

Application of SCM in Automatic Tracking Motion System of Organic Fertilizer Turning Machine

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Key words: SCM; organic fertilizer turning machine; automatic tracking

Abstract: The turning link inevitably exists in organic fertilizer production process. To solve numerous problems caused by low degree of automation in the turning process such as high labor intensity and low efficiency, a SCM-based automatic tracking motion system of organic fertilizer turning machine was developed and designed. The experiment shows that the system can reach the requirement of automatic tracking motion and effectively improve production efficiency of organic fertilizer.

Introduction

The turning link is essential in the production process of organic fertilizer. In China, the organic fertilizer turning machines can be roughly classified into track type and trackless type. The trackless type of organic fertilizer turning machine is mainly self-propelled type of organic fertilizer turning machine. The track type of organic fertilizer turning machine is easy to operate, with low labor intensity. But the track needs to be built, so it covers a large area. When the scale is large, the investment cost is high. In addition, the investment belongs to one-off investment. When the site is changed, secondary rebuilding is required. The trackless type of organic fertilizer turning machine is self-propelled organic fertilizer turning machine which motions flexibly. Besides, the machine motion is controlled by the cab, but it needs manual operation. The shape of turned fertilizer basically depends on the operation proficiency of the driver. It wastes time and energy, and the degree of automation is low.

In order to solve the above problems, promote organic fertilizer production efficiency and reduce labor intensity, the organic fertilizer which is made from biogas residue fermented by dry method and smashed sugarcane leaves is used as the object of study, and the self-propelled turning machine is applied in this paper. It is very significant to study and develop SCM-based automatic tracking motion system of organic fertilizer.

Principle and working process of the system

The system is mainly composed of line tracking detection module, control treatment module, display and alarming prompt module, drive circuit module and execution module. The line tracking detection module adopts QTI sensor detection. AT89S52 SCM is applied for control treatment module. The display module is LED2 polar tube panel. The buzzer is used for the alarming prompt module. The drive circuit module consists of pulse generation module and current amplification module. The execution module adopts steering mechanism motor.

AT89S52 is a CMOS 8-bit microcontroller with low power consumption, high performance and 8K in-system programmable FLASH read only program storage^[1]. The device is made by

high-density and nonvolatile storage technology of ATMEL Company. Besides, the device is compatible with MCS51 instruction system and its pin structure. In practical engineering application, AT89S52 with powerful functions has become the solution to many embedded control application systems with high cost performance.

After QTI sensor detects the ground, the voltage signal of high-low level is output to SCM AT89S52 of control treatment system for operation^[2]. After the treatment with the prefabricated procedure, it controls the output signal to go through pulse generation module and current amplification module, and then controls the steering mechanism motor to achieve left and right turning of the turning machine. The composition principle of this system is shown in Fig.1.

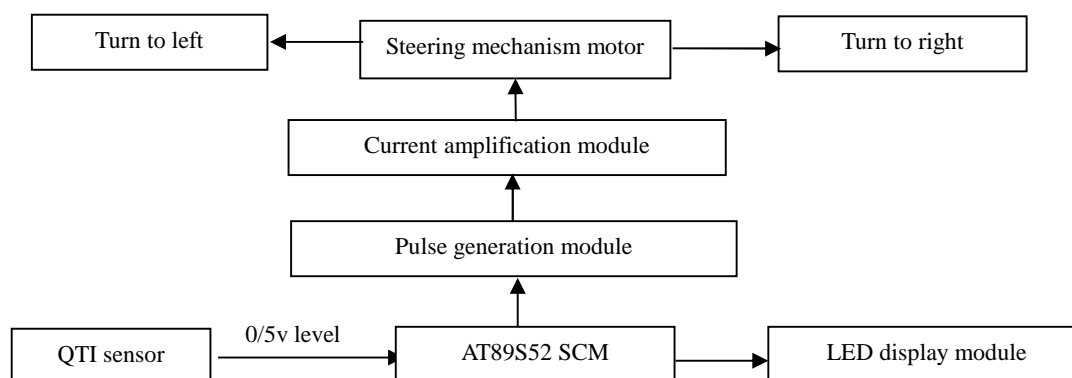


Fig.1 Block diagram of system principle

System track setting and implementation of line tracking motion

The system track line is designed according to the turning need of organic fertilizer. Generally, the straight line track is adopted, and pasted on the ground with “White-black-white” adhesive plaster.

