TELKOMNIKA, Vol.11, No.1, January 2013, pp. 151~157
ISSN: 2302-4046

Monitoring Dispatching System based on Port's Internet of Things

Duanfeng Liu*[1,2], Xuli Han[1], Xinru Liu[1]
[1]School of Mathematics and Statistics, Central South University, Changsha 410075, P.R.China
[2]School of Applied Mathematics, Guangdong University of Technology, Guangzhou 510006, P.R.China
*corresponding author, e-mail: ma.frank@163.com

Abstract

This paper proposes monitoring dispatching system solution based on the internet of things, which is through the analysis for port's current situation, system components, operation process, communication protocol and safety alarm, etc. The system can fulfill real-time precise positioning monitoring and dispatching for port's mobile terminals, and also fulfill real-time monitoring and effective management for the whole port. Eventually it can improve the total competitiveness of port by improving production efficiency of port, securing operation safety and decreasing production cost.

Keywords*: Port's internet of things, monitoring and dispatching system, GNSS, CORS*

1. Introduction

With the rapid development of a variety of techniques in production, business management and computer, enterprises have little benefit by reducing the cost of production in the era of the rise of smart city, cloud computing and internet of things [1-2]. The increasingly fierce competition among harbor enterprises is also turning from production areas to non-production fields. At the same time, these concepts such as wisdom port and internet of things of port have been proposed. Port's internet of things utilizes perception of internet of things [3-4], technology characteristics of interconnection and intelligence to make all resources, including port's equipment, cargo information and port's logistics, to interconnect widely with all participants. By doing so it can achieve port and dock's logistics intelligent recognition, positioning, tracking, monitoring and management, become more agile and deeper intelligent port [1-5].

The current port ore, coal stockyard usually takes forklifts to complete the loading of congestion vehicles and to monitor the dispatch status of port's vehicles by the ways of manual-dispatching, walkie-talkie or on-site dispatch. But due to the complexity of stockyard locations the execution of command for vehicles is hard to be on real-time monitoring, which incurs some vehicles often driving to wrong stations. At the same time, since traditional intercom system exist some questions such as crowded channel capacity and unstable signal, it affects the assignment of dispatching instructions and the execution of tasks. To change this situation, the real-time monitoring dispatching system of port which is based on internet of things of port has to be set up. Then the operation efficiency of port will get improved.

The real-time monitoring dispatching system of port is a key component of internet of things of port. It takes the following advanced technologies such as GNSS, GPRS, GIS, computer networking, data warehouse and etc. to establish the real-time monitoring control system which is based on GNSS positioning technology. By installing high-precise GNSS positioning devices on the following mobile devices such as port cranes, forklifts, stacking machines and reclaimers, also by the transmission of GPRS or 3G network, it can achieve the real-time precise positioning monitor and control upon mobile forklifts and big machines, and can real-time update and manage the information of stockyard positions, thus the existing problems of some vehicles often driving to wrong stations and dispatching instructions without real-time monitoring can be resolved smoothly. Meanwhile by implementation of real-time monitoring and management of whole yard area, we can improve the production efficiency of port, ensure production safety, reduce production cost and improve the comprehensive

Received September 29, 2012; Revised November 23, 2012; Accepted December 1, 2012

competitive ability of port. The Monitoring Center of port can real-time monitor all vehicles' status, real-time make dispatching for vehicles, real-time alarm and real-time display vehicles' location, task, status etc. through the GIS platform, providing users a new, transparent, visual, interactive, real-time vehicle monitoring service.

