

# Wise rescue, safety accompanying

-- Dawning Intelligent rescue system

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**Abstract:** According to the survey data, the annual death toll due to traffic accidents in the world reaches 1.25 million, in China is as high as 104,000, ranking first in the world. In the death rate of traffic accidents, more than 60% are caused by early warning or rescue in time. At present, there are many problems in China's traffic accident emergency rescue, such as low efficiency, rescue in time. According to the demand of smart city construction, the traditional emergency rescue mode of traffic accident is facing transformation. The rapid popularity of tachograph in recent years can be seen that car owners' awareness of safe driving is strengthening. However, the functions of the traditional tachograph are mostly limited to being the evidence carrier of traffic disputes. The latest multifunctional recorder on the market also aims to improve user experience, increase intelligent voice, navigation and other functions, and has not been applied in traffic accident emergency rescue.

**Keywords:** Smart city; Smart rescue; Travel safely; Big data; Optimal algorithms.

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## 1. Industry background

### 1.1. Social background

A smart city is a city that uses information and communication technology to sense, analyze and integrate key information in the core system of urban operation, so as to make intelligent responses to various needs, including people's livelihood, environmental protection, public safety, urban services and industrial and commercial activities. The essence of smart city is to use advanced information technology to realize smart city management and operation, thus creating a better life for people in the city and promoting the harmonious and sustainable growth of the city. With the continuous development of human society, cities will carry more and more people in the future. In order to solve the problems of urban development and realize the sustainable development of cities, the construction of smart cities has become an irreversible historical trend of urban development in today's world. Among them, smart transportation is one of the important projects of smart city construction. Smart transportation is the construction of "digital transportation" project, through monitoring, monitoring, traffic flow distribution optimization and other technologies, improve the public security, urban management, highway and other monitoring systems and information network systems, to establish a unified intelligent urban traffic management and service system construction focusing on traffic guidance, emergency command, intelligent travel, taxi and bus management and other systems. To realize the full sharing of traffic information, real-time monitoring and dynamic management of highway traffic conditions, comprehensively improve the level of monitoring and intelligent management, to ensure the safety and smooth traffic.

### 1.2. Policy Background

At present, with the deepening development of the information society, the way of production and life in modern society is undergoing fundamental changes. As an important carrier for the centralized application and display of modern information technology, smart city has become an important

force to promote the upgrading of economic and social construction. In order to seize the opportunities brought by the construction of smart cities, in August 2013, China issued Several Opinions on Promoting Information Consumption and Expanding Domestic Demand (Guofa [2013] No. 32), which officially listed the construction of smart cities as an important development strategy and encouraged pilot demonstration construction of smart cities in cities where conditions permit. The National New Urbanization Plan (2014-2020) released in March 2014 clearly proposed to promote the construction of smart cities, and formulated specific goals and strategies. Therefore, the construction of smart city has officially entered the period of practical promotion from the concept-oriented period, and the joint efforts of the whole society are needed to achieve various construction goals.

## 2. Overview of the system

### 2.1. System design

At present, cloud services are gradually mature, 5G has been launched, and artificial intelligence has been attached great importance by various industries at home and abroad. Such development situation provides better conditions than before for the realization of cloud monitoring traffic accidents. The maturity of cloud service technology provides a platform for cloud monitoring, the advent of 5G era will ensure more efficient data transmission efficiency, and the development of Internet of vehicles technology has stimulated the passion and vitality of this project.

With the rise of the Internet of Things and the rapid expansion of the market scale of dashcam and sensor, the technology maturity is gradually improving. This project carries out secondary development with the help of ordinary tachograph, builds the "cloud + terminal" traffic accident emergency rescue system, and develops the "Dawning Wisdom rescue" APP to cooperate with it. The "Cloud + terminal" traffic accident emergency rescue system is divided into three subsystems, which are information acquisition subsystem, information transmission subsystem and comprehensive early warning subsystem. DEMO of the new

dashcam product is shown in Figure 1.

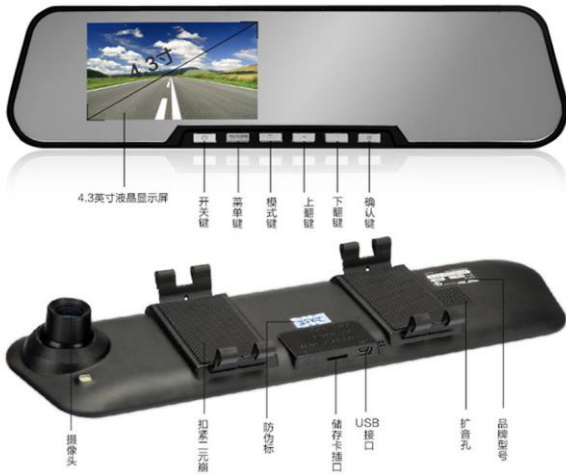


Fig.1 DEMO of the new dashcam product

## 2.2. System innovation

**Comprehensive warning:** On the basis of the original technology of dashcam, STM32 and Hi3516 chips are added to it, which play the functions of sensor data acquisition and transmission and video transmission respectively, so as to realize the function of vehicle accident alarm system.

