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Study on Automatic Weight Collection System of Maize Based on STM32

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Abstract. Based on the research and design of Gongzhuling Maize Growth Experimental Base project in Jilin Academy of Agricultural Sciences, this paper designs an automatic data acquisition system for moisture and weight change of maize growth based on the established facilities. The system uses the STM32 single-chip computer to realize the control of the whole system; the weighing data is collected by the load cell; the data transmission is realized through the RS485 bus; the STM32 MCU is programmed by Keil software, Testing; through the SOLIDWORKS software for mechanical design. Using the upper and lower computer integration, optimization, testing a combination of methods developed. It is important for systematic research to find out the rules of crop water demand and water consumption in irrigation decision-making, water resource management, agricultural water development and efficiency improvement.

Introduction

At present, with the increase of population, global warming, water resources and food problems have become the global problems facing human beings. It is imperative to scientifically utilize water resources and explore the relationship between the growth process of grain crops and water. As evapotranspiration of vegetation, soil evaporation (together referred to as evapotranspiration) plays an important role in the process of water movement, which is both an important part of water balance and energy balance. It is also closely related to plant physiological activities and biomass production, so the automatic collection of corn moisture parameters on the analysis of corn crop growth trends, for the subsequent intelligent production management to make judgments, decision-making, yield prediction has great significance.

Nowadays, the measurement of evapotranspiration in plant growth is more widely used in the field of small plants such as potted plants, and little research has been done on automatic measurement methods of field crop evapotranspiration. And most of the measurement is still in the use of scales, electronic balance or plant physiology method for measurement. On the one hand, this weighing method requires a lot of manpower; On the other hand, because of the inconsistent time measurement, it is affected by a large number of human factors, resulting in the large error, the data reference is relatively poor, and in the short time interval can not understand the amount of plant evapotranspiration Continuous change.

The aim of this project is to realize the automatic collection of corn moisture parameters based on STM32 microcontroller technology, mechanical lever principle, RS485 bus technology and sensor technology. It is not only saving manpower but also realizing the continuous change of crop weight in a short period of time, thus improving measurement precision.

Development Technology

STM32 Microcontroller. The acquisition system is composed of distributed upper and lower computer. Among them, the upper computer adopts the high configuration industrial computer and the lower computer adopts STM3 embedded development board, which is based on ARM Cortex-M3 R2 core. The upper and lower machine realize the data transmission through RS485 bus. Because of the measurement parameters are relatively simple, the measurement interval is relatively

short, and high reliability of microcontroller, this system uses the Cortex-M3 R2 as the core of the LPC1768MCU, with high performance, low power consumption advantages. It is rich in components and supports many extensions, including WiFi module, Bluetooth module and wireless control module, which has great significance for the expansion of later devices. It also meets the requirements of data transmission and is relatively reliable.

RS485 Bus.RS485 bus with its mature technology, simple structure, low price, high maintenance characteristics are widely used in industrial and civilian sites. RS485 is half-duplex work, supporting for multi-point data communication. Network topology generally uses the terminal to match the bus structure, which does not support ring or star network. RS485 uses balanced transmission and differential reception, the transmitter uses the serial port ttl level signal converted to differential signal a, b two outputs, after transmission through the cable at the receiving end of the differential signal is reduced to ttl level signal. As the transmission line is usually used twisted pair, and differential transmission, it has very strong resistance to common mode interference, because of its reliable communication, and for a host, multi-slave communication, so the device used in this communication transmission.

Modbus Protocol. In the RS485 bus network, the RS485 bus only defines the physical layer of the network, the upper layer of the network is not defined. According to the laboratory site inspection, we use Modbus protocol as the host and slave communication protocol between.

Modbus protocol is a common language of application and electronic controller. The advantage of Modbus protocol is that it has no specific physical layer specification.It can be applied to RS232, RS485 bus and other bus to achieve transmission, and make the controller via network (such as Ethernet) and communicating with other devices. Modbus protocol provides a main and more from the transmission mode, in the entire system, there is only one host device, all operating instructions are initiated by the host device, the slave device to respond to data provided by the host device to achieve a separate host and each from Machine to communicate.

