1. Introduction
In recent years, domestic corn harvesters have developed in the direction of large-scale, efficient and intelligent, and with the continuous development of computer technology and electrical system control technology, corn harvesters can be equipped with corresponding sensors in various parts to detect the operation of the harvester State, and process the output data of each sensor through the programmable controller, and then control the various electrical components on the harvester instead of manual operation\(^1\), realize the high intelligence of the corn harvester and improve its reliability.

Therefore, according to the basic structure and transmission mode of the traditional corn harvester, Hall sensor, temperature sensor and moisture sensor are installed in the appropriate position to measure the running speed, hydraulic oil temperature and moisture content of corn grain.

2. Composition of the control system
The control system of corn harvester is generally aimed at improving the efficiency of harvester and reducing the impurity and damage rate of corn grain. The main structure includes programmable controller and control elements\(^2\).

The intelligent control system of corn harvester can be divided into four parts, including hydraulic walking drive system, cutting table system, threshing system and cleaning system. The data is transmitted to the controller by the controller, and the control elements are controlled according to the environment and working requirements. Corn harvester is a device composed of various mechanisms. Through various sensors, the harvester body interacts with the upper computer, describes the completed operation of the harvester in the corresponding program language, and stores it in the controller. The data change of various sensors can be observed intuitively by computer software.

Hardware of Intelligent Control System for Corn Harvester\(^3\) as follows:
(1) Information acquisition device. By installing the corresponding sensors on each mechanism of the harvester, the data of the mechanism, such as rotational speed, temperature, moisture, pressure and so on, can be detected in real time, which can directly reflect whether the current harvester is working properly.
(2) Control devices. Generally, PLC is used as the core controller of the control system to process all kinds of information, analyze the data of the sensor, produce the necessary control password, and complete the corresponding control to the drive device.

(3) Drive device. In order to make the corn harvester complete the control actions, it is necessary to install the corresponding driving device as the control element of the controller, such as hydraulic components, electrical components, etc., which can complete the instructions issued by the controller, and can correctly control the corresponding actions of the harvester.

3. Hydraulic Continuously Variable Speed System

In order to solve the problems of easy wear of walking clutch friction plate, frequent stepping on clutch pedal makes driver labor intensity, unable to adjust stepless speed change accurately, poor handling comfort and noise in shift and speed regulation, a hydraulic stepless speed change system is designed to replace and control the traditional mechanical walking drive system. According to the hydraulic principle and the driving mode of the harvester, the hydraulic continuously variable speed system mainly includes the hydraulic transmission system, the hydraulic system, the electronic control unloading system and the operating system. The installation diagram is shown in figure 1.

Hydraulic mechanical transmission system includes front axle assembly composition, engine, transition wheel assembly and triangle belt, engine is power source, transition wheel assembly and triangle belt are power transfer device, front axle assembly is power conversion device. The engine power range is 88~180 kW, the speed range is 750~2400 r/min, the front end is equipped with walking output pulley, the walking output pulley slot type is 3-type SPC, the maximum output power is 80 kW. The driving mode of hydraulic walking system is one-bar operation, the motion function of various hydraulic actuators is integrated on the operating rod, and the engine throttle position, driving mode gear and engine speed signal are collected by sensor. The driver's choice of driving mode depends on whether the walking machine works in a load-changing working environment, which determines the best working line the engine needs to run. In addition, the target speed of the engine can be obtained from the throttle opening signal. By comparing the deviation between the engine speed and the target speed, the control signal calculated by the control algorithm is sent to the stepping motor to change the angle of the variable pump inclination. The hydraulic schematic diagram of the system is shown in figure 2.
4. Sensor selection

The sensor is a device that converts all kinds of physical changes of the detected objects into electrical signals. It is mainly used to detect the changes of physical quantities of each mechanism of the harvester and the state of the current harvester. The controller can effectively control various actions to provide information \[4\]. According to the requirements of this project, temperature sensor, moisture sensor, pressure sensor and speed sensor are selected.

4.1. Temperature sensor

Because the walking system of the corn harvester is not a traditional mechanical driving mode, but a hydraulic walking driving system, it is necessary to detect the hydraulic oil temperature in real time. Prevent harvester work interruption or harvester structure failure due to high hydraulic oil temperature. The optimum hydraulic oil temperature of the hydraulic system is 40°C~50°C according to the principle of hydraulic walking drive system of harvester. Therefore, the temperature sensor is installed at the return port of hydraulic oil tank, according to the above requirements, the temperature measurement range is -50°C~100°C.

