

Development of Automated Coconut Harvester Prototype

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ABSTRACT: This paper focuses on designing an automated a tree climbing robot, Treebot which does not require human labor to accompany the device but only to control it from the ground using a remote control. Conventionally, harvesting of coconuts has always been done manually and any device developed also requires a human labor to accompany it. 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 V 3000 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.

KEYWORDS: Coconut Harvester, Stability analysis, L293 Driver, Low cost modelling

I. INTRODUCTION

Last few decades has witnessed a rapid development in robotic technology. Different types of intelligent machines which facilitate various tasks in industry environment are becoming popular. Conventionally, harvesting of coconuts has always been done manually and any device developed also requires a human labor to accompany it. Safety of the worker and the increased labor charges are the primary concerns of the coconut farm owners now. Due to the height and lack of branches, it is very difficult to climb on coconut trees. A professional climber with proper training could only be able to climb coconut tree. Due to the risk involved nowadays very less people are coming forward to climb on coconut trees, and due to the lack of professional climbers, the existing professionals may charge more from the owners, moreover as the educational background of Indian youth is increasing most of the people may hesitate to come into this type of profession. Considering this scenario, a device which will help the user to climb a coconut tree easily will be useful for the people who are having coconut farms or even residents. These kind of devices will encourage more people to come forward into the agricultural sector. etc.

Paper is organized as follows. Section II describes automatic text detection using morphological operations, connected component analysis and set of selection or rejection criteria. The flow diagram represents the step of the algorithm. After detection of text, how text region is filled using an In painting technique that is given in Section III. Section IV presents experimental results showing results of images tested. Finally, Section V presents conclusion.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

II. LITERATURE SURVEY

Coconuts are exported in large amounts around the world, bringing in revenue to various tropical countries. However, they also have other important uses. Appropriately referred as “The Tree of Life” by villagers, every part of the coconut is utilized in some way. The outside husk is used to make strong ropes, while the leaves of the tree are used as roofing material in villages. Inside, tender coconut water is a delicious and healthy drink. More importantly, tender coconuts are used as a medicine for diseases such as thyroid. Therefore, it is not an exaggeration to claim coconuts support many aspects of village life.

The tree climbing device for climbing up trees and for maintenance of trees having trunks which do not branch out but rather have a single stem, such as palm or coconut trees.[1]. Safety tree climbing device for climbers used to climb trees which have a single stem such as palm or coconut trees. The wheel drum of the device is designed to move along the trunk of the tree without any damage to the trunk. This can also take a human up and down the tree safely. It uses a power engine that is easy to operate and ensures safety [2]. Tree climber uses a steel wire belt to climb coconut or palm trees safely. This can also be used to pluck fruits and to apply pesticides. Here the device has to be operated by standing and there is no support for the body while climbing. [3]. The automatic coconut climber can oil the coconut tree or any other pole to any height as wished by the operator on ground and carry any type of tools to carry operations such as cutting any bunch of coconut, or leaves tea, spray pesticides. A harvester apparatus equipped in a work vehicle and capable of at least cutting down, pruning, and cross-cutting wood, the harvester apparatus being configured to include a gripping claw that can hold the wood by opening and closing in the thickness direction of the wood, a chain saw capable of cutting the wood held with the gripping claw, a pruner for pruning the wood arranged at a different position in the lengthwise direction of the gripped wood relative to the gripping claw, a slide frame that can change the lengthwise distance between the pruner and the gripping claw, and a sensor for detecting the slide amount of the slide frame.[4]. A self-propelled palm tree trimming and trunk skinning apparatus is disclosed which includes first and second curved arms pivotally affixed, at their respective first ends, to a coupling member. At the opposite ends of the curved arms, a tension spring is provided to pull the two arms toward one another. A cutting blade is carried by one of the curved arms, and the blade edge is oriented at an angle from the horizontal when the apparatus is operatively engaged with a palm tree trunk. A d-c motor/speed reduction unit/cog wheel system is provided for circumferentially driving the apparatus such that the cutting blade, as a result of its skewed orientation, causes the apparatus to follow a spiral path upwardly, the cutting edge of the blade skinning and trimming the trunk of the tree as it ascends. Upon completion of the operation, the direction of the motor is reversed permitting the apparatus to spiral downwardly. The reversible motor is preferably energized from an integral rechargeable power pack and is manipulated from a control box connected by a cable to the apparatus and suspended for access by an operator standing at ground level.[5]

The rock climber stuff their hands inside cracks, pull on them and push on the legs in opposition and walk up the rock. This front foot technique to climb coconut tree is very similar. The climbing person has to put his hands close to each other on the back of the trunk, and pull one foot in front of the other one in front of the climbing person on the tree. By keeping pressure on the trunk with the balls of the climbing person's feet and toes, walk up alternating moving feet and hands. Technically it seems to be the easiest to learn but requires good balance and arm strength[6]. Every coconut in a bunch are at the same stage of growth. The lowest bunches are the ripest and the upper bunches are tender. Every coconut tree in the farm is different in height and diameter; this makes the use of an efficient flexible component important [7]. Moreover there is a visible variation of diameter along the height of every tree. The coconuts are harvested on a regular interval of 40 days, wherein the lower most bunches in the tree is harvested[8]. A tree has one or more bunches around the head that are to be harvested at the same time, hence the device should have this capability. Also, it is not possible for the device to reach up to the head of the tree from where the bunch grows.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 4, Issue 8, August 2015

III. METHODOLOGY

The device consists of three main motors that are used to drive the body and another three motors used to drive the arm. The driver used to drive the motor is L298D which is in turn controlled by a RF transmitter/receiver. Fig.1 shows the block diagram of the proposed model.

