Analysis of Traffic Based on Mobile Signalling in Smart City

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ABSTRACT

There are abundant resources of users and relative basic data in mobile network. More correct and more comprehensive data can be gotten with the statistical and analysis data based on mobile signalling. The analysis results can provide detail transportation analysis results for government. In the same way, better data will be provided for traffic planning and policy formulating. It is benefit for traffic management department to improve the efficiency and effect when they optimizing traffic planning. The citizen’s traffic states in big city have been analysed in this essay with the collected mobile signal based on mobile network. And the simplicity and high efficiency have been tested with real experiment. All of those will establish groundwork for smart traffic in the process of smart city.

INTRODUCTION

At present city management has been evolved from digital to wisdom. And smart city requirements to achieve a more comprehensive and more thorough city awareness and management, in the field of traffic management for need of wide-area scope of city traffic monitoring and management [1]. With the development of social economy and the speeding up of urbanization, the fast rise in number of motor vehicles, and the more the number of residents, big cities in China is facing increasingly serious traffic congestion, especially in the rush-hour traffic jams, it has affected the urban economic growth, people's living quality and the whole level of society development.

It is a kind of new technology to investigate the travel characteristics of the public whose mobile phone signal data is applied. The analysis is based on the mobile data of traffic and the information contained in it can meet the demand of traffic information analysis. Now the application of the technology of commercial systems are also available, its technology and market pattern in China, the United States, Canada, Australia, Japan, South Korea, and other countries was verified and promoted. Given its technology and the predictability of the market, there will be increasingly manufacturers and researchers to involve in this field [2].

In the process of commuter traffic analysis, how to analyse the position where people live and work is the key to solve the problem. Mobile network has a huge

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user resources and related data, the method used in this paper is the signalling data statistical analysis which is based on the mobile wireless network to obtain a more comprehensive and more accurate user data. And the analysis algorithm is put forward based on clustering of the position between live and work. The data analysis results will provide more in-depth statistical results and good data base for the committee and other relevant government departments in traffic planning or policy making. It can also help the transportation departments to improve efficiency and effectiveness of the transportation planning, monitoring and management.

MOBILE SIGNALLING POSITIONING

Signalling is to accomplish a certain business operation interaction and issued a series of instructions and commands. Signalling must abide by the agreement at the time of transmission. Implementation way of signalling function is called signalling devices. The signalling system of communication network is composed of specific way of signalling and signalling device. Communication network mainly used in our country is No.7 signalling protocol made in 1980 [3].

Mobile Signalling

With the rapid development of Internet and mobile communication technology, the proportion of the population of mobile users with smartphones is rising rapidly, especially in the developed regions such as Beijing, the mobile users share close to 80% of the total population. Therefore, the distribution of mobile users is like the overall regional population distribution [4]. It is representative to investigate and collect sample using mobile signal of the traveller’s departure and arrival. So, the research of this paper is based on the analysis of China mobile GSM network. The GSM system is mainly composed of the four subsystems. They are exchange network subsystem (SS), wireless base station subsystem (BSS), a mobile station (MS) and the operation and maintenance centre (OMC). Each subsystem connects through relevant interface and exchange control information between various communication equipment in the form of a signalling.

Data transmission at base station is mainly through A interface and Abis interface which is shown in figure 1.

![Figure 1. The GSM system.](image)

For transportation, it is need to reflect when and where the user position changes for the mobile phones data. That is important to know about when the mobile phone users change the position, and where they will move to. In the mobile phone signal data, each of the mobile data are triggered by events, such as mobile phone users calling, called switch, send/receive messages, community change or location update, etc., each of them is corresponds to a signalling data. It is necessary to reflect when and where the user moves, include the final position for mobile phones data once the transportation is analysed through mobile phone signal. Now the mobile phone signalling data can accurate to seconds provided by China mobile base stations, and time information deviation is less than 5 seconds.
So, it can completely meet the requirement of the analysis of transportation based on this theory.