Acquisition System Design

The Overall Structure of the Scquisition System. At the beginning of weighing, the weight of the plant is obtained by the load cell and sent to the data acquisition module of the lower computer (LPC1768). The data is sent to the communication module by the data acquisition module. In this process, the lower computer can short- Stored or directly connected by the lower computer digital meter head for visual display. The data is transmitted from the RS485 bus to the host computer through the communication module, and the host computer can receive, display and store the data to facilitate the further processing of the data by the researchers.

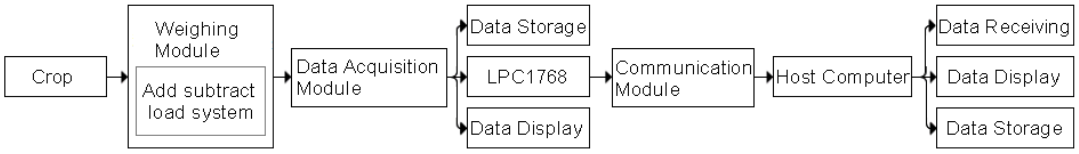

Figure 1. Overall structure

Weigh-in Design. Weighing part includes perspex plant barrel, base, blade support points, double horizontal lever, T-bracket, counterweight module, STM32 microcontroller, sensors and electric crane. Perspex tubes are used to hold saturated or unsaturated soil column with using leverage to achieve supporting and moving. Perspex tubes are placed at the bottom of the electric crane and load cell. Data which was collected by the calibration of the digital meter after the first real-time viewing, can also be transmitted through the STM32 microcontroller to the host computer software and read the view. Load cell resolution 0.1g, range 5kg, creep / return to zero (30 minutes) 0.02% RORS232 communication interface, 1200 baud rate, no parity, 7 data bits, 1 stop bit, small lifting Motor coefficient according to the actual weight of the barrel and equipment design.

Weighing part can make the weight of the soil and plants in the bucket balanced by the balance

system and counterweight system, eventually reflected in the weight of the lever at the end of the change from the weight of the water before doing the difference we can see the weight of water changes in the bucket, thus When measured by the bottom of the high-precision weighing sensor value, sufficiently to meet the accuracy requirements of the equipment, as the load cell using the more advanced international electromagnetic torque sensor, the lever to 0.1g weight changes can be perceived, according to Leverage the design factor of 50, can be within the weight of 50g resolution, to meet the design requirements. Specifically shown in Fig. 2.

