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Design of remote wireless remote control system for corn harvester

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Abstract: *A design method of remote wireless remote control system for corn harvester is pointed out. It can realize real-time monitoring, recording and video recording functions of corn harvester through remote control operating platform and operating terminal. The principle and components of remote control technology are introduced in detail in this paper.*

Keywords: *Corn harvester; remote control; controller; cooperative operation*

1. Introduction

All With the increasing support from the state to the agricultural sector, the existing corn harvesting machines in China are basically operated manually, requiring drivers to have a high level of driving[1]. For example, to ensure the complete collection of corn harvesting, visual observation and simultaneous operation of multiple keys can complete the coordinated operation of lifting, pushing and turning in the working cycle. When operating, the operator needs to reason on the basis of sight and hearing and rely on empirical knowledge to control and monitor the operation process[2]. Physical and mental consumption is great, in addition, the work will be affected by different geographical environment and climate, and often have to face a variety of situations[3]. Therefore, it is necessary to research and develop wireless remote control system of remote harvester.

At present, corn harvester is often operated manually in the cockpit, but because of its high technical requirements for the driver, the harsh environment can not be operated, and to ensure the personal safety of the driver. Secondly, the remote control is carried out with the handle remote control. The remote control distance is close, the operation is complicated, the experience is poor, and the operation efficiency is low. This project studies the design of a remote wireless remote control system for corn harvester, which can realize remote control, about 3km. The remote control platform can obtain the actual situation of the field according to the real-time monitoring and recording device. Then the corn harvester can be operated remotely more efficiently.

2. Technical Principle

Wireless remote control system fig. 1 of corn harvester. Mainly by the harvester end control system, recording and video device. And real-time monitoring system. Remote control system communicates with harvester through wireless network bridge [4]. During remote operation, the control system of the remote control system obtains all operation instructions and transmits them to the wireless network bridge of the remote control terminal through the switch through the network interface [5]. After wireless transmission, the signal is transmitted to the wireless network bridge at the harvester end, and then transmitted to the control system at the harvester end through the switch. The control system controls the engine according to the received instructions. The solenoid valve group is controlled by realizing the throttle speed of the harvester engine and the actual situation of the whole machine movement.

All kinds of sensor data, engine information and other data obtained by the control system at the harvester end [6]. All kinds of sensor data, engine information and data in the recording and video system are transmitted to the wireless network bridge at the harvester side through the network interface and switch. After wireless transmission, it is sent to the wireless bridge of the remote control for receiving, and then transmitted to the computer host in the monitoring system through the switch for data analysis, and finally display the harvester working parameters display and recording, video playback and electronic map on the screen. All network communication devices in the system are set to the same

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network segment, and each device has a unique IP address to implement the communication between devices.

