

DESIGN AND FABRICATION OF COCONUT TREE CLIMBING ROBOT

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ABSTRACT

Agriculture, the prime sector is the backbone of India. As the coconut palm growers are struggling with the acute shortage of human coconut tree climbers to climb and harvest the coconuts, many are working towards possible alternatives to help them handle this situation. In this study paper we analyse the problems associated with the shortage of human coconut tree climbers in-depth. Along with this we discuss how robotics and automation could be a possible solution for this entire problem. In this context we discuss about the features of such robotic system and also give suggestions on various unmanned robotic models that can be designed and implemented. Coconut is inseparable part of life of people of southern India particularly in the states of Kerala and Tamilnadu. Coconut as tender coconut water, coconut gratings, coconut milk, coconut oil etc. find its way in at least one food item cooked daily the people of this southern part of India. Due to extreme shortage in people to climb the coconut trees and pluck the coconuts, the cost of coconuts is increasing steeply. One solution to this problem is to have a robotic coconut tree climber with an arm to cut the coconuts.

Keywords: Dc motor, Relay, Receiver, Drive card.

INTRODUCTION

Primary goal of the study is to design a coconut tree climbing and harvesting coconuts for farmers and residents. It is very difficult to climb on coconut tree manually due to the constant cylindrical structure and single stem. In other type of trees there are branches for holding and to support the climber. A professional climber with proper training only could able to climb a coconut tree. There are no 100% safe coconuts harvesting device currently in the market. The required movements for climbing a coconut tree which is grown vertically are flexion at interphalangeal and metatarsophalangeal joints, for flexion, abduction, extension and the lateral rotation of the hip, flexion and extension of the knees, plantar and dorsiflexion at the ankle, and inversion at the subtalar joint. The climbers following the method of gripping trees with two hands and feet and thus climbing higher by pushing up the body, results in discontinuous pressure over the forearm, skin, palms and the soles. With India getting the tag as the second largest coconut producer in the world, it produces large variety of coconut products. These include tender coconut water, copra, coconut oil, raw kernel, coconut cake etc. Coconut milk and coconut oil are used in most of the food items cooked, particularly in southern states of India that includes Kerala, Tamilnadu and Karnataka. People of south east Asia too use coconuts as important food ingredient which includes Thailand, Malaysia, Indonesia etc. Others parts of coconuts are also useful for making crafts including coconut husks and coconut shells. Until recently coconut plucking job conventionally was taken up by socially and economically backward people in these areas. Due to various government welfare programs and increase in literacy, the number of people taking up this job has dwindled a lot which is one of the main reasons resulting in increase in the price of coconuts.

PROBLEM DEFINITION

India contributes to about 23% of the world's total coconut production, and is the second largest producer of coconuts in the world. About 92% of India's total production is from south Indian states like Kerala, Tamil Nadu, Karnataka, etc. Coconut Production has a significant influence on the agrarian economy of the country. But in the recent times there is an acute shortage of coconut tree climbers, which have adversely affected the harvesting of coconuts throughout the country. This is mainly due to the risk factor involved in climbing coconut trees. There have been many accidents, some of which have even resulted in deaths; thus a dire requirement of an unmanned system for harvesting coconut trees has become relevant. One of the main parts of this unmanned system would be the arm which is used for cutting coconuts. So the focus of this research work is on constructing a human controlled robotic arm dedicated to the coconut harvesting system to be used in a coconut tree climbing robot. Usually the coconuts are spread around the top of the coconut trees in an unpredictable fashion, and its stacks are very hard; therefore heavy-duty cutting machinery is required.

Furthermore, the robotic arm must have sufficient degrees of freedom to reach the desired area of the coconut palm and should be able to cut down coconuts without affecting the stability of the coconut harvesting system. The whole system should be user-friendly and cost-effective.

RELATED WORKS

There are variety of robotic arm designs available in literature and lots of researchers have worked on it. There are many arm designs with various degrees of freedom and with various control methods including man-machine control, neural networks, co-ordinate based control, EOG/EEG based control, voice-based, switch-based etc. Also robotic arms have found various interesting applications - visually challenged, cleaning cargo containers, stroke patients, remote surgery, space applications etc. Authors in paper [1] discuss about a computer based control multifunction intelligent robotic arm which can perform fancy dancing, weight lifting, Chinese calligraphy and color classification. In another research work in paper [2], the author proposes application of embodiment theory to design and control octopus-like robotic arm. which mimics contraction, elongation, bending and grasping. Recurrent Neural Networks is used by the researchers in [3] for their design of flexible and robust robotic arm which would find applications in industry, particularly for grasping and carrying things. Similarly the papers [4] and [5] discuss about design of robotic arms with varying degrees of freedom and applications like pancake cooking etc. In all the above works we see that the application is specific but not anything related to arm to be used for coconut plucking. We have found some coconut tree climbing robots in the literature but not any specific design aspects to be considered for designing arms for such robots.