2. System Components

According to the functional requirements of the system, the system consists of CORS base station, power supply system, data communication module, GNSS mobile terminal, GIS displaying platform, central communication server and central database server, where CORS base station mainly provides difference data of GNSS mobile terminal. GNSS mobile terminal can implement orientation, position and credit card information sending, acceptance of the difference data and execution of other commands. Data communication module is the central of information transmission and completes all communications. With graphics and spatial patterns GIS displaying platform can visually demonstrates vehicles' running status. The central communication server is responsible for data calculation of mobile terminals and data transmission while the central database server is responsible for data storage. The system principle diagram is shown in Figure 1 and the system hardware diagram is shown in Figure 2:

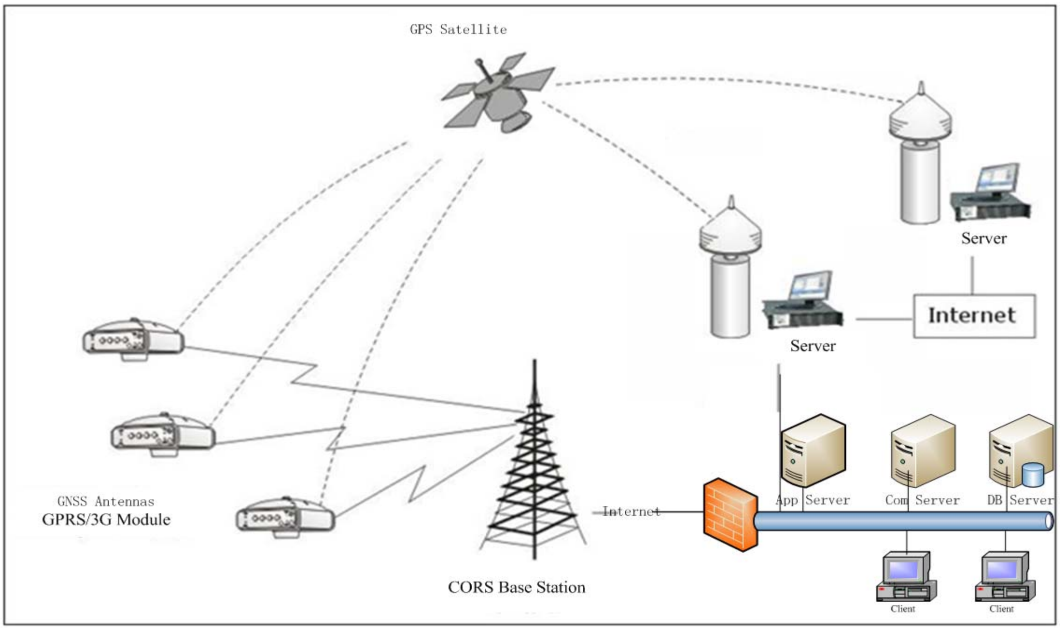

Figure 1. The system principle diagram

3. Operation Process

Baseline stations obtain accurate WGS84 location coordinates by continuous observation. This coordinate system is divided into two parts. One part is the monitoring software sending to server system, the other is forwarded to GNSS mobile terminals through GPS communication software. Vehicle terminals receive the satellite carrier signals via GNSS module, and acquires differential information via Data Communication Module, then calculates the location coordinates. Vehicle terminals will transmit the coordinate data that have been calculated to the server through Data Communication Module. According to the vehicles information and geographic information returned from terminals the server will proceed the data and display the vehicle's location on GIS map, and the server will also carry out intelligent analysis and proceed on the relevant data according to the running status of the vehicles. On-duty drivers must login to the system via RFID authentication on GNSS terminals and then wait for instructions from the dispatching center where will send dispatching instructions and alerts according to vehicles' positions. The Workflow is shown in Figure 3.