4.2. Moisture sensor

The detection of corn grain moisture content is an important parameter related to the quality of corn harvester. The designed intelligent control system needs to control the driving elements by analyzing the current corn grain moisture content in real time. In order to ensure the harvest efficiency of the harvester. According to the structure of harvester and the detection method of corn grain moisture content, the water transmitter of Jianda Renke was selected. Maize seed moisture content detection has real-time performance, so choose to install in the grain delivery port.

4.3. Pressure sensors

The feed rate of corn harvester is an important factor affecting the efficiency of threshing and cleaning in the later stage, so it is necessary to detect the feed rate of corn harvester with corresponding sensors. The pressure sensor is used to measure the pressure value of corn entering the bridge when the harvester is harvested. The pressure sensor is selected according to the pressure generated by the bridge structure of the harvester. The S pressure sensor is selected with a measuring range of 500 N.,
The pressure sensor is selected according to the pressure generated by the bridge structure during the harvester operation.

4.4. Speed sensor
According to the measurement of speed of corn harvester cutting table, threshing drum, cleaning fan and so on, Hall sensor is selected for real-time measurement of its data. Part of the installation position is shown in figure 3.

![Fig.3 Installation Position of Hall Sensor](image)

5. Drive device

5.1. Recessed screen clearance adjustment
Gravure sieve is one of the core components of the combined harvester. Its performance directly affects the working efficiency and performance of the combined harvester. Therefore, it is of great theoretical significance and practical value to study the automatic control technology of the concave clearance of the joint harvester so as to realize the active control of the concave clearance to prevent the threshing drum clogging, which can improve the working efficiency, performance and reliability of the joint harvester.

Therefore, the project team uses the electric push rod instead of manual operation, and uses the controller to control the opening and closing of the electric push rod relay to control the length of the push rod elongation, so that the electric push rod can drive the slot adjusting rod of the concave screen.

5.2. Cleaning Fan Speed Control
The fan on the combined harvester is used for grain clearance, and the air volume of grain clearance is different in different crops, that is, the speed of fan should be changed to achieve the purpose. At present, the speed regulation of small and medium-sized combine harvester cleaning fan is mostly axial movement of mechanical rotating fan tensioning wheel. By changing the position of belt on it, the speed of active and passive belt wheel is changed, which requires machine hand to get off.

This project group uses the electric push rod instead of the manual operation to realize the speed regulation process of the harvester cleaning fan, and uses the controller to control the opening and closing of the electric push rod relay to realize the automatic speed regulation mode.

5.3. Speed adjustment of cutting table
Corn cutting table is an important device to transport corn straw to corn harvester and the main component of corn harvester. The speed of cutting table plays an important role in the harvest process.

Therefore, the project team decided to adopt the electric control method, use the electric push rod to replace the manual operation, use the controller to control the opening and closing of the electric push rod relay to control the extension length of the push rod, so that the push rod drives the cutting table to run the belt tensioning wheel.

6. Controller
This project adopts Zhijie Technology C490 Controller, C490 is a field programming controller based on CoDeSysV2.3 software platform. Controller programming conforms to IEC-61131-3 standards, users use codesysV2.3 software for application development, as shown in figure 4.
The controller is based on CoDeSysV2.3 software platform to develop the program, using ladder diagram programming method to write the program, ladder diagram is close to the structure of electronic circuit, on the one hand ladder diagram is very suitable for the construction of logic switches, on the other hand, It can also create network diagrams in FBD images[5]Therefore, profiled graphs are useful in controlling calls to other program organization units.

7. Control logic

The overall control logic diagram of the harvester is shown in Figure 5.

After monitoring the data of each sensor uploaded by the FBOX, the upper computer outputs the control instruction according to the actual operation needs. After receiving the signal, the controller outputs the analog signal to each executive element, thus controlling the operation of each device.

8. Conclusion

In this paper, the intelligent control system of corn harvester is described, the controller, sensor and driving elements are selected and installed, and the hydraulic walking drive system of corn harvester is designed. The control logic design of hydraulic system and each driving element is carried out.

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