SIMULATION OF POSSIBLE ESCAPE ROUTES OF A CRIMINAL GANG FROM THE CRIME SCENE WITH GIS DATABASE

ABSTRACT:

The traditional system of tracking crime suspects has failed to live up to the requirements of the existing crime scenario. The system should be so effective that the crime suspect could be tracked within minutes of the robbery. Manual processes neither provide accurate, reliable and comprehensive data nor does it help in decision support. The solution to this ever-increasing problem lies in the effective use of Geographical Information System.

In this paper, a GIS database of the possible escape routes in the vicinity of the place where theft has occurred is created. The path of the crime suspect is simulated considering various factors like the type and speed of vehicle, width of the road, presence of traffic signals etc. Minute-by-minute simulation of the path within a specific radius around the place i.e., Radial analysis is done. Once the alarm is sent to the control tower, the officials can access this database to know where the crime suspect could be at that particular minute so that they can direct the patrol to that place immediately. Further if GPS mounted patrol vehicles are present, the spot can be reached faster. This paper presents a methodology for optimal deployment of patrol vehicles to track and catch the crime suspects faster.

INTRODUCTION:

Crime suspect activity continues to be a major concern in contemporary society. Most nations are faced with unacceptable levels of delinquency and crime. The existence of crime is as old as the creation of man itself and man has always looked for ways to combat it and reduce it as much as possible. One such attempt is our paper, to track the possible escape routes of a crime suspect using GIS.

GIS has popularized the use of geographic information by empowering individuals and organizations to use such information in areas that earlier generations of GIS users could never have thought of even with their wildest imagination. It is now commonplace for ordinary people to use GIS to check the weather and traffic conditions before they leave home for work, locate the nearest ATM when they need money, and find information about the country or city they are about to visit.

GIS as a tool can be used by police personnel to plan effectively for emergency response, determine mitigation priorities, analyze historical events and predict future events. The Network Analyst extension in ArcView GIS is used in our paper to find all portions of the network that are connected with the progress of the crime suspect from the crime scene. The contact numbers of the police stations that fall under the buffer area are displayed, so that these stations can be alarmed to track the crime suspects faster.

OBJECTIVE OF THE STUDY:

- To find the possible position of the crime suspect using the Network of Communication routes after specified time interval.
- To generate the buffer zone around the scene of crime.
- To notify the police stations which get covered in the service area.

SCOPE OF THE STUDY:

- Effective method to hunt down the crime suspects.
- To reduce the crime rate.

STUDY AREA:

The Chennai City, the capital of Tamil Nadu State is the fourth largest city in India. Chennai is situated in the 13th north parallel and 80° longitude, along the Coromandel Coast in the southern part of the Indian peninsula.

The present area of this Metropolitan city is 170 sq.km. with a population of about 7 million. As per the 2001 Census density of population is roughly about 24,000 persons per square kilometer.

Five major National Highways radiate outward from Chennai:

- Erukancheri High Road to the northwest, becoming National Highway 5 to Kolkata;
- Poonamallee High Road (*Periyar Salai*) to the west, becoming National Highway 4 to Mumbai;
- Mount Road (*Anna Salai*) to the south-west, becoming National Highway 45 to Tiruchirapalli and the interior of Tamil Nadu;
- Madras-Tiruvallur High Road (*MTH Road*), built parallel to NH 4 to the west, leading to Tiruvallur;
- Beach Road to the south along the coast, becoming East Coast Road to Mahabalipuram, Pondicherry and beyond.

METHODOLOGY:

Data Acquisition:

- **Spatial Data:**

  The TTK map of Chennai city was scanned using a Drum Scanner. Rectification was done by obtaining the coordinates of Ground Control Points from Institute of Remote Sensing, Anna University, Chennai-25. The roads were digitized by on-screen digitization technique using ArcGIS software. The police stations were plotted on the digitized map using Eicher Chennai City Map.

