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KANAN: An Intelligent Application to Determine Road Accidents Associated with Mental Fatigue in Queretaro within the Paradigm of a Smart City

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Abstract. Queretaro is a large city located along in center of Mexico with a population over a million people in 87 km^2 has recently experienced a situation of violence and insecurity related directly to organized crime: assaults, kidnappings, multi-homicides, burglary, between others. However, the second leading cause of death in the city is associated with traffic accidents: 1,377 deaths in 2019 alone. For this reason, citizens have actively pursued specific programs that would decrease the overwhelming statistics: 3,897 deaths from 2014 to 2018. The reason of the following project is to provide drivers with a technological tool with indicators and sufficient information based off statistics compiled by the *Queretaro Security Government Department* and other public sources. Then drivers would have more information on possible traffic accidents before they happened. This research tries to combine a Mobile Device based on Data Mining and a Kriging Model to determine the danger of suffering a traffic accident associated with mental fatigue of bus drivers in a given part of the city during a specific time. KANAN, means vigilant guardian in the Mayan language is therefore the acronym of our intelligent application of ubiquitous computing

Keywords: Data mining, kriging model and mobile devices.

1. Introduction

According to literature is feasible to use an application to determine the possibility that a traffic accident will occur using data associated with most frequented areas. Then the users will be aware of alternate routes to their destination, among other advantages. Using technological tools, data analysis and mathematical models would then decrease drivers' chances of suffering a traffic accident. The aim of this project is to create a model that uses these tools in a mobile geographic information system (SIGMA) on levels of traffic accidents in specific areas of Queretaro, which is presented in detail below, this research include the analysis of Data Mining to determine the danger that a traffic accident would occur during a specific time. We realize an exhaustive analysis

of other similar research, the only similar context is explain in [6], where the authors calculated the insecurity of a vehicular group which requires product delivery in different places with random scheduling, but this research does not considers real on-time statistics and the perspective to suggest a different route to travel or stay for a determinate period of time.

Kanan is a project that was developed as a proposal to improve the road safety by providing accurate, useful and representative data to understand the factors that creates the conditions for a car accident to occur. The tool, that consists in three different stages is the result of an analysis and investigation performed as a part of a Design and Innovation Master´s degree program from the Universidad Autónoma de Queretaro, in Mexico.

The objective of this experiment is to identify how does the proposal works. Through this experiment, a beta app was used to have volunteer users creating reports of the incidents they observed during their daily activities. The reports coming from the app provided the information that built the database that at the end should allow to identify conflict zones through a geostatistical analysis. In order to rate the project as successful, the system had to provide a clear identification of those conflict areas from now on called red spots.

2. Implementation of the Intelligent Application

There are several aspects that need to be taken into account when designing mobile applications: limited screen size, different resolution and screen sizes across devices. Therefore, the designer has to develop the interface uniformly so that it suits most devices. This module explains how to work with different layouts provided for the Android API. The programming interface we will work on is XML.

There are several ways to obtain the geographical position of the device, however we would thoroughly use GPS and access points (Wi-Fi) nearby; both perform similarly but differ in accuracy, speed and resource consumption. Data Server Communication is the most important module because it allows communication with the server, allowing you to send the GPS position obtained by receiving the processed image and map of our location, thus showing the outcome of your application that is the indicator of insecurity.

3. Test Development

The beta version from the Kanan app was developed with the support of the company Next level, based on the minimum requirements which were the delivery of a very basic app with the capability to interact the user using a simple but practical interface and automatically register within the report generation the date, hour and location given by the mobile device GPS.

The app has in its main page the option for a registration or a login. A registration of the user allows the identification of the user’s profile and demographic information.

Fig. 1. Intelligent Application developed to determine incidence levels of traffic accidents in the Queretaro Metropolitan area.

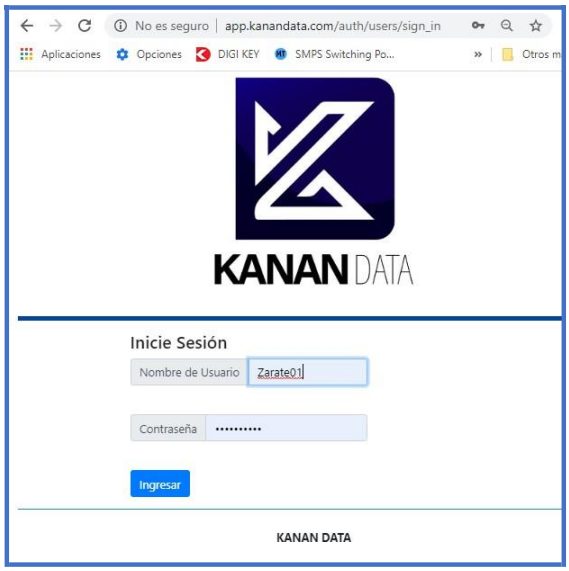

Fig. 2. Connection to a remote server with real data of transport and mobility in Queretaro.

