Design and Application of Running State Detection System for the Oscillating Subsoiler Based on CAN Bus

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Keywords: CAN Bus, sensor node, an oscillating subsoiler

Abstract. In view of problems such as difficulty in measuring state parameters and disturbance in the process of agricultural machinery, the monitoring system is designed for running state of the oscillating subsoiler based on CAN bus, to collect the deep loosening machine running speed, tractive resistance, the temperature and humidity of the environment, vibration frequency of key point and electrical system status for fault detection. A master control system based on mega128 and C8051F040 and several slave independent sensor node based on C8051F040 could build a intelligent monitor network via CAN Bus. The parameter of machine working state can be set, displayed, storage, and block positioning information by GPS and related operational data could be uploaded to the far range control center through GPRS network. The results show that the system is stable and reliable, and can adapt to the different working condition of the oscillating subsoiler.

Introduction

Soil subsoiling is an important part of agriculture conservation to break the hard plow bottom, add depth of arable layer, improve soil aeration performance, and increase soil moisture storage capacity. It has been a research focus to reduce the working resistance, lower fuel consumption and improve energy utilization rate of the deep loosening machine at home and abroad[1-3]. At present, it is still in the traditional mechanical aspects of deep loosening in china; and it need to rely on the experience of farming personnel to determine the cultivation parameters and time, machine tool utilization and efficiency greatly reduced. It is imperative to research and development of strategic modern intelligent agricultural equipment with the reform and innovation. Modern intelligent agricultural equipment consists of real-time online intelligent monitoring, parameters acquisition, running state of alarm, closed loop regulation control, intelligent maintenance and based on multi sensor information fusion of fault self diagnosis function, and both easy user interface and strong man machine interaction[4-6]. Can bus of embedded platform and micro operation system development was used in foreign developed countries or a small number of domestic high-end equipment vehicle monitoring system use bas, the utility model has the advantages of small size, high reliability, with intelligent decision and fault diagnosis function, man-machine friendly and convenient [6-8]; While the possibilities presented are exciting to many, its mass appeal has yet to be established because that the price is expensive and system software does not conform to the Chinese agronomic requirements or manipulate habits. Therefore, it is urgent to develop the intelligent monitoring system based on different working conditions to meet the needs of China [9-10].

Based on the above background, this paper designs an intelligent deep loosening machine running status monitoring system based on mega128 and C8051F040 MCU, focuses on the CAN bus communication mechanism and implementation method, GPRS remote data transmission, GPS positioning information acquisition and based on LabVIEW remote data control heart construction.

Overall system architecture

Vibrating subsoiler running parameter monitoring system include of key point vibration signal

detection module, operating speed fault detection module, driving resistance detection module, environmental temperature and humidity detection module, GPRS module, intelligent display terminal and remote data monitoring center.

The monitoring hardware of the system contains tension and pressure sensor node by CAN bus interface, torque and acceleration sensor node with CAN bus interface, can bus, MCU, terminal display, data storage, indicating light, GPS / GPRS circuit and an output driving circuit, as shown in Figure 1, which is mainly composed of two parts of main control circuit and intelligent sensor node circuit. At the same time, the system has a remote monitoring center, as shown in Figure 2.