**Mobile Signalling Positioning Based on Base Station**

Base station positioning is generally applied to mobile users. Mobile base station location services are also known as LBS, namely the Location-based Service. It is through the telecom operators' networks (such as GSM) to obtain the position information of mobile terminal users (also referred to as latitude and longitude coordinates). Methods that commonly used positioning are TA (Timing Advance) positioning method, TOA (Time of Arrival) positioning method, the TDOA (Time Difference of Arrival) positioning method, the AOA (Angle of Arrivals) positioning, TOA-AOA location method and positioning method based on field, etc. At present the most commonly used positioning method is the COO (i.e., the Cell of Origin) positioning method. The basic principle of COO localization method is according with the ID number of the mobile station in a community (Cell) to determine the location of the mobile station. Every community has a unique ID number, also called CGI (Cell Global Identity). CGI is composed of LAI (Location Area Identification) and CI (Community Identification). LAI is made up of MCC (Mobile Country Code), MNC (Mobile Network Code) and LAC (Location Area Code), namely:

\[
\text{CGI} = \text{LAI} + \text{CI} = \text{MCC} + \text{MNC} + \text{LAC} + \text{CI}
\]

Mobile station of community ID number is already available in the network information. The mobile station will be in correspondence with the community ID when the mobile station in a residential area registered in the database of the system. The effective range of mobile station can be known roughly if the centre of the base station in the community and cell coverage radius are gotten. The position precision of COO positioning method is the coverage radius of community.

**ANALYSIS OF LIVE AND WORK LOCATION**

**Confirmation of Work Location**

A period (generally the period about 10:00 ~ 17:30 will be selected when user moves more frequently) is chosen to analyse the location area code LAC and community identity CI of a user data. The LAC and CI will be clustered. The cluster radius of choice is r. The centre of the coverage of the highest cluster is calculated. And the clustering centre of LAC CI, coverage and coverage radius size is recorded. If the cluster coverage rate is too low (below 50%) or the coverage radius is too high (>r), it can be considered that the user has no fixed work place. Otherwise longitude and latitude of the cluster centre of the LAC CI can be considered as the working position of the user, in the same time the related cluster information is preserved.

The result is recorded to the user’s archives, and then set the different weight value. The weight value is higher the interval from the current time is nearer. Clustering LAC CI of user files can confirm the user recent work location.
**Confirmation of Live Location**

A period (generally the period about 20:00 ~ 7:00 next day will be selected when user moves more frequently) is chosen to analyse the location area code LAC and community identity CI of a user data. The LAC and CI will be clustered. The cluster radius is r. The centre of the coverage of the highest clustering is calculated. And the clustering centre of LAC CI, coverage and coverage radius size is recorded. If the clustering coverage rate is too low (below 50%) or the coverage radius is too high (>r), it can be considered that the user has no fixed work place. Otherwise longitude and latitude of the clustering centre of the LAC CI can be considered as the live position of the user, in the same time the related cluster information is preserved.

The result is recorded to the user’s archives, and then set the different weight value. The weight value is higher the interval from the current time is nearer. In addition, the weight that is associated with motor switch for LAC CI should be higher. Clustered LAC CI in user files can confirm the user recent live location.

**Statistics and Analysis of Travel From Work**

Through the above analysis, where users to live and work have been able to get. Then we can analyse the travel condition on the morning and evening rush hour. First user data with clear position to live and work are selected. The data in close range (less than 3 km) are filtered. LAC CI of users live position that filtered are clustered and the cluster radius of choice is r. Each user's residence cluster results are recorded. The $i$th user live clustering results is set as $O_i$; Similarly, the $i$th user work cluster result is carried out for $D_i$. Thus, each user's residence and workplace cluster results of binary group $(O_i, D_i)$ is gotten. Then we count the number of each binary group with the same user, and sort the statistical results according to the quantity from large to small. Finally choose the sort of binary group combined with the GIS data. On the map from the cluster centre of $O_i$ to the cluster centre of $D_i$ is arrowed. Based on the marked map, corresponding public transportation lines can be planned combined with the actual situation of urban road.

**EXPERIMENT AND CONCLUSION**

Community identification codes of Beijing within each district are shown in figure 2. The division size of code is very fine to reduce the deviation and avoid the influence on the result. Table 1 shows the statistical results of the traffic situation through the experiment on a certain day from a subway station to another station.
The public transport traffic analysis system is based on community’s mobile phone signalling message acquired through the platform of mobile network to statistic and analyse. Users information of the work, live and travel behaviour are analysed and recorded according to the signalling network parameter information to get relevant results. Final data are used to ease the traffic pressure in big city. Public traffic is very important in the construction process of smart city. It is deserved to pay more attention to speed up the pace of smart city construction.

REFERENCES