INTELLIGENT CRIME MAPPING SYSTEM (CMI SYSTEM)

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Introduction

Spatial mapping of criminal data will support on decision making and security arrangement activities of any Police department in any country. According to the department of Police in Sri Lanka, they are practicing this method for a long time for regional security arrangement and placement of police patrol services. But, still these activities are being done manually by using paper maps and pins, which give a least support on decision making.

Current method does not facilitate crime trend analysis, real-time crime outbreak detection, analysis of crime patterns etc. As the map is in a main police station in the region, an officer from each of other stations has to physically present in the main station at every time they need to update the map. Those updated information are not visible to other stations. Also, a map or a crime clock contains only the data belongs to the current week in operation. But introducing web based geographical information system (GIS), will give additional support on real time decision making on security arrangement activities.

Although there several web based crime mapping and crime clock systems are available in the internet, they have been custom made for legislative authorities in different countries and those systems are not accessible to outside of those respective authorities. iMap website (iMap, 2009) and CrimeReports website (CrimeReprots, 2009) are two such automated systems.

The proposed intelligent crime mapping system (CMISystem) has facilities such as online, real time crime mapping, analyze criminal activities by different types of crimes, recognize nearest police station to a crime location, recognize crime hot-spots, detect crime outbreaks, crime trend analysis, crime clock visualization and analysis etc. In future, facilities of this system can be further expanded by linking crime data with GIS.

Methodology

Online mapping and displaying of features, on maps, were developed using WMS (web mapping services), WFS (web feature services), and vector layer technologies. The system is implemented in GeoServer which is an open source web server that provides web services related to geographical data.

For identification of hotspots (Fig. 1 - Appendix), all the data points were clustered using a clustering algorithm, where it first accepts the interested area to be investigated (A) as the input. Then according to the user's inputs the algorithm will measure the Euclidian distances among all the data points with each other within the

defined area A and it will cluster the data points into the most suitable number of clusters using the nearest neighbour concept according to the calculated Euclidian distances. Finally the coordinates of the centres of the clusters identified and the number of crime points inside each of those clusters will be returned. Depending on the values returned with a coordinate, each cluster will be assigned a colour and a radius according to the magnitude of the cluster. Then using the vector layer concept, those points are graphically displayed on top of the base map.

To identify the nearest police station in a user defined spot on the map, the "J48" classification algorithm was used which has already been implemented inside the "Weka" data mining tool. First, the J48 algorithm was trained for about 150 data points per each 400 Km^2 area. Those data points include the coordinates and the relevant cities (cities will behave as the class labels of those coordinates). Then the algorithm was trained several times to adopt the coordinates to the predefined classes (cities). Then, when the user clicks on a desired point on the map, that coordinate will be analyzed by the algorithm and the most suitable class (nearest city) of that coordinate will be returned.

"Crime outbreaks" and "Hotspots outbreaks" are two agent systems that observe for number of crimes in different regions and if the number of crimes are increasing out of control the system will prompt an alert to all the relevant police stations. In this system, initially the user can define a reference time fame (by default it has been set to 3 days) and then the system will calculate average (μ), and standard deviation (σ) of number of crimes per day per each cluster. If, in a particular cluster, number of crimes within a day is greater than $\mu + \sigma$, the system will prompt the alert.

A pie-graph was used to get the percentage comparison between the crime scenes. Crime clock is another graphical representation for the number of crime scenes happened during a particular time period. Crime clock (Fig. 2 - Appendix) was represented by using a bar graph, where the 24 hour clock is represented by using 24 bars on the graph and height of each bar represents the number of crime scenes per each hour. Time series plots and time series analysis techniques were used for crime trend analysis which gives an idea about numbers of crimes changes over time.

Results and Discussion

The proposed system will improve efficiency of crime mapping as any police station can enter crime data online. Also, up-to-date information is available and visible to any police station. As the system maintains past crime data, they will easily be used for crime trend analysis, hotspot analysis, crime outbreak detection etc. Using above mentioned hotspot identification facility, any police officer in any Police station can easily and quickly recognize hotspot regions where the crime density is higher than other neighbouring regions and the security arrangements can be planned according to the hotspots map.

For the identification of the nearest police station, J48 decision tree

induction algorithm was used as it is a fast and powerful algorithm to handle structures in large data sets (Monk, 2009). This functionality will instantly respond to Police officers to get an idea of the nearest police station relative to a given location.

"Crime outbreaks" (CO) and "Hotspots outbreaks" (HO) are two agents that can be activated and deactivated according to the user's preference. When CO is active, it will identify any kind of unusual crime incidences and if so, it will prompt an alert. When HO is active, it will behave in the same way as CO but it recognizes regions with higher crime densities.

Graphical crime comparison can be used to compare the occurrences of different crime types in different date periods while current crime trend helps the police officers to recognize gradual increment of crime incidence in different areas and hence they can change security arrangements in relevant areas. The crime clock will help them to identify the time periods within a day where crime incidences are high.

Conclusion

The proposed web based online crime mapping and intelligent decision support system will improve efficiency making timely decisions on security arrangements and hence the police department can provide high quality security service.

References

CrimeReprots (2009). Crime Mapping and Reporting System Available at http://www.crimereports.com/, accessed on 16th of October, 2010

iMap (2009). Intelligent Mapping System Available at http://mapping.ci.suisun-city.ca.us/imap/,accessed on 16th of October, 2010

Monk (2009). Metadata Offer New Knowledge Available at http://gautam.lis.illinois.edu/monkmiddleware/public/analytics/decisiontree.html, accessed on 16th of October, 2010

Appendix

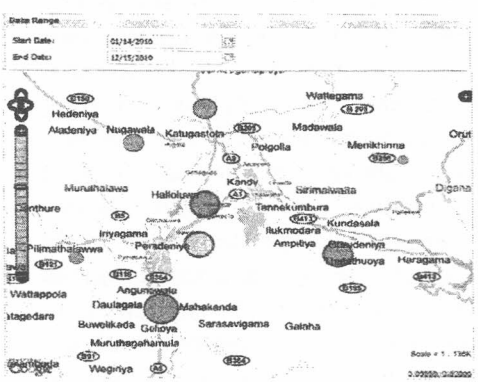

Fig. 1. Clustering

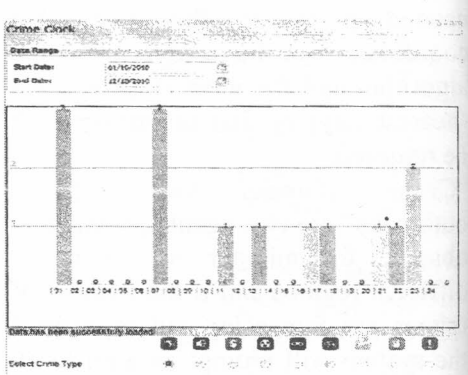

Fig. 2. Crime Clock