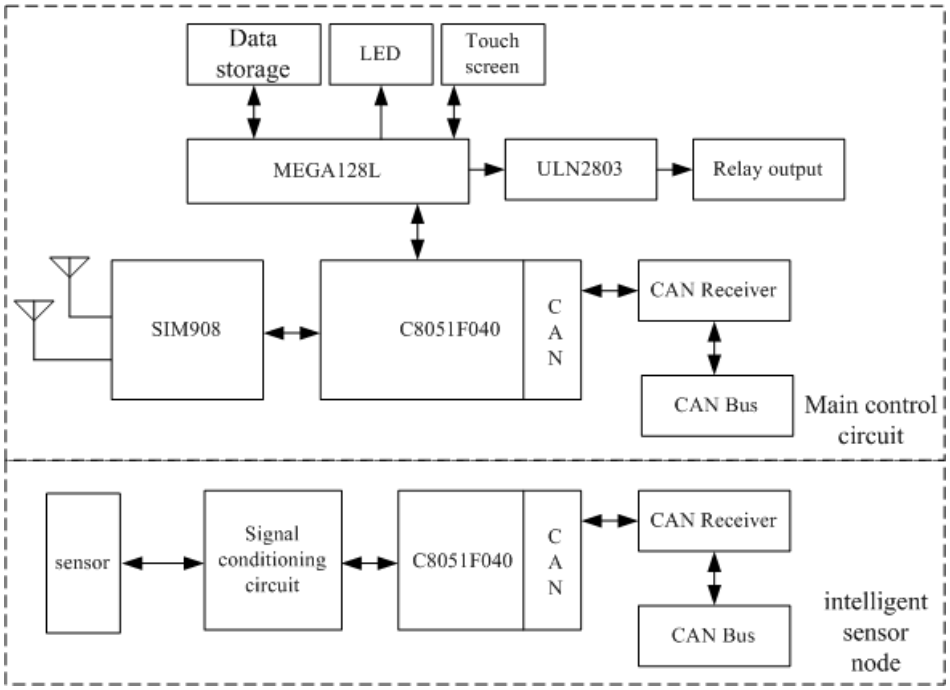


Fig. 1 overall framework of the system field monitoring circuit

Multiple sensors can be used to implement real-time monitoring and automatic measurement with a unified industrial bus interface based on CAN bus intelligent sensor node circuit that can be together to connect can bus and can be directly with the PC connection or through the data acquisition box and connected to the computer. In this paper, the design of the node is composed of a microprocessor C8051F040 with CAN controller, isolators adum1201, can transceiver chip SN65HVD251, analog signal acquisition front-end processing circuit. Smart sensor nodes with CAN bus has a RS232 serial port and a USB port with CP2102, can connect with the PC, easy debugging, or a smaller detection system.

Intelligent display processing terminal is responsible for the system parameters settings and data monitoring, as well as to send the relevant operating parameters to the remote data monitoring center. Among them, the data monitoring data including GPS information, machinery running speed, running resistance, vibration information of key points. Field monitoring system would collect sensor data and GPS positioning information and then send to the remote monitoring center through the GPRS network and Internet, and the remote monitoring was built based on LabVIEW through TCP/IP protocol to collect data.

The system can not only on-site mobile testing subsoiler working performance and key parameters, also can through GPS positioning and GPRS DTU wireless transmission technology realize synchronous remote computer monitoring, on line data analysis and mass storage, computer on the positioning block data check inquiry and analysis and combined with the machine returns the key technology of data analysis, obtained the land optimal cultivation period, the most appropriate tillage depth, work efficiency highest machinery subsoiling frequency and amplitude parameters and parameters sent to the lower machine for reference, in order to achieve true less farming, and

farming.