**Dual positioning:** Beidou navigation system is adopted, which can provide all kinds of users with high-precision and reliable positioning, navigation and timing services all day long and all day long all over the world. At the same time with the use of GPS for dual positioning, to make up for the defects of a single method.

**Data processing:** In the cloud platform of the integrated early warning subsystem, the communication models of terminal access, rule-based heterogeneous data storage and historical data management, user-device communication and device-device communication are completed, and the massive data received by the cloud platform is periodically replaced and stored to ensure the stable operation of the whole system.

**Intelligent and fast mobile client:** with the development of the APP of the accident alarm system, the user information can be fully input to achieve the unique matching of the cloud platform information.

**Multi-interactive emergency rescue system:** The traffic accident emergency rescue system based on "cloud + terminal" implanted in the new dashcam can notify 110 rescue center, 120 first aid center, fire emergency center and insurance company emergency center in the first time when the traffic accident occurs, to ensure that the traffic accident is dealt with comprehensively and efficiently in the first time.

## 2.3. System functions

Based on the understanding and analysis of the cloud real-time monitoring traffic accident emergency rescue system, the system is divided into the following five main functions:

**Accurate positioning:** The Beidou navigation and positioning system can provide rescuers with the precise location of the accident, and provide the specific position coordinate information in the accident message, so as to facilitate the understanding of the source of the accident.

**Information processing:** collect the parameters of the acceleration sensor and gravity sensor in the process of vehicle driving, calculate the alarm threshold of the accident to carry out the analysis of the risk parameters.

**SMS transmission:** the specific information of the accident will be transmitted to the rescue personnel communication equipment in the first time, so that it can be the first time in the accident for rescue preparation.

**Video transmission:** When the alarm information is sent, the video before the accident is automatically retrieved from the cloud server, which can help rescue workers to understand the situation of the accident site.

**Comprehensive warning:** When the warning value exceeds the threshold, the system can request the cloud platform server to retrieve the dashcam video and the driving vehicle location information, which can be displayed to the rescue personnel in the form of mobile phone messages to help them understand the scene, so as to achieve the purpose of rescue in the first time and reduce the probability of secondary accidents.

## 3. Research and development and technical implementation of traffic accident emergency rescue system

### 3.1. Accident recognition algorithm

The realization of accurate judgment of traffic accidents is the premise of ensuring the accuracy of the system warning, as well as the premise of determining the risk parameters. Among the existing accident identification algorithms, the method based on acceleration sensor and gravity sensor is more suitable to be used as the trigger algorithm of accident early warning because of its strong comprehensiveness and simple calculation. Based on the analysis, a trigger algorithm based on gravity sensor and acceleration sensor is proposed to monitor and judge whether the vehicle has an accident by taking the driving state such as acceleration and inclination Angle of the vehicle.

The accident recognition algorithm adopted can judge whether the vehicle has a collision by detecting the acceleration and whether the vehicle has rollover by detecting the horizontal inclination Angle.

By detecting the acceleration, the following methods can be used to determine whether the vehicle has a collision accident:

Set the peak value of vehicle acceleration, emergency braking time and other parameters under different working conditions, specifically: in emergency braking, the peak value of vehicle acceleration is set as  $-0.65g \sim -0.75g$ , and the acceleration signal rises sharply in a short time after emergency braking, and the peak time is long; Under normal braking, the peak acceleration of the vehicle is  $-0.35g \sim -0.45g$ , and the braking time is longer than that of emergency braking, the peak acceleration is about  $\pm 0.2g$ ; When passing the roadblock, the peak acceleration of the vehicle is  $-0.25g \sim -0.35g$ .

When the acceleration signals are integrated, their respective integral curves will be significantly different, according to which the collision accident of normal braking of the vehicle can be judged. The peak value of acceleration, emergency braking time, peak duration, acceleration signal climbing amplitude and other parameters are analyzed and processed, and the judgment value is obtained, and compared with the preset value under different working conditions. When the judgment value falls into the preset value range of emergency braking, it is judged that the vehicle has a collision accident; when the judgment value does not fall into the preset value range of emergency braking, it is judged that the vehicle

is normal.