LITERATURE REVIEW

A.R.C.H (ark) robot is a coconut tree-climbing robot prototype which is controlled remotely from the ground. It's climbing and fastening mechanism is designed to climb a pole of varying diameter. This manuscript deals with the design of a manipulator, with two unique modular end effectors for the harvesting mechanism of A.R.C.H-1. The two robotic arms with three degrees of freedom are designed in such a way that it can be mounted on either side of the robot head. (Anoop Abraham *et al.*, 2014)

A coconut harvesting machine has been designed for harvesting coconut. The design is made in such a way that the machine fits in various sizes and shapes of the coconut tree. The robotic arm will cut the coconut in more precise manner than any other machine do. It is controlled by an RF remote controller. The machine can be manually controlled under any required circumstances as per the necessity. (A.P.Mohanraj *et al.*, 2014)

An automated tree climbing robot has been developed which does not require human labor to accompany the device but only to control it from the ground using a remote control. Safety of the worker and the increased labor charges are the primary concerns of the coconut farm owners now. The device is a triangle with a movable third side and consists of three wheels, one attached to each side of the triangle. Two springs, each attached to the other two sides of the triangle help in adjusting to the varying diameter of the tree. Each wheel is driven by a high torque geared DC motor. Two L293D drivers are used to drive the three motors in a bidirectional way. These drivers are fixed on the frame of the device. A RF transmitter/receiver unit is used to provide control signals to the driver. A 12 V3000 mah rechargeable battery pack is used to provide on-board power supply for the receiver, two drivers and the three motors. An arm with a rotary blade at its end is fixed to one side of the Treebot to harvest the coconuts. drivers are fixed on the frame of the device. A RF transmitter/receiver unit is used to provide control signals to the driver. A 12 V3000 mah rechargeable battery pack is used to provide on-board power supply for the receiver, two drivers and the three motors. An arm with a rotary blade at its end is fixed to one side of the Treebot to harvest the coconuts. Mani A *et al.* (2014) has been developed and fabricated a semi-autonomous tree climber and harvester (COCOBOT). Cocobot comprises of two mechanisms namely a climbing mechanism and a harvesting mechanism. The climbing mechanism consists of an octagon shaped chassis. Four active wheels are set at specific intervals around the tree of which one pair is for the upper side and the other for the lower side of the chassis. The main features of the climbing mechanism include the location of centre of mass of the cocobot outside the tree and the innovative climbing strategy fusing the straight and spiral climbs. The harvesting mechanism consists of an arm with three degree of freedom with a circular saw as an end effector. The bunch of nuts is located by a vision sensor (camera) which is placed at the wrist of the arm. The nuts are harvested using the saw based on the output received from the camera. The entire movement of the cocobot and the harvesting mechanism is controlled using remote controller.

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COMPONENTS

1. Hand operated remote control.
2. Motor.
3. 3.5 V DC to 12 V DC Drive card.
4. Forward relay.
5. Reverse relay.
6. Battery.
7. Driving wheels
8. Raw material.

HAND OPERATED REMOTE CONTROL :

Remote control is a component of an electronic device used to operate the device from a distance usually wirelessly.



Fig 6.1

Specifications

- Noise floor/Minimum discernable signal
- Blocking dynamic range
- 3 rd Order dynamic range
- 3 rd Order intercept

MOTOR:

It is a rotating device. To create a torque in a rotating motion.



Specifications

- RPM
- No-load Speed
- Stall Torque

- Maximum Current

5 V DC TO 12 V DC DRIVE CARD

It is a converting device. To converting a 5 V DC to 12 V DC from the help of drive card.



Fig 6.3

FORWARD RELAY:It is the device of go to forward motion in work order.

In mechatronics system to give a power.



Fig 6.4

REVERSE RELAY:

It is also a moving relay for reverse direction. Mechatronics programs are done this operation.



Fig 6.5

Specifications

- Trigger Voltage (Voltage across coil) : 5V DC
- Trigger Current (Nominal current) : 70mA
- Maximum AC load current: 10A @ 250/125V AC
- Maximum DC load current: 10A @ 30/28V DC
- Compact 5-pin configuration with plastic moulding
- Operating time: 10msec Release time: 5msec
- Maximum switching: 300 operating/minute (mechanically)

BATTERY:

This is the power of total main processor. In 12 V battery is enough to operate this system.



Fig 6.6

DRIVING WHEEL:

To drive the wheel, total system move the up & down. And also right & left side.



RAW MATERIAL:

To construct a frame for design and connectivity to one point to another point.



Project model

WORKING

The wood cutting tool is directly connected to the shaft of the DC motor and hence runs at the same speed as that of the motor. The setup is built over a frame equipped with wheels which makes the machine portable over short distances. The machine is operated using switches, one for each DC motor. The switch used for controlling the extension mechanism is a reversing circuit switch which changes the direction of current flow to the DC motor thus causing the motor to rotate in the opposite direction when the current flow is switched. This switch has ON-OFF-REV positions. Therefore the extension and retraction is performed using the same switch. The wood cutting tool run by a DC motor is operated using another switch. This switch has only ON-OFF positions. During operation, the cutting machine is moved to the tree which has to be cut by manually moving the setup like a trolley towards the required location under the tree. Once positioned properly, the cutting tool is extended to the desired height by extending the cylinders using the extension/retraction switch. The wood cutting tool run by a DC motor is operated using another switch. This switch has only ON-OFF positions. During operation, the cutting machine is moved to the tree which has to be cut by manually moving the setup like a trolley towards the required location under the tree. Once positioned properly, the cutting tool is extended to the desired height by extending the cylinders using the extension/retraction switch. Later the cutting machine is turned on and the cutting operation is started. The machine is provided with a T-bar extension near the lower end which is used during cutting operation to manually provide force to the cutting tool. The extension is held by hand and pushed to provide the necessary force required for cutting. Once the cutting operation is complete the wood cutting tool is stopped and the retracted using the retraction switch.

ADVANTAGES

- Low cost coconut harvesting/branch cutting machine.
- Reduction in human effort towards harvesting.
- This machine reduces dependence on labour.
- This machine can be easily operated by farmer.
- It does not require any extra skill to operate .

CONCLUSION

Coconut plucking is very laborious and difficult job. The automatic climbing is much easily controlled and operated, which has to be wireless even up to the ground station as compare to other methods. This method which is proposed is comparatively faster, as it is manually controlled and will be adjusted to be apt for the structure of each tree. Future work for this project includes altering a plucking unit and climbing unit for improving climbing and plucking. Also design compact multi-axis robotic arm/rotary blade for plucking the coconuts.

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