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AUTONOMOUS TREE CLIMBER: ROBOT FOR ARECA NUT PLUCKING

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ABSTRACT**:** This paper describes the sourcing skilled labor for agriculture sector has become a tedious job in today's time. There is a need for mechanization in the farming process in order to cope with lack of manpower. Kerala, despite being the second largest producer of areca nut in India, depend on conventional climbing techniques which involve high risk for harvesting areca nut. This paper is an intuitive mechanized robot, which would eliminate the need of manual climbing for harvesting areca nut. The main goal of the system is the use of economical technology which is safe and can be easily implemented. The robot consists of two mechanisms, climbing mechanism and plucking mechanism. The robot is so simple that it can be controlled by anyone.

Introduction

People in rural areas of south India like Karnataka and Kerala mainly depend on agriculture for their livelihood. The main crops grown are Areca nut and coconut. For harvesting purpose, skilled labourers have to climb manually up the tree. Such a process looks easy, but in reality, it is a laborious and dangerous task. Arecanut trees attain a height of about 60-70 feet. It is mandatory to climb the trees thrice to harvest the arecanut. Only skilled labourers can carry out these farming operations.
They have to climb the trees using muscle power. In an acre that has 550 trees, a labourer has to climb a minimum of 100 to 150 trees. As this involves real hard, physical exertion, younger generations of labourers are losing interest, with potentially harsh implications for arecanut cultivation. The harvest time is typically in summer. It requires skill to climb a areca nut tree. Skilled areca nut tree climbers have become scarce and farmers are finding it difficult. There is a need to invent a device to address efficiency safety and cost effective. The design of the device has to be simple enough for villagers to operate, yet workefficiently to appeal to the majority. In present days the climbing methods that are beenused by the farmer are Rope climbing method and Rectangle wooden seat climbing method.
Tree climber is economical and simple in design which consists of rope oflength one meter twisted to the shape of the sandal, the user wears this sandal and climbthe tree manually. In rectangle wooden seat climber the user hangs the wooden seat on hisback and climbs the tree manually, once he reaches the tree top he ties the wooden seat tothe tree and rest on the seat to harvest the areca nut. Although this two methods are simple and economical. It is not safe and cause physical strain to the user. In summary although many device were invented to climb the areca tree it was noteconomical and user riendly. In this project aimed to overcome these deficiencies bydeveloping a smart multitalented robot for arecanut farming.

I. RELATED WORK

EliahuEliachar et. al.,(1994) have invented a tree climbing device, toclimb up trees.The climbing unit connected to power source and to a PLC(programmable logic controller) and the climbing unit comprised of two pairs of arms and means for opening and closing arms around the trunks and means for varying the difference between the pair of arms. The operator had to choose the designed destination up or down on the control box. In 2007, a climbing aid was invented by Neralicet al., for assisting a user to scale a structure, the climbing aid including at least one apparatus having a limb engagement portion associated with a lower forwardly facing engagement portion and an upper rearward facing engagement portion, the user weight on the limb engagement portion creating rotational force on the lower and upper engagement portion to engage the structure being scaled. Although these two device were successful in climbing the tree, they were costly and not affordable by farmers. Subhas Mukhopadhyay(2010) have explained comparison was made on an original tree climbing robotic system published in reference. This optimized robotic system only relies on one stepper to achieve the anti-falling and anti-jamming functionality under either static or dynamic situations. This improved design feature reduces the total robot weight and enhances the control system

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robustness. Moreover, to achieve the robot spiral climbing morphology and decrease the servomotor rotational frictional forces, a special servomotor module and a bearing supporting mechanism are designed and implemented. The optimized mechanism design of the climbing robot is modeled in Solid Works and the climbing process is simulated using Sim Mechanics. The simulation outcome of the initial and improved design shows that the new design has higher climbing speed and lighter weight. Physical prototype experiment matches with the simulation outcome and verifies the feasibility and effectiveness of this redesigned tree climbing mechanism.

