Materials Distribution Monitoring and Management System Based on Sensing Card

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Abstract. This paper first analyzed the technique architecture of materials distribution monitoring and management systems, including hardware and software requirement. Furthermore, then summarized the protocols of materials distribution monitoring and management systems. Finally, a materials distribution monitoring and management system based on sensing card was proposed. The proposed systems can capture some good features, such as real-time sensing, safe translating, full monitoring, etc. These features were produced in these procedures, including the sorting and out-warehouse procedure, the set-forming packaging procedure, the car loading and case filling procedure, the en-route monitoring and control procedure, and the en-route distribution and receiving confirmation procedure.

Introduction

Along with the accelerating of the process of industrialization, as an important part of the logistics, special transport is in rapid development [1]. In order to prevent the occurrence of unsafe factors, special transport has a very high demand on equipment and process monitoring. At present, most of the materials distribution monitoring systems can effectively monitor the location and the quantity of materials [2] [3] [4], but can’t monitor and manage the environment information, situation information and carriage information of materials. This paper integrates the sensing card into the materials distribution monitoring and management system, so that it can realize the monitoring and management to the materials quantity information, situation information, environment information, status information and position information in distribution process, thus it can find abnormality in time and give an initiative alarm, eventually we can reduce the unsafely factor in the materials distribution process.

Material Sensing Card

Basing on the wireless communication protocol module, sensing card is a customized communication terminal, which is composed of three parts including the sensor, the core protocol module and the power supply. Generally, it has different physical forms in different application scenarios. It has the functions of information perception, ad hoc networks, network behavior feedback and so on. In order to meet the needs of personnel portable, sensing card can have a variety of physical forms. Built in temperature and humidity sensor and acceleration sensor, sensing card can be used for making a perception for environmental information and giving detection for moving object. Fixed on the target device, such as a pallet in storage environment, sensing car can also be used to record on the tray materials information. After built-in a sensor, sensing car can also be used to detect the activity state of the tray.

Technical Architecture

Basing on the sensing card, the materials distribution monitoring and management system is mainly composed of three parts: the hardware equipment, mobile network of materials distribution, and software for monitoring and management to the materials distribution. The hardware equipment is consists of the electronic signature lock for the compartment door, sensing card for the materials state, portable terminal, tablet PC, the computer management terminal,
integrated gateway and the standby power supply.

According to the needs of the users, materials distribution mobile network is temporarily deployed in the train, the ship, the automobile and other motor carrier, which achieves a lot of functions, including management for the materials, acquisition for the materials condition (quantity, quality), monitoring for the transportation safety, data transmission and other functions.

The software is mainly used for processing the position information, alarm information and materials state information, which is transmitted through the mobile network, at the same time, it is used for carrying out the monitoring, scheduling and management to the mobile launch platform, and implementing the remote monitoring, and taking aware and full control of materials’ state. The above two parts realizes interconnection through the 3G network or Beidou satellite system and GPS. The overall architecture is shown in Figure 1.

**Figure 1. The overall architecture diagram.**

**Protocol of Materials Distribution Mobile Network**

The design of the network protocol is more important in the mobile network for the materials distribution, wireless MESH network topology is used in the materials distribution monitoring and management system.

**Wireless MESH Network Topology**

Wireless Mesh network is a wireless network model, which combines the advantages of wireless local area network and Ad hoc network, thus it has the intelligent advantages of self-organized, self repair, multi hop and the node self management [5]. The overall architecture of materials distribution mobile network is based on MESH network. Gateway is the data gathering center of sensor network, at the same time, sensor network expands its network coverage by the relay equipment. In addition, the terminal equipments make a collection for the network information through the access relay or gateway. The network architecture of sensor network uses the hierarchical topology which combines the backbone communication network of MESH and the bottom cluster access network.

**Operating System of Wireless Sensor Network**

Stable and efficient tool library is one of the necessary conditions for the rapid development to realize the mobile network for the material distribution. Considering the more simpler functions and less cost, the sensor node has very limited resources, because the RAM generally is below 2K, the sensor node is unable to effectively run the mainstream RTOS, such as embedded Linux, µ/OS-II etc. If you develop the agreement between onstage and backstage, these protocols won’t be reuse along with the integration protocol development platform code. At the same time, some of the other sensor nodes’ resources are rich, but for the reasons of hardware structure, transplantation of mainstream RTOS becomes difficult and complex, which greatly reduces the efficiency of development, so that we develop agreement only between onstage and backstage.

In order to solve the above problem, WSN OS is used in the wireless sensor network. Strictly speaking, WSN OS is not a real operating system, and it is no need to transplant, it takes less resource consumption, and it supports multi task to development, but it does not support the task preemption. WSN OS mainly provides three basic functions, including the task management, the message queue management and memory management.
The Protocol Stack of Sensor Network

Network protocol stack is the core module of the node software, which provides the data transmission channel and the network control interface for the upper software. In order to facilitate the transplant, protocol stack must be independent of the underlying operating system and hardware platform, and it only exchanges information with running environment module of nodes software and the abstract module of hardware device. Protocol stack of sensor network generally consists of the physical layer, the media access control layer, the network layer, the transport layer and the application layer. The physical layer provides a simple but robust modulation signal and wireless transceiver technology; Media access control layer is responsible for the data frame, the frame detection, the medium access and the error control; the network layer is mainly responsible for route generation and routing; the transport layer is responsible for the transmission control of data flow which is main part to guarantee the quality of communication; the application layer is responsible for a variety of applications support.