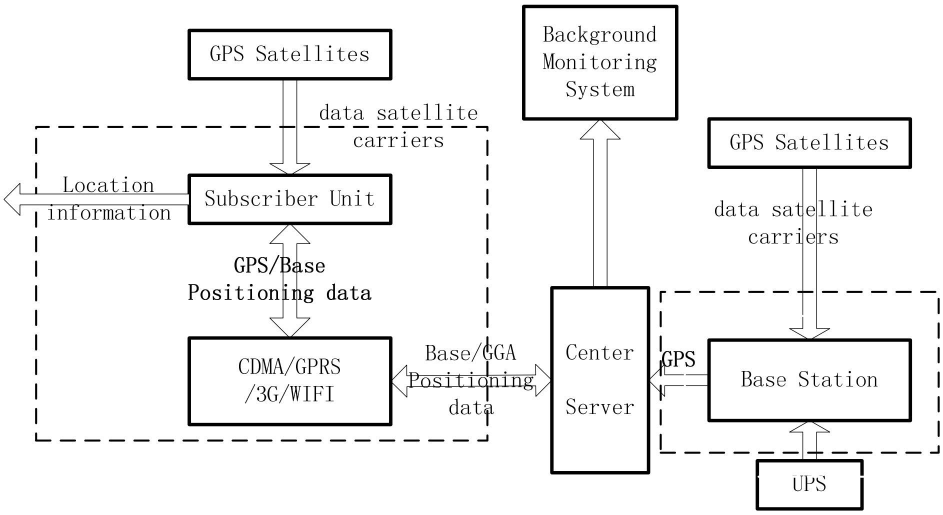

Figure 2. The system hardware diagram

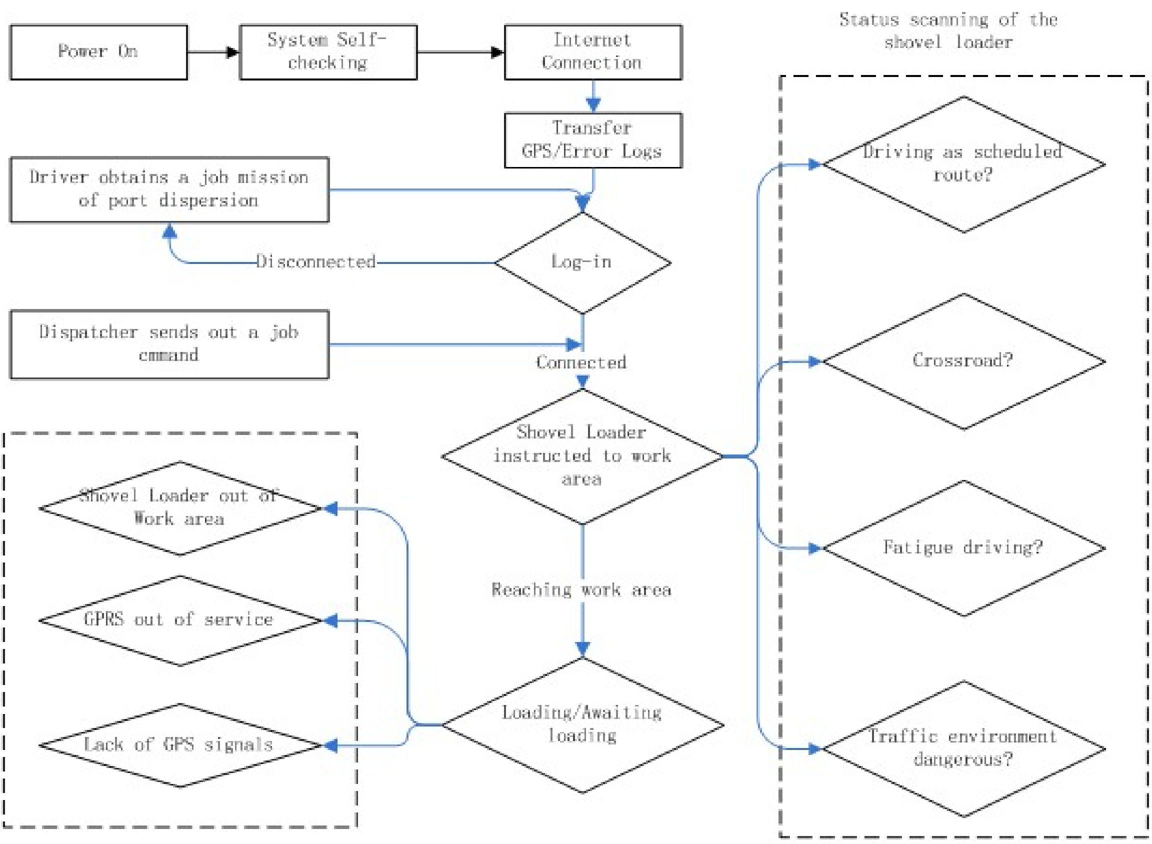

Figure 3. Workflow

4. Realization of communication module

The value of interconnection lies in the network rather than the thing, and also lies in application of the data collected by all kind of sensors, so the network communication module and external interface are very important. Port's internet of things' real-time monitoring dispatch system can do data exchange with ERP systems, eg. stockyard information synchronization, stockyard information update and maintenance, dispatching information synchronization, forklift information synchronization, and so on. Those data will include two parts, one part is the data collected by onsite mobile terminals and will be uploaded to ERP server, the other is acquired from ERP server. Data communication is the foundation of integration of all current port's information systems eg. office automation system, weighting management system, computer network system, ERP and so on. In order to ensure all systems working compatible and provide the port an intelligent, integrated and strongly practical Port's internet of things' real-time monitoring management platform, data communication is playing a critical role.

Data Communication Module consists of two parts, one is Central communication service software, the other is GPS data recording service software. Central communication service software is responsible for the communication between GPS and central servers. It includes the following main functions: reading differential data via serial port, distributing differential data to each GNSS mobile station, receiving and decoding the GPS positioning data from mobile station, forwarding decoded GPS data to GPS data recording service software. GPS data recording service software is responsible for receiving positioning data and making record in database, including the following functions: receiving GNSS mobile station data forwarded by Central communication service software, completing conversion of coordinates for positioning data and saving to database, sending testing dispatch orders, initializing the setting for online GNSS mobile station and recording the setting result, citing other system interfaces, reading relative ERP dispatching information and record them to local database. To realize Data Communication Module we have to clearly define data communication format and proceed TCP sticky package, which ensuring the stability of communication.

