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Design and Development of Selective Tea Leaf Plucking Robot

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Abstract To acquire the developing trend and ways of robotizing of tea plucking, with analyzing the developing backgrounds and situations of tea plucking robot both at commercial and agro automation, this article also analyses the reason why agriculture domain has a poor mechanization of tea plucking and points out existing problems. Finally, invention claims a selective tea leaf plucking robot belongs to agricultural automation. This robot is designed considering selective tea leaf plucking and ergonomics aspects, which helps to operate robot without any fatigue. The robot includes portable robot mechanism, multi-sensor, robot control unit, rail conveyer and distributing system with container arrangement.

Keywords: *robot, multi-sensor, robot control and rail conveyer system*

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1. Introduction

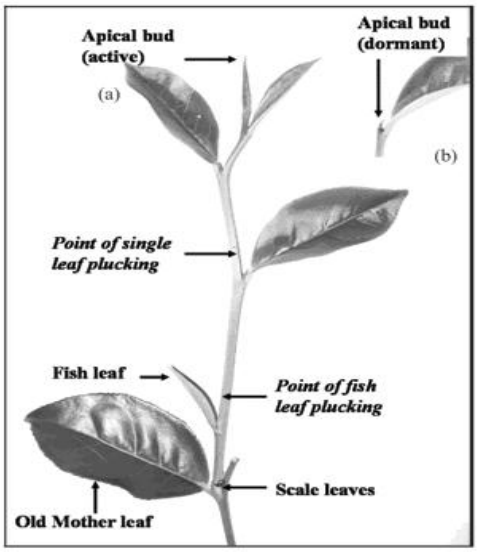

Figure 1. Typical active (a) and dormant (b) shoots of tea. (Source: Wijeratne, 2001)

Tea has been the most popular and low cost beverage around the world. The goal of selective tea plucking robotics is to overcome agricultural challenges. An agricultural robot must deal with an unstructured, unknown, uncertain and varying environment. Tea leaves are randomly located on tea plant, and it is difficult to detect different categories in tea leaf (such as bud, fresh leaf, active leaf, mother leaf, etc..) I have found that Tea plucking machines are designed in many countries but they are designed only for plucking with any selective method and these machines are very large and expensive. Therefore quality is being reduced.

So in order to improve the quality it is necessary to improve the plucking methodology using sensors, and more over the available resources (Fuel, Electricity, Human resources etc..) are less and expensive. This project is carried out to design and fabricate a portable and powerful cutting system that can be operated even by layman with dual power system.

2. Problem Definition

The typical harvesting machines which is being used currently has few problems such as selective Tea Leaf plucking, as they are not using any intelligent system.

It also has the problem of damaging the tea plants due to the running blades, and most importantly fuel and human resource.

3. Problem Statement

Tea is a major beverage in most of the countries. The study is to understand the tea leaf plucking methods and to develop new tea leaves plucking robot. The shortage of laborers, electricity, fuel and the increase in wages has paved way for automating the process of tea leaf plucking. Selective tea leaf plucking robot helps in increasing the output rate of tea plucking with reduced man power and low cost.

4. Methodology

The tea leaf plucking robot has the special function of detecting the selective type of leaf which is used for the manufacturing of the first class tea. This robot's intelligence system is high when compared with others. It will perform the sensing of leaves, detecting the selective type of leaves, level of the leaves etc. It works on rechargeable batteries and also the battery can be charged using solar power, so this robot is much more efficient in fuel consumption. When all the conditions of the sensor are accepted then the robot starts to pluck the leaf from the plant. It will not cause any damage to the plant. When the robot starts functioning it won't require any operators to operate. This robot starts to pluck the leaves and collects the selective type of leaves in the tray attached to the robot. This robot arrangement is attached to a rail which is located on the front side of the robot, it has portable and adjustable. According to the rail arrangements the robot moves and plucks the selective tea leaves. In-between if there any disturbance in the rail or plant the robot automatically stops and starts indications.

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5. Experimental Setup

The block diagram of the system is shown. The schematic of embedded control hardware circuit is shown in diagram. The hardware and software description of the data acquisition system for monitoring physical parameter are described below.

