The Development of the Assistant Driving and Monitoring and Assessment System for Missile Weapon Special Vehicles

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Abstract. Based on the analysis and study of the characteristics of missile weapon special vehicles, combined with the problems existing in the driving operation training process of the military drivers, an assistant driving and monitoring and assessment system for missile weapon special vehicles is developed. The design ideas of the hardware modules of the system and the realization methods of the software design of each subsystem are introduced in detail. Finally, the application effect of the system in the training of equipment formations of National Day parade is illustrated.

1. Introduction
The missile weapon special vehicles of the Rocket Force are nearly ten meters longer than the ordinary transport vehicles. There are problems in the launching position, such as long positioning time, low positioning accuracy, and difficult positioning at night. In the process of military parade training, there are some problems such as the inability to accurately locate due to the existence of multiple vehicles and the lack of training and assessment methods, resulting in low efficiency of the military parade training and the inability to record the operation actions in the driving process. In view of the problems existing in the missile weapon special vehicles, using advanced technologies such as the laser ranging, satellite positioning, panoramic imaging and electronic assessment, adopting mature I2C bus technology and ARM embedded technology, the assistant driving and monitoring and assessment system for missile weapon special vehicles is developed to solve the problems of long positioning time and low positioning accuracy of vehicles in the launching position, which provides an effective means to ensure the safe driving of the missile weapon special vehicle drivers, improves the training efficiency of the military parade formations of the missile weapon special vehicles, and provides methods for the driving skill assessment of the missile weapon special vehicle drivers.

2. The Overall Structure of the System
The assistant driving and monitoring and assessment system of missile weapon special vehicles is composed of four parts: the satellite positioning module, the laser ranging module, the panoramic imaging module, and the assessment and evaluation module, as shown in Fig.1.
Driving assistance monitoring and assessment system of missile weapon special vehicles

Satellite positioning module  Laser ranging module  Panoramic imaging module  Training and assessment module

Signal receiving module  Solution processing module  Data communication module  Laser emission module  Video capture module  Data processing module  Video display module  System database  Personnel management module  Operation evaluation module

Figure 1. The composition diagram of assistant driving and monitoring and assessment system for missile weapon special vehicles

The satellite positioning module consists of the signal receiving module, the solution processing module, the data communication module, etc. It mainly completes the functions of vehicle positioning, ranging, etc., which can provide the relative position information between vehicle teams for vehicle array commanders in the process of military parade training, guide the launching vehicle drivers to locate the launching vehicles quickly and accurately, and reduce the missile launching preparation time.

The laser ranging module consists of the laser launching module, the laser receiving module and the data processing module, which can accurately judge the distance between the vehicle body and the surrounding objects, guarantee the constant speed, equal distance and equal interval travel of the vehicle square formations of the military parade, and can guarantee the missile force to avoid the vehicle scratch accident in the night synthetic training.

The panoramic imaging module is composed of the video capture module, the video processing module and the video display module, which can complete video capture, real-time video processing, data storage, video panoramic display and other functions around the vehicle, eliminate the blind area of the driver’s vision, and ensure the driver’s driving safety.

The training and assessment module is composed of the system database, the personnel management module and the operation evaluation module, which completes the training and assessment of the driving skills of the missile weapon special vehicle drivers and completes the comprehensive training and scoring of the vehicle square formations in the process of military parade training, providing a scientific and effective platform for quantitative evaluation and auxiliary training for driver training.

The assistant driving and monitoring and assessment system of missile weapon special vehicles integrates positioning, camera, ranging, assessment, display and terminal processing. The driver can adjust timely according to the transmitted data and image, and realize all-round real-time monitoring of the missile weapon special vehicle, the safe distance alarm, and the scientific and effective assessment of driver’s driving skills.

3. The Design and Implementation of System Hardware
The assistant driving and monitoring and assessment system for missile weapon special vehicles
combines skill training, collaborative drilling, assistant driving and assessment organically. Based on the embedded ARM, it adopts advanced technologies such as the laser ranging, the satellite positioning, the panoramic imaging, and the electronic assessment, combines bus control technology, and adopts modular design idea. The main equipment selection and connection diagram of the system is shown in Fig.2:

Figure 2. Main equipment selection and connection diagram of the system

Hardware equipment mainly includes: embedded ARM system S3C2440, video decoder TVP5150, video processor DM642, video encoder SAA7121, satellite signal receiving device TD3020, laser transmitting device PGEW1S09, laser receiving device C30724P, display device and signal conditioning board.

The system adopts the architecture of ARM+FPGA, and uses the powerful processing ability and rich interface of embedded ARM to ensure the real-time performance of the system. FPGA is a programmable logic device with flexible configuration, which can be developed flexibly and conveniently to improve the working efficiency of the system.

3.1 The Design of the Satellite Positioning Subsystem
The satellite positioning subsystem mainly completes the reception and analysis of navigation satellite signals, and displays the position information on the display.