4.1. Communication protocol

Communication protocol is the basis of information exchange between the central communication server and GNSS mobile terminal. The protocol defines information exchange process and information format of mobile communication terminals among GPRS/CDMA/3G/ WiFi and data center. The design of Data Message format is divided into two parts. One part is the fixed format of data message, the other part is the detail format of various types of data message. The design of Data Message format is mainly to verify the integrity and legality during the sending and receiving every data package. Datagram format is shown in Table 1:

Table 1. Datagram format

Number	Data Type	Length	Memo
1	Header	2 byte	0xaa 0x55
2	Type	2 byte	ID (short)
3	Length	4 byte	int
4	Data	N byte	Data
5	Checksum	1 byte	LRC

Message types: GPS differential data package, GPS positioning data package, Central dispatching instruction package ,Central dispatching instruction confirmation package ,RF card package, Central alert package, System setting update package, System setting update ack-nowledgment package, System task package, GPS terminal registration package and Cleara-nce package for cache recording, reading serial package according to customer's needs. Data package formats is shown in Table 2:

Table 2. Data package formats

Number	Data	Length	Memo
1	Source	8 byte	Data source address
2	Target	8 byte	Data destination address
3	ID	4 byte	Message serial number（int）
4	Length	4 byte	The length of the message content（int）
5	Content	N byte	Transmission of specific content

The contents of the message is designed according to actual specific requirements, for example, to match GPS differential package is the positioning difference data (RTCM1 format) sent from central server to GPS Terminals, while to match corresponding GPS positioning data package is GPS location data (GPRMC format) sent from GPS terminals to central servers.

