Research on the Key Technology of Intelligent Tea Picking Machine -- Measurement of Depth and Height of Tea Gathering in Visual Processing System

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Abstract: China is the main region of origin of tea in the world. As one of the world's major tea growing, consuming and exporting countries, it is an inevitable trend for China to develop an intelligent tea picking robot that can work independently in the field. In China, there are many ways to pick tea, from manual picking to mechanical picking. The advantage of manual picking is that it can accurately distinguish the size, aging and evenness of tea buds and leaves, and the quality of the new shoots harvested is also much higher than that picked by machine.

However, at the present stage, in the era of labor shortage, tea picking is characterized by high labor intensity and low picking efficiency, and mechanized tea picking emerges as The Times require.Mechanized tea plucking has now become the only way to realize the sustainable development of tea industry, many machines picking efficiency is low, however, one of the reasons is to determine the depth of picking machine error brought by the incorrect, determine the length of the machine is now through the CCD photograph, picture for graphic images, CCD sensitivity, pixels, and the plane to the three-dimensional high conversion method between there are considerable problems, thus put forward a way to accurately measure the tea picking in depth the height of the device is particularly important.

Aiming at the realization of precise picking by the intelligent tea picking machine, this paper designs a tea gathering depth and height measuring device which can accurately measure and reflect the data to the grating sensor.

1. Background Knowledge of Intelligent Tea Picking Machine for Famous and Excellent Tea

Japan, the first country to study mechanized tea picking, started the research on tea picking equipment and pruning equipment around 1990.

In the early stage of his research, scissor picking and tea pruning were the main methods.

Subsequently, the Soviet union, the United Kingdom, India, Argentina, Australia and other countries began to carry out different degrees of research on tea picking machines, but these mechanized picking was limited to the study of bulk tea.

Because there is no requirement for the integrity of tea leaves, there is no systematic research on the famous tea picking robot in foreign countries.

Simply importing or imitating foreign tea picking equipment cannot meet the domestic demand.

In China, most of the tea picking machines are still in the theoretical stage, although from 1958 to the 1970s, the research on bulk tea is quite effective, and the machine picking efficiency is high and the quality is good.

However, because the young and old leaves are often cut together during the picking process, the buds and leaves are not even, which cannot meet the tea picking standard of famous and excellent tea.

Although later zhejiang university and China agricultural university studied famous and

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excellent tea machines one after another -- spatial multi-dimensional vibration parallel screening machine, self-propelled automatic tea picking machine prototype [19], and dual-arm tea picking robot [20].

However, the tea picking machines introduced above are all for bulk tea picking and picking famous and excellent tea, with extremely high requirements for raw material tenderness and fresh leaf picking. In addition, they are also affected by season and other factors, and manual picking is still the main picking mode in China.

But in recent years, although our country has a breakthrough in the field of excellent tea - nanjing forestry university and nanjing agricultural mechanization research institute produce the prototype, but the experimental results show that although picking accuracy is high, but its efficiency is low and the fuselage size is too big to meet the needs of the work and the actual production, rectify its reason, is the low efficiency of picking.

The depth measuring device involved in this paper has a significant impact on the improvement of efficiency and can better serve the intelligent tea picking equipment supported by this design.

2. The Related Research of Tea Picking Machine

Involved in this paper, related to tea plucking machine is shown in figure 1, 1-1 of caterpillar base, 1-2 shading tent, 1-3 OV5640 CCD camera 1, 1-4 tablet carrying frame, 57 zl80bh 1-5-100 stepper motor, 1-6 arc carrying frame, 1-7 tea inlet, 1-8 blower, 1-9 blow straws, 1-10 tea boxes, 1-11 LCD display, 1-12 mandrel picking front-end, 1-13 curved contact surface, the tea ridge 1-14 slippery course.

The specific working process is shown in figure 2: press the power button of LCD display screen to power the system and advance the track base.