This redesigned tree climbing system uses only one stepper which can adjust the robot holding force to fulfill the anti-falling feature, anti-jamming feature and suit different trunk size. It utilizes the servomotor module to overcome the high normal force on the servomotor shaft during spiral climbing and bearing support mechanism to acquire accurate control of step motor. The robot climbing process is simulated in Sim Mechanics. Both the simulation outcome and the test made on the physical system verified the feasibility of this improved robot design. However, it still remains work for further research. For example, during the passive anti-falling test, when the climbing robot keeps still on the testing rod, sometimes the robot wheel will roll back if the servomotor turns the wheel not at a proper angle. In the dynamic test, when the robot climbs up, the robot platform can be tilted and turned around the rod, which means only relying on PID control algorithm applied on the three DC motors to climb up the trunk is not enough. Thus, an IMU module integrated with intelligent control algorithm is needed to solve this issue[1]. DaqianRen and Shixi Yang have explained the main parts of the robot are 2 vehicles, which are attached on the trunk of a tree and were stick tightly on the tree because of a holding device. A kind of spine array is distributed on the wheels, and the friction is enhanced. Static stress analysis shows that the robot can overcome gravity and can be attached reliably to the tree trunk. Experiments show that the new type vehicle tree-climbing robot can climb trees in a steady speed , and can be adapted the different diameter of the tree trunk.The first problem of tree climbing robot research is how to overcome the gravity, so that the robot can be attached to the trees surface. Then some power should be provided, and the robot can move up on the surface of trees. The wheeled robot of this study has a unique mechanism to overcome the gravity. The main components are two vehicles attached to the truck of a tree. A hold device is connected between the vehicles. The rubber wheels of the vehicles are equipped with an array of spines, which will provide sufficient adhesion to ensure that the vehicles don't drop due to gravity. The array of spines can also provide the friction properties of the wheel. When the robot climbs up, the friction is also the pulling force. The holding device provide a force towards the surface of the tree for the vehicle, and the vehicle will not flip out and fall. This study focuses on a new type of wheeled robots, which can climb trees. The main structure of the robot is two vehicles arranged on the trunk of tree. A holdingdevice connects the 2 vehicles. Static analysis and experiments show that the robot can be attached to the tree surface stably, climbing on the tree surface in a pretty high speed[2]. P.SuryaTeja, K.Sai Kumar(2015) have explained the embedded system based wireless pole climbing robot for multipurpose applications. This can be a great boon for electrical technicians who has to climb the pole in order to carry our repair works related to power transmission lines, for climbing trees etc., in countries developing nations like India, Bangladesh, Srilanka etc. Initially we pair smart phone with Bluetooth module connected to embedded system which is part of the robot. Then using the graphical interface in android app we can give instructions to move up or down or to stop moving. These commands are received by Bluetooth module and give corresponding instructions to Arduino of the embedded system board, which, depending on the code in it drives the motor driver accordingly. In this work we explain in detail about the working of wireless control of motors, how the app developed using MIT appinventor, model of the pole climbing robot.Finally we made the pole climbing robot work with ourcircuit which is controlled by android application which usesBluetooth technology. We are able to use only one motordriver which helps in reducing the circuit size and cost. This works well for normal pole heights[3]. M.I. Nor Faizal, W.A.F.W. Othman, S.S.N.A. Syed Hassan have explained climbing robot is designed to climb a tree with diameter of 10 cm. The robot utilizes modular mechanism aslocomotion of the robot that consists of 6 steps which enable theclimbing module to carry its weight by using two servo motors. The robot utilizes encompassing grip in gripping module which wrapped the tree to increase the surface area of frictional force.In the initial condition, the climbing module extends and bothupper and lower gripper in grip. The climbing motion starts when the lower gripper releases, the climbing module contract upward and the lower gripper return to grip again. Then, theupper gripper releases, the climbing module extends