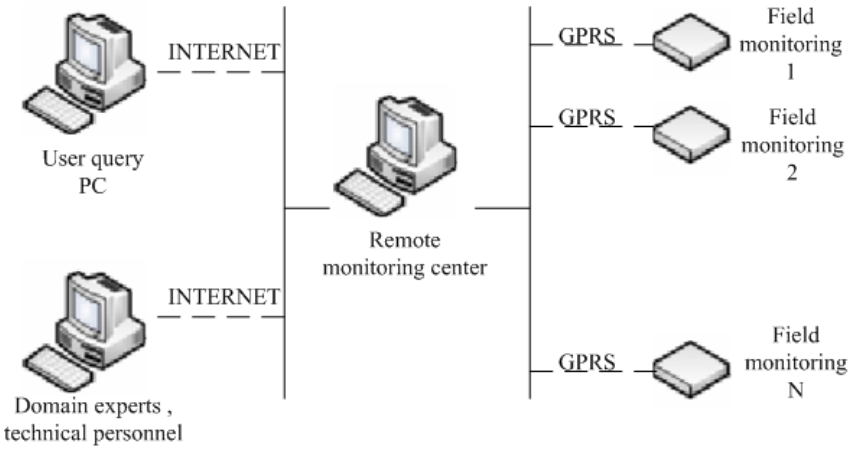


Figure 2 overall framework of remote monitoring center

System hardware structure

System hardware uses MEGA128L chip, 128K bytes of the system can be programmed flash, 4K bytes of EEPROM, can meet the needs of the system program storage, parameter memory. It has 2 PWM, 8 high speed 10 bit A/D conversions, 53 general I/O port, and it can meet the system LED, sound, light alarm and output of driver without further expand the I/O port. Two USART, USART0 was used to communicate with touch screen, and USART1 was conducted to C8051F040 communications. C8051F040 microcontroller is a chip on the mixed signal system level microcontroller, a CAN2.0B integrated controller. CAN2.0B control has 32 information objects, and each has its own shield, so that the use of at least one chip resources to complete the CAN communication. Chip integrated 8 channels AD with 12 bits; it can be easily implemented on sensor signal acquisition.

