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Smart Governance and Analysis System for Traffic Police Officers

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Abstract: ***With rapid economic growth, the management of employees working outdoors gradually becomes more intensive. The traditional attendance systems typically focus on collecting employee attendance information and are not suited to the accuracy of work performance. As a remedy to this issue, we have designed a system, which consists of three components: a Smartphone-based APP to collect employee attendance, work, and location information; a database to store the data; and a smart data analysis centre to make a systematic evaluation of employee work performance. Management can obtain the key information quickly and adjust work assignments based on performance. New solutions for indoor and outdoor location, GPS deviation improvement, and work performance measurement are put forward. This system will be helping government to better regulate the traffic operation and reduce associated costs. With the attendance management system, this system also consists a challan system to bring about a corruption free and formal legal challan system.***

Keywords: Attendance management, work performance measurement, GPS, police officer

1. Introduction

Global Positioning System (GPS) was developed by the United States in the 1960s, and it was put into use in 1994.It uses 24 satellites distributed in 6 orbits. Once a receiver receives signals from more than 3 satellites, the specific position can be identified. Up till now, GPS is the most successful satellite positioning system in the world. In practice, many applications and experiments use GPS, and it plays a key role. The entire world benefits from this advanced and powerful product in both military affairs and daily life. Gradually, more and more products have been developed

Based on the utility of GPS, for instance, navigation systems that use GPS technology to guide travellers and bus tracking systems that use GPS technology to track specific bus locations. Two popular and widely used applications, Google Map adopt GPS as well. Moreover, almost all cell phones currently have an installed GPS device. Obviously, GPS use is everywhere. The service it provides help change the world and make it a better place for everyone. For many types of outdoor work, such as road construction, policing traffic, oil exploration, railway work and garden maintenance, the work schedule and location are planned in advance and vary frequently, even daily, and often, workers may be given last-minute tasks requiring a change in work location. For instance, a traffic officer often receives some urgent tasks to address a traffic jam or traffic accident as soon as possible to ensure smooth traffic and safe travel. Generally, the situation where an employee does not work in his normally assigned area is referred to as "away from work location". The working areas planned in advance are arbitrary polygons on a map, so we can judge whether the user is "away from work location" by determining whether the employee's location is in the polygon. Management needs to know whether employees are at work on time in the specified areas, whether they arrive late or leave early, and the quality of their work performance in a given period of time. Unfortunately, the traditional attendance management systems are not designed to monitor and evaluate how the employees work outdoors. However, with the wide use of GPS, scientists can develop new solutions, and there are many systems and tools being proposed to solve this problem. Among all types of employees working outside, police officers are of the greatest importance. Their responsibility is to guarantee human safety, regulate social activities and make sure everything progresses smoothly. From this perspective, a work performance measurement system for police officers who always patrol outside is needed. Such a system can promote the best work performance from officers

And eliminate the phenomenon of dereliction of duty. To meet this demand, this paper proposes to develop a system based on Google Android, GPS.

Map/Reduce to fulfil the desired monitoring and work performance measurement functionality. Compared with the traditional approaches that monitor attendance and work performance via manual operations by the human resource department, the proposed system achieves its designed goals with high accuracy and efficiency. It not only collects all employees' commuting time, location trajectory and other work information but also judges whether they arrive late, leave early or are away from their assigned work location. The most important point is that the system can evaluate work performance based on these data, so management can review the performance of the entire department easily. At the same time, the police department can adjust employee assignments according to their performance to save manpower, eventually yielding significant cost savings in the long run. In this paper, a smart governance and analysis system for traffic police officers is proposed with three components. The system also provides some practical functions to improve department management, such as notices for a temporary task assignment and online and real-time inspection via SMS and APP pushing. To summarize, there are three main contributions of this paper. A smart work-performance measurement algorithm is created to evaluate work performance based on attendance, work and location information. This system can determine whether employees are indoors or out, according to the location collection environment, which is an important attribute in work performance evaluation. The remaining content is organized in the following fashion. The next section gives a

review of previous work related to GPS application in determining indoor and outdoor location and relevant techniques widely used in this field. Some technical and research solutions for indoor and outdoor location computation, data quality control and work performance measurement are put forward. The paper concludes and gives some ideas for future research.

2. Literature Review

Employee attendance management is an important aspect of the smooth operation of enterprises and government departments. There are two main ways to achieve this. One encompasses a number of manual operations, which is complicated, entails high management cost, and is often unreliable. Another method uses special equipment to record employee attendance data, such as bar code scan, IC card scan, magnetic card scan, iris recognition and facial recognition. For this method, equipment must be installed and maintained. It is generally unsuitable for employees who work outdoors. An attendance management system based on bar code scanning is proposed. Obviously, this type of system requiring special support equipment has some drawbacks, such as high material consumption, serious queuing problems during peak periods, and the problem of lost cards and their replacement. To overcome these drawbacks, attendance systems based on physiological characteristic recognition have appeared, such as the fingerprint identification system, but its drawbacks include expensive equipment, complex technology and complex deployment.