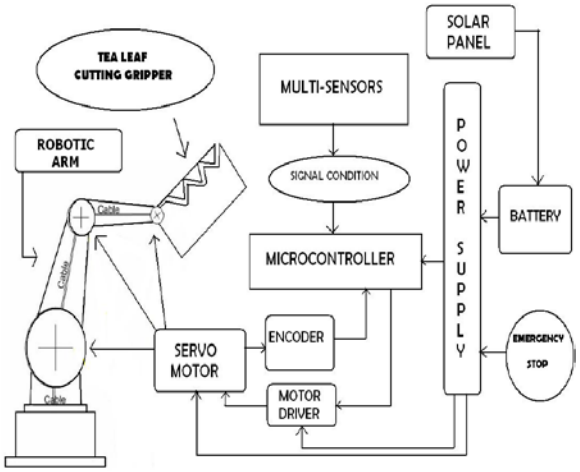

Figure 2. System Block Diagram

6. Hardware Description

The blocks are divided into the following sections
Multi sensors
Signal conditioning
Microcontroller
Servo motor
Motor driver
Encoder
Solar System
Battery
Power supply

6.1. Multi Sensors

The system consist of multi sensors which are used for cutting the selective tea leaves from the plants, there are totally five types sensors used in this system. Each type of system has their different types sensing applications. The sensors used in the system such as leaf sensor, humidity sensor, temperature sensor, level sensor and color sensor.

Figure 3. Leaf Sensor

The leaf sensors are used in the system for detecting or to sense the availability of the leaves in the tea plants. When the sensor is high then the robot will allows for doing the next sensing methods

The humidity sensors in the system will sense the range of the humidity available in the leaves in the plants if the humidity range is accepted to the condition which is suitable for a selective leaf that is the tea leaf which is at the beginning stage is used for the preparation of the tea powder. By using this sensor robot can identify the selective leaf.

The temperature sensor is used to sense the temperature level of the selective leaves in the tea plants.

The level sensors are used in the system for sensing the level of the tea plants and its leaves in the top of the plant according to the sensing output the robot arm vertical movement was controlled. If the level was sensed the arm of the robot is ready to start the operation.

The color sensor is used to sense the color of the tea leaf which are selective type (beginning stage) and the selective type leaf has the color different as compared to the normal leaf. By using the color sensor we can able to detect the selective leaves in the plant. If the all sensors conditions are became ok then the robot arm starts to do the operation of plucking the selective leaves in the tea plants.

6.2. Signal Condition

The output of the sensor is very low. To amplify and calibrate the sensor response, signal conditioner circuit is designed by using OPAMP (LM35DZ). This section is designed especially for accurately up to one decimal place.

6.3. Microcontroller

The microcontroller (MR-C3024) is used to control the servo motor in the system. Servos controller is used to

control the position of the pulse of servo motor. Servo controller is the electronic part which functions as the program language to sending pulse to servo motor. Servo controller usually comes with required program which can be controlled by computer or PIC circuit.

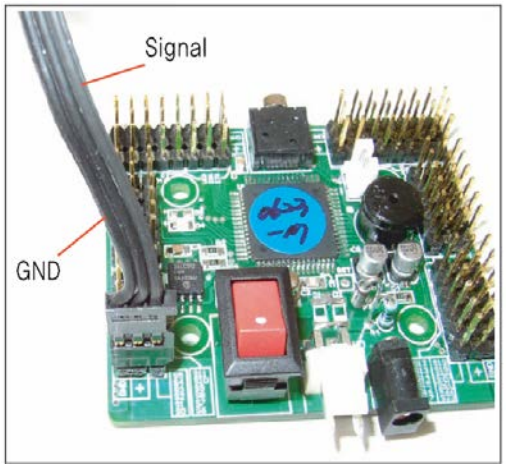

Figure 4. Structure of MR-C3024

Model	MR-C3024
Photo	
CPU	Atmel ATMEGA128 8bit RISC
I/O Ports	24 I/O ports
Servo Control	24
PWM DC Motor Control	3
A/D Conversion Channel	8 ch
Program Memory	32Kbytes
Ultrasonic Sensor	12 ch
IR Remote Control Reception	Yes
RF Control Reception	Yes
Common Features	1. LCD Module Control 2. 6 Octave Piezo (Music, Voice) 3. RS-232 (UART) Serial Communication
Misc	1. Direct Serial Control (Using VB, VC++) 2. Robot Programming : Requires ROBOBASIC v2.0 or above 3. Download : Requires serial cable

Figure 5. MR-C3024 Specifications

6.4. Servo Motor

A servomotor is a specific type of motor and rotary encoder combination, usually with a dedicated, that forms a servomechanism.