Shading tent at this time of the LED power open, open and CCD camera to photograph, the image back to the STM32 MCU module in the analysis and processing, specific steps as shown in figure 3, the analysis of the image to display in the LCD display, after that, the STM32 MCU module sends commands to 51 MCU module, started the tea gathering ranging process.

See figure 4 for details.

51 MCU module control stepping motor rotation drive grating ruler sensor drops, at this point in carrying on five pressure sensor through the contact area feel pressure change, back to the 51 single-chip microcomputer, when the average stress reaches program built-in default X, 51 single chip microcomputer is a stop command signals, motor stop running, the grating ruler sensor to stop down, deep sure at this time.

After that, 51 MCU module controls motor reversal and retracts the measuring device.

Collection structure, since the grating ruler sensor height data from X feedback to PC STM32 MCU module, thus it will transmit the data to the data of dc gear motor, dc gear motor and mechanical arm started operation on the steering gear, drives the mandrel tea plucking machine front picking tea leaves, at the same time, blower rotating equipment, will pick good tea shoots through the tea inlet suction boxes, tea boxes of light intensity sensor will have collection at this time of tea shoots to the LCD display screen size, acquisition, STM32 microcontroller send stop picking orders,

When the crawler moves forward to advance the picking, when the total collection amount displayed on the LCD reaches more than 4/5 of the display screen, the tea collection box will be removed.

In view of the overall process of the above intelligent tea picking machine, the design of the measuring device for the depth and height of tea gathering, combined with the actual situation of the tea garden, this paper will make further research.

