Design of intelligent seeding fault monitoring and alarm system for fine seeding machine

Weiyun Meng1,a, Yunlong Su1,b, Changhu Wang1,c, Lei Qin1,d, Jianxiang Wang1,e, Xinsheng Yan1,f, Yingyue Pan1,g

1Shandong Agriculture and Engineering University, Jinan, Shandong, 250100, China
aemail: z2017019@sdaeu.edu.cn, bemail: 1834925732@qq.com, cemail: z2013168@sdaeu.edu.cn, demail: qinlei5064@126.com, eemail: 3381584317@qq.com, femail: z2013158@sdaeu.edu.cn, gemail: 1176204038@qq.com
*Corresponding author’s e-mail: z2017019@sdaeu.edu.cn, tel:15069168059, fax:0531-88117693

Abstract: Due to the influence of the operating environment and the design of the corn seeder, the seed will be missed and the quality of seeding will be seriously affected. Based on STM32 single-side machine technology, an operation system for real-time monitoring and remote monitoring of corn seeding operation, which is also a compensation system for the phenomenon of missing seeding during the operation of corn precision seeding machine. The monitoring system is based on the STM32 MCU as the core of the controller combined with human-computer interaction module, reflection type photoelectric sensor, Hall sensor and other principle. The compensation system is composed of self-compensation system and auxiliary compensation system. The monitoring system and compensation system together can effectively solve the phenomenon of maize precision seeding machine in operation, it improves the economy and efficiency of seeding.

1. Introduction

With the increasing demand for grain in China and the continuous development of intelligent agricultural machinery and equipment technology. Corn seeder has been widely used in agricultural production[1-2]. However, due to the influence of the operating environment of the seeder and the failure of the agricultural machinery itself and the influence of the design will cause the blockage of the seed tube, the failure of the transmission system, the empty seed box and other problems resulting in the leakage of seed sowing phenomenon, which seriously affects the sowing quality, reduces the operating efficiency and causes economic losses[3-4]. Therefore, a reliable operation monitoring system is equipped on the corn precision seeder to realize the local real-time monitoring, fault alarm and remote data evaluation of the working parameters and operation quality of the corn precision seeder, which can effectively reduce the economic loss of grain caused by the omission of seeding and improve the data utilization rate[5].

Therefore, a leakage detection system and alarm device composed of reflective photoelectric sensor, Hall sensor and other components are designed, and a compensation system combining self-compensation and auxiliary compensation method is designed. The signal is transmitted to the human-computer interaction interface, remote control system and seeding compensation system through STM32 single-side machine. This paper mainly discusses the fault detection and fault alarm...
device in the seed row pipe of the corn precision seeder.

2. Design of monitoring and compensation system for corn precision seeder

2.1 Current status of monitoring and compensation system of corn precision seeder

With the continuous development of agricultural science and technology in China, precision seeding technology has been greatly improved in China, and has been widely used in China's agriculture. However, compared with the advanced technology of corn precision seeding machine abroad, there is still a big gap in China's precision seeding technology, mainly in the low quality of seeding, low monitoring accuracy, few supplementary seeding methods and low efficiency[6-8]. In addition, foreign scholars are also constantly studying and updating jade precision seeder. For example, AI-Yamani et al[9], carried out researches on the optimization of seed sequencing and replanting. When the monitoring equipment and controller detected the missing sowing signal, a new coded seed would be replanted, and the sowing quality was significantly improved. SINGH[10]developed a seeding, fertilization, such as the controller, the metering device and distributing device, powered by 24 V dc motor, the application of pulse width modulation (PWM) control dc motor operation, through the speed sensor to monitor machine speed, the controller calculates the dc motor speed, make the machine according to the set of parameters for precise seeding control. Arzu et al[11], used response surface method to optimize the uniformity of sowing spacing of precision seeder, and the results showed that the lower the circumferal speed of seed disc, the better the uniformity of sowing spacing[12]. Therefore, it is urgent to update the corn precision seeder to improve the monitoring accuracy and compensation efficiency.

2.2 Overall scheme of monitoring and compensation system for corn precision seeder

The detection and compensation system consists of hardware and software. System control module chooses STM32 series single chip microcomputer processing core, through the photoelectric sensor, infrared sensor and hall sensor devices such as real time collect the corresponding signal process of planting, through relevant circuit convert them into electrical signal transmission to the core processor, data processors will be compared with the set parameters, determine whether fine sowing machine at work occurs leakage, the phenomenon such as replay.

The monitoring data is transmitted to the human-computer interaction module through the wireless module, which can quickly realize the collection, monitoring, recording and real-time display of seeding data. When the seeding fault occurs, the display screen of the human-computer interaction module on the seeder cockpit will issue a fault warning, and the LED fault alarm light will light up and the buzzer will sound to prompt the operator. Assist seeding system work. The driver can make corresponding processing through the touch screen of the human-computer interaction interface to reduce or avoid the seeding precision. The following diagram is the system structure diagram:
3. Missing broadcast monitoring and alarm design

3.1 Design of seed row tube monitoring sensor

In order to ensure the precise monitoring of the conditions in the corn precision seeding and seed planting tube, the monitoring sensor of the seed planting tube adopts the opposite photoelectric sensor. The working principle of the opposite photoelectric sensor is to realize the control by converting the change of light intensity into the change of electrical signal. Correlation photoelectric sensor by the transmitter and the receiver and the monitoring circuit of three parts, precision seeding machine during normal operation in the row of kind of drum adopts three wide Angle 120° of the straw hat type infrared transmitting tube as a transmitter, infrared light by the row of pipe wall and diffuse, ensures the infrared field full coverage of pipe internal, parallel set three receiving tube at the bottom of the tube at the same time, to ensure the accuracy of detection[12].

