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Research and Application of Intelligent Robot Electronic Coach System Based on Ai Technology

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Abstract: With the development of national economy, China's highway transportation industry is growing rapidly, and the demand for motor vehicle drivers is increasing day by day. Driver schools all over the country have emerged at the historic moment. The electronic coaching system of intelligent robot based on AI technology combines the system model developed by electromagnetic induction technology, remote sensing technology, electronic lighting technology and many other technologies on the basis of electronic control. It uses intelligent sensors, AC/DC converters and many other electrical equipment, and uses electronic lighting display to remind driving school students that the driving position is wrong and correct the wrong driving route. Bring unprecedented convenience to the majority of driving school students, and let them get their driving licenses in a relaxed and active atmosphere.

1. Introduction

China has a huge vehicle base, and the traffic control department strictly controls the driver's driving qualification, and the driver's license must pass the driving qualification examination sponsored by the vehicle management office. At present, there are many limitations in driving schools, such as venues, training time points, training time and so on, so various auxiliary training equipments are gradually born. A variety of intelligent driving test and training systems came into being, with the functions of basic teaching, intelligent evaluation, robot teaching and safety protection, to realize the transformation of self-training and driver test from manual evaluation to intelligent evaluation [1]. However, the traditional intelligent evaluation has no prediction function, and can not inform the driver of the vehicle's position information in advance, so it is necessary to add trajectory prediction. Commonly used trajectory prediction methods include Kalman filter [2], least square [3] and curve fitting [4]. These methods need historical data, and their algorithms are complex and difficult to implement.

Starting from the above problems in driving schools, based on electronic control technology, electromagnetic induction technology, remote sensing technology, infrared electronic pile inversion technology, electronic lighting technology and many other technologies are combined. Using intelligent sensors, AC/DC converters, electronic lighting displays and many other electrical devices, an intelligent robot electronic coaching system based on AI technology has been

developed.

2. System Hardware Design

2.1 Hardware Architecture

In this system, the motor vehicle is used as the carrier, which consists of a central processing unit module (S3C2440 microprocessor), a vision sensor module (OV9650 CMOS camera) [5], a speed sensor module (A3144 switched Hall sensor, STC 12 C52021 AD speed chip), a voice broadcast module (ISD 4004 voice chip, speaker) and a power supply (20C2200mah model lithium battery) The hardware structure of the in-field driving test electronic trainer is shown in Figure 1.

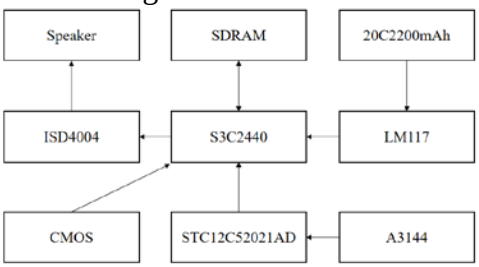

Fig.1 Hardware Structure Block Diagram of Electronic Coach for Infield Driving Test

The boundary signals collected by the vision sensor module and the speed signals collected by the speed sensor module are transmitted to the CPU module for rapid processing through serial communication, and the CPU module uses SDRAM to temporarily cache data and update the status in real time. The CPU module transmits the processed data to the voice broadcast system through serial communication, and then broadcasts the voice through the speaker.

2.2 Main Circuit Design

(1)Power supply circuit design

The power supply of automobile is obtained by charging the battery with the generator driven by the engine. The voltage of the battery is usually 12V, but in actual use, the load and power supply (generator and battery) will change frequently, which makes the power supply voltage change frequently. Under this fluctuating voltage, some electronic components cannot work normally or are damaged [6]. Therefore, the vehicle power supply must be stabilized and filtered before it can be used in electronic equipment. Fig. 2 shows a power filter circuit.