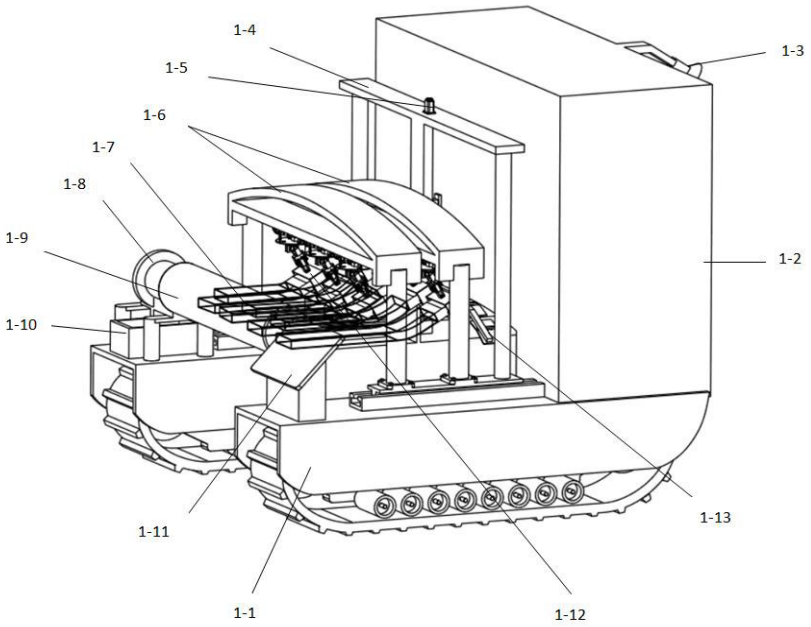

Figure. 1

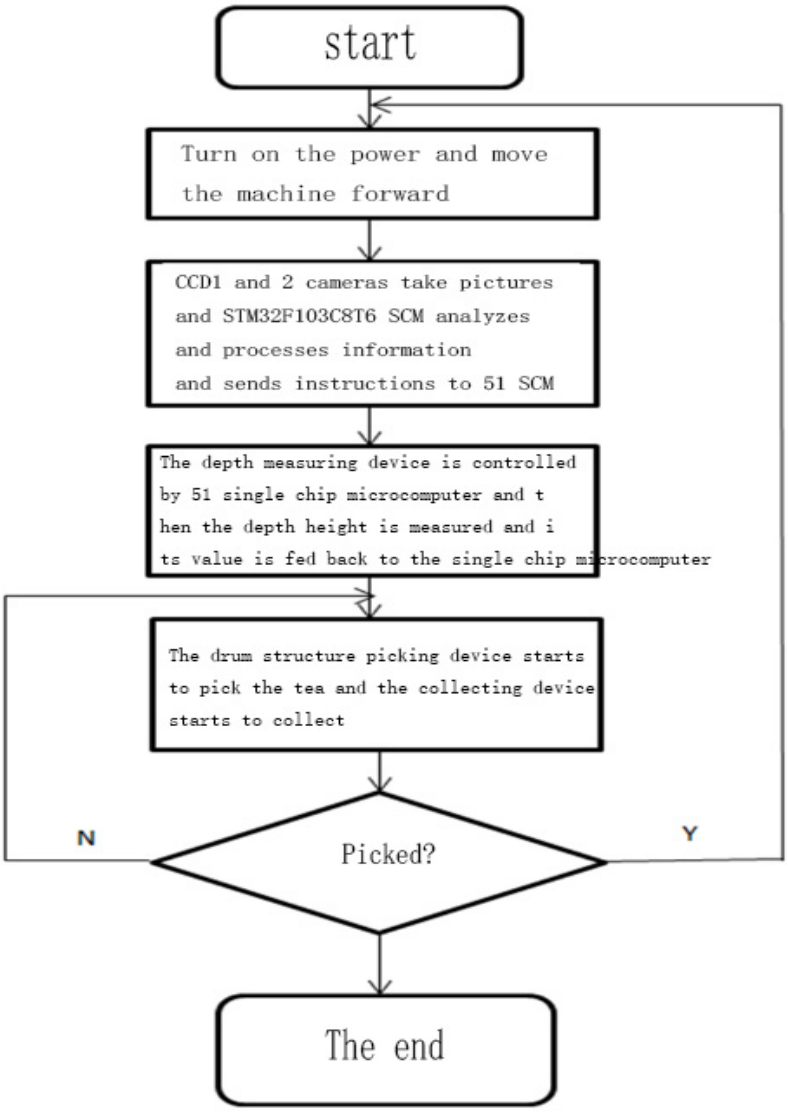

Figure. 2

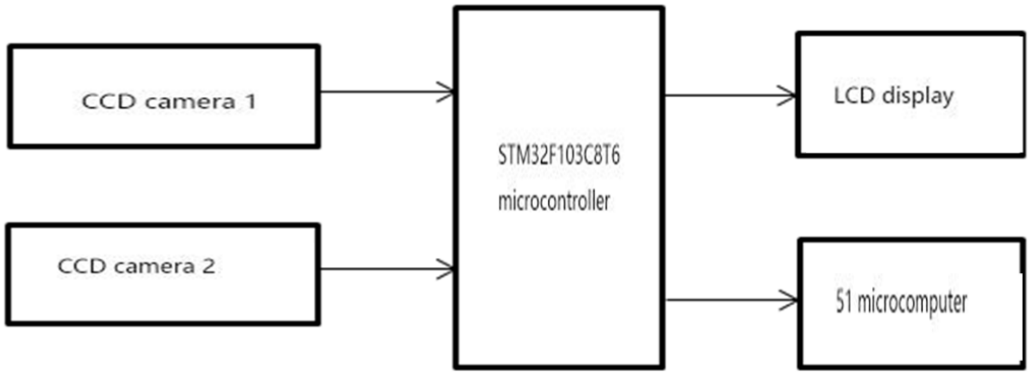

Figure. 3

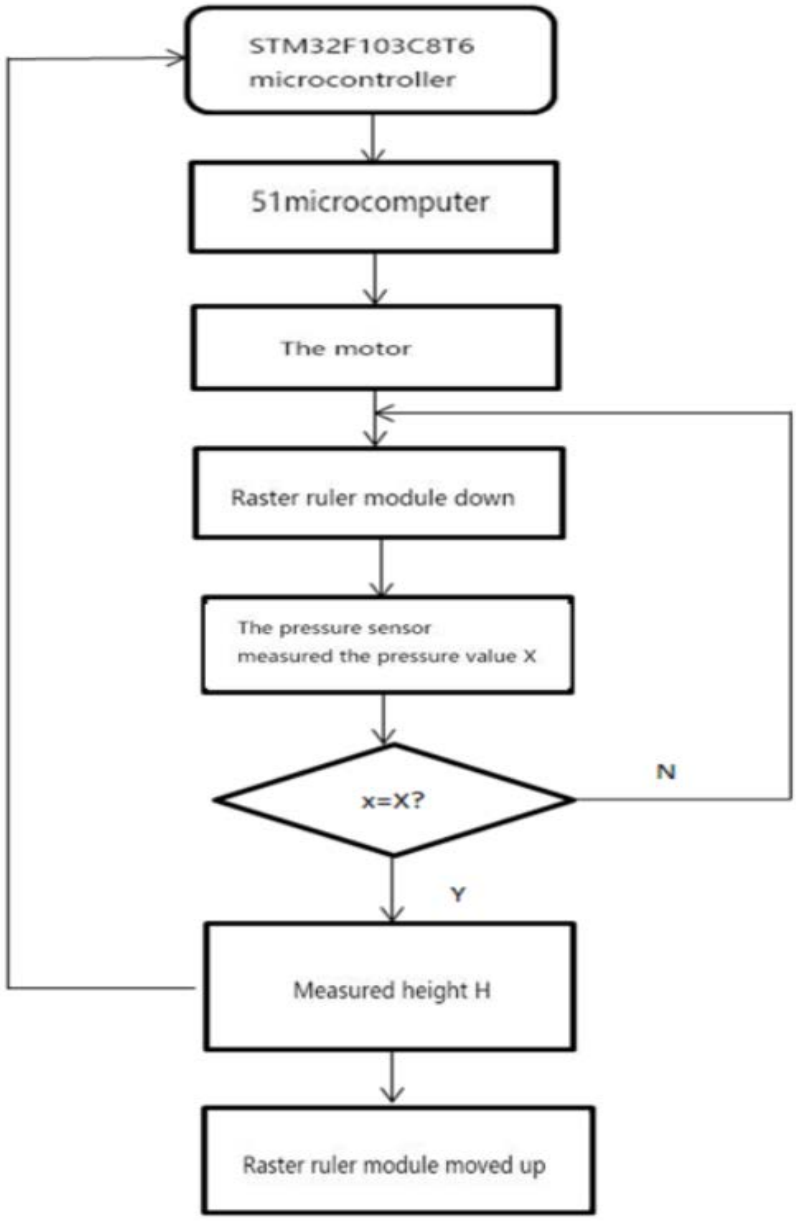

Figure. 4

3. Actual Circuit Design of Measuring Device

The design of the 52 series microcontroller as a central processing chip, for the measurement device to provide driving and data conversion of some basic functions, to ensure the normal

operation of the device.

4. Pressure Sensor Module Connection Procedure.

```
# # ifndef __HX711_H__
# define __HX711_H__

# include < reg52. H >
# include < intrins. H >

/ / IO Settings
Sbit HX711_DOUT P1 = ^ 0;
Sbit HX711_SCK P1 = ^ 1;
Sbit HX711_DOUT1 = p ^ 2;
Sbit HX711_SCK1 P1 = ^ 3;
Sbit HX711_DOUT2 = P1 ^ 4;
Sbit HX711_SCK2 = P1 ^ 5;
Sbit HX711_DOUT3 = P1 ^ 6;
Sbit HX711_SCK3 = P1 ^ 7;
Sbit HX711_DOUT4 = P2 ^ 3;
Sbit HX711_SCK4 = P2 ^ 4;

// function or variable declaration
Extern void Delay__hx711_us (void);
Extern unsigned long HX711_Read (void);
Extern unsigned long HX711_Read1 (void);
Extern unsigned long HX711_Read2 (void);
Extern unsigned long HX711_Read3 (void);
Extern unsigned long HX711_Read4 (void);

# endif
```

Five sensors are placed here, so five ports are defined to receive changes in the feedback surface data brought by the HX711 sensor module.