In this design, QTI (Quick Track Infrared) sensor is applied. The sensor applies photoelectric receiving tube to detect the intensity of surface reflected light. When QTI sensor is on a dark surface, the intensity of reflected light is very low. When QTI sensor is on a bright surface, the intensity of reflected light is very high, thus leading to the changes of sensor output^[3]. In other words, high level is output when a black object is detected. Low level is output when a white object is detected. QTI sensor is mainly suitable for line tracking, maze navigation and site edge detection.

The schematic diagram and wiring diagram of QTI sensor are shown in Fig.2 and Fig.3. In the wiring diagram, w is the white line and represents VCC pin. R is red line and represents the pin of signal SIG, and it is connected with I/O pin of SCM. B is the black line and represents GND pin. QTI gains a device (equivalent to photoresistance) through coupling 1 light emitting diode and 1 phototriode to control the level of signal lamp. When QTI sensor passes through the black surface, reflectivity is low, and the phototriode is not connected. Then, the time constant of RC circuit which is composed of capacitance and audion is large, and the charge-discharge duration is long so that most voltage drops at both ends of audion. Meanwhile, R end outputs high level 1. When QTI sensor passes through the bright surface, reflectivity is high, and the phototriode is connected. Then, the time constant of RC circuit which is composed of capacitance and audion is small, and the charge-discharge duration is short so that most voltage drops at both ends of capacitance. Meanwhile, R end outputs low level 0^[4]. The optimum distance between the fixed detection surface of QTI sensor and the detected ground is 5~8mm, and the scattering angle is 65°.

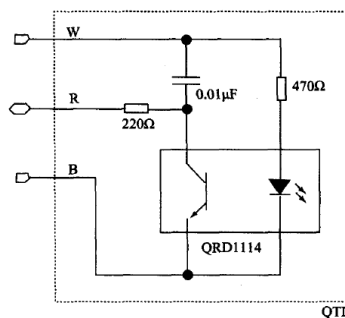


Fig.2 Schematic circuit diagram of QTI sensor

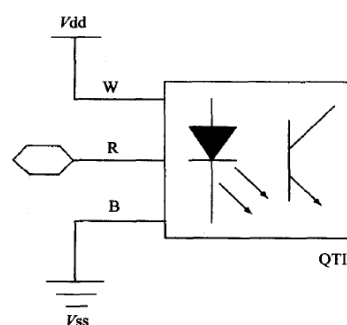


Fig.3 Wiring diagram of QTI sensor

Line tracking principle and design

Line tracking of turning machine utilizes QTI sensor to detect the color of objects and judges whether it moves along the line according to the color and whether it is necessary to start left-right correction procedure.

The location distribution diagram of the sensor and the line tracking diagram of turning machine are as follows:

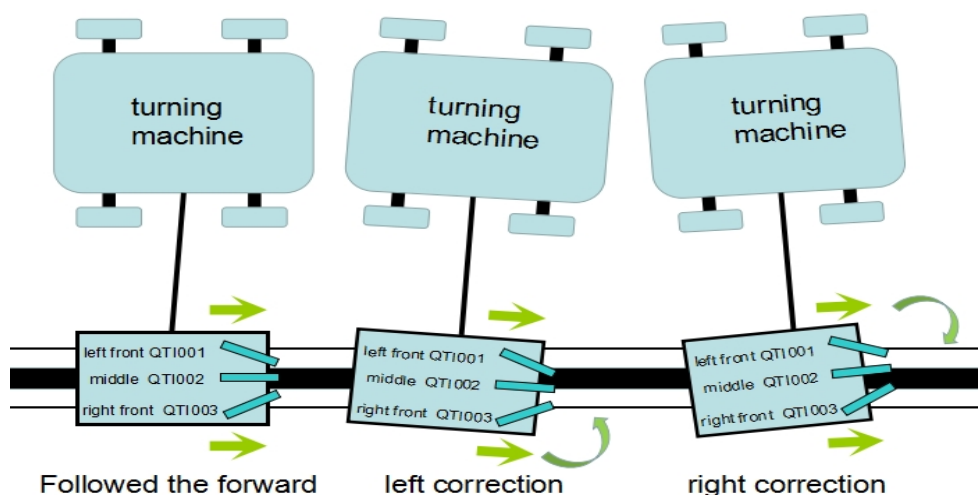


Fig.4 Advancing diagram of line tracking of turning machine

As shown in Fig.4, the advancing principle of line tracking of turning machine is as follows. ① When sig signal end of middle QTI002 has high level and sig signal end of left front QTI001 and right front QTI003 has low level, the turning machine is driven to advance by the rear wheel, and the front-wheel steering mechanism does not work. The advancing direction of turning machine keeps unchanged, and the line tracking of turning machine advances. ② When sig signal end of left front QTI001 sensor has high level, the steering mechanism motor of turning machine operates for left correction to make the turning machine advance along the line. ③ When sig signal end of right front QTI003 sensor has high level, the steering mechanism motor of turning machine operates for right correction to make the turning machine advance along the line.