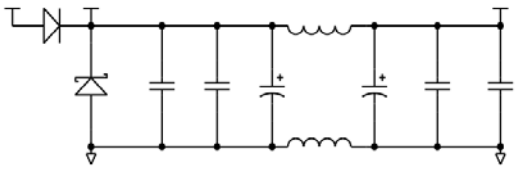

Fig.2 Power Filter Circuit

(2)Design of speed signal acquisition circuit

The speed pulse signal of gearbox output shaft collected by Hall sensor has been shaped by processing circuit itself, but waveform distortion often occurs after transmission. Because when the capacitance on the transmission line is large, the rising edge of the waveform will obviously deteriorate; When the transmission line is long and the impedance of the receiving end does not match the impedance of the transmission line, oscillation will occur at the rising and falling edges

of the waveform. When other pulse signals are superimposed on rectangular pulse signals through distributed capacitance between wires or common power lines, additional noise will appear on the signals [7]. The automobile itself is a complex electromagnetic environment, and the signal from the sensor to the MCU is bound to be deformed. Therefore, the ideal rectangular pulse waveform must be obtained by filtering and shaping circuit.

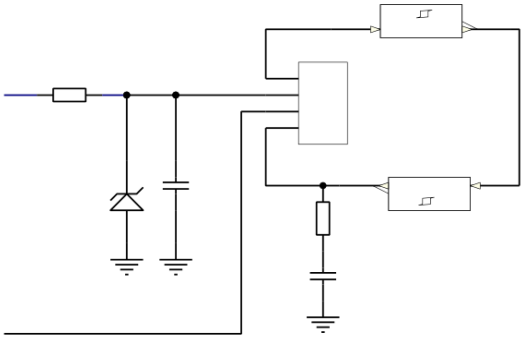

Fig.3 Vehicle Speed Signal Acquisition Circuit

The speed signal acquisition circuit of this system is shown in Figure 3. In the figure, Speed is the input terminal, which is the pulse signal obtained from Hall sensor after shaping, and D1 is the transient voltage suppression diode, which can prevent components from being damaged by instantaneous high voltage. C10, R5 and C11, R5 all filter the speed signal. In the working process of the system, due to the interference of the ignition signal, the peak voltage will be generated. The SN74HC14 Schmitt trigger can filter out the peak voltage and make the pulse signal input to the control chip more regular. After being shaped by SN74HC14, the pulse signal will reverse, so SN74HC14 shaping is used twice.

(3)Hardware anti-interference measures

According to the characteristics of interference sources and transmission channels of interference signals of intelligent robot electronic coaching system based on AI technology, the following hardware anti-interference measures are adopted:

3. Anti-Interference Measures of Power Supply Circuit.

A filter circuit and a processing circuit for preventing instantaneous high voltage are set in the power supply circuit, and a decoupling circuit is set to filter out the mutual interference between the front and back stages in the circuit. Capacitance filtering is installed at the power supply end of each chip of the control system to suppress high-frequency interference. The power supply of electronic control system is 12V battery, but the voltage generated by vehicle-mounted generator is unstable, which causes the power supply voltage of electronic control system to fluctuate within a certain range, and sometimes produces instantaneous over-limit voltage. Therefore, low-voltage protection circuit and high-voltage buffer protection circuit are adopted in the design of power supply circuit to ensure that the controller will reset at low voltage for self-protection when under-voltage, and the electronic control unit will not be damaged by instantaneous over-voltage when under-voltage.

4. Place Relevant Devices as Close as Possible

Keep noise-prone devices and high-current circuits as far away from signal circuits as possible. High and low frequency signals are arranged separately. The analog circuit and the digital circuit are wired separately, and the connection length between components is minimized to reduce the distributed inductance. The power amplifier and I/O driver shall be arranged as close as possible to

the edge of the outgoing connector and printed board. Try not to use right-angle broken lines when wiring, so as to reduce the high-frequency signals emitted by the system.

5. System Software Architecture and Algorithm Design

5.1 Driving School Coach Robot

The driving school coach robot is equipped with Beidou receiver and high-precision measurement dual antennas, which can accurately measure the real-time position, attitude, speed and heading of the vehicle by receiving the differential correction information broadcast by the reference station. In addition, the vehicle-mounted signal collector and industrial computer can obtain the vehicle state sensor data in real time, for example, various vehicle lamp signals and engine signals through OBD interface.

