Visualisation of fire incidents using, 'Map Animation', in Arcview and development of Fire Emergency Management Information System for Central Pune

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Introduction:

Fire risks in urban areas have undoubtedly increased over the years and the rising cost of fire losses would seem to indicate that they are increasing at a greater rate than the measures devised to control them. Due to the rapid increase in population, industrialization, rapid rise in new colonies, construction of high rises etc the fire risk in the cities has tremendously increased.

Pune city is growing at a very fast rate, the city core, containing a major share of residential as well as commercial development, is marked by high densities, narrow roads, heavy traffic and paucity of open spaces.

The present study was aimed at achieving three objectives:

1) To develop a visualization technique (map animation) to analyze the nature of fire incidents by their type, their spatial distribution, their variation over time in Arcview using it's scripting language 'Avenue'.

2) To analyze the effectiveness of the existing fire station network in terms of their serve-ability or reach-ability for different response times (eg., 3, 5, 7, 9, 11 minutes) and find out the time required to serve the entire area assuming the average speed of the fire vehicle to be 30 km/hr.

3) Development of a Arcview customized interface which would improve the decision making of the fire brigade personnel especially with reference to routing with a easy to use interface.

Database generation:

i) Fire Stations Layer generated from commercially available map of Pune city at a scale of 1:5000.

ii) Hospitals Layer generated from the same commercially available map of Pune City.

iii) Past Fire Incidents Layer generated from data provided by the Central Fire Brigade, Pune Municipal Corporation. The data provided contained details of 1100 fire incidents dated from 25/08/2001 to 24/02/2002, out of which only 346 were inside the study area.

The address of the fire incidents provided by the Central Fire Brigade, Pune Municipal Corporation was the most detailed form of spatial reference available in the data. The addresses were not suitable for automatic geocoding; consequently a labour intensive manual process was conducted using a combination of the commercially available map, and other street atlases. The address field was removed from the database after plotting the fire incidents to help preserve confidentiality in the analysis phase of the study. Since some addresses could not be precisely located the number of incidents that were finally plotted was 235. These incidents were further used for analysis and visualization.

iv) Roads layer: The current study needed roads information at a very large scale and so the roads layer of the city was digitized from the commercially available map of Pune City at a scale of 1:5000. The map was scanned and geocoded with reference to SOI Toposheet no 47 J 14 and the roads were digitized and projected into Universal Transverse Mercator/Everest Projection. The Central Fire Brigade's report on a survey of the city roads provided information about the roads that are very narrow and thus inaccessible by the fire tender, these roads were excluded from the study.

The attributes of the Fire Stations viz., name of the Fire Station, no of personnel, name of the Station Officer, no of fire tenders etc. were collected. The attributes of the fire incidents included date, time, type (whether short circuit or gas leak) and complete address of the incident and was collected from the Central Fire Brigade, Pune Municipal Corporation.

The costs for traveling the roads were given on a scale of 1 to 10 based on a report of the study of traffic density conducted by the Traffic Control Branch, Pune Municipal Corporation, in which the roads were classified into 5 classes according to the traffic density viz., very high, high, moderate, low and very low traffic density.

The rights of ways for roads was incorporated into the roads layer by creating a turntable in Arcview through Avenue scripting as Arcview does not provide a means for the generation of a turntable for a network through it's GUI.

Map animation:

A map contains lot of information that can be used by different individuals and organizations. "*A map is the greatest of all epic poems. Its lines and colors show the realization of great dreams.*" Gilbert Grosvenor, Editor (1903-1954), National Geographic.

Map Animation is a visualization tool that goes beyond conventional static point mapping, avoiding potential large data loss when the time dimension of datasets is aggregated. The use of animation as a means of data presentation and visualization of information is increasing with the diffusion of 'multi media technology'. Map Animation techniques have been applied in the social geography arena to analyze crime incidents, epidemiology and urban growth. In the current study an attempt was made to visualize the fire incidents and their spatial and temporal patterns in the form of an animated map. It was hypothesized that patterns across space and time would be evident in the fire incident database. Arcview 3.2a was used to test this hypothesis.