5. Pressure Measuring Program.

```
If (KEY3 = = 0)
{
Delay_ms (5);
If (KEY3 = = 0)
{
While (KEY3 = = 0);
Get_Maopi ();
Get_Maopi1 ();
Get_Maopi2 ();
Get_Maopi3 ();
Get_Maopi4 ();
/ / to skin
}}
```

Obtain the specific weight of the object, and when it reaches a certain level, it will give an alarm (the above is the strength set according to the surface of the tea).

Perform the program a total of 5 times (since the pressure sensors are in different positions, statistics are required).

Void Get_Weight ()
{
Weight_Shiwu = HX711_Read ();
What kind of Weight_Shiwu = weight_shiwu-weight_maopi;
// get the net weight
If (Weight_Shiwu > = 0)
{
Weight_Shiwu = (unsigned long) ((float) Weight_Shiwu/GapValue);
// calculate the actual weight of the object
If (Weight_Shiwu > AlarmValue) // overweight alarm
{
Buzzer = 0;
}

In order to obtain the relative average strength, the idea of adding and averaging is adopted, but this involves a structural force, which will be analyzed in detail later

Void Get_SUM ()

{Weight_SUM = (Weight_Shiwu2 Weight_Shiwu Weight_Shiwu1 + + + + Weight_Shiwu4 Weight_Shiwu3);