4.2. TCP sticky package processing

Sticky package and subpackage are difficulties of Socket communication. After the actual test for the monitoring dispatching system of port for a long time, sticky package and subpackage issues have been solved well. TCP sticky package refers that data packages stick into one package when sender sends data packages to receiver. For this phenomenon, the solution is to use bi-directional queue's data model in the receiving buffer cache. We use multithreading in actual programming, and the receiving thread is responsible for receiving data to the buffer cache, while the data proceeding thread will proceed data subpackage for the data in buffer cache, extracting a block of data from the cache every time and extracting data package according to the communication protocol. Above data and data package must be verified. If the data package is complete it'll proceed enqueued (complete package queue) operation. If the data package is not complete it'll head up in the bi-directional queue (data block's queue). The data package will be discarded if it fails to be verified, while the protocol proceeding thread will sequentially response to the data message from the complete package queue.

4.3. Operating Effectiveness

Port's internet of things' real-time monitoring dispatch system has over 120 GNSS terminals which communicate with data communication servers through GPRS/WIFI network. GNSS terminals will complete the collection of vehicles positioning data, vehicles status and so on, and exchange with central server through GPRS, while central server will complete data receiving from GNSS terminals, then complete the calculation and save them in central server. Central server will send position alert data to GNSS terminals after conversion of coordinates for terminals' data and comparing it with original task stockyard area, at the same time central server will acquire task information through real-time data synchronization with ERP system and then send task information to GNSS terminals according to task status. Till now system has experienced 2 years stable operation and it has been working pretty well. The system interface is shown in Figure 4.

5. Alarm Module

Construction of Port's internet of things is a long way practice. To further improve port's operation efficiency, control production costs, lower production accidents and worker's workload, we have to adopt advanced information technology methods to realize real-time monitoring and centralized management for port's vehicles. During the construction of Port's internet of things, we may put the most concerned safety question to top priority. Port's safety management is completed by alarm module.

Over-speed alarm: When vehicles exceed the set highest speed, their status on the e-map will be changed from normal status to dangerous alert status and will be highlighted to alert on-duty staffs. Meanwhile it'll send out alarm information to current vehicles via GNSS terminals, alerting on-duty drivers to their operation safety. It will also make a record in database and create an over-speed report according to relative requirements.

Beyond-scope alarm: When vehicles drive beyond the set effective scope (for example, don't follow the set route to drive, vehicles are drove out of port's dock, vehicles go to wrong location, vehicles are not in the scope, and so on.), system will pop up the dialogue box with alert information and will send out alert voice message to on-duty drivers via GNSS terminals.

Collision danger alarm: The system can do danger forecast to vehicles based on current port's vehicle's running speed and driving direction and also based on surrounding traffic environment. During vehicles executing dispatching order, according to port's vehicles distribution system will use running speed and direction to do intelligent calculation for the current vehicles within the set scope, and also analyze the potential danger and notify on-duty drivers timely. System will send out alert to those vehicles which are driving to the certain scope to the fixed location devices such as stockers, bridge ship-unloaders and belt conveying lines. It will also send out alerts to those vehicles which are driving through temp construction area.

