since the technology is based on .Net Framework, this can also be developed for distributing in any other software and hardware platforms.

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