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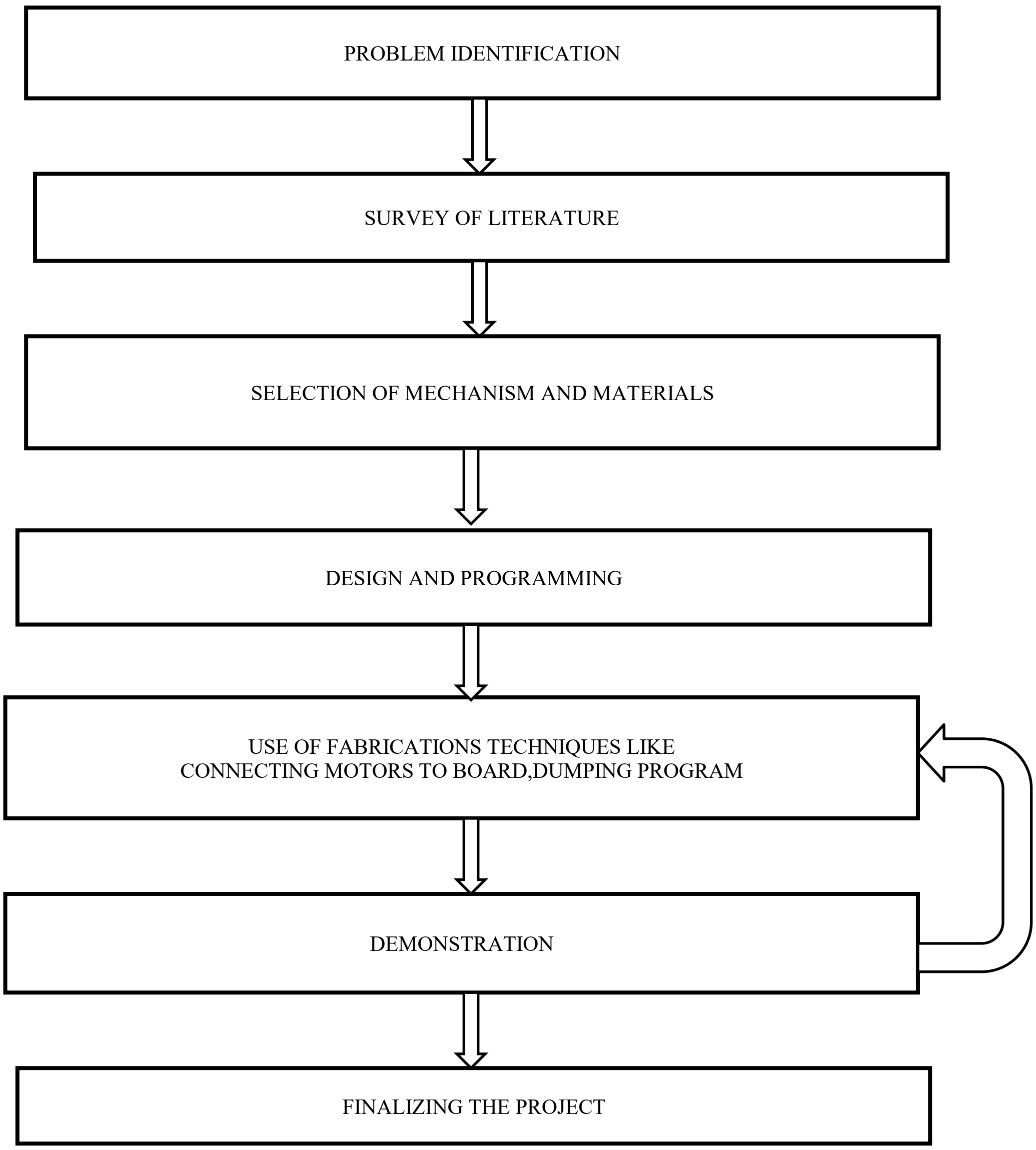
again and the upper gripper returns to grip. This sequence will continue until the robot reaches the desired location. The Arduino Uno microcontroller is used to send the PWM signal to the servomotors to control the robot movement. To ensure the efficiency and performance of the robot, various simulations and test have been done. The weight in simulation data is 0.9 kg whereas the actual weight is 0.88 kg. After the tests have been done, the simulation average climbing speed is 0.1568 m/s while the actual average climbing speed is 0.00183 m/s[4]. In Section I of the paper brief Introduction is discussed, In Section II related work is discussed ,In Section III Methodology and block diagram of the proposed work are described. In Section IV results are discussed, hardware and software used to implement the work are described. In the fourth chapter, results are discussed. In the fifth chapter conclusions of the proposed work are explained. At the last Bibliography is given for the reader's reference.

II. METHODOLOGY

In this chapter, the methodology used, block diagram for the implementation are explained. The detailed explanation about the design specification, designe of the project, and the steps taken to overcome the problems faced during the preparation of the project are explained.



Brief description of methodology is given below-

- The people in rural areas of south India like Karnataka and Kerala mainly depend on agriculture for their livelihood. The main crops grown are Areca nut and coconut. Arecanut trees attain a height of about 60-70 feet. It is mandatory to climb the trees a minimum of five times a year for a successful harvest - twice for the preventive spray against fungal disease, and thrice to harvest the arecanut.
- Only skilled laborers can carry out these farming operations. They have to climb the trees using muscle power. In an acre that has 550 trees, a labourer has to climb a minimum of 100 to 150 trees. As this involves real hard, physical exertion, younger generations of laborers are losing interest.
- Because of this it is found that there is wastage of arecanut, man-power and money. To overcome these, there is need to design a “multitalented robot machine for farming”.
- This robot should work by using power source as external dc source or by using solar panel dc current. This current is supplied in remote control, which controls the motion of motors.
- To designthe robot specification of arecanut plant are taken into consideration and also the effect of monsoon and summer on arecanut plant. Design robot body, climbing mechanism, cutting mechanism and programs related to motion are to be done.
- Final design of robot machine to be analysedwith the help of software for load, power, material and its working to check the required results.
- Then the cutting mechanism is to be made by using DC motor. As a finel step, fabricationof robot arm and assembling the integrated unit.