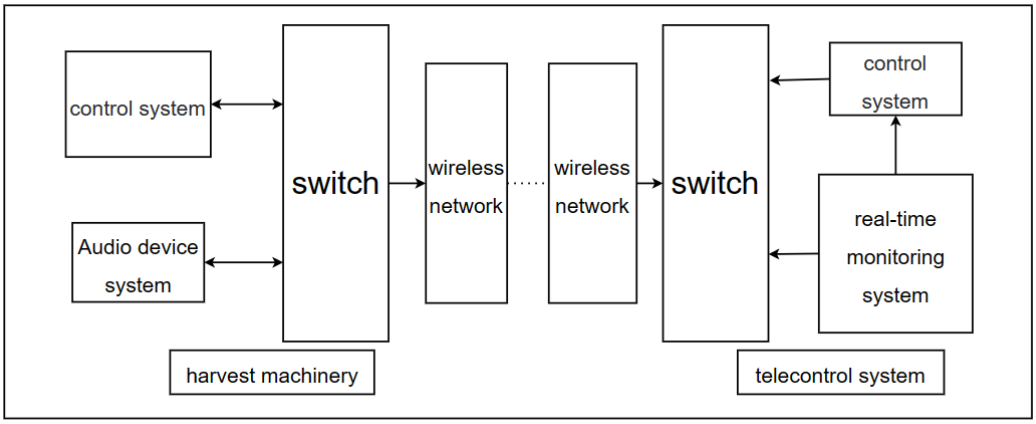

Figure 1: Wireless remote control system

3. Harvester control system

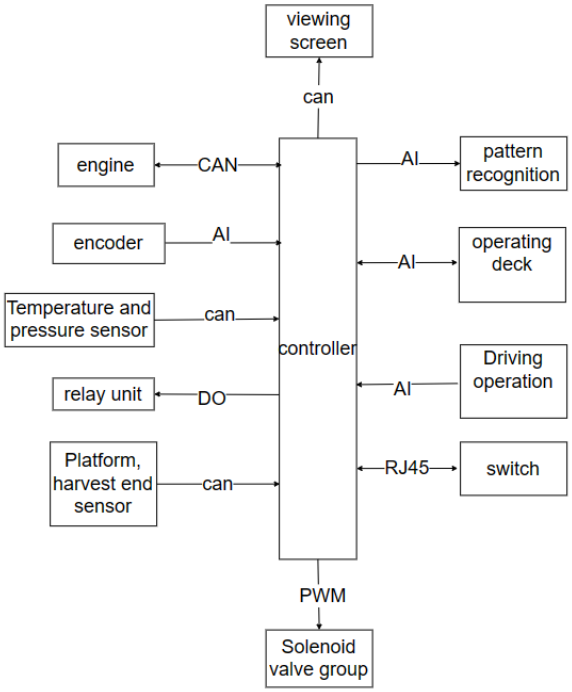

Figure 2: The system schematic

Harvester control system mainly consists of controller, display screen, mode switch, engine ECU, sensor, solenoid valve group, relay, etc. The system schematic diagram is shown in Figure 2. In the system, with the controller as the core, the controller is connected to the engine ECU, rotary encoder, tilt sensor and display screen through the CAN bus for data communication. The relay group is controlled through the output of switching quantity, and the data of sensor, operating terminal and walking foot are acquired through the acquisition of analog signal. The controller is connected to the switch through the RJ45 network interface. Through DO and PWM output control solenoid valve switch or solenoid proportional valve current size.

When the harvester works, the controller reads the mode switch signal, determines whether it is manual mode or remote control mode, and collects the signals of the operating end and walking pedal. Read engine system speed, cooling water temperature and other working data, as well as engine fault

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code information. Collect and read the temperature and pressure data of the hydraulic system of the harvester, read the platform rotary encoder data to obtain the rotation Angle value of the vehicle on the harvester, read the platform and equipment inclination sensor data to obtain the inclination value of the vehicle body, running state and rotation Angle value, and transmit the data to the display screen and switch. The controller sends throttle speed control instructions to the engine ECU through the CAN bus. In order to control the engine speed, it controls the solenoid valve switch and the proportional solenoid valve current, and realizes the speed control of the machine remote operation [7].

When the mode switch selects the remote control mode, the controller receives the operation instruction signal from the remote control end, and does not execute the operation handle, pedal and other signals in the driver's room; Motion control, no longer receive remote operation instructions, distinguish between manual mode and remote mode function.

3.1 Sound recording and video system

The recording and video recording system mainly includes network component, webcam and 360° panoramic circumnavigation system. The system schematic diagram is shown in Figure 3. The network component is used to obtain the sound of the remote control harvester at the work site and is installed in the driver's room. The web camera is used to obtain the perspective around the machine and harvest. The 360° panoramic circumnavigation system consists of 6 cameras and the host. The 6 cameras are respectively installed in the six directions of the harvester: front, back, left, right, left front and left back. The network component, webcam and 360° panorama host are connected to the switch through the RJ45 network interface.