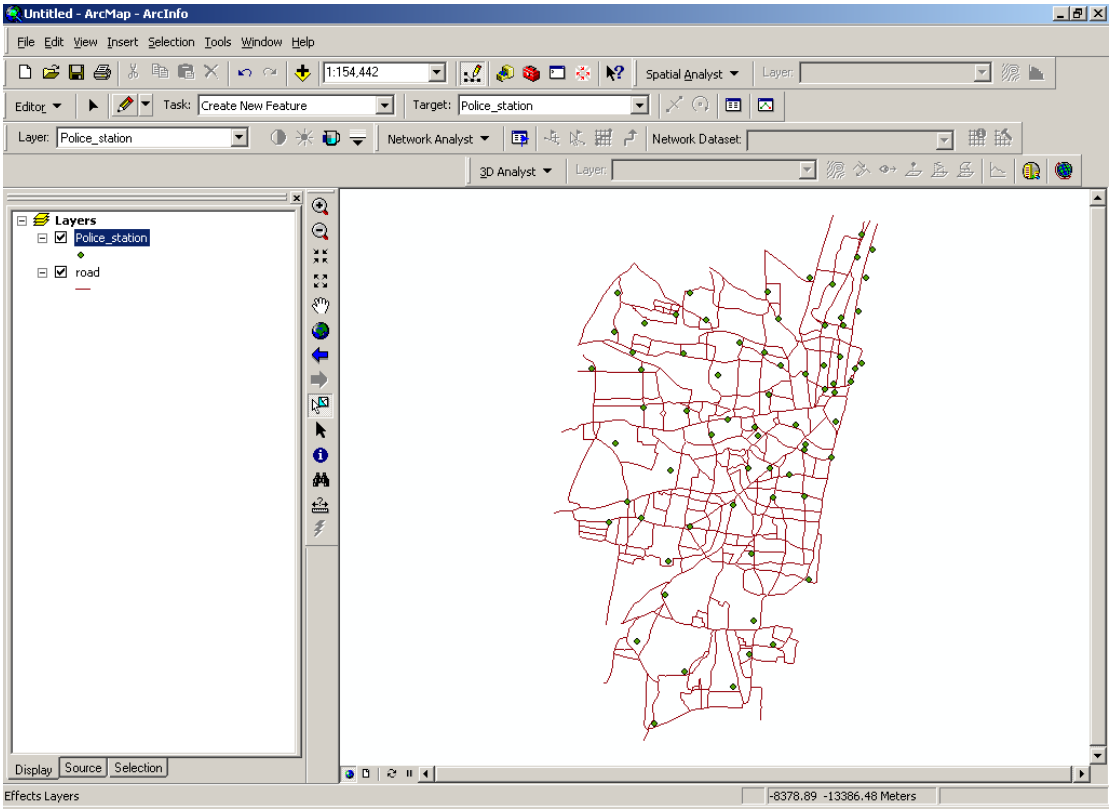

Fig 1. Digitized Chennai road map with police stations

- **Non-Spatial Data:**

The Classification of roads (Arterial, Sub-Arterial, Collector) was adopted as in Eicher maps. The Speed of vehicles for different classes of roads at various traffic densities were assumed as follows:

TRAFFIC DENSITY	MODE OF TRANSPORT	ARTERIAL ROAD	SUB-ARTERIAL ROAD	COLLECTOR ROAD
HEAVY	RUNNING	3	2.5	2
	2-WHEELER	40	30	20
	4-WHEELER	30	25	15
MODERATE	RUNNING	4	3	2.5
	2-WHEELER	60	50	40
	4-WHEELER	50	40	30
LOW	RUNNING	5	4	3
	2-WHEELER	90	70	50
	4-WHEELER	70	50	30

Fig 2. Speed of vehicles in kmph (assumed)

The phone numbers of the police stations in Chennai city were obtained from Yellow Pages.

Data Processing:

Network Analysis has been performed in ArcMap using the digitized layers. The Concepts of Network Analysis are discussed here.

Network Analysis:

A network is a set of linear features that are interconnected. Common examples of networks include highways, railways, city streets, rivers, transportation routes (e.g., transit, school buses, garbage collection and mail delivery) and utility distribution systems (e.g., electricity, telephone, water supply and sewage). Collectively, these networks form the infrastructure of modern society. They provide the means for the movement of people and goods, the delivery of services, the flow of resources and energy, as well as the communication.

Despite the obvious geographic importance of networks, however, GIS in general is not optimized for network data processing. It is more oriented towards resource and environmental applications that emphasize the use of polygons. Dealing with networks requires sophisticated processes and data structure that may not be available in the core functionality of most GIS software packages. Network data-processing procedures are usually provided in the form of software extensions that are obtainable from the GIS vendors or third-party software developers.

ArcView GIS provides an extension known as **Network Analyst** that allows the user to solve network-related spatial problems such as finding the best routes, defining travel costs, and modeling traffic flow.