By detecting the inclination Angle between the vehicle and the horizontal plane, the following methods are used to determine whether the vehicle rollover occurs:

Set the lateral inclination Angle of the vehicle relative to the horizontal plane in advance, specifically: set the output of the neutral sensor when the vehicle maintains the horizontal state with the horizontal plane is, the output when the inclination Angle is, and the output under the action of acceleration is. The calculation formula is:  $\alpha V_0 \alpha V_\alpha 1g$

$$V_\alpha = V / g \times \sin \alpha \times 1g + V_0$$

$$\alpha = \arcsin[(V_\alpha - V_0) / V]$$

Then the inclination Angle of the vehicle in the lateral direction and the longitudinal direction are respectively:  $\alpha_x$   $\alpha_y$

$$\alpha_x = \arcsin[(V_x - V) / V], \alpha_y = \arcsin[(V_y - V) / V]$$

Compare the lateral inclination Angle and longitudinal inclination Angle of the vehicle with the threshold. If the lateral inclination Angle and longitudinal inclination Angle exceed the set threshold, it is judged that the vehicle rollover occurs. The rollover threshold of the vehicle's lateral and longitudinal inclination relative to the horizontal plane is 60 degrees.

### 3.2. Information acquisition subsystem

The main devices of vehicle information acquisition subsystem are three-axis acceleration sensor, gravity sensor and traffic recorder. The supply voltage of the sensor is 4.9 ~ 5.5V, the input range is -25 ~ 25g, and the sensitivity is 80mV/g. The three-axis acceleration sensor can obtain the acceleration signal of the vehicle in the process of driving, and the gravity sensor can obtain the inclination Angle of the vehicle and the horizontal plane. Tachograph can be divided into card type, hidden type and rearview mirror type.

### 3.3. Information transmission subsystem

Sensor transmission data module: the STM32 chip can obtain sensor signals and send them to the ESP8266 WIFI module through the UART serial port communication. Then, they can be forwarded by the router through WIFI and uploaded to the cloud platform server.



Fig. 2 Flow chart of sensor data transmission module

Dashcam video transmission module: the original video is converted into digital video data to be encoded by the acquisition program, and the original video data is compressed and encoded by the H.264 compression coding technology inside the Hi3516 chip, and the data is packaged under the support of RTP protocol.

The design of the mobile terminal of the client of the vehicle video monitoring system, that is, the "administrator" user, is shown in Figure 3 below. The session between the user and the tachograph on the device is carried out through RTSP for data information exchange, which is transmitted from RTP to the mobile terminal, and the encoded data transmitted to

the mobile terminal is decoded by the corresponding video decoding module of the mobile terminal, and then played. The decoding module of this video monitoring system is decoded and played directly by the player, because the Android system can decode FLV files directly.

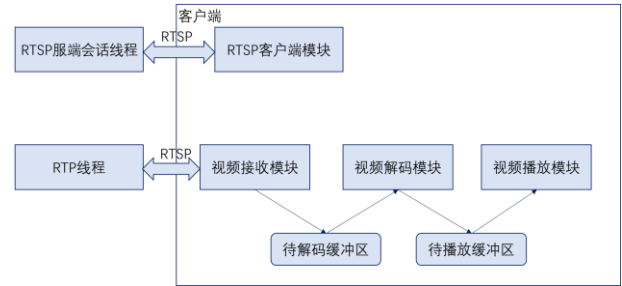


Fig.3 Design diagram of real-time video retrieval process on the client side

### 3.4. Integrated early warning subsystem

The integrated early warning subsystem mainly relies on the cloud platform, which is divided into communication gateway area, data analysis area and data storage area according to the functional needs. The communication gateway area uses Flume framework for data collection, uses the unified data format JSON, distributes to Kafka for temporary storage, the data analysis area uses Spark Streaming to receive Kafka data and analyzes. The data storage area uses the non-relational database MongoDB to store the data of the accident vehicle and the video uploaded by the dashcam.

## 4. Expected results

The project development of tachograph is based on the existing traditional tachograph technology, secondary development, the formation of a new tachograph with "cloud + terminal" traffic accident emergency rescue system, and synchronically equipped with "Dawn wisdom rescue" multifunctional APP." Cloud + terminal" traffic accident emergency rescue system is based on traffic accident recognition algorithm, with the help of vehicle built-in sensor data collection, construction of driving vehicle risk data monitoring cloud platform, when an accident occurs, cloud platform monitoring data reaches the warning threshold, immediately send an alarm message, through the system alarm message to obtain the accident location information. At the same time, the system sends a video request to the server. After receiving the request, the server will upload the recorded video before the accident to the "Dawn Wisdom Rescue" APP of 110 rescue center, 120 first aid center, fire emergency center and emergency center of the insurance company through coding, compression and decoding. Rescue personnel can understand the accident situation through the video, and formulate the optimal rescue plan.

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