

GIS Based Health Care Information System for Aurangabad City

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Abstract: Now a day there is tremendous increase in the use of GIS applications in various fields. Everyone wants easy access for their desired location's including all the necessary details of the location. But in terms of Health Care Centers in Aurangabad city the use of GIS application is limited. This study tries to solve the problem by creating a GIS-based information analyses and system so that patients can find out the information about necessary treatment in a hospital based on specialist services provided. The main objective of this study is to integrate information on the actual position of health centers in Aurangabad city with the services and facilities provided. In addition, this study demonstrated the function of the shortest path in network analysis for finding the nearest health care facilities from patient's location. The area selected for study is Aurangabad city. The base map of the study area is collected while the coordinates of the health care centers obtained in the field using Global Positioning System (GPS). These data incorporated into GIS environment and analyzed using ArcGIS 10.0 software.

Index Terms: Digitizing, Geographical Information System (GIS), Hospital Information System, Network Analysis

I. INTRODUCTION

A Geographical Information System (GIS) is a computer system for capturing, storing, querying, analyzing and displaying geospatial data. Geospatial data means the data which describes the location and characteristics of that location [1]. For improving the quality of any health care, it is necessary to represent it properly so that ordinary people can understand easily. This goal can be achieved by designing such a system that will help the patients to find the appropriate hospital according to their need and can avail the proper treatment provided by the hospital. In case of Aurangabad city it contains the various hospitals ranges from major multispecialty hospitals to small clinics.

Currently the location of each health care center in the Aurangabad city is based on addresses and the position of the health center. Without providing the information about the facilities provided by the hospitals, expertise available, various treatments carried out in the hospitals, along with the different departments present in case of multispecialty hospitals in a single system. This goal can be achieved with the help of GIS.

GIS provides the facility of combining spatial data and associated attribute data in a single system. With the help of GIS applications the actual position of the health center can be mapped accurately based upon the coordinates taken. The associated information, such as

name, facilities, addresses, phone number, can give more additional information in the combination of spatial location. This information can also be useful in network analysis such as measuring the distance and calculating the shortest path from user location [2].

The GIS has been used in several areas such as retail site analysis, transportation [3], emergency services, fire, petrol station mapping, and health care planning for the measurement of physical accessibility [4][5].

Spatial database management, visualization and mapping and network analysis are the important function of geographic information system. Database management offers the flexibility of linking, integrating and editing much kind of data collected from variety of disparate sources from different databases. Visualization & mapping can explore the spatial pattern and placing the object accurately [6]. Network analysis is useful in performing network related problems such as calculating the shortest path and finding the closest facility.

This study shows how GPS and ArcGIS software can be combined to locate hospitals and other infrastructure in a city.

II. LITERATURE SURVEY

Hospitals are complex organizations with intensive information needs. Effective management of information within hospitals is crucial for higher service effectiveness and efficiency levels. HIS is a necessary component of modern hospital infrastructure. Hospital Information System (HIS) is considered a prerequisite for the efficient delivery of high quality health care in hospitals [7]. The use of Information technology in hospital is necessary to improve the quality of the services provided and also to reduce the cost [8]. Hospitals are extremely complex institutions with large departments and units coordinate care for patients [9]. The health information system is widely spread and the integrated information system designed to store, manipulate, retrieve and use information related to administrative and clinical aspects of the hospital operation [10][11][12][13].

Office of Statewide Health Planning and Development (OSHPD), in California USA, established a powerful system for resource and facility management in 2002. The conceptual model was designed based upon result of need analysis. Classes, subclasses and available relations was defined in software. Collected data was entered and final system was created for their requirements [14].

In Karnataka, project was performed for dividing regions and specifying local health care responsible for

that region. This study was performed to solve the problem of imbalance between location of health center and population of region. The main aim was to fulfill the clients need and optimize the use of available health resource. The required data has been collected from PHC and SC institutes for all sections and regions. The final result of this project was a GIS application having the ability of spatial analysis such as region zoning and finding the location for new facility [15].

III. METHODOLOGY

The detailed methodology as shown in Fig.1 for carrying out the results is explained as follows.

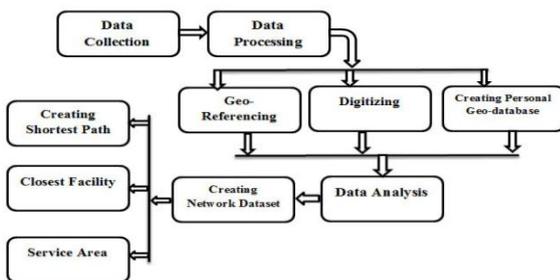


Fig. 1: Methodology for Proposed Work

A. Data collection

1. Study area

It is the first and important step towards the completion of the project. For this work Aurangabad city (19°52'59" N and 75°19'59" E) is considered as the study area which is situated in the Maharashtra State of India.