The concepts and techniques of network analysis in vector-based geographic data processing can be explained from three perspectives:

- The Network Layer
- Network Analysis Algorithms
- Applications of Network Analysis

The Network Layer:

A network layer is made up of topologically structured *line segments, junctions*, and, optionally, *turns*. A line segment, also known as an *edge*, is the basic spatial unit of a network. It is identified by a segment identifier and is tagged by related attributes such as street name, length, and speed limit in a street network. A junction, or an *intersection* as it is sometimes called, is a point or node in the network where line segments meet. It is identified by a junction identifier and the line segments leading to and from it in the network. A turn is a numerical value specifying the time or cost required to travel through a junction.

Network Analysis Algorithms:

Network Analysis Algorithms are based on relatively sophisticated mathematics using graph theories. Even a spatial problem using networks, such as finding the shortest path between two points requires a considerable amount of computation to solve.

The shortest-path algorithm probably represents the simplest scenario to which it is applied. The process will be much more complicated if the shortest travel time or least travel cost between the two points is required. Since travel time and travel cost are not necessarily proportional to distance directly due to, for example, different speed limits and different values of turns at different junctions, it is necessary to perform the analysis using the time and cost associated with each individual street segment and junction, rather than by simply multiplying the total distance by an average travel time or average cost.

Applications of Network Analysis:

There are many spatial problems that require the use of network analysis for their solution. These include:

- *Path finding:* This analysis finds the shortest path (in terms of physical distance or least cost) that can be followed to visit a series of locations in a network.
- *Allocation:* This analysis assigns one or more portions of a network to be served by a facility or business location.
- *Tracing:* This analysis finds all portions of the network that are connected with the movement of a particular feature.

Simulation of escape routes:

Based on the assumed speed, travel time is computed for each mode of transport at various traffic densities. The notations used in the attribute table are:

- RT_LT, RT_MT, RT_HT - Running Time at Low, Moderate and High Traffic respectively
- W2_TT_LT, W2_TT _MT, W2_TT _HT – Two Wheeler Travel Time at Low, Moderate and High Traffic respectively
- W4_TT_LT, W4_TT _MT, W4_TT _HT – Four Wheeler Travel Time at Low, Moderate and High Traffic respectively

Attributes of road

LENGTH	ROAD_NAME	TYPE	RT_LT	W2_TT_LT	W4_TT_LT	RT_MT	W2_TT_MT	W4_TT_MT	RT_HT	W2_TT_HT	W4_TT_HT
399.352	SARDAR PATEL ROAD (ELLIOTS BEA	1	4.792	0.266235	0.342302	5.9902	0.399352	0.479223	7.987	0.599028	0.798704
111.519	SARDAR PATEL ROAD (ELLIOTS BEA	1	1.338	0.074346	0.095588	1.6727	0.11152	0.133824	2.230	0.16728	0.223039
818.105	SARDAR PATEL ROAD (ELLIOTS BEA	1	9.817	0.545404	0.701233	12.271	0.818105	0.981726	16.36	1.227158	1.636211
739.700	BESANT AVENUE ROAD	2	11.09	0.634029	0.887641	14.794	0.887641	1.109551	17.75	1.479401	1.775281
315.800	3RD AVENUE ROAD	3	6.316	0.378961	0.631602	7.5792	0.473701	0.631602	9.474	0.947402	1.263203
972.762	LINK ROAD	3	19.45	1.167315	1.945526	23.346	1.459144	1.945526	29.18	2.918288	3.891051

Record: 673 Show: All Selected Records (0 out of 673 Selected) Options

Fig 3. Road Attribute Table

The fields From to To (FT) time and To to From (TF) time are created for each of the above fields. In case if the traffic flow on the road is uni-directional either F or T field may be created.

Using ArcCatalog, Network Dataset is created for the feature dataset. The above attributes are added while creating the network dataset.

In ArcMap, a new service area is created using **Network Analyst** tool. Default breaks, impedance and direction is specified. The user can specify the default break value i.e., the time interval elapsed since the crime occurred (5 minutes, 10 minutes etc.). The mode of transport (Running, 2-wheeler or 4-wheeler) and traffic condition (Heavy, Moderate or Low traffic density) can also be selected in *Impedance*. The crime scene is marked as the Network location and solved. For the given break value, buffer is created as a polygon feature around the crime scene. This buffer area shows the possible escape routes of the crime suspect.