Some systems are implemented to allow users to login at different a geographic and network location, which aims to map attendance, location and time distribution. Basically, the proposed attendance management system for outdoor staff uses GPS to collect location information. Four aspects of the GPS process including receiver positioning, coordinate transformation, Gauss projection and map matching are discussed. Additionally, the paper explains the phenomenon that occurs when a GPS receiver cannot receive a satellite signal because of occlusion by tall buildings and describes two countermeasures. To determine whether employees are working outside or are indoors, the system should support the ability to distinguish indoors from out. There are many studies regarding Indoor positioning that are mainly based on ultrasonic positioning technology, infrared-based location technology, ultra-wideband-based location technology or RFID positioning technology. In practice, these methods require additional expensive accessibility tools. There are some mature attendance management products on the market, such as the "Easy Control" mobile attendance system, which uses cell phone GPS chips to obtain employees' real-time locations, the "Outside 365"attendance system, which includes some improvements compared to "Easy Control" and the "Sign-in Overall ‘attendance system, a phone-based application. They mainly focus on the collection of employee information and do not make a comprehensive and systematic evaluation of employee work performance, so management cannot obtain the necessary data quickly to adjust task assignment according to performance. In this paper, we also aim at solving another "popular" work performance issue, namely work performance measurement of outdoor employees, using GPS and big data analysis technologies.

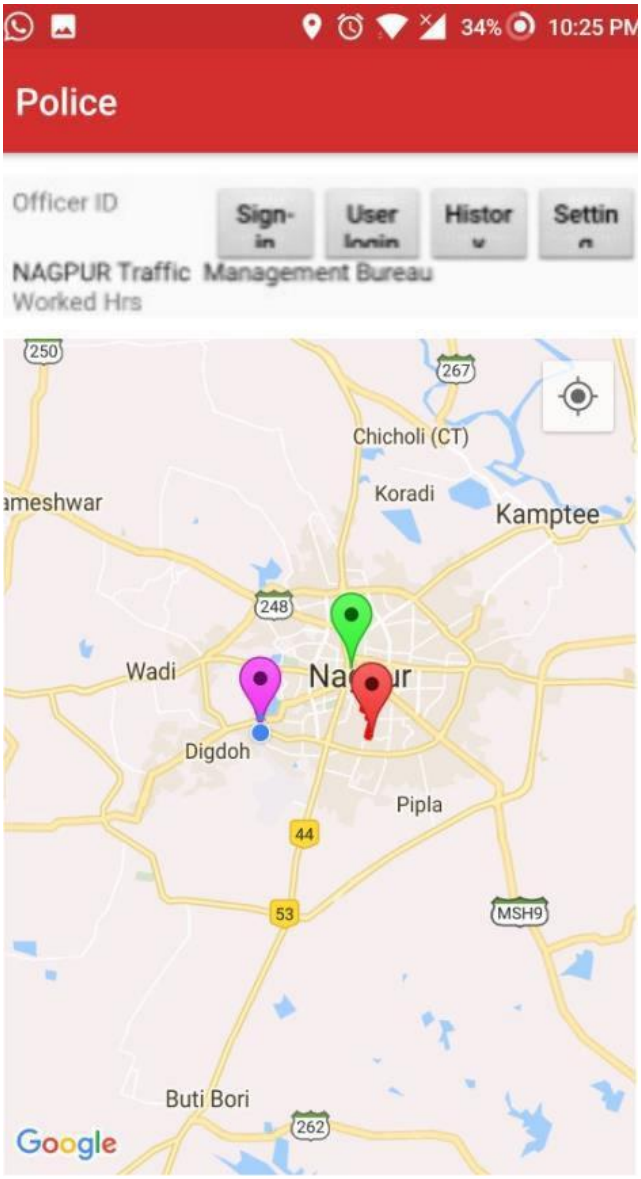
3. System Architecture

The design of the application plays a critical role in performance and scalability. This system is intended to be continuously improved by the expansion of system capabilities. The system primarily consists of three parts: a mobile operation APP working on the Android system to collect information; a data warehouse placed in the police department for data storage; and an efficient and stable data analysis centre running in the backend. The mobile operation APP is based on the Android system and can support versions 4.0 and higher. It is designed to collect officer data for work performance evaluation and can upload the data to the data warehouse continuously. The data warehouse receives stores and pre-processes the information, which includes login records, work start and end times, officers' photos and GPS information. The data analysis centre is mainly used to calculate the officers' work performance according to their attendance and GPS data. The police officers log into the application installed on an Android cell phone equipped by the police department. The APP can manage the user's information and collect location information every minute. When the officer clicks the logout button, it uploads all data to the data warehouse via TCP protocol and stops collecting data until it is started again. The data warehouse receives all officers' location information and applies some filters to improve the data quality. The backend layer of the data analysis centre contains a series of computations to provide a measure of an officers' work performance according to predetermined formulas.