Toposheet of Aurangabad city as shown in Fig. 2 is obtained from the "Government office of Survey of India, Pune", having "Scale 1:50000" traced and scanned, which is considered as the base map for further work. For creation of map, the data collected must be in the form of spatial and attribute data. Spatial data can be obtained by digitizing the base map of city. The hospitals information can be obtained by visiting the desired hospital and taking the important information about the facilities provided number of beds and the specialty of hospitals etc. The attribute data like name of hospital, contact number specialty, site address etc., are need to be stored in the separate database.

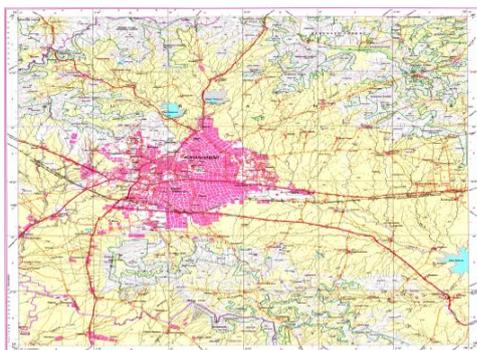


Fig. 2: Toposheet of Aurangabad city

2. Data Processing

In this step, the spatial data and the attribute data are merged together and form new GIS database. This information can be used in next step i.e. data analysis. Steps for data processing are as follows.

B. Geo-referencing

The geographic data which is available is not in the format that can be immediately integrated with other GIS data. For using this type of data, it is necessary to align it with existing geographically referenced data called geo-referencing. This is very crucial stage to obtain the high accuracy or precision in measurements. It can be also known as rectifying map.

Geo-referencing of base map is critical stage, because geo-referencing allows us to register the base map with respect to the earth's surface. Geo-referencing can be done by selecting the four control points on the corners of the scanned map and placing that point by giving appropriate latitude and longitude values and it is very important to perform this step with minimum RMS error in order to gain maximum accuracy.

The RMS (Root Mean Square) error can be calculated by using following equation (1).

$$\sqrt{(x_{act} - x_{est})^2 + (y_{act} - y_{est})^2} \quad (1)$$

Where x_{act} and y_{act} are the x and y value of the actual location, and x_{est} and y_{est} are the x and y values of the estimated locations [1].

RMS error determines the goodness of control points which measures the deviation between actual and estimated locations of control points.

1. Digitizing

Digitizing converts paper map features into digital format. The digitizing process creates spatial data. It allows the attribute data to be stored in together.

2. Shape file creation

This is the first step after geo-referencing. Select the folder in which you will create your new shape file, so select that folder and right-click on it. Go to New and select shapefile and give an appropriate name such as Hospital. Click on Edit to see the coordinate system of the file. In the Spatial Reference Properties window click Import to use the projection of the Toposheet layer. Click OK and OK again to create the shape file [16].

Two separate shape files created. Point shape file used for storing hospital data and polyline for storing road network data.

3. Creating Personal Geo-database

It is the primary step for the data processing stage. Geo-database stores all the information about the projection of maps, spatial data and attributes data. After the creation of geo-database, the external/personal database is joined together by database connection.

C. Data Analysis

Data analysis deals with the creating network dataset and the shortest path.

1. Creating a network dataset

The creation of network dataset incorporates the model which shows multimodal network for transportation. Network datasets are collections of feature classes that possess a connectivity relationship. It is used for creating the shortest path using network analysis tool to find out the closest facility available from the location of user.

2. Shortest path Analysis

Shortest Path problems are important in Network analysis. Travelling is part of daily life of every people. As the traffic condition among a city changes from time to time and there are usually a huge amounts of requests occur at any moment, it needs to quickly find the solution [17].

Network analyst tool of ArcGIS uses Dijkstra's algorithm [18] to find the shortest path.

Dijkstra's Algorithm:

```

1 function Dijkstra(Graph, source):
2   dist[source] := 0 // Distance from source to source
3   for each vertex v in Graph: // Initializations
4     if v ≠ source
5       dist[v] := infinity // Unknown distance
6   previous[v] := undefined // Previous node in
  optimal path from source
7   end if
8   add v to Q // All nodes initially in Q
9   end for
10  while Q is not empty: // The main loop
11    u := vertex in Q with min dist[u] // Source node in first
  case
12    remove u from Q
13    for each neighbor v of u: // where v has not yet
  been removed from Q.
14      alt := dist[u] + length(u, v)
15      if alt < dist[v]: // A shorter path to v has been
  found
16        dist[v] := alt
17        previous[v] := u
18      end if
19    end for
20  end while
21  return dist[], previous[]
22 end function
  
```

3. Closest Facility Analysis

The closest facility solver displays the best routes between incidents and facilities. For finding the closest facility; we have to specify constraints, like a cutoff cost beyond which ArcGIS Network Analyst will not search for facilities. In this example, the hospitals are facilities, and the accident is the incident. ArcGIS Network Analyst

allows performing multiple closest facility analyses simultaneously. This means you can have multiple incidents and find the closest facility (or facilities) for each incident.