6. Actual Circuit Diagram.

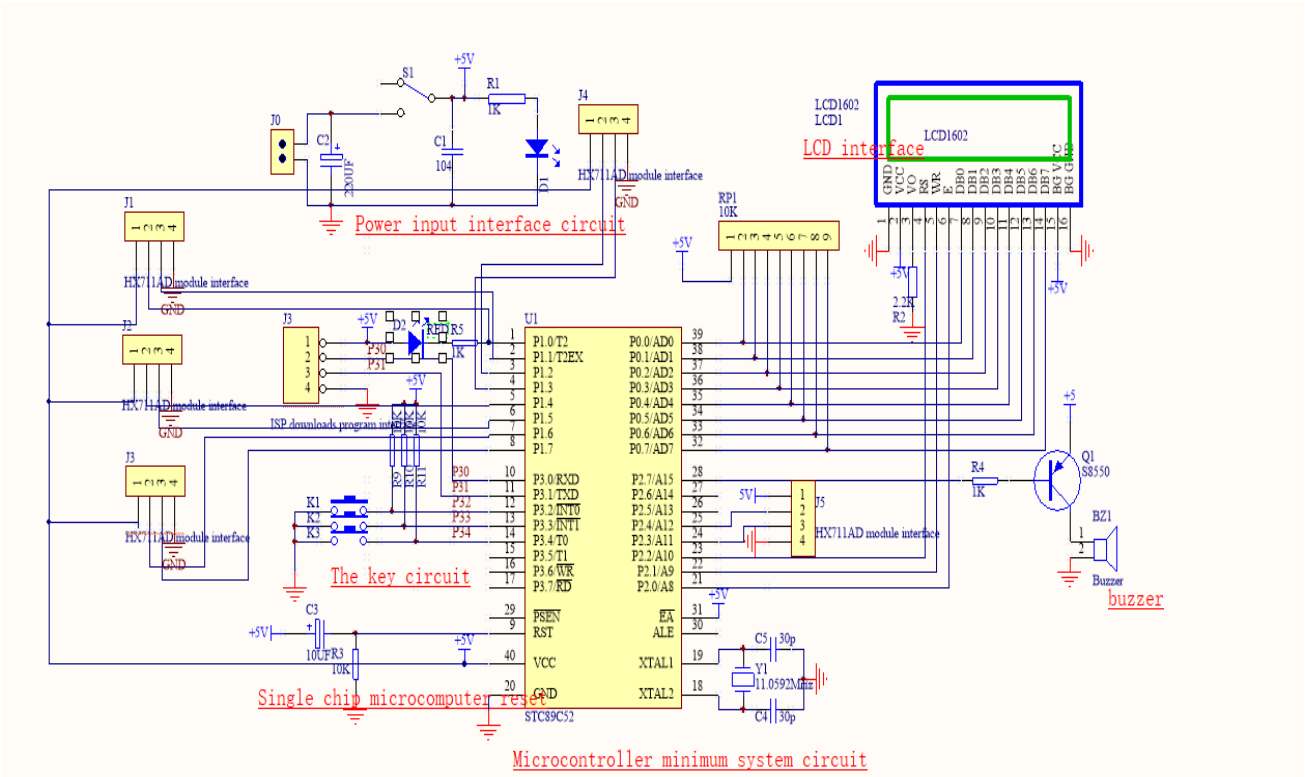

Figure 5

7. Design of Mechanical Structure of Measuring Device

(1) The depth height and width of tea gathering surface between tea gardens were measured

The average value method is used to calculate the experimental data to pave the way for designing a reasonable mechanical structure.

There are 5 groups of tea clusters in total in the tea gardens. The measured data are as follows

Table 1

width /cm	altitude /cm	width/ altitude	
174	33	5.272727273	1
139	23	6.043478261	2
126	23	5.47826087	3
110.5	23	4.804347826	4
127	23	5.52173913	5
135.3	25	5.412	Average

It can be seen from the above that the average width of the tea cluster is 135.3cm and its depth is 25cm, so the design radian of its mechanical structure is calculated based on the aspect ratio.

(2) Draw relevant designs and design schemes with Autocad

The mechanical device frame is drawn according to the tea gathering surface CAD[26], as shown in figure 6 (drawn according to the analysis of the measured data).

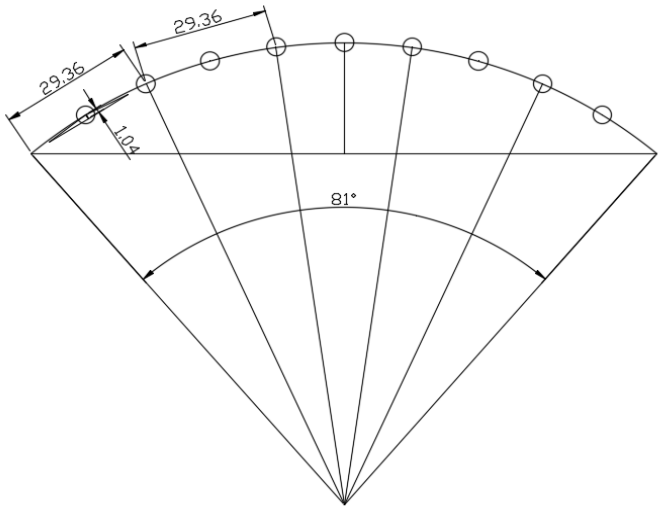

Figure. 6

According to the actual situation of tea approach surface, also need to consider the selection of materials, and distribution

<1> is carried on the whole. Five sensors are planned to be set on the arc. The arc adopts soft iron sheet material, and soft iron sheet material is used as the contact surface to form a hierarchical structure of carrying frame, sensor and soft iron sheet.

One of the contact surface materials also consider soft board

<2> multiple sensors are set, and a separate measuring board is set under each sensor to form a quasi-circular arc structure, as shown in FIG. 7.

