CMIS: Crime Map Information System for Safety Environment

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Abstract. Crime Map is an online web based geographical information system that assists the public and users to visualize crime activities geographically. It acts as a platform for the public communities to share crime activities they encountered. Crime and violence plague the communities we are living in. As part of the community, crime prevention is everyone’s responsibility. The purpose of Crime Map is to provide insights of the crimes occurring around Malaysia and raise the public’s awareness on crime activities in their neighbourhood. For that, Crime Map visualizes crime activities on a geographical heat maps, generated based on geospatial data. Crime Map analyse data obtained from crime reports to generate useful information on crime trends. At the end of the development, users should be able to make use of the system to access to details of crime reported, crime analysis and report crimes activities. The development of Crime Map also enable the public to obtain insights about crime activities in their area. Thus, enabling the public to work together with the law enforcer to prevent and fight crime.

1. Introduction

Index crimes in Malaysia mainly include murder, robbery, rape, assault (these comprise the violent crime); theft and burglary (these comprise the property crime) [1]. Crime visualization is a process of producing interactive visualization in term of graphs and maps of crime happened, based on geospatial data. The crime visualized is separated by categories. In this system, the process of finding, exploring, capturing and localizing information of a specific subject can all be done via visualization. Crime Map is a web-based crime visualization system designed and developed to provide a platform for the public communities to share about the crimes they encountered. It helps the police to fight against
crimes and the public to take precautions from becoming victims to crime activities by raising their awareness. The goal of this project is to develop an interactive web driven system to provide crime for the public to raise their awareness on crime activities. The project is based on following objectives:

i. To design and develop Crime Map as a web driven geographical information system that provide crime data to the public.
ii. To implement clustering technique on markers for better readability.

Crime Map enables public to access to crime information happened in Malaysia in visual form. The target user of this project is all the peoples reside in Malaysia where crimes could affect and is a concern to them. However, the system requires a user to register to be able to report crime activities in their area. Registered users could report crime by filling a report consist of the details on the crime happened into the system. Registered users should be able to report a crime based on location, and manage the crime report they submitted. On the other hand, it doesn’t need registration or login to access to the information presented on the site. Crimes are categorized in categories to enable easy analysis done to the data. Categories are separated into theft, hit and run, burglaries, snatch thief, robberies.

The concept deployed in the system is discussed in details to foster comprehensive understanding on related subject fields. The technology being deployed in this system is known as Geographical Information System (GIS). It is being implemented as a web based system for working with maps and geographical information. It’s also used for acquiring, storing, interpreting, and displaying geospatially organized information known as geospatial data. The primary component being used in GIS is spatial data and non-spatial data. Geospatial data is the basic data type that describes the absolute and relative location of geographic features. It describes the specific location such as latitude-longitude or address which has a significant occupied space. It is different from non-spatial data which only describes the characteristics of a property such as name and value. All these data are then named as geographic data. Geospatial data can be stored efficiently and with a very high quality, and it can be manipulated very easily using computers [4]. Geospatial data are usually presented in the form of a map with geographic positioning information included within it. Geospatial data may be divided into two types, which are raster type and vector type. Raster Data represents geometric data in form of cells matrix. Geometric data are organized into rows and columns in a grid where each cell contains a value representing information. Raster model can be digital aerial photographs, imagery from satellites, digital pictures, or even scanned maps. Raster data is mainly used to represent continuous data and uses a lot of space [3]. Vector data represents geometric data using directional lines (vector). Geometric data are organized using directional lines connecting vertexes. It 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.

2. Design and Implementation of CrimeMap
In the design phase, data collected from analysis phase are used to generate a detailed specification of the proposed system. Architectural specifications for the design of the system are identified and discussed. The data model then generate based on functional and non-functional requirements to promote a better understanding of the needs of the system. System design is based on modules of entity relationship diagram which are designed to match the design of the database. MySQL is used for database management. To create a user-friendly environment, aspects like input and output are planned carefully. Interface design using wireframe shows the design of input and output interface for users. Wireframe is designed using draw.io to provide an illustration on expected output. The development of the web system is based on PHP language.
In implementation phase, the development phase of the system is carried out based on the system specification which was defined in the previous stage. The implementation of the back-end of the system is divided into two essential parts which is the functionality (server-side script) and the database. The functionality designs is the design of function used by the users and it allow the users to complete tasks such as submit crime report, editing crime report submitted, request for data, login, and registration. Database implementation enable the systems to use its’ data storage to create, store and manipulate data appropriately. The database used in the system implementation is MySQL and the language used in database implementation is Structure Query Language.