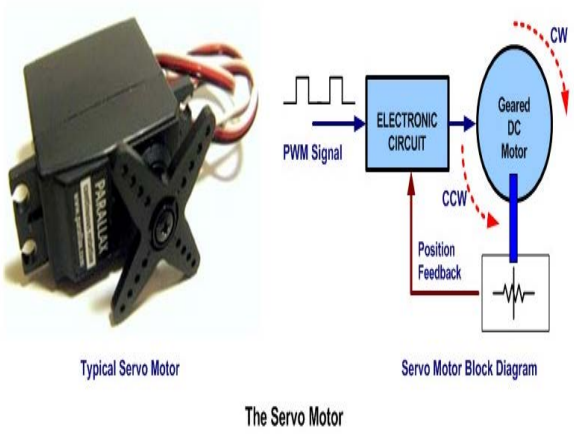

Figure 6. Servo Motor

A typical servo consists of a small electric motor driving a train of reduction gears. A potentiometer is connected to the output shaft. Some simple electronics provide a closed servomechanism. The servo is controlled by three wires: ground, power, and control. The servo will move based on the pulses sent over the control wire, which set the angle of the actuator arm.

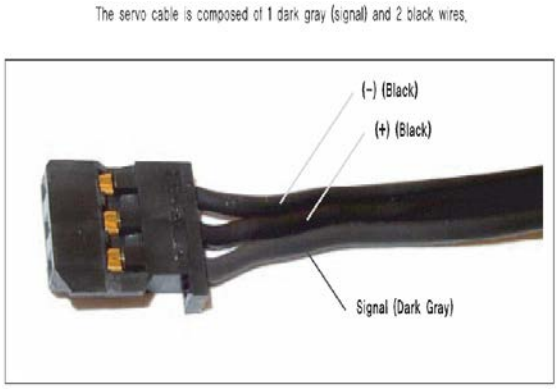

Figure 7. Wire Connection

6.5. Motor Driver

The motor driver is used in the system to drive the all motors by giving the required amount of the voltage and the current. Normally the motors are not able to drive using the microcontroller input voltages. So the drivers are implemented to drive the servo motors used in the arm and the rail axis.

6.6. Encoder

The encoder provides position and usually speed feedback, which by the use of a PID controller allow more precise control of position and thus faster achievement of a stable position (for a given motor power).

6.7. Solar System

The solar panels are used in the system. These panels will get charge from the solar energy and stores it in the battery the battery was connected to the power supply, so the system can perform the operation using the solar power also.

6.8. Battery

The battery is used in the system to get charged from the solar panels and the stored power was used for performing the operation of the robotic arms. These batteries are very useful during the power shutdowns.

6.9. Power Supply

The power supply is used to supply the input power source to the system that is the robot. This power supply can gives the supply from the direct AC source and also from the battery, from the solar source also.

7. Software Description

The Robo BASIC V2.5 software is used to program the microcontroller it is used for control the servo motors.

Once the controller is powered, connect it to the host computer using the DB9 to mini jack serial cable. This cable allows the computer to issue commands and flash the MR-C3024 microcontroller's ROM with coded program. There two ways to program the robot using teach box through online and with computer off line program.

8. Conclusions

In Analyzing from the developing progress of mechanization of selective tea plucking robot all around the world, it is evident that tea plucking robot, according to working principles, could be classified into reciprocating plucking type, old mother leaf, fresh leaf active leaf type, among which reciprocating plucking robot has been widely applied for its high harvesting quality and high efficiency.

This paper, design and analysis of selective tea leaf plucking robot is very challenging, because different tea estate have been taken into consideration simultaneously and studied in varies condition, different functions of the teach box of the robot were tested successfully. Since it was designed to be user friendly, the operator can control the robot easily after short training.

Acknowledgement

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