Using our intelligent application (see figure 1) we can determine in detail the prevalence of any traffic accident associated with mental fatigue of drivers in the Queretaro Metropolitan area.

The generated reports were sent automatically to the web-based database, with the domain app.kanandata.com. The reports are listed and classified according to the way they were reported. In order to protect the information, the database requires secured access. In figure 2, we receive information associates with connecting with a specific server which obtain information from Queretaro transport department.

In order to do the test, it was published on social network sites the call to participate in this experiment, therefore, all the 13 registered users were volunteers.

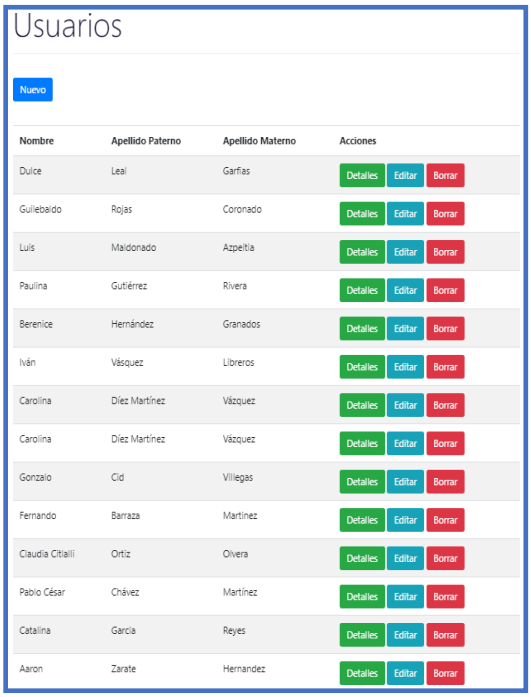

Fig. 3. List of users of our Intelligent application using real data to take a correct decision related with traffic in a Smart City.

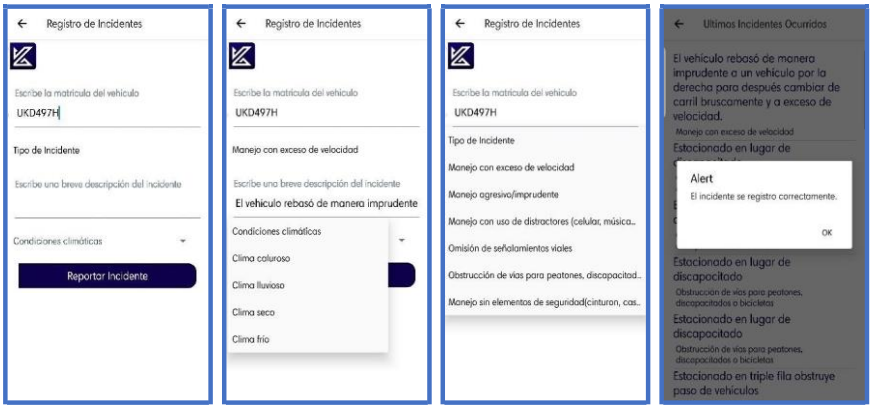

Fig. 4. Textual information related with a new traffic accident involves bus drivers.

Due to the simplicity of the app at this point, where it is still not available a voice interaction feature, which will be intended to avoid the driving users to incur in the usage of the app as a distractor, the selected profile were those people that do not typically drive during their daily journeys, like public transport or bike users, or walkers. In that case, they could stop for a moment to register an incident without putting themselves in risk. Each user obtains new data related with section of city where

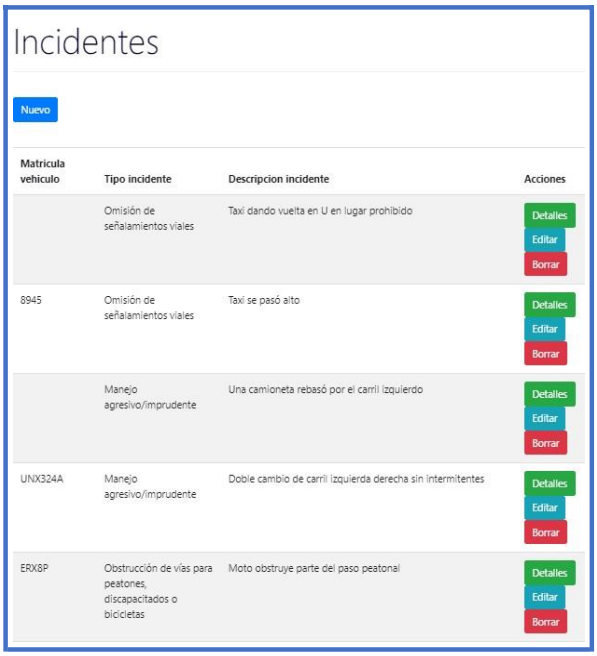

Fig. 5. Relation of each traffic accident by type and geospatial data to built clusters in a Smart City.

occurs an extra traffic to prevent risk of future accidents as is possible see in figure 3.

