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The Application of Motion Controller in Banana Stalk Crusher

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Abstract*:* Banana is one of the major crops in the tropical areas of China, it has an important position, banana industry has become one of the main pillar industries in the tropics. Banana harvest also produces a large number of banana straw, traditional piling and burning processing mode restricts the scale development of the banana industry. This article in view of this situation, a king of banana straw grinder is designed based on motion controller, and the hardware and software design are introduced. The banana straw grinder can realize the whole process of automatic feeding cutting, grinding, and discharging, which has a certain practical significance.

**Keywords** Banana straw grinder; Control system; Motion controller

INTRODUCTION

China is one of the main producing countries of banana in the world, banana is one of the largest trade volume fruit in the world, because of this, the banana has become one of the most important crops in the South China [1]. Banana is a tropical crop, it has the advantages of short growth cycle and large amount of output. But at the same time, it also will produce a lot of banana by-products [2]. After banana harvest, banana straw processing has become the biggest problems plagued banana farmers. Processing of banana straw is artificial cutting, then the straw is stacked directly at the edge of the field or get together to burn. The measures for the treatment of such seriously damage the ecological environment of banana plantation. Meanwhile it also spends a lot of manpower and material resources, and reduces the effective utilization rate of banana garden, so comprehensive cost will greatly improve [3]. Improper treatment of straw has influence to the development of the banana industry, and restricts the banana industry large-scale road [4]. On the above problems, in this paper a set of cutting and grinding into one banana straw grinder is designed, the grinder control system uses motion controller as the control core. The motion controller has the advantages of high control accuracy, good reliability, strong portability [5]. The grinder can realize the whole process of automatic feeding, cutting, grinding, and discharging, the work efficiency is greatly improved. It has some practical significance for the development of the banana industry.

BANANA STRAW GRINDER SYSTEM SCHEME DESIGN

Banana straw grinder overall design

As shown in Figure 1, the banana straw grinder is mainly composed of a feeding mechanism, a cutting mechanism, a grinding mechanism, a discharging mechanism and a machine frame etc. The feeding mechanism, a cutting mechanism and the grinding mechanism is key parts of the straw grinder work, feeding mechanism is the role for the straw feeding, straw is driven forward, in order to satisfy the different sizes of the straw, feeding mechanism adopts a floating type design, feeding roller mechanism can fluctuate up and down to adapt to the different diameter, the friction between the roller drives the straw forward.
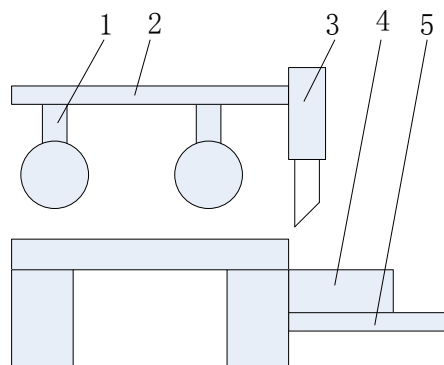
1.Feeding mechanism 2.Frame 3.Cutting mechanism 4.Grinding mechanism 5.Discharging mechanism
Figure 1.The diagram of banana straw grinder

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The cutting device is a crank rocker mechanism, if the system detects the straw, motor drives cutting device to do reciprocating up and down movement, the straw is cut into fixed length segments. The chopped straw will be sent into the grinding device, the grinding device chops the short straw, chopped straw falls into the discharge mechanism, straw will be sent out from the discharging mechanism.

Banana straw grinder control system

As shown in Figure 2, the straw grinder control system mainly consists of the motion controller, servo system, detection system and execution system. Motion controller is the core of the control system, the other hardware is communicated with motion controller, motion controller decides signal output according to each different feedback signal. Servo system is the power source of the straw grinder, each of mechanism is through the servo driving to complete the work, servo systems coordinate together according to the motion controller instruction to complete the whole process of straw grinding. The detection system includes a variety of sensors, such as straw location detection sensor, sensors of cutting mechanism movement control, and sensors of the grinding mechanism motion control etc. The system determines the position and the straw grinder running state through the detection of each sensor. Execution system comprises indicating lights, they are used to display the working state of the straw grinder.
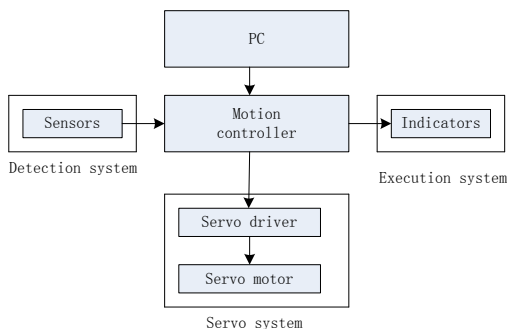
Figure2. The design of control system