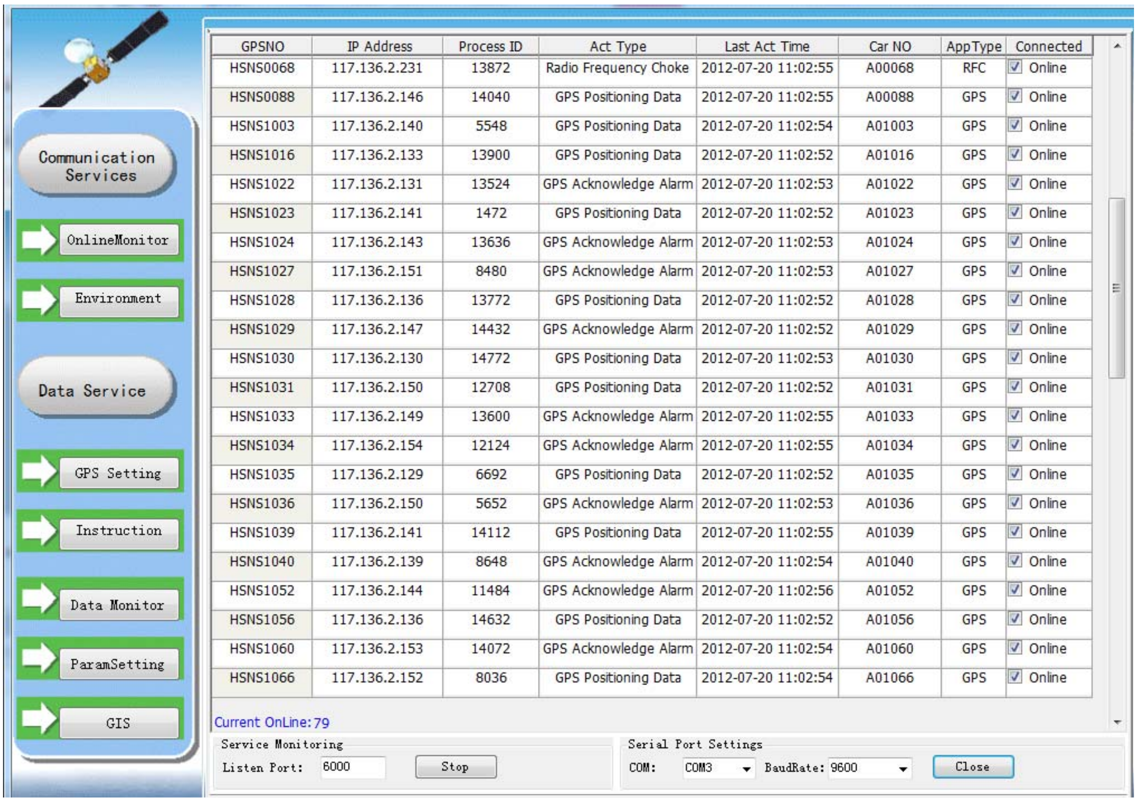

Figure 4. The system interface

Fatigue-driving alarm: when on-duty drivers remotely login to system via authentication, system will play alert voice message to those drivers who continuously work over 4 hours or accumulative total 8 hours, preventing them fatigue-driving.

Driving record: vehicles driving record can be saved automatically. System can create reports, make queries and playback records based on requirements.

Crossroad alert: system will play alert voice message at crossroads, T-junctions and corners, notifying drivers to reduce the speed. System will play alert for any other abnormal cases.

6. Conclusion

To develop port's internet of things technology is the best technology method of improving the port's information integration and represent the general trend of the future information technology. In the era of internet of things, the application of port's internet of things will enter rapid development channel. At the same time the application based on port's internet of things will surely become the first element in modern ports' information. Internet of things technology will become the core technology of ports' information. The development of any port's new businesses won't be separated from support of internet of things technology. Information work based on internet of things technology will advance before the new value-added business.

Acknowledgement

This work is supported by Natural Science Foundation Project No. 60970097 and Fundamental Research Funds for the Central Universities No. 721500356.

References

[1] Peng Li, Junping Dong, Junhao Wen, Wei Zhou. A SOA-Based Service Discovery Framework in Internet of Things. *Journal of Convergence Information Technology*. 2011; 6(9): 310-315.
[2] Tao Yan, Qiaoyan Wen. A trust-third-party based key management protocol for secure mobile RFID service based on the internet of things. *Advances in Intelligent and Soft Computing*. 2012; 135: 201-208.
[3] Yujun Pang, Jun Wang, Lifeng Wei. Research of embedded internet technology for internet of things. *Applied Mechanics and Materials.* 2011; 55-57: 2153-2156.
[4] Sarfraz Alam, Mohammad M. R. Chowdhury, Josef Noll. Interoperability of Security-Enabled Internet of Things. *Wireless Personal Communications.* 2011; 64(3): 567-586.
[5] Amardeo C, Sarma J G. Identities in the Future Internet of Things. *Wireless Pers Commun.* 2009; 49: 353-363.