A. Mobile Operation App

This application is specifically designed for those police officers who primarily work outdoors, for example, law enforcement police officers and patrol officers. All police officers are equipped with identical cell phones with this application installed. Officers can register their basic information and login to use the APP's functions. In addition to the login function. Here we concentrate on the APP's location collection function. When a police officer clicks the "Sign in" button, the program running on the APP backend begins to collect location information using the GPS chip inside the cell phone, according to the APP environment, every minute. Once the officer clicks the "Sign-off" button, all data in the APP are uploaded to data warehouse. It also integrates the online Baidu Map allowing users to review their exact trajectories.

It provides the officer ID, how long the officer has worked for the current day, and work start and end times. Then, a map with the trajectory is displayed below. This interface demonstrates the application's ability to track an individual’s movement on duty. This allows for improvement in work performance measurement and evaluation of responsibility. The map shows the officers' trajectory, and every red point represents an address where the APP collects the user's location information. Mobile app also contains the second part for that person who breaks the rules related to traffic; we refer those people as user.



This side of app again has two views, first one is the login form for already registered users and the second one is for new users, which contains entities as the first name and the last name of user, their email id, mobile number, licence number and the vehicle number. After that the user has to create his password as per his comfort. Licence number is not mandatory to be filled because the user can be caught for not having driving licence.

B. Data Warehouse

The Sql database is widely used all over the world. Cross Platform operation, big data and multi-user management, High performance system maintenance and outstanding portability, Compatibility, and connectivity form its unique value. It is used by our system to store the data. We also use Map/Reduce technologies to generate data. Typically, police officers activate the application when they Start working and deactivate it when off duty. Data generated during the day are then uploaded to the backend and Stored in the Sql database, including attendance information And GPS trajectory data.

Record ID	Officer ID	Check-in Date	Check-out Date
158505	xxx865	2015-08-20 08:09:48	2015-08-20 10:59:58
158517	xxx925	2015-08-20 09:00:31	2015-08-20 12:11:27
158514	xxx800	2015-08-20 09:06:03	2015-08-20 12:06:21
158521	xxx569	2015-08-20 10:00:01	2015-08-20 11:44:33

Sample Attendance Record

The attendance datasets include attributes for police number, check-in time and check-out time. The GPS data include attributes for collection Date, location coordinates, and the signal type how the positioning is conducted. These data are pre-processed to ensure their integrity before being permanently stored in Sql. Within a given working period, for example, 9am to 6pm, the application cannot be turned off once activated. In this way, the work performance of any police officer can be evaluated reasonably.

Sample Location Record

Location Record ID	Officer ID	Collection Date	Longitude	Latitude
109158243	xxx057	2015-08-17 16:38:50	106.636899	26.658991
109158244	xxx057	2015-08-17 16:39:50	106.637041	26.659359
109158245	xxx057	2015-08-17 16:40:51	106.63704	26.659438
109158246	xxx057	2015-08-17 16:41:51	106.637063	26.659171

Location record ID is the unique identifier of a location record and is a self-increasing Integer. Officer ID is the same as above. Collection date refers to when the corresponding record is generated. Location type indicates the type of location report and can be, for example, GPS location. Latitude and longitude indicate the relevant location. The data warehouse also stores the officers' job scheduling Data, such as work start time, work end time and work Location. Record ID is the unique identifier of a job scheduling record and is a self-increasing integer. Working date is the officer's work Date.

Sample Job Scheduling Record

Record ID	Officer ID	Working Date	Working Start Time	Working End Time	Area ID
87121	xxx116	2015-08-18	8:00	17:00	356
87122	xxx116	2015-08-19	9:00	12:00	237
87123	xxx116	2015-08-19	13:00	18:00	240
87124	xxx116	2015-08-20	18:00	23:00	290

Working start time and working End time indicate the time when the officer starts and ends work on the working date. Area ID is the work location ID.

Users are considered as common people that break traffic rules. When any user caught by traffic police officer, he/she have to register in user side of APP. User have to fill his basic information as first name, last name, age, contact details and vehicle number etc. Licence number is not mandatory as any user could be caught for not having licence also.