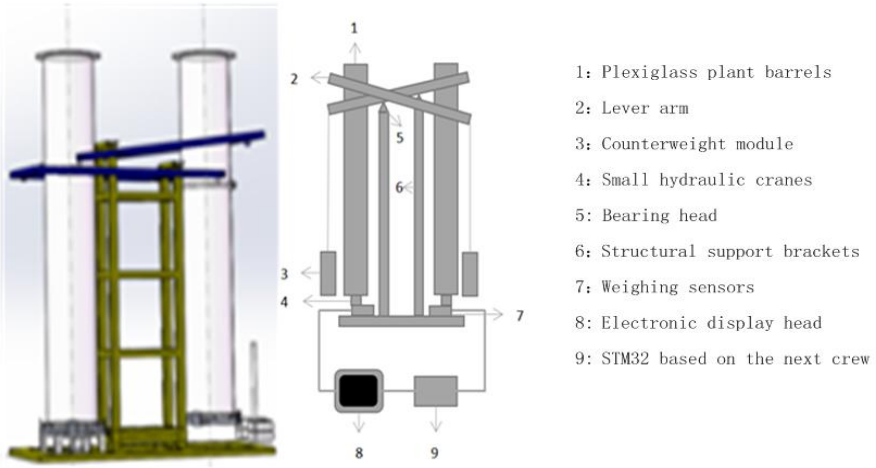

Figure 2. Weighing end 3D and floor plan

Design of Load and Unload System. To prevent the weight sensor from squeezing for a long time and zero drift and creep phenomenon, but also to meet the real-time access to a single corn growth process of weight changes and measurement accuracy requirements, this part to solve this problem, specially developed Automatic Load Control System Based on Small Electric Crane. So that the system in the measurement, the host computer to issue instructions, the next crew to receive, the instructions loaded into the embedded development board STM32 embedded in a small controller, the controller issued a command to control the small motor down, so that the weight sensor and the transfer perspex cylinder base contact began weighing, when weighing finished, and then sent by the host computer instructions, through the same process to convey to the small controller, the small electric crane to rise, making the plant tube and the sensor phase separation. As the balance of the other end of the lever weight system, so the required lift is small, small electric crane can complete this work.

As shown in Fig. 3 the controller integrated in STM32 development board is based on LPC1768 MCU design of ARM development board. It supports MODBUS protocol. It can communicate with host computer through RS485 interface. It uses GPIO interface and photoelectric isolation circuit to drive small electric crane to raise and lower control.

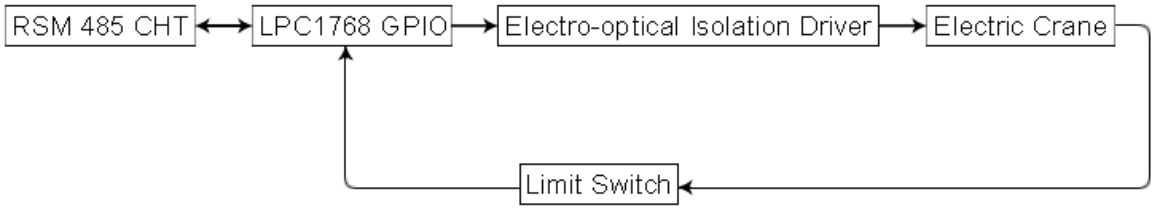

Figure 3. Addition and subtraction load controller structure

Transmission System Based on RS485 Bus. Because the RS485 bus is a pair of balanced

twisted pair, it means that it can achieve half-duplex communication, that is, the bus is running at a time when only one device in the state of sending data. As its transmission rate up to 10Mbps / s, in order to ensure data Communication reliability, the transmission rate is setted to a lower level. Transmission system consists of a host (in this system is the upper computer connected to the first address of the lower computer), and a number of subordinate machine. The backbone of the network equipment, such as fence machine, management machine, host, etc. are assigned an ID number , That is, communication contact address. Each subordinate machine collects the data transmitted by the load cell through the A / D converter, and then transmits to the host computer through the RS485 bus. The host computer can display the data collected by each slave.

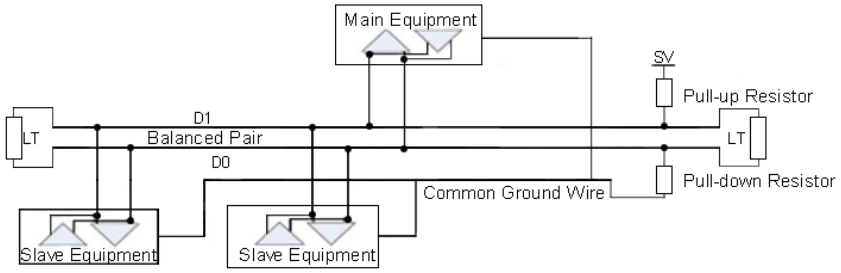

Figure 4. Two - wire RS485 bus topology

In the whole bus system, the host computer and all the subordinate machines are controlled by the LPC1768 MCU chip. The A/D converter is used to collect the data and RS485 communication through the serial port. The interface circuit consists of RS485 transceiver MAX3485 composition, the microcontroller can be connected through the USART and RS485 bus network. Circuit shown in Picture 4 PB10 pin and STM32 microcontroller USART3 corresponding to the transmission, PB11 pin STM32 microcontroller USART3 corresponds to the reception. PB13 and PB14 to control the RS485 bus network data transmission direction.