The tree topology structure is adopted in the sensing network, which merges the transport layer and network layer. Sensing network can be divided into four levels: the physical layer, the media access control layer, the network layer and the application layer, and it give consideration support to the security and the networking identified.

Design on System Software

Software Architecture

Software architecture is shown in Figure 2. Taking using of the integrated access gateway and infrastructure equipment, the system makes data exchange with other systems. The development of system is based on the integrated operation platform, and then Data Resource Center of materials distribution monitoring and management is established, on this basis, the system provides management for related business. The user of the system mainly includes the leader of distribution center, the picking persons, the set packing staffs, the loading delivery persons and other relevant persons.

Integrated operation platform is based on the Eclipse environment, which includes the software development environment, the software integration environment, the operation support, the basic services and the software quality control etc, and provides logistics link services and logistics public services required for business management functions. The logistics link services include the planning, the procurement, the transportation, the distribution, the warehousing and the settlement services; logistics public services include the document tracking, the material cataloging, and the query and statistics service.

Data support is a very important part in the software, which consists of data resource center, logistics management data interface and comprehensive statistics and query interface. Static data and dynamic data is sorted in the data resource center; the static data refers to some basic data required for the system operation, such as the distribution information, the material transportation information and other basic information, the dynamic data refers to the information produced in the process of system operation, such as the inventory information, the vehicle location information and the vehicle loading supplies information etc.
Software Functions

The software functions mainly includes the distribution list management, distribution management, capacity management, out storage management, group sets of package management, loading management, distribution route management, materials tracking management and other functions.

1) Distribution lists management
The module is mainly responsible for receiving distribution list that come from the superior, and automatically provides analysis and processing for distribution lists, then present the information in the database, which can be used for query, browsing and printing. A distribution list mainly records the list number, the generation date, the producer, the approver, the types of materials, quantity of materials, delivery time requirements and other information.

2) Distribution places management
The module is mainly responsible for managing the basic information of distribution places, such as the name, the address, the distance, the area, the equipment, the persons, the facilities and other basic task information of distribution place, which can be used for adding, editing, query, browsing and printing.

3) Capacity management
The module is mainly responsible for managing basic information and dynamic information of vehicle that belongs to the distribution center, basic information including the name, the type, the mileage, the availability status, the loading of the goods quantity and variety; dynamic information including the current location, the loading of the goods and the travel route arrangement, which can be used for adding, editing, query, browsing and printing.

4) Out storage management
According to the distribution lists information and materials inventory information, the module can generate the picking out scheme, so that the operator can chose material location and make related operating quickly, and at the same time, can transmit the corresponding out storage information into warehouse management information system.

5) Group sets of package management
This module is mainly responsible for the input, the edit, the query and the print of set packaging technology and related standards, and according to the information that including the types of material, material quantity and the other requirement of the distribution material, this module can generate set packaging scheme, so that the operator can make set packing quickly, standard and efficiently.

6) Loading management
According to the material information after being set packing, binding the capacity information, the loading capacity information, the loading mode information, the loading requirements and other information, this module is mainly responsible for making the calculation and analysis on the materials stowage, at the same time, basing on making full use of the vehicle transport capacity, it
can generate set loading scheme, so that the operator can make loading and count the quantity of materials quickly, standard and efficiently.

7) Distribution route management
This module is mainly responsible for making optimization and scheduling management on distribution. According to the delivery time, the place and the number of quality requirements, basing on the linear dynamic programming and the classical shortest path algorithm, this module makes scheduling and allocation of capacity (allocation and personnel carrier task), and makes planning management of the best transportation route. This module can achieve the best route selection and dynamic allocation of transportation basing on the Beidou Positioning and geographic information system (GIS).

8) Materials tracking management
This module can display the actual position of the carrier (car, boat, train etc.) and the materials by using of the Beidou/GPS, and can take the initiative to the query the status of vector and materials and electronic map, so that carrying on the reasonable scheduling and management. After the handset terminal receiving the current vehicle position information from the Beidou satellite /GPS, it will upload these information above and the information of the number of materials, the state of vector and the goods information to the system through a communication mode, then this module will make display these information on the electronic map, at the same time, it can provide external access entrance, so that we make active query the state of vector and material.

9) The basic map management
This module includes these functions as follows: amplification, narrow, roaming, the whole picture display, positioning display, layer control and map output. This software will use the electronic map. Based on user needs, the electronic map can improve the performance of the map by displaying relevant content step by step.

10) Authorization management
This module is mainly responsible for receiving external authorization request and sending the authorization information.

11) User management
This module is mainly responsible for maintenance all the user's basic information, which including increasing, deleting and modifying the user roles and the user permissions.

12) Data management
This module is mainly responsible for making backup, importing and exporting of data in time.

System Deployments
System is mainly deployed in the material distribution center and the materials distribution unit, and software is deployed in distribution center, handset is deployed in the distribution unit, which is connected by wireless network and integrated access gateway. The deployment of the system is shown in Figure 3.
Conclusions
According to the demand for material distribution and safety transport, this paper presents the materials distribution monitoring and management system based on sensing card, which takes the mobile launch platform as the carrier, and takes independent launch box as sensing point, thus builds the whole platform vehicle into a wireless mobile network. Basing on building a complete monitoring system of material distribution management with host computer, this system is mainly responsible for solving the problems of real-time information sensing, the safety transmission and the whole process monitoring in set, the loading box sealing, the monitoring on the way, the distribution on the way, and the delivery confirmation.

Reference