User have its separate database, when new user break rule and caught by traffic police officer, he have to register first and then pay fine for corresponding rule break. When same user breaks rule again i.e. user who has already registered in this system and caught for rule break, he has to simply login to his own account and pay fine.

User's all previous *Challans* can be seen in his account *Challan* section.

C. Data Analysis Centre

The data analysis component is responsible for a variety of jobs based on the original data stored in the data warehouse, which is a major function of the system. To better check the work status of police officers, the data analysis Centre (DAC) combines a variety of data to support many Data report requirements. For instance, to judge whether an Officer is on or off duty on schedule, the DAC must be able to compare the attendance data with job scheduling data. The DAC can also determine whether officers leave the duty area and calculate how much time they take off, how much time they patrol, and even how long they have remained indoors and out. Combining location data with velocity, the DAC can conclude whether the officers are patrolling on foot, riding in a police motor van or driving a car. Among all the data analysis jobs, the most important is to calculate the work performance in a distributed system.

4. System Feature Design

The application is designed to record police officer movement trajectory during working hours. Fulfilling this function is composed of three steps: outdoor and indoor positioning, data quality control, and trajectory creation. To better record movement trajectory, the application is designed to query the GPS chip inside a cell phone to record the location every minute. Baidu map is activated by the application to visualize the results. During the trajectory mapping process, several problems are noticed frequently. The details of the process, as well as countermeasures corresponding to the identified problems, are discussed below.

A. Indoor and Outdoor Positioning

When the officers are working outside, where a GPS signal is available, accurate positioning is not a problem because GPS can provide the precise location. However, patrol officers sometimes have to conduct indoor activities where there is no GPS signal. Without such a connection, location cannot be recorded. We have designed a countermeasure for this situation. Usually, one's location can be determined via GPS. The problem of determining indoor position without a GPS signal is addressed by this three-step countermeasure; however, due to the instability of Indoor signals, indoor positioning accuracy is limited to some degree.

B. Data Quality Control

In most cases, outside positioning using GPS satellite signals is accurate enough; however, tall buildings and thick woods sometimes cause interference. Once a cell phone loses the GPS signal, it automatically switches to receiving its signal From nearby ISP base stations. Due to the nature of the Cellular network, a cell phone may receive several signals from different ISP base stations at the same time, resulting in some points jumping away from the original position. These points are called biased points or noisy points. Biased points on the map make the whole trajectory look messy. Only a clear trajectory provides a reasonable work performance evaluation. To achieve this, biased points must be eliminated from the database. The criterion to identify biased points is based on whether the officer can move from Point A to point B within one minute. Because the coordinates of any two points are known, the surface distance between two points is used to approximately represent the displacement. Therefore, periods of displacement can be used to determine whether this point is normal by analysing the movement trend.

C. Work Performance Measurement

A set of evaluation indicators and many algorithms are used to evaluate officer work performance. To quantify officers' work performance, the data include individual attendance data, location and trajectory information and given parameters of different work priorities. There are three types of evaluation dimensions used in this paper: arriving late, leaving early and being away from work location. The original score, penalty coefficient and item weight are described. And these items are set according to many experiments and the police officers' experience. To demonstrate how the system works to record a police Officer's daily movements and how the results are reported, we present the record of one officer for one day in this section. The selected officer launched the application via the "Sign-in" button. Then, the APP ran in the backend, and his position was recorded by the system every Minute. When he clicked the **"Sign-out"** button to indicate his workday was over, and the APP was terminated. Then, the day's work location history was generated automatically. Over time, several trajectories in one day can be generated. The data analysis centre can automatically calculate this Officer's work status, including how long he was indoors and out, how long he was on patrol and how long he was not. Tables are generated regularly in the data analysis centre, and Managers can access them at any time. The officer's Photo taken when he activated the APP is displayed in the APP.

5. Conclusion

As an important contribution to police officer attendance Management and work performance measurement, this paper introduces a Smartphone based system with three major components to evaluate comprehensive work performance. The Front end component-mobile operation APP performs the task of data collection, including attendance data and location information, using tracking and positioning technologies, while the backend data warehouse and data analysis centre components are used, respectively, for data storage and analysis. The obtained results are encouraging; the system can be further enhanced. More efficient data storage and transportation technologies can be used to improve system performance. Furthermore, many machine learning techniques can be applied to this system to improve data analysis and obtain more accurate results. For example,

the system could be used to identify recurring misbehaviour of individuals using multiple data and promptly notify the administrator. Data mining technology can also be used to link officer location data and traffic information to evaluate police officer work status and help the administrator optimize officer Deployment.

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