3.2 Design of leak detection

When the seeds fall, will keep out light pathways between transmitter and receiver, the receiver will output a signal of change, the signal after filtering of the monitoring circuit outputs a threshold change signal, at the same time send signals through the amplifier amplification, plastic become pulse signal through a differential circuit. The pulse signal is transmitted to the STM32 microcontroller module to judge the seeding quality of the current seeder. If the current sowing quality is within the range of the set threshold value, the corn machine works normally. If the current seeding quality is not within the threshold range, the human-computer interaction module displays the alarm information, and the alarm device acts. The following figure is the monitoring flow chart of the beam photoelectric sensor:
3.3 Alarm design

3.3.1 Overall design of alarm device
When the precision broadcast machine misses, replay and other faults occur, the core controller will send the corresponding signal to the LED lamp, buzzer, human-computer interaction module and other alarm devices, and they will make corresponding actions to prompt the operator that the precision broadcast machine is currently out of order.

3.3.2 LED lamp module
When the miss sowing and replay fault occurs, the STM32 core controller will send out a low-level signal, the LED will turn on, and the alarm light on the seeder will light up to remind the operator of the failure of the precision seeder. The following diagram is the schematic diagram of the LED lamp:
3.3.3 Buzzer module
STM32 core controller will send out a low-level signal and the buzzer will be switched on to give an alarm and remind the operator that the precision seeding machine has a fault. The following figure is the buzzer schematic diagram:

![Buzzer Schematic Diagram](image)

3.3.4 Human-computer interaction module
Human-computer interaction module is a part of the interaction between operating machinery and operating personnel, the human-computer interaction interface refers to real-time visible part of the operational staff, homework personnel can through the human-computer interaction module real-time operation data and historical operation data, and through page control can achieve certain function at the same time, the precision seeding machine failure can also be in human-computer interaction page fault alarm, remind workers and observers. The control interface includes start, stop, initialize, history record button, missing play replay sound and light alarm and speed, agronomic parameter transmission parameter button, and seeding state display interface, etc.

4. The conclusion
For the corn precision seeder, the data monitoring of seeding and the alarm action of the precision seeder when the faults such as missing seeding and replaying occur are designed, so as to remind the operator of the precision seeder failure and make corresponding measures. It realized the reduction of omission rate and resowing rate and accurate detection of omission rate and resowing fault of precision seeder, and improved the sowing efficiency of corn.

Acknowledgments
This work was financially supported by the Innovation Project for Agricultural Major Applied Technology of Shandong Province under grant No. SD2019NJ011.

Reference
[1] Ge T, Zhao B, Yi S, et al. (2017) Research on Air Suction Corn Planter Seeding Monitoring System J. Journal of Agricultural Mechanization Research, 39:82-85.
[2] Liu K, Yi S. (2019) Design and experiment of seeding performance monitoring system for suction corn planter J. International Journal of Agricultural and Biological Engineering, 12:97-103.
[3] Wang R, Zhang X, Wang S, et al. (2015) Research on Vacuum Precision Planter Seeding and Fertilizing Wireless Monitoring System-Based on NRF24L01 J. Journal of Agricultural Mechanization Research, 37:101-104.
[4] Jin C, Xu Y, Li Y, et al. (2016) Design and research on monitoring system of seedling planter manipulator J. Journal of Chinese Agricultural Mechanization, 37:159-162.
[5] Yang C J, Meng Z J, Mei H B, Luo C H, Dong J J, Fu W Q. (2019) Design and experiment of corn precision sowing monitoring system [J]. Agricultural Mechanization Research,
[6] Wu N., Lin J., Li B f., et al. (2017) Design and test on no-tillage planter reseeding system for miss-seeding J. Transactions of the Chinese Society for Agricultural Machinery, 48: 69-77.

[7] Koller A A, Taylor R K, Weckler P R, et al. (2013) Design, Performance Prediction, and Validation of a Seed Orienting Corn Planter[C]// Kansas City, Missouri, July 21-july..

[8] Li S, Xue Y, Zhou Y. The Intelligent Control System of Air Suction Electric Corn Planter[J]. Modern Food, 2017.

[9] AL-YAMANI A A, MIT R A S, MCCLUSKEY E J, et al. (2005) Optimized reseeding by seed ordering and encoding J. Transactions on Computer-Aided Design of Integrated Circuits and Systems, 24: 264－270.

[10] SINGH C D, SINGH R C. (2011) Computerized instrumentation system for monitoring the tractor performance in the field J. Journal of Terramechanics, 48:333-338.

[11] A RZU Y, ADNAN D. (2007) Optimisation of the seed spacing uniformity performance of a vacuum-type precision seeder using response surface methodology J. Biosystems Engineering, 97: 347-356.

[12] Zhang P, Chen T H, Guo Zh J, Yang Z R, Teng S. (2021) Design and experiment of seeding quality monitoring system for scoop wheel seed metering device J. Agricultural Mechanization Research, 43:54-59.