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Operation of the device

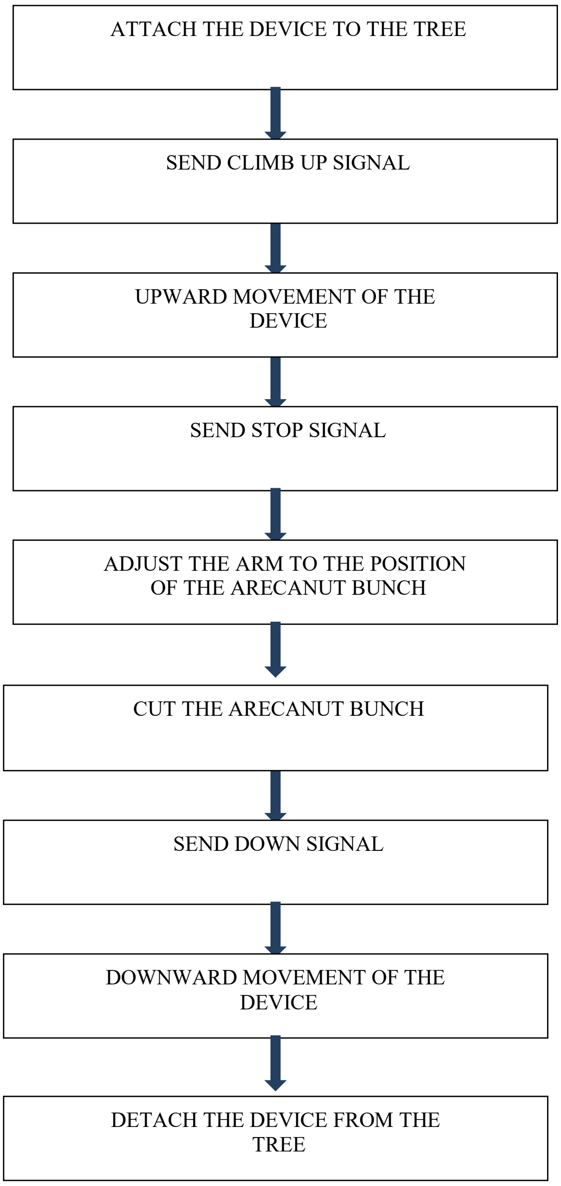

Fig 2 Operation flow of device

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III. RESULTS AND DISCUSSION

In this section , different attempts were made to successfully demonstrate the robot climbing. These experiments are explained in the sections.

Results for Model 1

Fig.3 shows the first model which we designed for the project. An aluminium plate was used and 2 tires consisting of 10rpm dc motor to design the model.The model was made in such a way that it will climb in the inclined way in such a way that as more weight is put, the grip of the bot to hold the tree would increase. But while testing the robot, it failed and it started to fall down after climbing few meters. Therefore, the model was requiring modification to model 2.

Fig.3 Model 1 of tree climbing robot

Results of Model 2

Fig 4 shows the second model which was designed for the project as the first model was a failure.The model is made up of 4 tires which are made as one by combing using a grip holder and each tire is connected to 10rpm dc motor as shown in Fig. 5.2. The model was designed in such a way that by using clamps it will hold the grip and climb the tree.But unfortunately this model was failure while testing. The tires didnot hold the grip at all and the bot failed to climb even a meter.Sothis model was requiring modification to model 3.

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Fig 4 Model 2 of tree climbing robot

Results of Model 3

After failure of both the Model 1 and Model 2, a new Model 3 was designed.

Fig.5 Testing weather the model will hold grip to climb

This model is in hexagonal shape of diameter 15cm. There are totally 4 tires of 7cm diameter placed at the corners in such a way that they hold grip and apply force at the centre. 10 RPM,7Kg/cm torqueplaced at the corners in such a way that they hold grip and apply force at the centre. Each tires is attached to 10rpm DC Gear Motor which helps to move the tiers up and down .These motors are

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connected to 6V-5Ah rechargeable battery which will give the power supply to the motor. As shown in figure the model is attached to the and is given 12v power supply. The model successfully climbed up the pipe with out falling at the rate of 1m/min and then it was made to stop at a point to check weather model will hold grip or not. Then the model was made to come down safely at the rate of 5m/min

Result: The test conducted was successful.

IV CONCLUSIONS

The design is efficient in climbing the tree very smoothly without damaging the tree. Human will not climb the tree so safety is increased.The design is simple and appealing to the majority. An unskilled labour can operate the machine safely and efficiently.By installing properly designed cutting device many number of trees can be harvested in a single climb thus increasing the efficiency.So, we conclude that the multitalented robot machine is a safe, reliable, efficient and automatic tree climber which reduces the problems in climbing the arecanut tree and also it solve all arecanut harvesting problem and it avoids the arecanut wastes to a good extent.

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