Using the app, the users could register different information, such as the car plates (if they were able to catch it), the type of incident, a brief explanation of the incident (if feasible) and the weather conditions. Regarding the type of incidents, there is a pop-up menu to select between the 6 different listed types: Speeding; rash driving; driving with distractors; road markings omission; pedestrian or disabled path obstruction; and driving without safety elements (seatbelt, helmet, etc.). As mentioned before, the app register by itself the time, date and location at the moment of the report generation, with no chance for the user to edit this information. An important aspect of our intelligent application is that each user can feed with reliable information, the clearest and most detailed description of a traffic accident and those involved as you can see in figure 4.

The test lasted a total of 4 weeks. Within this period, the users were able to register a total of 111 reports. There are two ways to get an overview of accidents in our intelligent application, in figure 5 you can correlate accidents by type and in figure 6 you can particularize an accident and if there were injuries or deaths coupled with geospatial data of it.

Based on the worldwide known Google maps, importing the data from the database, the incidents were added to a map to understand the location of the reported incidents according to the registered coordinates, as can be seen in the next figure 7, which describe each accident within the range of occurrence and its radius of affectation considering the time and degree of actors involved.

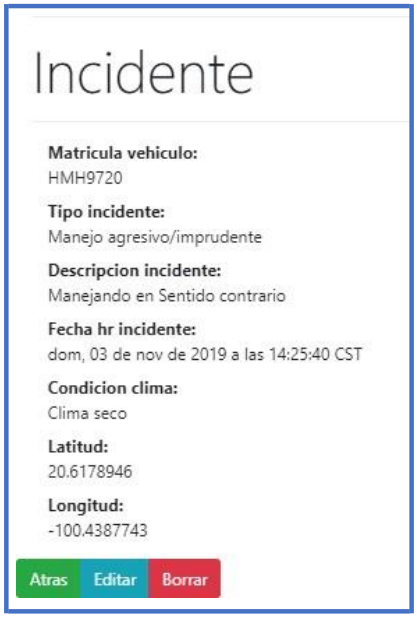

Fig. 6. Correlation of each traffic accident with relative information associated with vehicles involved.

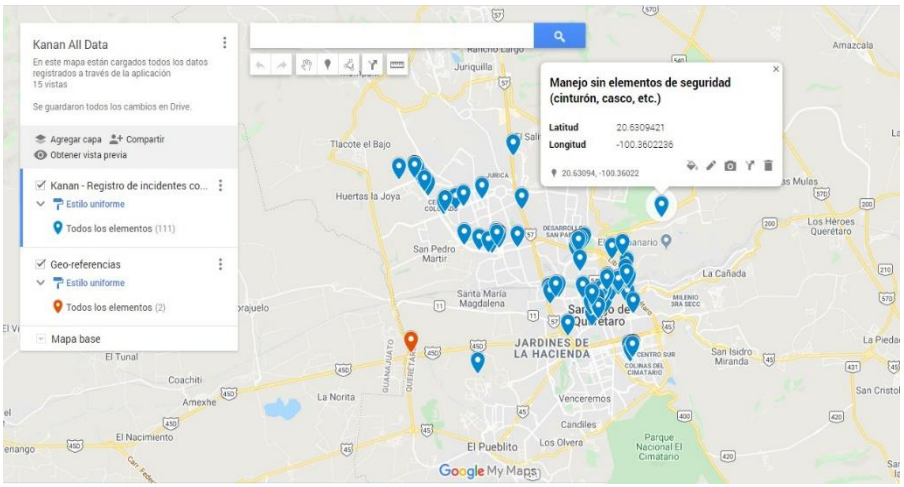

Fig. 7. Detail description of each traffic accident in a Longitudinal study to our intelligent application.

In order to do this, it is necessary to save the information in a spreadsheet with a CSV format, which can be used to automatically transfer the information to the Google platform. This is a simple way to understand the density of the participation of the user. In the map is very evident the areas where the users were reporting the incidents.

