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Application of Big Data in Intelligent Traffic System

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Abstract: *With the rapid developmentof society, transportation industryis also facing unprecedented challenges, if big data is used in this area, the advantage is obvious, it can resolve the questions of traditional traffic management system, in this article we propose an architecture of intelligent transportation system on big data platform, then we disuse the key technology in ITS:calculation of bayonet traffic flow, calculation of average speed of a road, querying the travel path of a vehicle, checking and controlling the fake vehicles.*
keywords:big data; Intelligent traffic system; application

I. Introduction

With the rapid developmentof society, transportation industry is also facing unprecedented challenges:
1. Transportationindustry can't meet the rapid growth of data. The data of transportation industry have rich sources, diverse types, and new data is produced continually. customer information of rail way, road traffic, aviation industry, public transit, are recorded ,and tens of billionstravel records are generatedevery year. Operating data generated by transport companies, such as the data generated by the courier companies. Dynamic data generated by various sensors, such as induction coil at bayonet point, infrared detector, microwave detector, ultrasonic detector, laser detector, video detector, and so on, and the data are generated by GPS vehicle location tracking system and other mobile deviceseach year the amount of data generated by the transportation industry in a cityhas exceeded TB level, are developing from PB level to EB.A massive data storage space and equipment are required and it must have fault tolerance and stability.
2. Traditional data processing systems are faced with the problem of inefficient or even failure.The information system of transportation industry after development forten years has had a certain foundation and scale, But generation of new business, rapid growth of data, complexity of the data processing are not foreseen.The traffic information management system using traditional data processing technology can't meet the rapid growth of data, it is inefficient, collapse and failures have occurred,when processing big datarecent years, new projects and renovation of the old system were carried outin some places,The rapid growth of data is still not considered, In the course of project construction and maintenance, the construction was emphasized,the maintenance was overlooked,data have not been excavated deeply, with the change of leadership, the life cycle of the system is shortened.
3. The current management system appeared single function, the lack of integration, backward technology and other issues.In the process of building the transportation information system, homogenization is serious, at the same time, development ofinformation technology in different regions is not balanced, data acquisition is at different depths in different area, and without uniform standards, The administrative department for the project only examine and approve it, but supervision and evaluation is lack.The data in most information system scattered in grassroots enterprises, the functional departmentjust collect the report and ledgeron a fixed time period, they did not achieve connectionsand data synchronizationbetween systems, and do not know well the data produced by enterprises.
The appearance of big data for resolving the above questions provides a new technical approach, big data applied to transportation industry has the following advantages:

1.Traffic management systemused big data technologycan handle vast amounts of complex and diverse data.

Big data has resolved three questions: datastorage, dataanalysis and datamanagement. Hadoop system is born with the ability to handle massive amounts of data,Data is stored on different nodes. A large task is divided into small tasks, and be finished in MapReduce model. At the same time, its stability and fault tolerance is important. Hive as a data warehouse can save big data in HDFS, its HQL sentence is translated into MapReduce task, and be executed on different node, HBase as a database can store and operate the data in column mode. Sqoop can translate data between RDMS and Hadoop. Flume is a highly available, highly reliable systems, it can collect distributed massive logs, and aggregate, transport them.

2. Big data can improvethe efficiency of transportation industry.

Transportation industry,involvingmany aspects of work, need to handle massive amounts of data,has more control model of application, has a great deal ofequipment, if a little accident occurred,the entire system

will run into inefficient state, after using big data technology, the information system can process the data and discover the accidentin good time, automatically handle it, or reported to the management staff and ask them to make decisions.Big data has a good predictive ability,it can reduce the probability of false alarm and underreportingof traffic incidents.Traffic guidance is an important part of intelligent transportation systems.By publishing guidance information for travelers, itcan indicate traffic conditions of downstream road, allow travelers to choose the right travel path, improve the traffic situation in the city. In the aspect ofimproving transport efficiency, improving the capacity of the road network, adjusting traffic demand, big data technology has obviousadvantages.

3. Big data can improve the safety level of traffic.

The real-time processing capabilities of big data can accurately probe traffic accidents, its predictive ability can effectively predict the occurrence of traffic incident, using microwave detection systems, video surveillance systems, mobile detection system, we can build an effective security model to improve the safety of vehicles. When security incidentshappened,and emergency rescue needed, Because of its comprehensive processing and decision-making capability, rapid response capability, big data can greatly improve the ability of emergency rescue, and reduce casualties and property losses.

II. Architecture of Intelligent Transportation on Big Data Platform

Intelligent transportation system on big data platform is a combination of multiple systems, models, department, technology.It can be said, It is a comprehensive system of system science, management science, mathematics, economics, behavioral science, and information technology.From the architecture, the platform includes basic business layer, data analysis layer andinformation publishing layer.As shown in Figure 1.

