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Research on Logistics Solutions for Dangerous Chemical Products

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The objective of this paper is to design and realize the logistic monitoring system for dangerous chemical products. As for problems of robbery accidents and leakage accidents during the transportation process of dangerous chemical products, the identification and tracking technology on moving objects in the real-time video stream transmission and video sequence are the main research objects; and the specific discussion and research on the video monitoring technology in the logistic monitor system of dangerous chemical products is carried out based on the research on theory principle and technology realization of existing video technology. The real-time transmission of video stream is achieved by collecting the video of YUV4:2:2 form, video coding & compression of H264 form and using RTP protocol, so that the identification and tracking on moving objects in the video sequence can be achieved. The experiment result indicates that the logistic monitoring system for dangerous chemical products designed in this paper can be effectively applied to identify the moving objects. Therefore, the logistic monitoring system for dangerous chemical products can be used to improve the stability and effectiveness of the transportation of dangerous chemical products.

1. Introduction

The weight of dangerous chemical products in road transportation in China is hundreds of millions of tons, which takes more than 30% in the volume of freight traffic (Dey, 2017). A city is located in the intersection of coastal economic development zone and Yangtze river economic development zone, which is the distributing centre for important liquid chemical products; more than 30 discharging quays for dangerous liquid-type chemical products are set up in this city (Memon et al., 2017), which has become the largest port city for the transportation of dangerous chemical products, and also the most important discharging centre for dangerous liquid-type chemical products in China (Paes et al., 2017). With the rapid economic development in China, the traffic volume of dangerous liquid-type chemical products is increased, and the variety is rich; vehicles and industry staff for the transportation of dangerous chemical products are also increased continuously (Proskurnikov, 2017). However, with the increasing volume of chemical products traffic, the entire quality of staff working in the industry of transportation of dangerous liquid-type chemical products is still increased slowly, and transportation accidents of liquid-type chemical products is subject to the occurrent frequency getting higher year-by-year; the accident damage degree is getting deeper and deeper, which endangers the production and living of the society, and also affects the life, property and succory greatly(Rato et al., 2017). If the dynamic supervision system is insufficient in the transportation of dangerous liquid-type chemical products, very serious consequence may be caused in case of accidents (Thekkudan et al., 2017). In order to solve the frequent robbery accidents of vehicle-mounted dangerous liquid-type chemical products, the project bidding is proposed by the government of a city (Wang et al., 2017).

2. Domestic and foreign research status

There are two types of video monitor technology products in the domestic and foreign markets (Wu et al., 2017). One of which is the video monitor system using analog circuit technology, and the other one is the video monitoring using digital circuit technology (Wu et al., 2017). The digital monitoring technology is developed on the basis of analog-video monitoring technology, which requires the continuous improvement

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and perfection (Yuan, 2017). The popularization of digital video monitor system is the trend of future development based on current trend, which is of important practical significance.
The digital video monitor system is usually divided into two types: the first type is the traditional computer-multimedia working mode (Geng et al., 2016). The other type is the digital video-monitor system based on embedded technology. The rapid development of embedded technology is the strong technical support for the popularization of embedded-type digital video-monitor system (Park, 2016). The V4L2 programming specification is used in the video collection. As the Linux is the operation system for logistic monitor system of dangerous chemical products, the interface provided by the Linux operation system to the application vising the video driver is V4L2. (Sironi et al., 2016) The video capture interface is usually used in the video monitor system, and the monitor video is collected through V4L2. The flow of V4L2 is: open the camera; check and set up the property of the camera; set up the frame form of the video collected; set up the input and output methods; obtain the video data circularly; turn off the camera (Stoyanov et al., 2016). In case the video collection is completed, the original video should be subject to coding and compression so as to improve the utilization rate of communication bandwidth and storage space. H.264 is a standard of digital video coding. It is established on the basis of MPEG-4, and the coding and decoding flow consists of five parts (Zeng et al., 2016).
After the video is collected, coded and compressed by the monitoring system, in case the video is to be transmitted or stored, the UDP or RTP protocol is usually used for transmission. The video can be watched in real time by the observer when it is transmitted with RTP protocol, and the RTP protocol is used in many famous Internet video websites (Youku, Tudou and You Tube) for video transmission (Chithambaranadhan et al., 2015). Many objects may occur in the same scene in the real world, and such objects are independent to each other, which should be processed separately, and may be interest in one or more types of things in one scene. The detection of moving objects is implemented in the sequence image by combining the moving objects, and the methods of which mainly includes the statistic model, optical field flow and image difference image (Naeem et al., 2015). The optical flow field is of important value in fields such as object identification and object segmentation etc (Li et al., 2014).