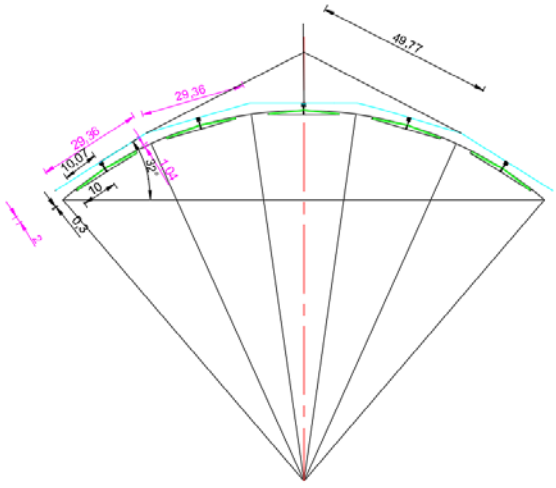

Figure. 7

Finally, CAD is used to draw the overall mechanical structure of the design, as shown in FIG. 8

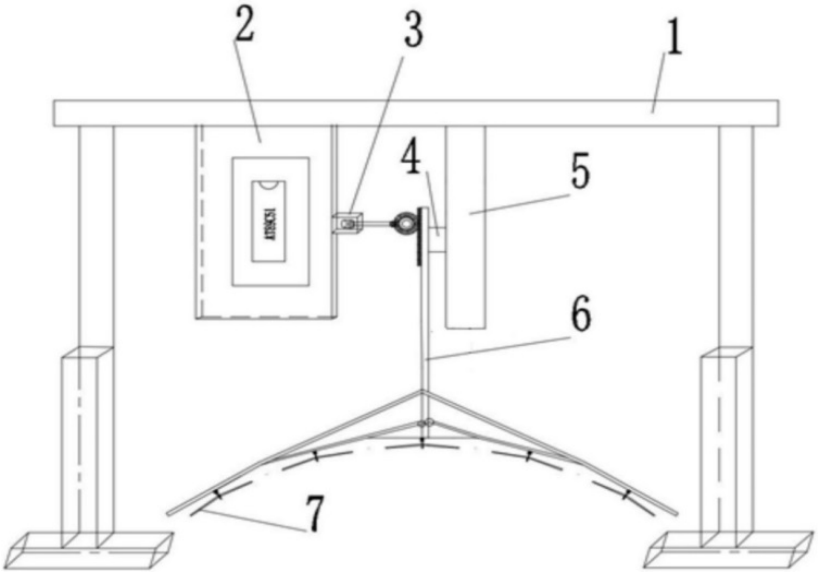

Figure. 8

1. Bracket, 2. Microprocessor module, 3. Driver module, 4. Slider, 5.YE series grating ruler shift sensor, 6

The <1> class scheme is not introduced in detail, only its experimental data are shown here

According to the mechanical distribution characteristics of its circular arc, inverted objects are placed in phase with each other to carry out force measurement experiment (distance/Angle from the center).

<1> class structure material using contact surface is soft iron sheet

Table 2

Experiment 2 /4.5cm Angle 58.878							
Quality/location number	1	2	3	4	5	6	7
20g	5	5	6/0	6/0	7/0	6/0	4/0
60g	7	18	14	11	6	0	0
100g	34	37	40	41	40	33	29
Experiment 2 /2cm Angle 58.878							
Quality/location number	1	2	3	4	5	6	7
20g	5	6	7	7	8	8	6
60g	20	23	25	21	23	13	6
100g	47	46	50	53	56	42	
Experiment 2 /0cm Angle 58.878							
Quality/location number	1	2	3	4	5	6	7
20g	3	5	5	6	8	7	4
60g	19/18	22/25	24/25	34/23	31/31	25/25	17/16
100g	47/47	48/53	50/59	78	60/54	45/44	37/33