Methodology:

1) Map animation

The fire incidents layer (point map), the roads layer and the river layer was used in the production of the animated map. This was achieved through Avenue Scripting. The basic algorithm adapted for generating map animation was as follows:

Step1) Obtain a suitable space-time dataset with sufficient events and detailed spatial and temporal co-ordinates,

Step2) Choose a suitable time interval for the animation,

Step3) Generate a map for each time interval,

Step4) Group the maps together in sequence to produce an animation; using a suitable animation software (the software used in this study was Animation Shop Pro version 3).

The technicalities of operationalising this algorithm are not difficult. In this study a simple Avenue script was written to generate the individual map frames for each time interval

that was provided in the script (a one hour time interval was chosen for the present study), saving them to small graphic files (exporting the view document to JPEG format) before feeding them to the animation software. The resulting map animation can be played back independently of its creation using a suitable animation player like windows media player, which is part of the standard windows installation. The algorithm was developed with some modifications from an earlier study done by Martin Dodge(1996).

2) Efficiency of existing fire station network:

The study area has 4 Fire Stations. For any Fire Station network to serve its service area effectively, they should be strategically placed in the city, so that they can serve their immediate service area in an appropriate minimum response time. Network Analysis using Arcview 3.2a was performed to assess the efficiency of the existing fire station network in terms of the minimum response time needed to serve the entire study area by the four Fire Stations. The speed of travel of the fire tender was assumed at an average of 30 km/hr and the service area for each Fire Station was calculated for different minimum response times viz.,3, 4, 5, 6, …11 minutes, using the 'find service area' function of Arcview 3.2a.

3) Custom application development:

Arcview's Dialog Designer extension was used to create the dialog boxes and avenue scripts were attached to them for performing given tasks. For the automation of Network Routing, buttons and tools were added to the View document and the roads information dialog box was created using label buttons, tools and listboxes. A roads information module was also incorporated because of the availability of very detailed roads information, with built in queries, which would enable the user to get information about a particular road on the click of a button.

Results:

1) Map Animation:

It was hypothesized that patterns across space and time would be evident in the fire incident database. Arcview 3.2a was used to test this hypothesis.

Spatial concentration:

Previous research provides strong evidence that certain types of fire incidence are spatially concentrated. It was observed that in certain areas the number of occurrences was fairly high to observe the spatial trend. These were the areas that were highly congested, mostly slums and areas of high densities. The high-class localities showed a remarkably less number of fire occurrences. Clusters were evident in the city center, which is highly congested.

Temporal Patterns:

Incidents are not evenly distributed over time, with distinct concentrations at certain periods. There is also a marked variation in incidents in terms of time of day. For all types of incidents the peak is between about 11 to 12 and 16.00 and 20.00 hours, with very few incidents during the 24.00 to 08.00 period. This is closely related to activity patterns of the mass of the population.

2) Efficiency of the existing Fire Station Network:

The efficiency of the existing Fire Station Network was calculated on the basis of the minimum response time in minutes required for the fire stations to serve the whole study area. The speed of the vehicle was assumed at an average of 30 km/hr. Using Arcview's Network Analyst Extension's Find Service Area function maps were generated for different response times viz.,3,4,5,..11 minutes. It was found that the four fire stations were able to serve the whole area in a matter of 11 minutes.

3) Custom application development:

The custom project was divided into two modules viz., the Fire Emergency Module and the Roads Information Module. The former gives routing solutions on the input of point of incidence and the latter having detailed information about roads and built in queries.

Conclusions:

1) Map Animation:

It was hypothesized that spatial and temporal patterns would be evident in the animation. The spatial and temporal patterns in the fire incidents were observed successfully in the map animation.