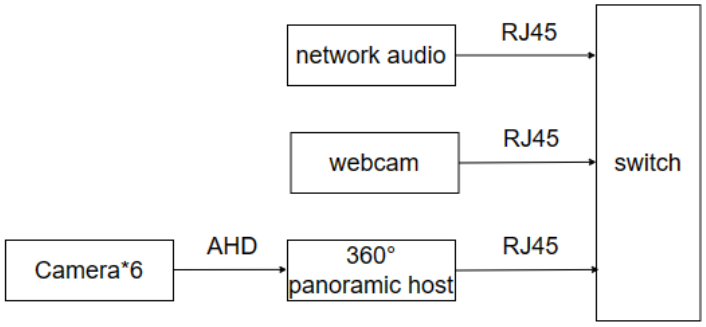

Figure 3: The system schematic

3.2 Sub heading

The remote control system and video monitoring are shown in Figure 4. The control system is mainly composed of the controller, the left and right operating end, front and rear walking foot, throttle knob and control switch. Video surveillance system is mainly composed of computer host and display screen. During remote control, the controller collects signals of the operating end, walking foot, throttle knob and control switch, which are converted into control instructions and transmitted to the switch through the RJ45 network interface after processing. The computer host receives the working parameters of the harvester sent from the control system of the harvester terminal through the RJ45 network interface, and the components of the audio and video system, electronic map, webcam, 360° panoramic host data and is analyzed through the software. Finally, the image display and sound playback are performed on the display screen.

3.3 Remote control terminal system

The remote control system and video monitoring are shown in Figure 4. The control system is mainly composed of the controller, the left and right operating end, front and rear walking foot, throttle knob and control switch. Video surveillance system is mainly composed of computer host and display screen. During remote control, the controller collects signals of the operating end, walking foot, throttle knob and control switch, which are converted into control instructions and transmitted to the switch through the RJ45 network interface after processing. The computer host receives the working parameters of the harvester sent from the control system of the harvester terminal through the RJ45 network interface, and

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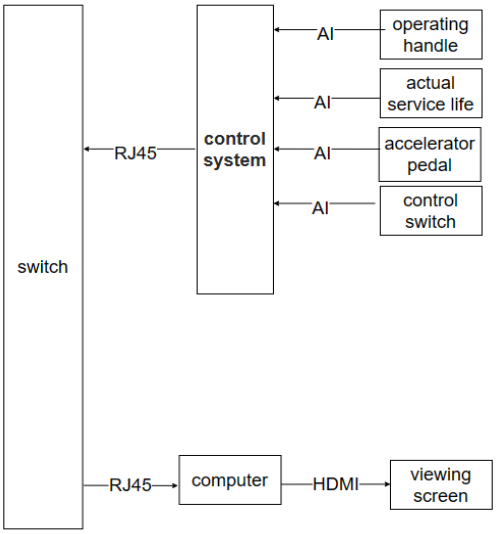

Figure 4: The remote control system and video monitoring

4. Main equipment selection

The main devices of the system are wireless network bridge, controller and camera, which affect the distance and speed of wireless transmission, control system function and video delay respectively. The system uses six cameras with a total speed of 9Mbps and one audio channel with a speed of 200kbps. The system working parameters and remote control instructions are calculated at about 900kbps. The wireless bridge can meet the bandwidth requirements of 10Mbps@3km. The controller should have multiple I/O ports and network communication functions, and the camera should be a low-delay on-board webcam. The video delay should be less than 250ms. It can control the functions of the vehicle and communicate with external devices through TCP/IP protocol.

4.1 Wireless bridge

The wireless bridge adopts P300 wireless bridge, and the equipment uses 5GHz band. The main parameters are shown in Table 1. It has the characteristics of large transmission bandwidth and strong anti-interference ability. Maximum throughput up to 100Mbps under 8km/5mi conditions.

Table 1: The wireless bridge major parameter

protect	parameter
working frequency	5GHZ
transmitted power	22dBm
periodic line	12km
channel bandwidth	20,40,80HZ
radio frequency	2*2
security	WPA2 AES
standard	802.11a/n/ac

4.2 Controller

The main parameters are shown in Table 2. The software of the controller can be used for on-line monitoring and off-line simulation, which is easy to use.

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Table 2: The SIMATIV S7-1200 controller major parameter

project	parameter
processor	CPU 1211 DC/DC/DC
Input simulator	SIM1274
incoming channel	8bit
output channel	8bit
monitoring module	SIM1281
serial communication	The RS485 and RS232 communication modules are suitable for point-to-point connections.