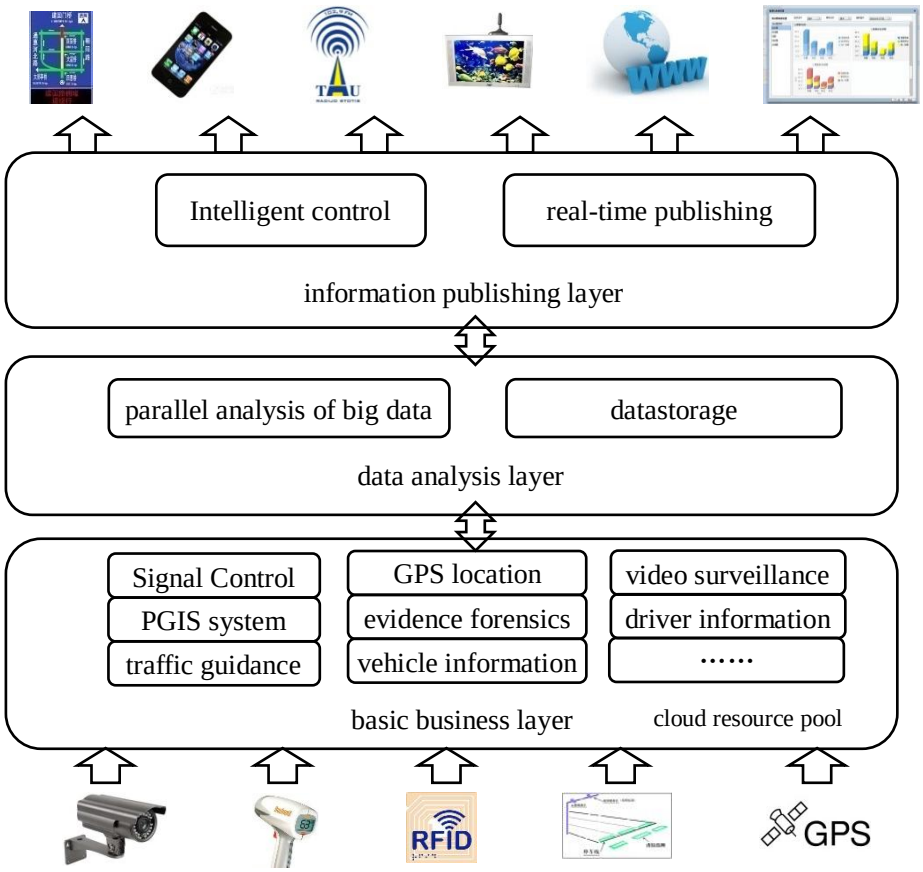

Fig.1 Architecture of Intelligent Transportation on Big Data Platform

The basic business layer is the foundation of data analysis layer and information publishing layer, its main function is to complete the basic work of the various business units, and to produce basic business data. It includes traffic information collection system, signal control systems, video surveillance systems, illegal evidence forensics system, 122 alarm receive and dispose system, GPS vehicle location tracking system, traffic guidance system, vehicle information management system, driver information management system, PGIS

system, and so on. the service of basic business layer is the basis for the work of the various business units,its data comes from data acquisition systemmentioned above, storage and handling of data is very important.Therefore, cloud computing technology can be used on the basic business layer, decentralized system can be integrated into the cloud, this will ensure the security and stability of the application system, and provide an efficient computing environment.

According to the information of the road network, the demand of public traveland comprehensive analysis of data, data analysis layer uses big data technology, data mining technology, combines with a variety of mathematical models for real-time effective analysis.It cangrasp the condition of the transportation systemin any time, such as road congestion degree, average speed, saturation, occupancy rate, interrupt rate.It can make further congestion warning, traffic guidance and other intelligent transportation behavior.Data analysis layer is built on Hadoop ecosystem, use commercial cheap server as hardware platform, use the open-source Linux as operating system, use HDFS as file system for big data storage, use MapReduce as a parallel computing model, use HBase as the database for processing the data, use Hive as data warehouse, use Sqoop and Flume as tools for data integration.

The information publishing layer according the result of the data analysislayer, publishes traffic conditions to public, business units, industry executives, etc. by internet, mobile terminal, desktop application, report, for their travel and business decisions. It is necessary for friendly interface, operating easily, rich feature.The information published includetraffic condition, traffic warning, data charts for decision. With the development of the times, publishing channels become diversified, changed from traffic radio and informationbulletin board to today's traffic radio, mobile TV, microblog, Wechat,information bulletin board and other forms and channels.