Given is an illustration of the animated map (one of the total 48 frames generated with a time interval of one hour.)

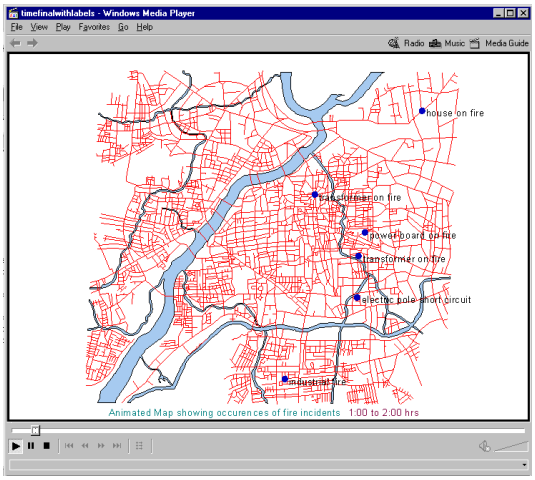

Figure 1: the animated map showing fire incidences.

Map animation is a simple but effective technique to assist human visualization and exploration of a space-time dataset; it will not find patterns (if there aren't any) in the data by itself. There is also the danger that any pattern observed could simply be an artifact of the map animation process.

2) Efficiency of existing fire station network:

The minimum response time for the four fire stations to serve the area is 11 minutes, which according to Indian standards is acceptable, but there is a major scope for improvement and it can be brought down to 4 minutes, which complies with international emergency standards with allocation of one fire station.

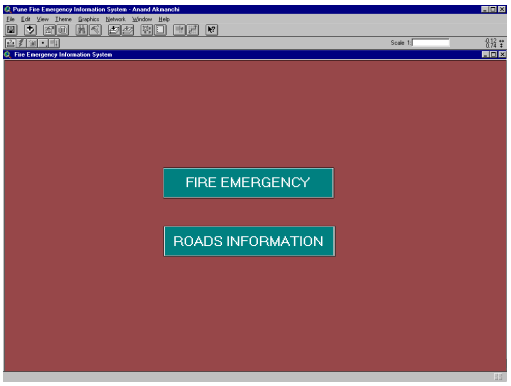

Figure 2: The two modules

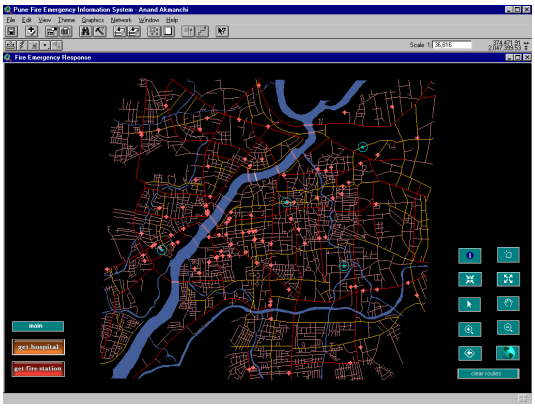

Figure 3: The Fire Emergency Module

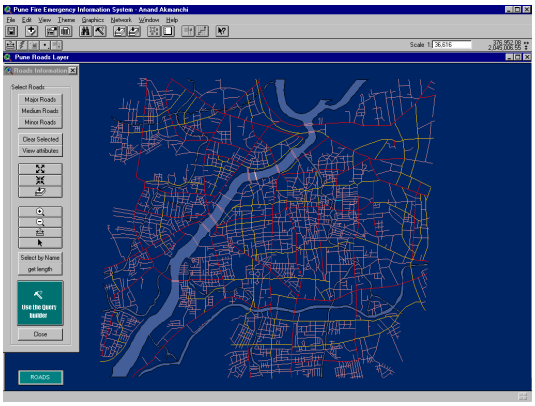

Figure 4: The Roads Information Module

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