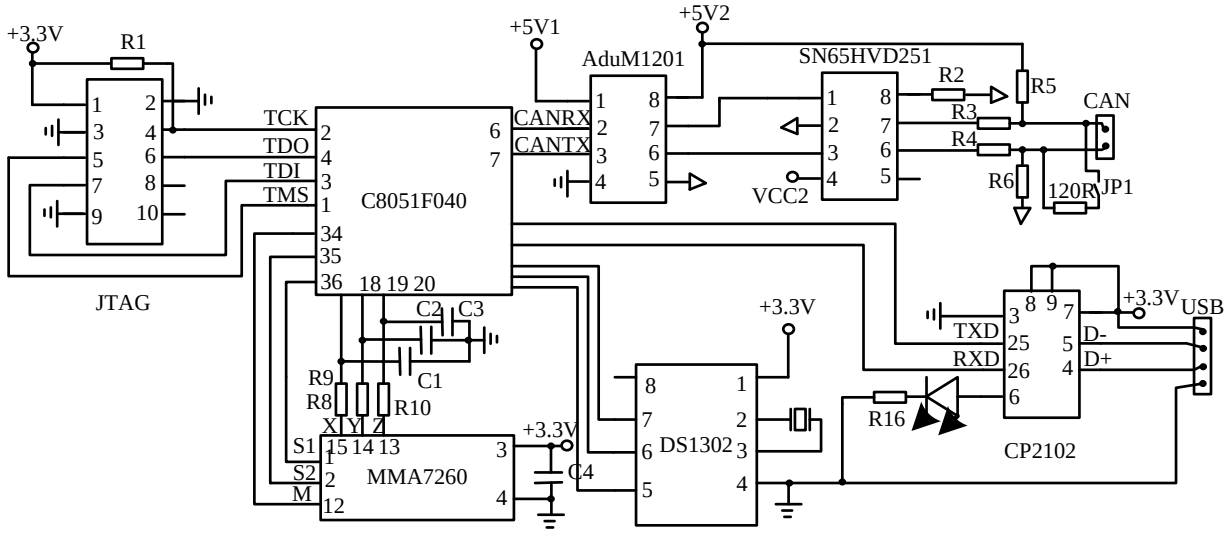


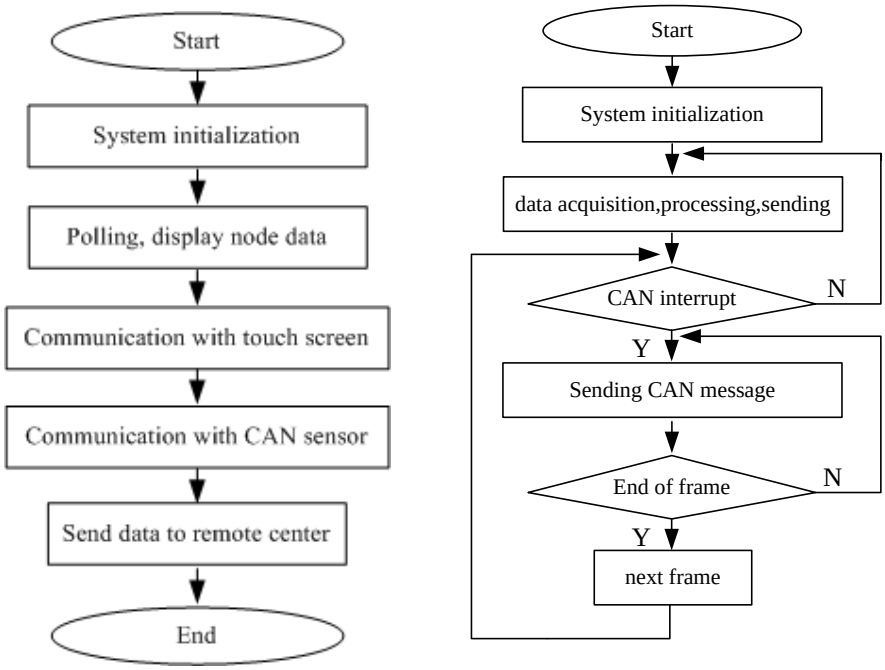
Figure 3 hardware circuit of the main control circuit

Can bus signal, CANTX and CANRX from the C8051F040 were isolated in electrical circuit with digitally isolating chip, after CAN bus transceiver interface chip SN65HVD251 having high EMC performance, and then reached the CAN Bus. Due to the harsh environment of the field, electromagnetic interference is more serious, in order to guarantee the system reliability, the dual high-speed magnetic isolator ADUM1201 digital isolation between the controller and the receiver node to avoid bus transient disturbance. DC-DC power supply module ZY0505BS-1W is used in the digital isolation and CAN transceiver power supply isolation to improve the stability and

security of the nodes. In order to further ensure that the acquisition system anti-interference ability and driving ability of anti-jamming performance, filter capacitors and terminal transient suppression diodes were added in parallel with the CAN Bus

System Software Structure

In the KEIL software environment, main program was made with the C8051040 construction of the node to complete the data collection, processing, information display and data upload. Among them, the main program flow chart, as shown in Figure 4(a); the program flow chart of intelligent sensor node module based on CAN, as shown in figure 4(b).



(a)program flow charts of the main control circuit (b) program flow charts of the intelligent sensor node

Figure 4 program flow charts

There has many CAN nodes and data types was not uniform in the system of subsoiler running state detection, so the CAN node information built with a frame of data packet of 13 bytes Extended frame format was selected, which contains one byte frame information, four word section of the frame ID, 8 bytes of data frames, data in the transmission process join frame starting character and frame tail CRC (1 byte).

Test results

The device was installed on the soil trough experimental trolley, and the vibration subsoiler was drove by car rear suspension. In the experiment, the sensor consisted of pull the pressure sensor, torque sensor, acceleration sensor, and temperature and humidity sensor. In the process of debugging, single module experiment was done, and the data was calibrated in different working conditions, then common experiment of each module was begun. The experiment data shows that the system can meet the needs of the system.

Conclusion

The detection system based on CAN bus was built to display information of subsoiler running state in the terminal Touch screen, each module of the information and key data can be through

GPRS promptly sent to the remote center. The data collection of running parameters of subsoiler can be used in the research of reducing the consumption, parameter optimization and performance analysis. Deep loosening data can be queried from the remote control center by GPRS to meet the user's needs. Experiments show that the system is stable, and can complete data acquisition and state monitoring.

Acknowledgement

The Project Supported by National Science Foundation of China: Research on Working Mechanism and Optimization Design for the Self-Excited Vibration Subsoiler (51175354).

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