3. Dangerous chemical products and their transportation

According Article 3 of the newly-revised Safety Management Rules on Dangerous Chemical Products, dangerous chemical products (hereinafter after referred to as “DCP”) means the highly toxic chemicals and other chemicals with the toxic, corrosive, explosive, combustion and comburent properties etc. and which are harmful to human body, facilities and environment; which requires special protection. It may be considered as the DCP when three features mentioned above are equipped (Silva et al., 2011). According to the national standard of the People’s Republic of China of 2010 – Classification and Marking of Dangerous Chemicals Commonly Used, the DCP is divided into three types in China based on the dangerousness: physical and chemical danger, health danger and environment danger.
Self-operated logistics transportation: all logistics businesses of this mode rely on their own logistic system to complete the transportation of DCP (Ranky, 2007), and the main economic source of these enterprises is not logistics.
Outsourcing logistic transportation: generally speaking, enterprise always only focus on their own core business; and in order to enhance their core competitiveness, business related the logistics of enterprises is always contracted by the third party-logistic enterprise. See the outsourcing logistic transportation pattern in Figure 1.

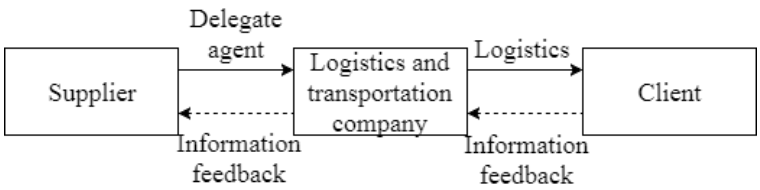

Figure 1: Relevant Patterns of Outsourcing Logistic Transportation

Transportation of common distribution: or it can also be sharing logistic transportation of the third party; it is of large difference to the coordinated distribution transportation, generally speaking, goods or products (most of which are of the same type) of many owners are collected together so as to be distributed and transported by the same third-party logistic enterprise, by which the vehicle resource can be saved and the transportation efficiency can be improved.

Mixed-type logistic transportation: this logistic pattern is the integration of advantages in outsourcing transportation pattern and self-operation pattern so as to achieve mutually reinforcing and organic combination.

4. Entire structure design of the software and software module division

The structure of the logistic monitor system of dangerous chemical products is divided into five layers, and necessary service is provided by each layer to the last layer. The lowest layer is the embedded hardware platform based on ARM11 processor, and the hardware design and manufacture is outsourced by OEM manufacturers so as to save the limited time and project fund; the hardware actually used in the project includes the USB camera, 3G module and liquid sensor based on RS232 interface etc. are obtained by purchasing. See the hierarchical structure division diagram of logistic monitoring system of dangerous chemical products in Figure 2.

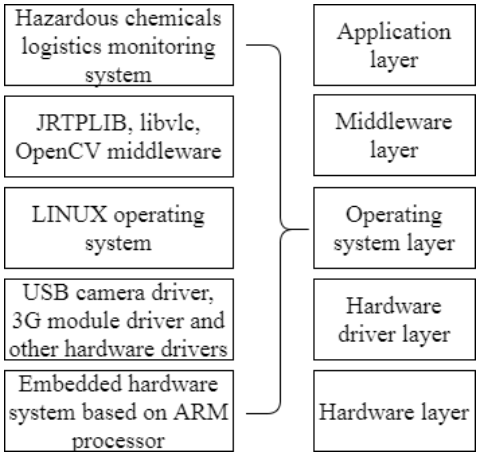

Figure 2: Hierarchical Structure Division Diagram of Logistic Monitoring System of Dangerous Chemical Products

The hardware driven layer is above the hardware layer, and the function of which is to make various hardware available for the operation system and to make the selected operation system equipped with basic drivers, such as the USB camera driver, 3G module driver etc. The existence of basic hardware driver in the operation system is the first indicator, and the read-write of RS232 interface should be completed by writing the standard serial communication programming.

The application-layer software is divided into submodules based on demand analysis. The logistic monitoring system of DCP consists of seven submodules, and the conclusion is obtained based on Party A's demand analysis. See the software module division of DCP logistic monitor system in Figure 3.

The hierarchy can be implemented to the DCP logistic monitoring system again after the submodule division is defined. The video collection module is the basis for the operation of application software; the local storage and video flow transmission is implemented after the video is coded and compressed, and the playing of real-time video floe as well as the identification and tracking of moving objects are the function presented to users directly. The layer of DCP logistic monitoring system will be divided again in the application software. See the module hierarchy of DCP logistic monitoring system in Figure 4.