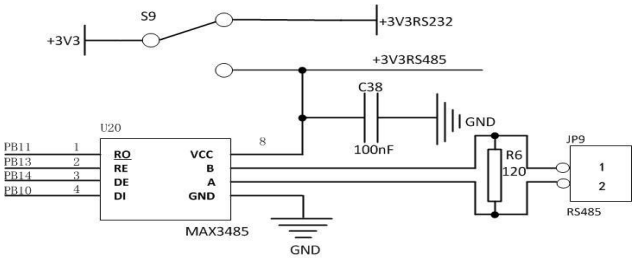

Figure 5. RS485 interface circuit

System Debugging

In this system, every two plant barrels is a group, using one lower position machine to carry on the connection with the RS485 bus, two barrels are labeled as A, B, which the address in the bus does not conflict with it. RS485 bus to meet this equipment group for data transmission needs, the test proved stably and reliably. Part of the test code is as follows, weighing equipment as a whole from the above parts of the combination, the use of Keil software for field testing, the following is part of the test code printscreen.

```
while (1)
{
        switch (RxMessage.Data[0])
        {
            case 0x01: up_1(); break; //1号电机上升
            case 0x02: down_1(); break;//1号电机下降
            case 0x03: up_2(); break;//2号电机上升
            case 0x04: down_2(); break;//2号电机下降
            case 0x11: all_off(); break;//全部电机停止
            case 0x22: all_up(); break;//全部电机上升
            case 0x33: all_down(); break;//全部电机下降
            case 0x05: data_send_1();       break;//上传串口1称重数据1
            case 0x07: datasend_2(); break;//上传串口2称重数据2
            default : break;
        }
}
```

```
/*
 * 函数名：USART1_Config
 * 描述  ：USART1 GPIO 配置,工作模式配置。9600 8-N-1
 * 输入  ：无
 * 输出  ：无
 * 调用  ：外部调用
 */
void USART1_Config(void)
{
    GPIO_InitTypeDef GPIO_InitStructure;
    USART_InitTypeDef USART_InitStructure;

    /* config USART1 clock */
    RCC_APB2PeriphClockCmd(RCC_APB2Periph_USART1 | RCC_APB2Periph_GPIOA, ENABLE);

    /* USART1 GPIO config */
    /* Configure USART1 Tx (PA.09) as alternate function push-pull */
    GPIO_InitStructure.GPIO_Pin = GPIO_Pin_9;
    GPIO_InitStructure.GPIO_Mode = GPIO_Mode_AF_PP;
    GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;
    GPIO_Init(GPIOA, &GPIO_InitStructure);
    /* Configure USART1 Rx (PA.10) as input floating */
    GPIO_InitStructure.GPIO_Pin = GPIO_Pin_10;
    GPIO_InitStructure.GPIO_Mode = GPIO_Mode_IN_FLOATING;
    GPIO_Init(GPIOA, &GPIO_InitStructure);

    /* USART1 mode config */
```

Figure 6. Partial test code

Summary

The system weighs the target weight in tons for the calculation, sensitivity (weighing resolution) requirements 50g, for such a large weight of high-precision requirements, there is no one load cell or electronic scales can directly meet this requirement, This paper has filled in the gaps in this aspect, and provided important equipment support for realizing the intelligent management of corn production. Weighing material selection of ordinary steel, relying on the overall support frame, the use of electric hoist to provide lifting function, in order to achieve a stable control, automatic collection; by loading and unloading system on the cylinder tube lift, to solve the sensor zero drift and creep Change the phenomenon, greatly liberated manpower, improve the efficiency of weighing.

Acknowledgements

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