BANANA STRAW GRINDER SOFTWARE DESIGN

Software structure design

In order to make the control system of the straw grinder has good openness, software design uses the modular design method. The motion controller used in this paper is running based on PC, it only has operational core, but no developing core, program can run when they are downloaded to the motion controller, but it cannot program, it need the assistance of PC. PC as upper computer will do programming and debugging of the motion controller. The modular system design is shown in figure 3. Procedures for the development and debugging is on the upper computer, then the written a program will be transmitted to the motion controller, the program

mainly includes management program, input and output program, logical control program and motion control program. Motion control program is transmitted to the motion controller, it can run independently in the controller, and does not need to run on a computer.
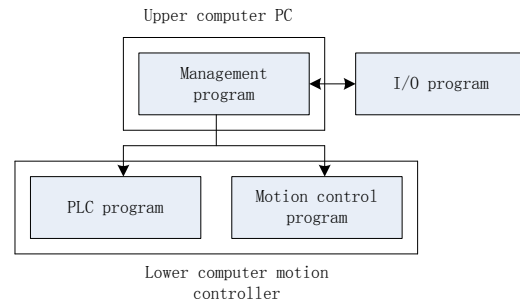
Figure3. The modular design of program

Software function design

According to the characteristics and process of the straw grinder, in order to guarantee the stability of the system, the straw grinder adopts sequential operation mode. Software work flow chart is shown in figure 4. First, system is on power, the system begins initialization after power supply, and detects the straw grinder state, if there is failure, there will have an alarm indicator lights up, if there is no fault ,it continues to run. The program starts after the completion of the initialization, the banana straw will be put into the grinder, feeding mechanism begins to work after that grinder system detects banana straw, and drives the straw forward. When the sensor detects a straw, cutting mechanism begins to work, banana straw will be cut into small pieces according to a set length. After cutting into short pieces, the grinding mechanism runs, grinding mechanism will grind it. The straw after grinded will be sent by the discharging mechanism. Repeat the above action, do the automatic grinding of straw. The system also has the function of self-protection, if there is failure in the midway, the system will prompt the fault, and the program jumps to the initialization state.
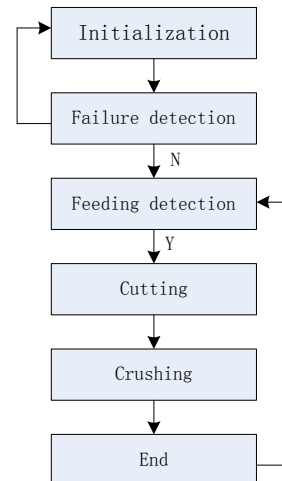
Figure4. Work flow chart

I/O design

The straw grinder system detecting and implementation system feedback and output are all through the I/O interface controller, detection system comprises straw position detection sensor, cutting mechanism start sensor, and grinding mechanism start sensor etc. The system design of I/O is shown in table 1.

Table1.System I/O design

Input		Output	
IN0	Position sensor 1	OUT0	Indicating light 1
IN1	Position sensor 2	OUT1	Indicating light 2
IN2	Position sensor 3	OUT2	Indicating light 3
IN3	Position sensor 4	OUT3	Indicating light 4
IN4	Limit switch 1	OUT4	Indicating light 5
IN5	Limit switch 2		

CONCLUSION

Aiming at the existing problem in the processing of banana straw, a banana straw is designed grinder based on motion controller, this machine can do effective treatment of banana straw, change the original work, improve work efficiency, and reduce the production cost. In order to expand the scope of work of banana straw grinder in this paper, feeding mechanism adapts floating type design, it can grind different dimensions of banana straw, which improves the working range. Using the motion controller as the core of the control system can improve the system's openness, the system response speed, and have good reliability. It has a certain practical significance to the development of the banana industry.

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