This uses a multiple-origin, multiple-destination algorithm based on Dijkstra's algorithm. Single-origin-to-single-destination route planning service provides travel route from one origin to one destination. In contrast, the single-origin-to-multiple-destinations[19] route planning service plans the routes from one origin to a final destination through one or multiple waypoints for multiple given source vertices (origin nodes) and one common destination vertex (destination node) in the graph. This algorithm finds a suitable rendezvous-point in which the total cost of paths from each given vertex via the rendezvous-point to the destination vertex is the approximate lowest.

4. Service area

A network Service area is a region which includes all the accessible streets within a particular area. The Service Area solver is also based on Dijkstra's algorithm. The main goal of service area is to return a subset of connected edge features such that they are within the specified network distance or cost cutoff; in addition, it can return the lines categorized by a set of break values that an edge may fall within. The service area solver can generate lines, polygons surrounding these lines, or both.

IV. EXPERIMENTAL WORK

A. Creation of Geo-database

Geo-database can be created by integrating the information of the hospitals with the coordinate (Latitude and Longitude) taken by using GPS. The information is collected for following details as shown in Table 1.

Table 1: Database Attributes for Geo-Database

Field Name	Data Type
FID	Object ID
Shape	Geometry
Name	Text
Type	Text
Facility	Text
Hours of Operation	Text
Closed On	Text
Address	Text
Contact No.	Text
Website	Text
E-mail	Text
Department	Text

After creation of geo-database, the final map is created by using the available information. The map created is in the form of “.mxd” which is Arcmap file. Further the map is converted into “.kmz” format using conversion tool of ArcGIS to open it into Google Earth.

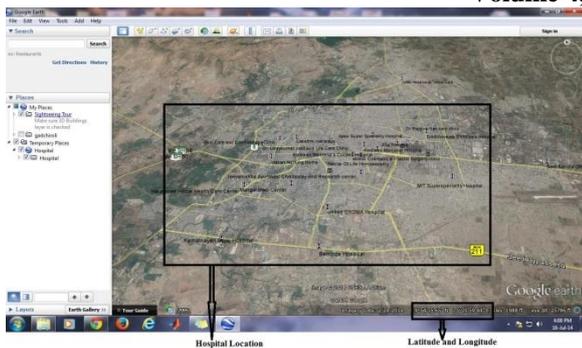


Fig. 3: Hospital Location

Fig. 3 shows the location of the hospitals corresponding to geo-database. Every time user clicks on any particular hospital, the information will appear on the screen regarding that hospital as shown in Fig. 4.

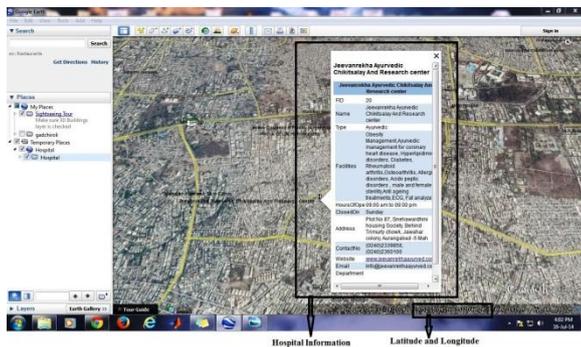


Fig. 4: Hospital Information

B. Shortest Path Analysis

Shortest path analysis is used for finding the minimum distance route from user location to particular hospital. It is accomplished by network analyst tool in ArcGIS. Source and destination location is to be selected by the user.

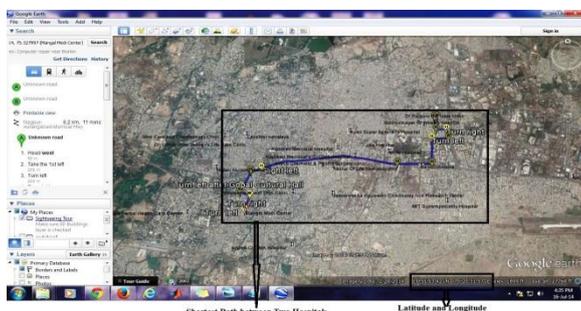


Fig. 5: Shortest Path Analysis between Two Hospitals

System will generate the shortest path between two locations by calculating the distance based on road length. This will help the user to reduce the traveling time to reach a particular hospital. Fig. 5 shows the shortest distance from MangalMedi Center, Usmanpura, and Aurangabad to Dr. Rajguru Hair Clinic, BajarangChouk, and Aurangabad.

V. CONCLUSION AND FUTURE WORK

Now a day the number of hospitals is increases as the population increases. It is observes that, finding the desired hospital needed for the desired patients is difficult task. The main objective of this study is to find the health care facility near from location of the user. It also calculates the shortest distance to be reached from user's location. The GIS application for health care facility can be used as a new technology for providing the information for the people. It can be beneficial not only to the user or patients but also to the organization.

As a future work, it can be possible to calculate the closest path from desired location to nearer hospital. It can also locate the service area around the hospitals to find the all available accessible streets for that hospital.

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