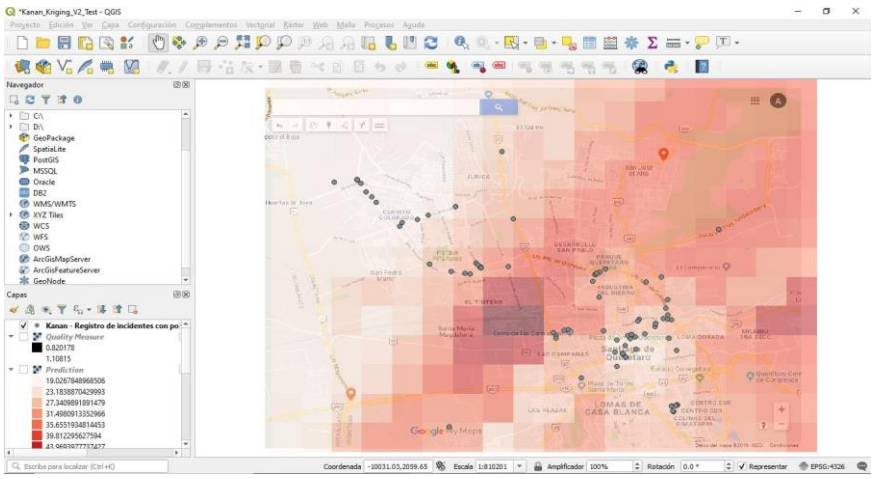

Fig. 8. A Kriging Model using correlative and transversal data to determine future traffic accidents.

But what exactly can be done with this information? We used a geo-statistical method named Kriging. This method uses the information from a geospatial delimited area, make an interpolation between registers with a similar origin or classification, to point out the areas that according to the analysis, are more susceptible (has higher probability) to an accident.

The analysis was done using QGIS, which is a free open-source platform for geospatial data analysis. In order to locate the data within a map, it is necessary to capture the map from any mapping source. In this case, we used the map from Google where we put the information at to visualize it. Then, selecting two specific points with its corresponding coordinates, there is a way to do the geo-reference. That way, once the reports are added, they will be located over a preliminary referenced map.

The reports, which are imported from the database, are loaded into the program which can be handled in different layers. Therefore, can be loaded different data to work within the same map. In this case, all the reports were loaded, and we ran the tool for Kriging analysis. The result can be seen in figure 8, we describe our proposed Kriging model to determine future numerical prediction.

According to the analysis, with such a few reports, the darkest area marked in the map is that with the highest probability of an accident. The way Kriging determines this information is doing interpolation of the different reports in different locations, and find in different directions the level of influence on of them can influence in some others.

4. Conclusions and Future Research

It is through all this validation process that we learned the potentiality of this system. The way that the tool could gather the information with just a few users and also

provides such a useful information with just a few reports, provides a very good taste of how good this proposal would work in a larger scale. The output of this exercise could be used, in this case, to focus the strategic measures to prevent accident in the conflict zones. If the measures are implemented in the areas where is predicted a higher probability of an accident, the impact of the measure will be higher. This provides a very good feeling about how useful and practical the proposed methodology can be.

With the use of this innovative application combining Data Mining and a Kriging Model based on a mobile dispositive is possible to determine the places where a traffic accident is possible to occur in Ciudad Juárez; by an alert sent to a mobile device with GPS, providing statistical information through a Web server that returns the level of rush hour in the area consulted [4]. The most important contribution is the possible prevention of future deaths in the city caused by traffic accidents. The future research will be to improve the visual representation of traffic problems with real on-time information through an Intelligent Diorama to specify an umbral of danger to an intersection of a Smart City. This design will bring common information to family members or social network close members.

Another possible extension will be to update our database using recent data from the local Transit Department's central server of security. Taking into account the 47,500 deaths related to traffic accidents in the last six years in Mexico, we think this innovative technology has promising application in another metropolitan cities in Latin America with similar problems of traffic, such as: Araguaiana, Blumenau, Joinville, Londrina, Manaus, Rondonópolis, Uberlândia. There exists a plausible application for motorcyclist since they face a higher risk of traffic accidents in Queretaro: 55 deaths out of 67 accidents in 2019. In addition, this application will be used as Recommender System when traveling to another countries [7] and explain different scenarios according time and location. In a future research we detail a prediction model using Random Forest to predict where will be occurs an attack of carjacking with basis on police department information, and using a hybrid model with another different Bioinspired Algorithm as Okapi Algorithm - This research group is researched about a novel paradigm related with Okapis, and proposes an idea about collective behavioral in a herd with skills different to each issue- or Wolf search algorithm with ephemeral memory.

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