After getting the coordinates of the roof dual antennas and the heading angle of the car body by the driving school coach robot, the coordinates of the vehicle sign points can be obtained by combining with the vehicle digital model, which is composed of 24 car body points and 8 wheel points. The distribution sequence of the car body points and the car body points is calibrated according to the setting, and each car body point is projected to the ground by a plumb hammer. The following X-O-Y coordinate system is established for the digital model of automobile body, with the origin at the center of the front antenna, the straight line passing through the centers of the two antennas as the x axis and the direction perpendicular to the straight line of the x axis as the y axis. The Beidou coordinates of 32 landmark points can be obtained from the relative coordinates of each landmark point in the vehicle digital model and the real-time Beidou coordinates and heading angles of the roof dual antennas.

The whole examination site and examination items are mapped by special surveying and mapping equipment, and a special high-precision map is formed by digital post-processing of special software for real-time evaluation by upper computer software. At the same time, combined with the vehicle digital model, by identifying the real-time graphic relationship among the outline model of the test vehicle, the tire model and the geometric model of the test item, it can be used to automatically judge whether the vehicle is out of the line, whether the parking is in a qualified area, whether the tire touches the lane edge, etc., and whether the test vehicle should be deducted in the test item.

5.2 Design and Implementation of Speech Recognition

The design idea of speech recognition system is still to adopt the basic theory of recognition based on statistical model, and let the machine transform the speech signal into the corresponding text or instruction through the process of recognition and understanding, so as to achieve speech control and speech operation.

5.2.1 Realization of Speech Signal Preprocessing

Speech signal preprocessing mainly includes speech signal acquisition, de-noising, pre-emphasis and endpoint detection. During its operation, the speech signal acquisition program must be called to find the beginning and end points of syllables and morphemes in each paragraph of speech signal by digital processing technology.

In Chinese, it is necessary to find out the initial and final ends of Chinese characters, and then recognize Chinese speech according to the position of the end points. Endpoint detection is a key link in speech system. Endpoint detection can easily distinguish noise from real speech signal, and

plays a key role in speech signal processing, noise reduction and denoising. The flow chart of Chinese speech signal endpoint detection is shown in Figure 4.

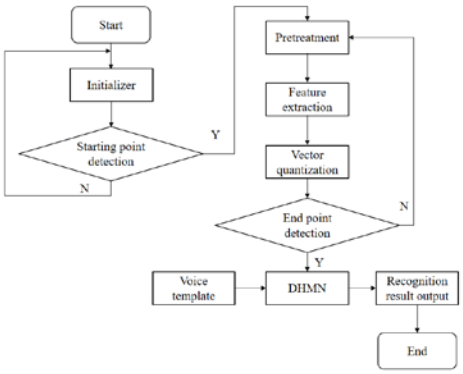

Fig.4 Flow Chart of Endpoint Detection of Chinese Speech Signal

The endpoint detection method adopted by the system is based on short-time energy or short-time average amplitude, because the main difference between speech and noise lies in the energy difference, and the energy of speech segment is larger than that of noise segment, because the energy of speech segment is the sum of the energy of noise segment superimposed with the energy of speech sound waves. Therefore, in a short time, according to the energy ratio of voice input signal, voice and noise can be well distinguished.

5.2.2 Key Code Design

The main program design of the software system is speech recognition program and application program, which mainly completes speech recognition and system application function.

The design of speech recognition program adopts object-oriented programming method, creates recognition command function and speech recognition interface by adding speech classes, takes the input audio data as the input source of recognition engine, and refers to the speech recognition engine interface to recognize and judge the audio input, thus outputting recognition results. Some identification procedures are as follows:

```
User user = new ConfigUser();
if (!user.exists(username)) {
throw new IOException("username is not exist");
}
SystemInfo si = new SystemInfo();
File base = new File(si.getOutput());
this.output = new File(base, username);
if (!output.exists()) {
output.mkdirs();
}
File[] olds = output.listFiles();
for (int i = 0; i < olds.length; i++) {
File old = olds[i];
if (old.isDirectory()) {
flownames.add(old.getName());
}
}
FlowFactory ff = new FlowFactory();
```

5.3 Design of Parking Electronic Fence

5.3.1 Gps Data Processing

By default, BH-ATGM332D module adopts NMEA-01834.0 protocol and outputs positioning data information through TTL serial port. NMEA is a standard format for marine electronic equipment developed by National Oceanographic Electronics Association of America. It is a set of standard information that defines the output of receiver. There are several different formats, each of which is an independent and related ASCII format. Comma is used to separate data, and the length of data stream varies from 30-100 characters.