In the development phase of the system, the implementation of front-end is focused on the readability and responsiveness of the system. The front-end system is developed using bootstrap framework to provide responsiveness to the system. While the system is optimized to mobile view and usages using the bootstrap framework, various techniques are also implemented to let the system has better readability and usability. Technique such as clustering are implemented to allow users have better readability on the map filled with crime report and markers. Google map’s info window and bootstrap modal are also being used to provide better usability as the users doesn’t need to change page and load for every report they wish to view.

2.1. Crime view

Crime data reported by the users populates the map and is presented in a marker with specific icon based on the category of crime. The marker is placed based on the location user specified the crime happened. An information window popup on the report is also added when user is to click on the marker as shown in Figure 1. To solve the issue of overcrowding the map, clustering technique are being applied to the map. Clustering technique is applied when there are too many markers on a specific location or small area. The technique combines multiple markers into one icon cluster based on crime category. The technique is implemented so that the map has higher readability and easy to navigate.

Figure 1. Crime Map Interface

Users could be able to manage the crime report they reported. The users could manage the crime report they submitted in their profile page. They’re able to either edit or delete the submitted report. The purpose of user editing they crime report is in case of human error in descripting the crime details. On the other hand, the administrator is able to manage all reports submitted by users. The administrator is able to re-categorize the report more accurate by editing the report. Administrator could also remove any invalid reports by users.

2.2. Heat Map and Graph Analysis

Heat Map analysis is implemented using Google heat map layer. The analysis generate hotspot map based on the geospatial data from crime report. The analysis is used to depict the intensity of crime rate at geographical location. Based on the data received from crime reports, the heat map would generate a layer of gradient colour overlay on the map for data visualization as shown in Figure 2. Graph Analysis in the project is implemented using Morris.Js, a JavaScript graph library. The
graph analysis helps to visualize the crime data in a form of visible vector graph image. Figure 3 shows one of the graph analysis implemented in the system. It visualize all the types of crime happened in Malaysia according to year. Using the analysis, it can be seen how the crime of certain types raises or diminish throughout the course of few years. Figure 4 shows another graph analysis implemented in the system using pie chart. It visualize the types of crime happened in Malaysia based on Location of the crime happened. In this case, the location is based on the states. It visualizes the crime rate in specific states. Using this analysis, user can compare the crime rate between geographic locations.

3. Testing of CMIS

Testing plan is conducted after a new version of prototype is developed. The testing plan is conducted to ensure that the system is functioning properly as intended. User acceptance test is evaluation from users. This test is important to ensure that user’s requirements were archived whereby the system can implement all the operations to generate useful output that fulfils user’s expectation.
This test was conducted based on two parts that were interface design and system function using 30 samples. Figure 5 shows the acceptance testing for system interface design. Based on the overall results, more than 50% of the participants have excellent experience with the system interface’s design. Figure 6 and 7 shows the system functional testing for user and administrator. The results show that they are satisfied in one way or another. In overall result, majority of the users agree that the page interface and system function are good.

4. Conclusion and Suggestion

This system is successfully developed and is able to fulfil the objectives and users’ requirements stated in the project requirement based on the current users’ acceptance towards the system.
However, there are still underlying improvement yet to be discovered in order to allow the system to cope with future development. Suggestions on improvement of the systems are vital to the future development of the system to overcome the limitation of the system defined. Based on the limitation of the system, it is suggested that the system to be able to access their crime report archive and implement a more accurate version of visualization of crime in Malaysia. It is also suggested that the system to be able to get access to the Malaysia citizen information database to register the users based on that information. Thus, enable appropriate action taken towards those who misuses or abuse the system, and better crime report accuracy would be achieved.

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