Experiment 2 /4.5cm Angle 30.96375						
Quality/location number	1	2	3	4	5	6
20g	9	14	17	15	12	8
60g	35	45	50	48	37	26
100g	57	75	81	76	62	42

Experiment 2 /2cm Angle 30.9675						
Quality/location number	1	2	3	4	5	6
20g	10	14	16	15	13	8
60g	32	43	49	47	38	24
100g	64	78	86	77	59	36
Experiment 2 /0cm Angle 30.9675						
Quality/location number	1	2	3	4	5	6
20g	7	11	13	13	10	5
60g	33	40	44	43	33	20
100g	68	77	81	74	55	33
Experiment 2 /2cm Angle 30.9675						
Quality/location number	1	2	3	4	5	6
20g	7	11	13	13	10	6
60g	32	40	45	43	33	20
100g	64	75	75	72	54	34
Experiment 2 /4.5cm Angle 30.9675						
Quality/location number	1	2	3	4	5	6
20g	8	11	13	12	9	5
60g	34	39	43	41	32	20
100g	62	69	72	69	55	38

However, according to the experimental data, the data deviation is too large.

In the subsequent design, the paper is fixed on an iron frame, but the experimental data deviation is not much different from the above

For the <2> class scheme, the measurement board model is adopted

Single gauge board model

Figure. 9

As shown in FIG. 9, the black part is the pressure sensor and the green part is the measuring plate connected with it. Five measuring plates are set in this paper, which can theoretically be set to infinity.

There are 5 measuring plates in this design, which are distributed at the distance of 0cm from the center, left 2cm, left 4.5cm, right 2cm and right 4.5cm respectively.

Measure 20g, 60g, 100g, and then measure another group of 500g and 200g

Table 3

Experiment 3 /4.5cm is on the quasi-circular ar										
Quality/location number	1	2	3	4	5	6	7	8	9	10
20g	20	20	19	19	19	21	21	21	21	21
60g	65	65	65	65	65	65	65	65	65	65
100g	109	109	109	109	109	109	109	109	109	109
Experiment no. 3 /2cm is on the quasi-circular arc										
Quality/location number	1	2	3	4	5	6	7	8	9	10
20g	22	22	22	22	22	21	21	21	22	22
60g	65	65	65	65	65	65	65	65	65	65
100g	109	109	109	109	109	109	109	109	109	109

Experiment no. 3 /0cm is on the quasi-circular arc										
Quality/location number	1	2	3	4	5	6	7	8	9	10
20g	22	22	22	22	22	23	23	23	22	22
60g	65	65	65	65	65	65	65	65	65	65
100g	109	109	109	109	109	110	110	110	109	109
Experiment no. 3 /2cm is on the quasi-circular arc										
Quality/location number	1	2	3	4	5	6	7	8	9	10
20g	22	22	22	22	22	23	23	22	22	22
60g	66	66	66	66	66	66	66	66	66	66
100g	110	110	110	110	110	110	110	110	110	110
Experiment no. 3 /4.5cm is on the quasi-circular arc										
Quality/location number	1	2	3	4	5	6	7	8	9	10
20g	22	22	22	22	22	22	22	22	22	22
60g	66	66	66	66	66	66	66	66	66	66
100g	110	110	110	110	110	110	110	110	110	110
Experiment no.3 / quasi-arc										
Quality/location number	1	2	3	4	5	6	7	8	1/200g	2/200g
500g	546	5465	545.5	546	545	546	546	546	250	250

According to the data, the error is 10%, which can be adjusted according to the internal algorithm of program one.

The plan is feasible.

Finally can realize, quasi circular arc surface contact surface of tea gathering, when carrying frame down, according to data from experiments and practical tea garden set beforehand by the measure of strength measurement values, triggered when the value is reached adaptation of the program, the data back to the single chip microcomputer and single chip feedback to the grating ruler sensors are down, and stop the operation, namely the distance after statistics, thus realize the depth measurement, and can be used to provide to the tea plucking machine vision processing system.

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