The one-chip computer system communicates with the BH-ATGM332D module through the serial port, obtains the original information output by the GPS module through the USART serial port, and outputs the decoded result using USART1. While the controller is processing data, the serial port will continuously receive GPS data, so it is necessary to coordinate the relationship between receiving data and decoding data and use DMA serial port buffer to solve the problem. When positioning deviation occurs due to inconsistency of coordinate system, it is necessary to call API of “converting original coordinates into Baidu coordinates” and input longitude and latitude of WGS-84 coordinate system to carry out coordinate error correction [8].

5.3.2 Monitoring Center

The monitoring platform is developed based on the Visual Studio 2015 platform. The Visual Studio 2015 is currently the most popular integrated development environment for Windows platform applications. It is a development tool launched by the Microsoft Group and can use a common code library in the Win/Mac/Linux operating system. Quickly develop your own application software. This project uses C# language programming to quickly visually build a monitoring platform, establish a C/S program framework, the monitoring center is the server, and at the same time can be used as a PC client to visualize monitoring data, using the Socket interface provided by C#, through GPRS and single-chip microcomputer The system client communicates in real time; the PC client mainly uses related controls such as button, textbox, panel, track-view, label, timer, checkbox, dateset, etc. [9].

5.4 Design of Face Recognition Algorithm

The Face Recognizer class was created to realize face recognition from OpenCV2.4 version 2.4 [10]. This system designs a face recognition algorithm based on LBPH to verify the examinee's face recognition.

Local Binary Pattern (LBP) is an operator used to describe local texture features of images. It takes the center pixel whose size is a window as a threshold and compares it with the gray values of the other 8 pixels adjacent to the center pixel. Set 1 for pixel values greater than or equal to the threshold, and set 0 for pixel values less than the threshold. Convert the surrounding 8 pixel values into 8 binary numbers, and get the LBP value of the center pixel of the window through these 8 binary numbers, and reflect the texture features of the region through the obtained values. As shown in fig. 5.

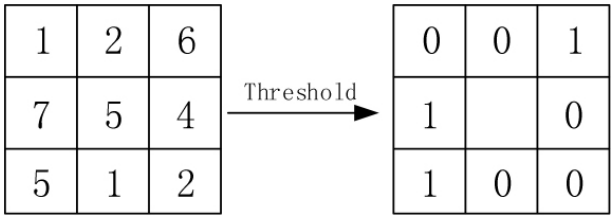

Fig.5 Lbp Operator

Local Binary Patterns Histograms (LBPH) is a statistical histogram of LBP features, which combines LBP features with spatial information of images to avoid errors caused by position deviation in feature extraction and judgment. The basic idea of face recognition method based on LBPH is as follows:

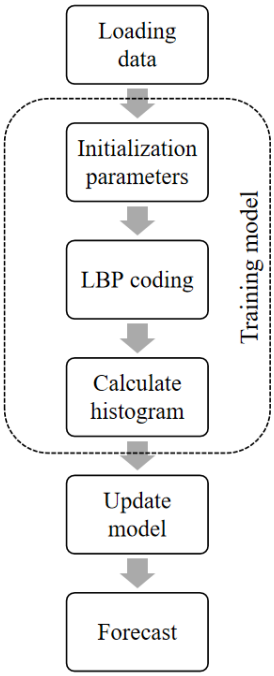

Fig.6 Face Recognition Flow Chart

(1)Taking each pixel in the image to be identified as the center, the size relationship between the gray values of the central pixel and the surrounding pixels is judged respectively, and the judgment result is binary coded, thus obtaining the LBP coded image of the whole image.

