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Performance Measurement System Smartphone Based Apps

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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 quantification of work performance. As a remedy to this issue, a smart work performance measurement system is proposed in this paper. The proposed system consists of three components: 1) a Smartphone-based APP to collect employee attendance, work, and location information; 2) a data warehouse to pre process and store the data; and 3) a smart data analysis centre to make a comprehensive and systematic evaluation of employee work performance. Management can obtain the key information quickly and adjust work assignments based on performance. New solutions and algorithms for indoor and outdoor location, GPS deviation improvement, and work performance measurement are put forward. This system is being used in civil management bureau, and the observed results are encouraging, demonstrating the efficiency and accuracy of our system, and helping builders to better regulate the work operation and reduce associated costs.*

Keywords: *Attendance management, work performance measurement, GPS, big data, Image collection, Supervisor .*

I. 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 identify . 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 benefit 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 and Yelp , 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 supervisor often receives some urgent tasks to address a construction site or load delivery on site as soon as possible to ensure smooth work and safe.

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, supervisor are of the greatest importance for various site. 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 site engineering who always patrol outside is needed. Such a system can promote the best work performance from engineering's and eliminate the phenomenon of dereliction of work. To meet this demand, this paper proposes to develop a system based on Google Android, GPS, WIFI and big data technologies integrating Hadoop and 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 foundation 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 work-performance measurement system is proposed with three components, and its efficiency is proven for one foundation with different site work in Chennai city. The system also provides some practical functions to improve 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 new algorithm is proposed to judge the location deviation data generated by GPS chip, WIFI and ISP base station. The algorithm can also make a correction to get actual location.
- 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. Section 3 portrays the system architecture's design and implementation. Some technical and research solutions for indoor and outdoor location computation, data quality control and work performance measurement are put forward in Section 4. Section 5 gives a practical and detailed case study using this system. The paper concludes and gives some ideas for future research in Section 6.

II. 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 described, but its drawbacks include expensive equipment, complex technology and complex deployment. Taylor and Nygren describe an attendance system that permits flexible use by employees and is integrated with the human resource system. The systems are implemented to allow users to login at different geographic and network locations, which aims to map attendance, location and time distribution.

Basically, the proposed attendance management system for outdoor staff uses GPS, WIFI and ISP base station location technologies 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. GPS indoor positioning difficulty is discussed, and a maximum likelihood estimation algorithm is proposed to improve indoor positioning accuracy that achieves some success. 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.

Factors Affecting to the Quality:

To maintain the quality throughout the project, following are the different factors affecting deeply to the quality.

1) Money and Time
2) Material
3) Manpower

4) Machines and methods
5) Market
6) Management
7) Checklist
8) Customer satisfaction

III. 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 workers 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, workers photos and GPS information. The data analysis centre is mainly used to calculate the workers work performance according to their attendance and GPS data. Fig. 1 shows the current system design and reflects our expectations. The site engineering's login 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 user 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 engineering's 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 site engineering's work performance according to predetermined formulas.

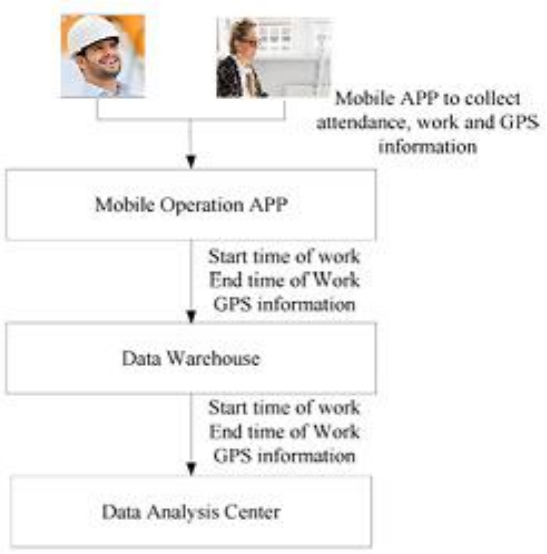

Figure 1. Application architecture.

A. MOBILE OPERATION APP

This application is specifically designed for those site engineer who primarily work outdoors, for example, site managers and site engineers. All site engineers and managers are equipped with identical cell phones with this application installed. Workers can register their basic information and login to use the APP's functions. In addition to the login function, there are some other practical features, such as notice of a temporary work assignment and online and real-time inspection via SMS and APP pushing. Here we concentrate on the APP's location collection function. When a engineers 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, WIFI or ISP base station, according to the APP environment, every minute. Once the engineers clicks the ``Sign-off'' button, all data in the APP are uploaded to data warehouse. It also integrates the online allowing users to review their exact trajectories.

Fig. 2 shows user SE011's working interface on the APP. At the very top, four buttons can be seen. Their functions are application activation/application termination, inspection, daily travel history, and system settings. For the content below, it provides the workers ID, how long the site supervisor 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 work. This allows for improvement in work performance measurement and evaluation of responsibility. In Fig. 2, user SE011 activates the application at 11:06:23, and it remains active for 37 minutes and 26 seconds. The map shows the user's trajectory, and every green point represents an site where the APP collects the user's location information. We can see there are 4 green points collected in 37 minutes.