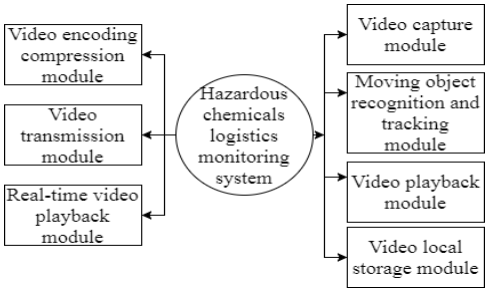

Figure 3: Software Module Division of DCP Logistic Monitor System

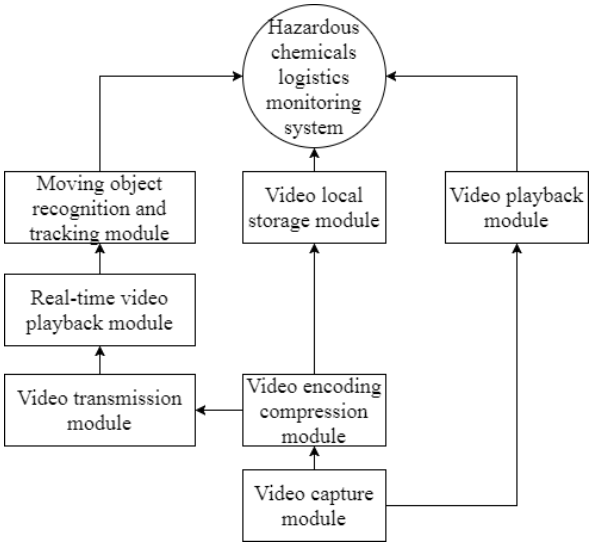

Figure 4: Module Hierarchy of DCP Logistic Monitoring System

The identification and tracking modules of moving objects are corresponding to the identification and tracking type of moving objects, and the main function of such type is to identify and track the moving objects in the video sequence. The data members of such type must include the feature points under tracking as well as the property of the tracking feature points. Member functions of such type must include basic functions such as the function of detection feature points and function of tracking feature points. The identification and tracking type of moving objects is subject to the use of member functions such as the video collection type, video coding and compression type as well as video transmission type; therefore, the identification and tracking type of moving objects relay on such types. See the dependency relationship between identification and tracking types of moving objects in Figure 5.

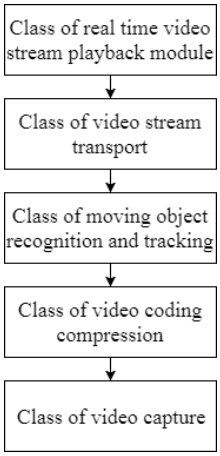

Figure 5: Dependency Relationship between Identification and Tracking Types of Moving Objects

According to the division of DCP logistic monitoring system types and the analysis on dependency relationship, the dependency relationship used in the system can be obtained. See the dependency relationship among types in Figure 6.

The quality of video transmission is improved based on existing network bandwidth and network speed foundation, and the key is to select the appropriate network transmission protocol. See the architectural design figure of communication protocol in Figure 7.

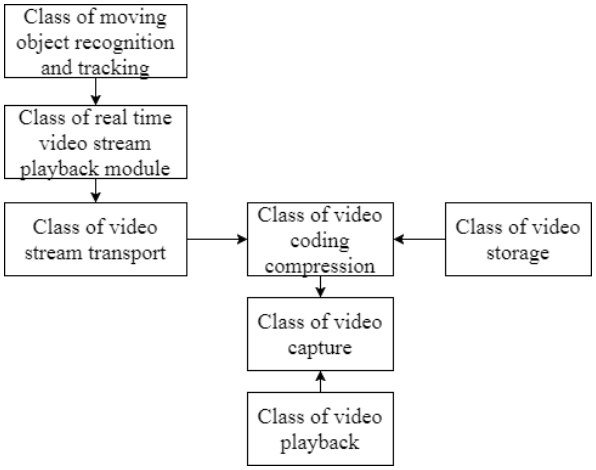

Figure 6: Dependency Relationship among Types

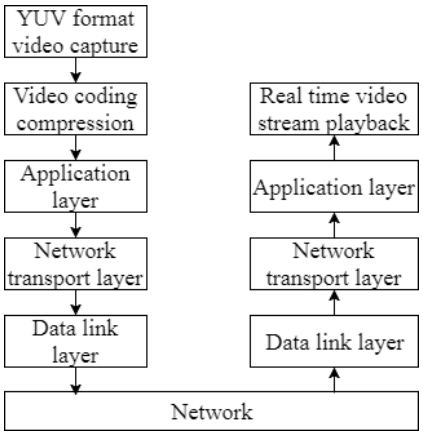

Figure 7: Architectural Design of Communication Protocol

5. Conclusion

The objective of this paper is to design and achieve one DCP logistic monitoring system. The video of YUV4:2:2 form is collected in the system, and the video coding and compression is of H264 form; the RTP protocol is used to achieve the transmission of real-time video flow so as to achieve the identification and compression of moving objects in video sequence. Excess software and hardware resources are used in the system operation, which is of high CPU usage rate. The thread of the system operation includes the video collection and compression real-time playing of the video, video flow transmission as well as the identification and tracking of moving objects; multiple threads are under the simultaneous operation, which requires a lot of hardware resources, which is the defect of the system. The specific resolution of moving objects cannot be achieved by the identification and tracking of moving objects effectively, only the moving objects can be identified in the video sequence. The demand analysis instruction of DCP logistic monitoring system clearly indicates that personnel around the oil tank truck must be identified, however, the current system can only be used to identify the moving objects, but cannot distinguish that if the object is human being or a thing.

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