(2)The LBP image is divided into several regions, and the LBP coded histograms of all the regions after division are obtained, thus obtaining the LBP coded histograms of face images, and the function of face recognition is achieved by comparing the LBP coded histograms of different face images. The flow chart of face recognition is shown in Figure 6.

6. Instance Verification

Taking a driving school demonstration site as an example, the upper computer can automatically judge in advance whether the car body is out of line, whether the parking is in a qualified area, whether the tire touches the lane edge, etc., and judge whether the test car should deduct points in the test items by identifying the predicted graphic relationship between the outline model of the test car, the tire model and the geometric model of the test items.

The results show that the host computer firstly guides the driver to drive the vehicle into the preset parking spot, and then judges whether the test vehicle will drive out of the boundary line by judging whether the vehicle model at the predicted point intersects with the boundary line, predicts the driver's vehicle position information in advance, and promptly tells the driver to adjust the vehicle body position by voice so as to pass the training or examination smoothly.

7. Conclusion

The AI technology of this system combines the algorithms of each module to complete the design of the whole system, including the hardware circuit design of each module, the algorithm design on the module and the serial communication design between the modules, etc., thus achieving the organic unity of people, vehicles and machines. The hardware of the system is simple, and it has the characteristics of tailoring, portability and portability. Fourthly, the system takes motor vehicles as the carrier, which can be used and practiced with real time; The system uses parking electronic fence design, which can avoid the defect that boundary objects must be protrusions, and has flexibility. Driving test electronic coaching series is still a relatively new research field, and there are few products of the same type. The main reason is the bilateral constraints of policy and technology. Therefore, the research on driving test electronic coaching has broad development prospects.

References

[1] Fernandez-Cervantes V, Neubauer N, Hunter B, et al. VirtualGym : A kinect-based system for seniors exercising at home. Entertainment Computing, no. 27, pp. 60-72, 2018.

[2] Liu M, Ma J, Lin L, et al. Intelligent assembly system for mechanical products and key technology based on internet of things. Journal of Intelligent Manufacturing, vol. 28, no. 2, pp, 271-299, 2017.

[3] Yang J, Gao Y, Ding Y, et al. Deep Learning Aided System Design Method for Intelligent Reimbursement Robot. IEEE Access, no. 99, pp, 1-1, 2019.

[4] Zhang J, Huang J, Chen W . Centralized management system of intelligent inspection robot based on wireless sensor. Microprocessors and Microsystems, no. 46, pp, 103409, 2020.

[5] Wang Wanliang, Zhu Yanliang, Wang Zheng, et al. Intelligent robot object detection algorithm based on spatial pyramid and integrated features. Computer integrated manufacturing system, vol. 023, no. 011, pp, 2382-2391, 2017.

[6] Hejazipoor H, Massah J, Soryani M , et al. An intelligent spraying robot based on plant bulk volume. Computers and Electronics in Agriculture, vol. 180, no. 3, pp, 105859, 2020.

[7] Huang Y A, H Wu, H Liu, et al. [Lecture Notes in Computer Science] Intelligent Robotics and Applications Volume 10462 A Novel Soft Robot Based on Organic Materials: Finite Element Simulation and Precise Control. no. 10, pp, 103-109, 2017.

[8] Scott, Moody. Design of an intelligent embedded system for condition monitoring of an industrial robot. Computing reviews, vol. 58, no. 7, pp, 403-404, 2017.

[9] Zhu X, Yi J, Ding H, et al. Velocity Obstacle Based on Vertical Ellipse for Multi-Robot Collision Avoidance. Journal of Intelligent & Robotic Systems, vol. 99, no. 1, pp, 183-208, 2020.

[10] Li D, Pan Z, Deng H, et al. 2D Underwater Obstacle Avoidance Control Algorithm Based on IB-LBM and APF Method for a Multi-Joint Snake-Like Robot. Journal of Intelligent & Robotic Systems, vol. 98, no. 3, pp, 771-790, 2020.