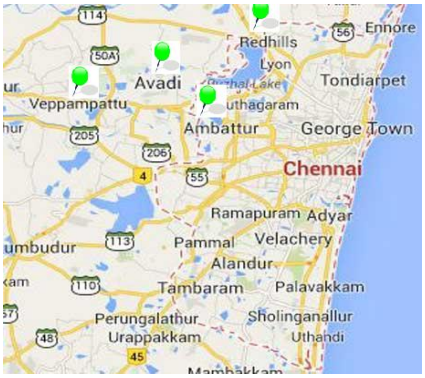

Figure 2. User SE011's location information

B. DATA WAREHOUSE

The Oracle 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 Hadoop and Map/Reduce technologies to generate data. Typically, site supervisor activate the application when they start working and deactivate it when off work. Data generated during the day are then uploaded to the backend and stored in the Oracle database, including attendance information and GPS trajectory data. The attendance datasets include attributes for police number, check-in time and checkout time. The GPS data include attributes for collection date, location coordinates, and the signal

type (GPS, WIFI, Base Station) how the positioning is conducted. These data are pre processed to ensure their integrity before being permanently stored in Oracle. 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 project manager can be evaluated reasonably.

Table 1. A sample attendance record

Record ID	Engineers ID	Check-In-Time	Check-Out-Time
12567	SE0101	23-03-2016 09:05	23-03-2016 19:05
12568	SE0124	23-03-2016 08:05	23-03-2016 20:15
12469	SE0111	23-03-2016 10:10	23-03-2016 16:05
12570	SE0123	23-03-2016 09:05	23-03-2016 18:25
12571	SE0142	23-03-2016 09:15	23-03-2016 21:19

In Table 1, record ID (referred to as aid) is the unique identifier of an attendance record and is a self-increasing integer. Worker ID (referred to as wID) is the site supervisor ID. Check-in date (denoted by ciDate) and check out date (denoted by coDate) indicate the time when the supervisor checks in and checks out. Accordingly, one attendance record can be formulated as follows:

$$ar = (aid, wID, ciDate, coDate)$$

Table 2. A sample location record.

Location Record ID	EngineersID	Collection Date	Longitude	Latitude	Type
10987	SE011	23-03-2016 19:05	106.2343	26.8675	15
10986	SE0752	23-03-2016 20:15	106.2324	26.5318	16
10956	SE0124	23-03-2016 16:05	106.4367	26.8765	16
10965	SE0165	23-03-2016 18:25	106.7632	26.1368	15

In Table 2, location record ID (referred to as nid) is the unique identifier of a location record and is a self increasing integer. Engineers ID is the same as above. Collection date (denoted by cDate) refers to when the corresponding record is generated. Location type (denoted by lType) indicates the type of location report and can be, for example, GPS location, WIFI location, ISP base station location. Latitude and longitude indicate the relevant location. Accordingly, one location record can be formulated as

follows: *lr* = (*nid*, *oID*, *cDate*, *longitude*, *latitude*, *lType*). The data warehouse also stores the engineers job scheduling data, such as work start time, work end time and work location.

Table 3. A sample job scheduling record.

Record ID	Engineers ID	Work Date	Start Time	End Time	Area
12987	SE011	23-03-2016	08:23:23	20:00:14	53
12986	SE0752	23-03-2016	10:23:45	19:56:12	48
13956	SE0124	23-03-2016	09:23:12	16:12:45	8
14965	SE0165	23-03-2016	09:00:00	18:34:12	45

In Table 3, record ID (referred to as jID) is the unique identifier of a job scheduling record and is a self-increasing integer. Working date (denoted by wDate) is the engineers work date. Working start time (denoted by wsTime) and working end time (denoted by weTime) indicate the time when the engineers starts and ends work on the working date. Area ID (denoted by areaID) is the work location ID. Accordingly, one attendance record can be formulated as follows:

jsr = (*jID*, *oID*, *wDate*, *wsTime*, *weTime*, *areaID*)

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.

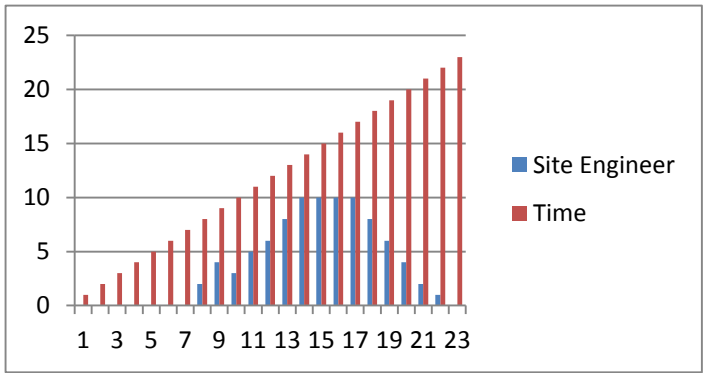

Figure 3. Site engineers timing on 23/03/2016

To better check the work status of site engineers, the data analysis centre (DAC) combines a variety of data to support many data report requirements. For instance, to judge whether an worker 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 engineer leave the duty area and calculate how much time they take off, how much time they outdoor, and even how long they have remained indoors and out. Combining location data with velocity, the DAC can conclude whether the engineer are outdoor work, riding for purchase materials. Among all the data analysis jobs, the most important is to calculate the work performance in a distributed system.

IV CONCLUSION

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. In addition to work performance evaluation, the system also provides practical functions like notice of a temporary work assignment and online and real-time inspection via SMS and APP pushing. This paper also puts forward some technical and research solutions for outdoor and indoor location calculation, data quality control and work performance measurement.

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