The satellite receiving module selected by the system is TD3020 dual system high-performance satellite receiving module, which supports dual-mode navigation positioning information of BD2 and GPS frequency points at the same time. By setting the working mode, three working modes can be used: single BD2 positioning, single GPS positioning and BD2/GPS hybrid positioning.

When the satellite receiving chip works normally, it outputs the standard NMEA-0183 format positioning data and 1PPS timing signal through the serial port, which provides BD2/GPS dual-mode solution with high precision, low power consumption and low cost for the missile weapon special vehicles.

3.2 The Design of the Laser Ranging Subsystem
The laser ranging subsystem uses the principle of laser ranging to realize the function of obstacle distance detection. According to the distance of the obstacle, it will automatically alarm, so as to achieve the purpose of all-round anti-collision of missile weapon special vehicles. Through the laser ranging system, the vehicle square formations participating in the military parade can travel in formation according to the requirements of horizontal alignment and vertical equidistance in the process of military parade, reducing the excessive dependence on the operation skills of special vehicle drivers. The design schematic diagram of the laser ranging subsystem is shown in Fig.3.
PGEW1S09 is selected as the laser emission device, the integrated chip C30724P is selected as the laser receiving device and the TDC-GP2 chip with higher accuracy is selected as the time measuring device. The embedded ARM controls the TDC to time, controls the laser emission device to send strong and narrow pulses, controls the laser receiving device to receive the feedback signal in real time, carries out the distance calculation in real time, and drives the LED display module to display the distance information. If the distance is within the dangerous range, it controls the alarm circuit to send out the sound and light alarm signal.

3.3 The Design of the Panoramic Imaging Subsystem
The system covers all areas around the vehicle body through six wide-angle cameras on the vehicle. Through the high-speed operation of ARM, the parameter information of six camera splicing relationship is obtained. According to the calculated parameter information, the panoramic top view image is generated. The core processing unit is DM642, a multimedia processor with high cost performance from TI company.

After the DM642 captures 6 source images, the video decoder TVP5150 decodes them. Then the image parameter information is synthesized by ARM, and the processed panoramic image information is output through video port and displayed on the display. The video display process is the opposite of video capture. The digital video processed by DM642 is encoded by SAA7121 and output in real time. The driver can control the missile weapon special vehicle conveniently, ensure the driving safety of the vehicle, record the driving track of the vehicle in real time, and provide the basic basis for the assessment system.

3.4 The Design of the Training and Assessment Subsystem
The training and assessment system is mainly aimed at the training and assessment of the driving skills of drivers of the missile weapon special vehicles. It trains and inspects the drivers’ familiarity with vehicles, operating accuracy, and the disposal of special conditions of vehicles, and gives a score for drivers’ operation.

During the training, it gives the user tips on how to operate, the key points of operation, the consequences caused by misoperation and how to deal with special situations. In the assessment mode, the program will not show any prompts, and only record all the information of the driver’s operation actions in detail in the background, including operation time, operation actions, handling of special situations, etc., for the assessment of the assessment results.

4. The Design and Implementation of System Software
According to the characteristics of the missile weapon special vehicles of the Rocket Force, combined with the design of system hardware, Microsoft C# .NET is selected as the development tool, and modular programming method is adopted. The software system is divided into four functional modules: system software, main control software, communication software and management software, as shown
in Fig.4.

Figure 4. The software system structure diagram

The system software is composed of boot loader, Linux operating system and FPGA programming, which can control, monitor and manage other devices. The boot loader exits and disappears after the boot function is completed.

The main control software consists of satellite positioning software, laser ranging software and panoramic imaging software. The satellite positioning software completes the processing of the positioning information data collected by the satellite positioning module, and obtains the positioning information. The laser ranging software carries out the high-precision time interval measurement through the propagation delay control of the internal gate circuit, and calculates the accurate distance information. The panoramic imaging software is to complete the collection, processing and output of video data and other functions.

The communication software is composed of three parts: the network communication module, the bus driver module and the video transmission module, which realizes the communication between the lower computer and the upper computer as well as the network communication function, bus driver loading, video transmission and other functions.

The management software consists of three parts: the personnel management module, the database management module and the operation evaluation module, which can store driver information, update database and make operation evaluation rules.

5. Conclusions
The assistant driving and monitoring and assessment system for missile weapon special vehicles developed in this paper has novel design, high efficiency cost ratio and wide application object. It has been applied in a special equipment driver training base of the Rocket Force and the equipment formation training of National Day parade, and successfully completed the training assessment task of relevant special vehicle drivers and the training task of the equipment formation of National Day parade, as shown in Fig.5. The application results show that the system runs stably and is based on the support of assistant driving and assessment and training of special vehicles. With lower cost, the system can complete multi-channel real-time timing, positioning, monitoring and assessment functions of multiple vehicles, and accurately measure the moving parameters of equipment formations such as uniform speed, alignment and equidistance. The system builds a hardware platform for the training
and assessment of the military missile special vehicle drivers and the military parade training of the equipment formations, reduces the cost of the special vehicle driving training, improves the driving training effect of the special vehicles, and has great military significance and greater economic benefits.

Figure 5. The practical application diagram of the system in training of equipment formations of military parade

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