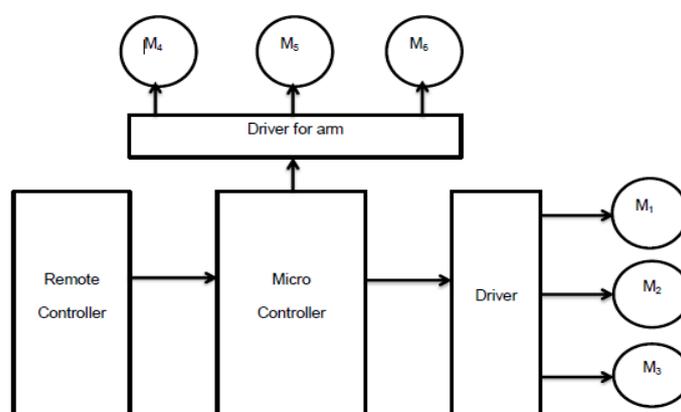


Fig.1 Block Diagram

. The various steps involved in the project are as follows:

- i. To study the shape and size of the tree to design a suitable device.
- ii. To develop a suitable mechanical model to surround the tree and climb smoothly.
- iii. To select the desired material which suits needs like less weight and less cost.
- iv. Selecting the desired components such as wheels and motors
- v. To study the strength and stability of the design using ANSYS software.
- vi. To attach an arm with minimum degree of freedom and to attach a rotary blade for an end effector.

IV. PROTOTYPE

Designing of the prototype needs the right selection of motors and wheels. There are different types of motors to choose from so a comparison study is needed to choose the one that is appropriate for this project. Apart from the motors, the selected wheel also had to be tested several times before deciding. Stepper motors and Servomotors are used in highly precise and accurate applications. Even though servomotors have very high holding torque, the high weight of the motor is a huge disadvantage. Keeping the light weight, cost and torque in mind, DC Geared motors are chosen for this application. Side shaft DC Geared Motor, as shown in Fig.2 is suited for Robotics and Control Automation based applications. It is rated to operate at 12 V but it can operate at a wide range of voltage of 4 V to 24 V. These motors are available for different speeds and varying torque.

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Fig.2 DC Geared motor

FORCE AND TORQUE CALCULATION

Torque (T) = Maximum Force (F) x Radius of the wheel

Maximum Force (F) = $m \cdot g \cdot \sin\theta + FF$

Where,

m – Weight of the body in kg (approximately 5)

g - Acceleration due to gravity (9.8 m/s²)

θ - angle between the ground and the tree

Here $\theta = 90^\circ$

FF - Other forces including frictional force (here we are considering it as 3 N)

There are several advantages to a wheeled design. Eliminating the use of legs for climbing makes the design much simpler. With a legged robot, comes the problem of how to build the legs which need many degrees of freedom to allow for proper maneuverability on varying tree diameters. Also, every joint needs to be actuated and a proper gait must also be devised, thereby complicating the programming. With a wheeled design, there is no gait. Instead, the driving motors directly rotate the wheels. The wheel to be selected for the device must be of low weight and have a larger diameter for better contact with the tree. Due to the uneven surface of a coconut tree, the wheel must have tracks for better traction. Fig.3 shows the prototype of the robot.



FIG.3 PROTOTYPE OF COCONUT HARVESTER

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V. FLOWCHART

The working principle of the device includes:

- i. Connect the motors to the battery and start the motors.
- ii. Feed in the required commands and check the working.