III. The Key Technologyon Data Analysis Layer

The difference between intelligent transportation systems(ITS) and the traditional traffic control system lies in its intelligent features,ITS can carry out intelligent control based on traffic condition.Hadoop ecosystem has a natural advantage in dealing with traffic big data.ITS hasa variety of data sources, complex data types, the huge amount of data, the traditional relational databaseis incompetence for big data.The bayonet in the cityis equipped with video surveillance system, and it collects traffic HD video data and vehicle information, Including vehicle pictures, vehicle type, vehicle color, passing time, speed, bayonet number, lane number, direction of travel and so on. The data generated by the GPS location tracking systemincludes the plate number, time, location coordinates;Internet of things produced the similar data. According to these basic business data, ITS can report traffic conditions, for example: trafficflow in the bayonet, average speed, degree of congestion.

1. Calculation of bayonet traffic flow

ITS can calculate the traffic flow of every bayonetin a certain time interval, such as 5 minutes, 10 minutes, 15 minutes, or other period of time, and push the calculated data to data publishing layer, report to the traveler, policy makers, business supervisor. Statistical analyzes were performed using Hadoop MapReduce parallel model, which is the most efficient way.The datagotfrom HBase database including bayonetID, directionID, passingtime. The key in map() function is bayonetID and directionID, the value in map() function is passingtime.

the output <key-value> pair of Map() function is <key, one>, the key include bayonetID, directionID and passingtime, the value is one.

Reduce () function can calculatethe sum of one direction of traffic flow,between the start time and end time in a bayonet, the output <key-value> pair is <bayonetID_directionID_passingtime, count>.

2. Calculation of average speed of a road

The average speed of a road is an important indicator of the efficiency of road traffic, in general, the higher speed of traffic, the higher the traffic efficiency.the average speed is not the speed measured by a radar at a placeand a time point. Because it can only represent a point, but can't represent the whole road.

We look the time measured the same car passing theadjacent bayonets as the spent time, distance between the adjacent bayonets as distance that the vehicle has traveled. The average speed may be represented by the following formula:

$$\bar{v} = \frac{n \times s}{\sum_{i=1}^{n}(t_{end} - t_{start})}$$

where, s is the distance between adjacent bayonets, t_{end} is the time the vehicle run out the road segment, t_{start} is the time the vehicle run into the road segment, t_{end} and t_{start} must be the time that the same vehicle run into and run out the road segment. The vehicle leaving or entering in the middle section of the road does not included.

In MapReduce model, to simplify programming, we use two MapReduce process to calculate the average speed. At the first round of calculation, map() function get the information that the vehicle pass the bayonet from HBase, including plate_num, bayonetID, directionID, passingtime. Reduce() function can calculate the time the vehicle has spent through the road.

At the second round of calculation, in the map() function, the key is bayonetID and directionID , the value come from the map() function's output at the first round. the reduce() function count the sum of the spent time and calculate the average speed.

3. Querying the travel pathof a vehicle

Querying the travel path of a vehiclehas an important role in the public security investigation work at a specific period of time. This work requires a lot of manpower, to search the surveillance videoday and night, to look for suspicious vehicles manually, thenthe travel path of the vehicleis drawn manually. Now, ITS can resolve this problemefficiently, the bayonet can identify and record the plat number of the passing vehicle, save it into HBase, index on plat number and passing time, when querying the travel path, enter the start time and end time,thenan ordered data set is returned, now we can draw the travel path very fast according it, it can reach the second level.

4. checking and controlling the fake vehicles

The fake vehicles , we call it clone vehicle, its plate number, type, color , even credentials are the same as the true vehicle, its harmfulness is obvious.The police carried out its strict management and controlto identify the fake vehicle,fully relying on personal experience before, the police can touch the plat, enquire the driver, query the information of the vehicle and driver.

Now, we can use big data technology to identify the fake vehicle. Its principle is shown as: ITS can query the information, and calculate the time difference between different bayonets, if the time difference is less than 5 minutes, even 2 minutes, the vehicle maybe is a fake vehicle, because the vehicle can't travel the distance between the two different bayonets within the certain time.

In MapReduce model, the key of reduce() function is plat_num, itsvalue is bayonetID+","+ pastime, then query the plat number that the time difference of it is less than 5 minutes between two different bayonets. Because opportunities that the vehicle with same plate number are limited, the function of map() and reduce() can calculate efficiently.

IV. Conclusion

In this article, we discuss the challenges faced by the transportation industry, and advantagesof big data used in the transportation industry. Then propose an architecture of intelligent transportation system on big data platform, at last, we discuss the key technology in ITS.ofcourse, ITS should have more advantagesin the future.

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