4.3 Webcam

The camera adopts iDS-2DY5425IXR-DM (T5) vehicle webcam, which has good vibration and shock resistance performance. The main parameters of the camera are shown in Table 3. It supports a maximum HD image output of 2560 × 1440@30 fps, and the image delay is no more than 300ms. And its own infrared supplementary light lamp infrared up to 250 meters, can meet the requirements of the harvester night construction operation of the camera.

Table 3: iDS-2DY5425IXR-DM (T5) major parameter

project	parameter
Sensor type	1/1.8" CMOS
Maximum resolution	400 万
scanning mode	progressive scanning
Maximum fill distance	50m
Focal length of lens	f=5.9~147.5mm, 25x optical and 16x digital
Support ultra-low illumination	0.005 Lux/F1.5(colours), 0.001 Lux/F1.5(black and white)
video compression standard	H.265 Video Compression Algorithm
resolution ratio	2560p/1440p
horizontal velocity	0.1°～150°/s

5. Function Realization

The remote control system of this scheme is installed on the harvester, and the appearance of the harvester is shown in Figure 5. The remote control terminal can operate the harvester remotely and monitor the information of the harvester. Pictures include camera pictures, 360° panoramic pictures, real-time model of harvester and working information, and electronic map, as shown in Figure 6. The experimental test shows that when the distance between the remote control terminal and the harvester is 3km, the operator can still control the machine normally in the remote control terminal, and the display inside the remote control terminal can obtain all the audio and video data of the harvester. The harvester is completely clear. And can be smooth real-time monitoring. The experimental results show that the scheme is feasible and meets the requirement of remote control operation.

Figure 5: The appearance of the harvester

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Figure 6: The real-time model of harvester and working information, and electronic map

6. Conclusion

The technical scheme of harvester verifies the environment of harvester. The results show that the scheme realizes the remote control of harvester and the video and sound monitoring of environment, and achieves the expected effect. Because the remote control end is simple and convenient than the layout and operation mode of the harvester cab, it greatly improves the efficiency of the remote control operation. It can realize remote control of about 3km. The remote control platform can obtain the real situation of the scene according to the real-time monitoring and recording equipment. As a result, corn harvesters can be more effectively controlled remotely. The utility model effectively solves the problem that the harvester is limited by dangerous working environment and has good popularization and application value.

References

[1] Hu Weishuo, et al. Research and implementation of unmanned remote control device for rotary tillage tractor [D]. Anhui Agricultural University, 2021. p.17.
[2] Sun Minghui, et al. Research status and development trend analysis of corn harvester [J]. Agricultural machinery use and maintenance, 2022, p.3.
[3] Fan Jin, et al. Research progress and analysis of selective harvesting robot technology [J]. Transactions of the Chinese Society for Agricultural Machinery, 2020, p.12.
[4] Wang Menghua, Wang Jianhua, Fu Shiyu, Han Xiaokun, Zhang Chuanchuan, et al. Intelligent harvester unmanned control system development and testing [J]. Tractors and agricultural transport vehicles, 2022, p.2.
[5] Ma Shuwei, et al. Design and application research of automatic driving drive-by-wire system [D]. Shandong University, 2021. p.12.
[6] Liu Xueliang, Wang Juntao, Liu Changsheng, et al. Design of remote wireless remote control system for excavator [J]. Construction mechanization, 2022, p.2.
[7] Chen Xi, He Xuan, et al. Design and implementation of remote control system based on Modbus TCP/IP protocol [J]. Integrated circuit application, 2022, p.2.
[8] Tan Yuanjie, Li Hong Peng, Wang Yan Hua, Luo Xiao Quan, et al. Research and application of unmanned agricultural vehicle technology [J]. Agricultural technology and equipment, 2020, p.1.
[9] Xu Huafu. Design and Research on Control System of unmanned remote control Submersible based on CAN Bus [D]. Shanghai Jiaotong University, 2009. p8.