Working process of the system

The system applies C language development procedure of SCM and is compiled with KEIL C51 software. Downloading is conducted through ISP online programming mode. The control procedure is designed with modularization mode for the sake of debugging and integration.

The system is mainly composed of main program, hardware system self-inspection subprogram,

initialization subprogram, left and right correction subprogram of turning machine. The main program implements system functions through calling each subprogram. The program flow is shown in Fig.5.

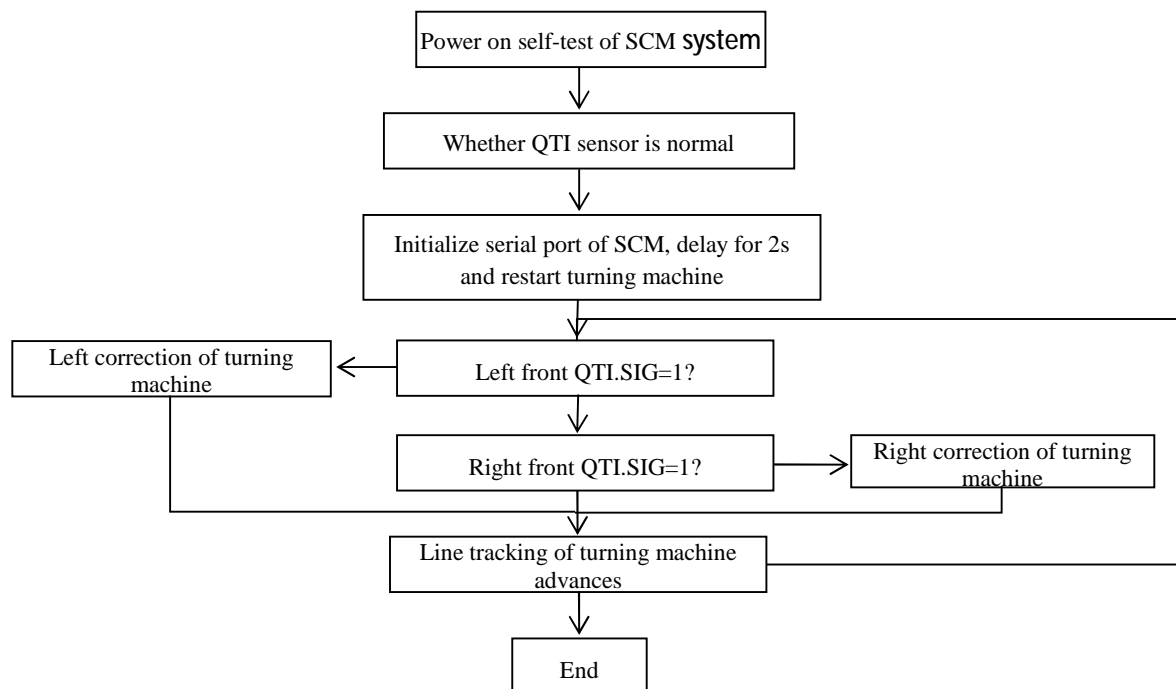


Fig.5 System process

Conclusion

The automatic line tracking walking control program developed by C language has such advantages as short programming and debugging duration, strong program readability and portability as well as simple operation. The on-site test result shows that the system has stable performance and reliable data. Its application in automatic line tracking walking control of turning machine can solve numerous problems resulting from low automation degree of turning machine. Organic fertilizer turning safety and efficiency can improve. Meanwhile, labor intensity can decrease.

Acknowledgement

This work is financially supported by college-level special scientific research program “Scientific and Technological Innovation Team of Tropical Agricultural Waste Utilization” (1630132017007), and science and technology planning project of Zhanjiang “Study on High-quality organic fertilizer Technology based on Biogas Residue of Livestock Excrements and Straws” (2017A03018).

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