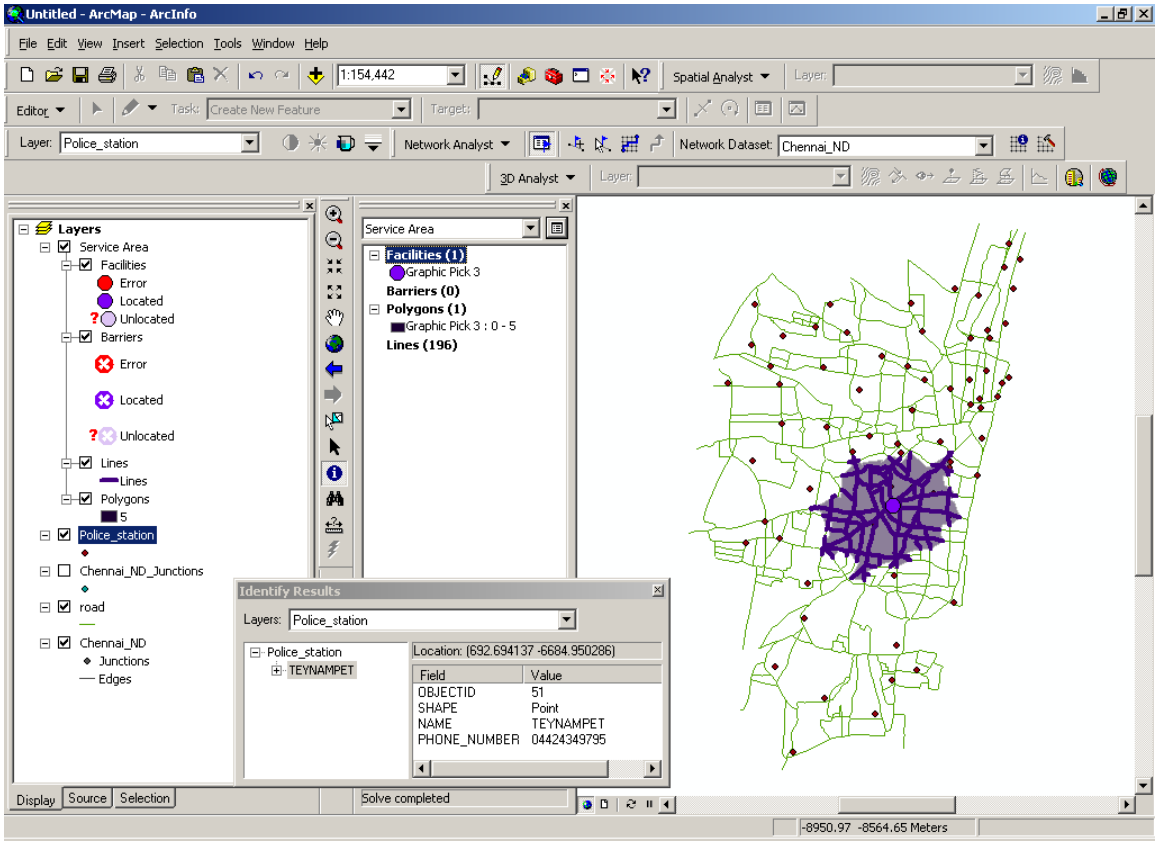

Fig 4. Escape routes of the crime suspect

Shown diagram is the location of the crime suspect within 5 minutes after the crime using 2-wheeler as the mode of transport in heavy traffic condition. The crime suspect will be within the enveloping area highlighted.

LIMITATIONS:

⇒ Traffic volume and vehicular speed is assumed.
⇒ Lanes are not digitized.

RECOMMENDATIONS:

⇒ This GIS database should be installed in the police control tower, so that information is passed to all the police stations within the buffer area.
⇒ Patrol vehicle need to be mounted with GPS, so that the location can be reached faster.
⇒ More check posts can be established in crime prone areas.

CONCLUSION:

Thus this technique gives an upper hand visualization of the escape routes of the crime suspect using GIS database. This technique, if implemented, would be a new revolution in the field of criminology.

REFERENCES:

- 'Concepts and Techniques of Geographic Information Systems' by C.P.Lo and Albert K. W. Yeung
- 'Principles of Geographical Information Systems' by Peter A.Burrough and Rachael A. McDonnell.