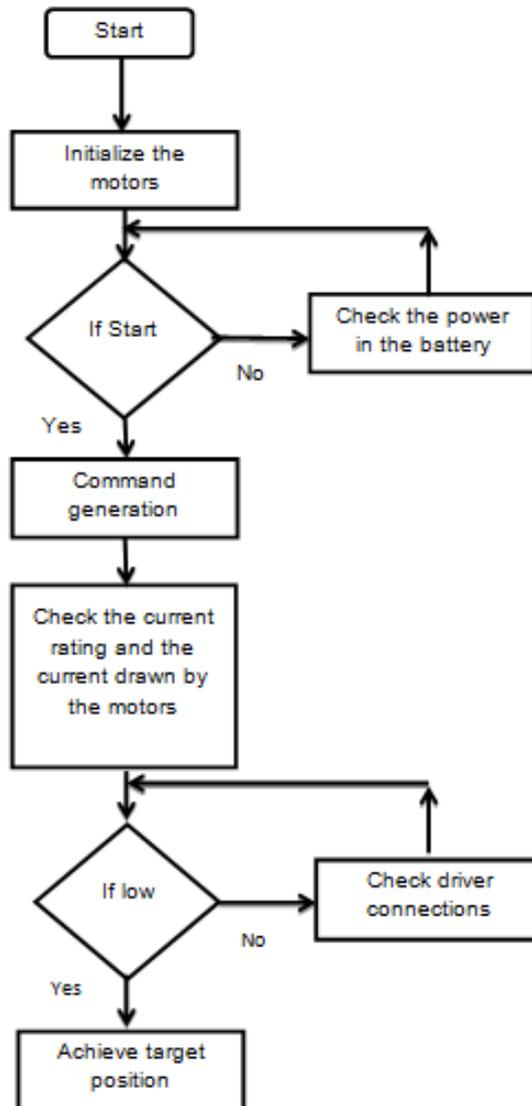


FIG.4 WORKING PRINCIPLE OF COCONUT HARVESTER

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VI. EXPERIMENTAL RESULTS

ANSYS is a general-purpose finite-element modeling package for numerically solving a wide variety of mechanical problems. These problems include static/ dynamic, structural analysis (both linear and nonlinear), heat transfer, and fluid problems, as well as acoustic and electromagnetic problems. In general, a finite-element solution may be broken into the following three stages.

(1) Preprocessing: Defining the problem

The major steps in preprocessing are

- (i) Define keypoints/lines/areas/volumes,
- (ii) Define element type and material/geometric properties, and
- (iii) Mesh lines/areas/ volumes as required. The amount of detail required will depend on the dimensionality of the analysis, i.e., 1D, 2D, axisymmetric, and 3D.

(2) Solution: Assigning loads, Constraints, and Solving

Here, it is necessary to specify the loads (point or pressure), constraints (translational and rotational), and finally solve the resulting set of equations.

(3) Postprocessing: Further processing and viewing of the results.

In this stage one may wish to see

- (i) Lists of nodal displacements
- (ii) Element forces and moments
- (iii) Deflection plots
- (iv) Stress contour diagrams or temperature maps.

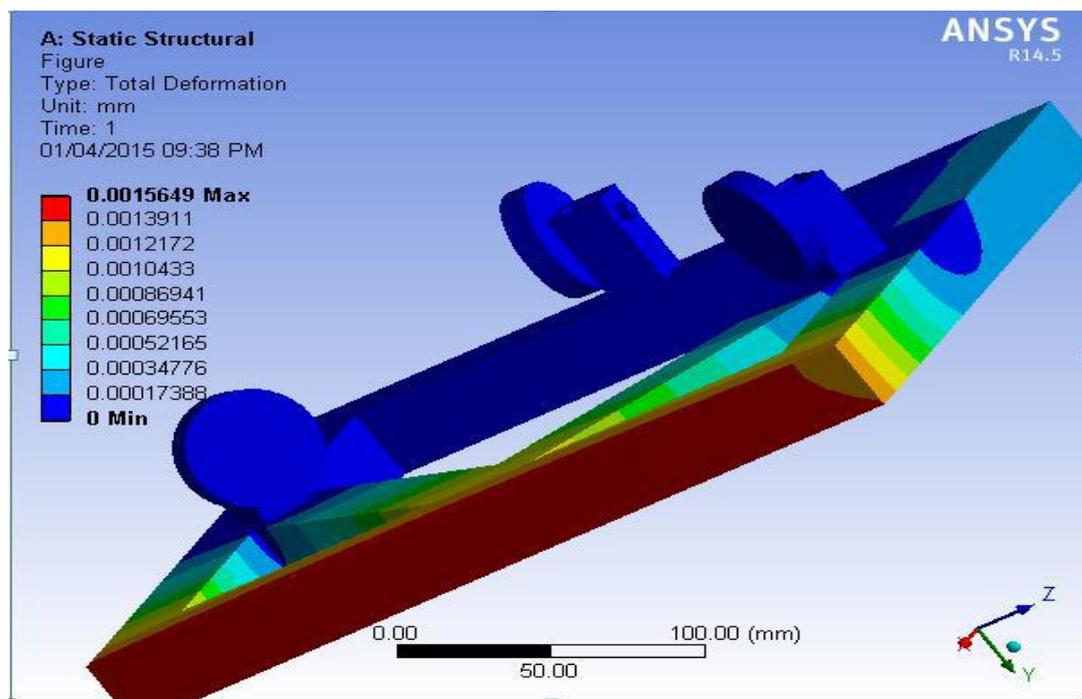


FIG.4. MODEL (A4) > STATIC STRUCTURAL (A5) > SOLUTION (A6) > EQUIVALENT STRESS > FIGURE

International Journal of Innovative Research in Science, Engineering and Technology

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VII. CONCLUSION

A novel method for coconut tree climbing and harvesting is proposed. The design of the hardware setup is discussed and the controlling units are designed. The shape and the material selected are appropriate for the device to function. Stability of the device is achieved through the three wheels on either side which tightly grip the entire circumference of the tree. All the aspects of this project like design, development and verification were done in detail using various software.

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