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Autonomous control and implementation of coconut tree climbing and harvesting robot

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Abstract

Last few decades have witnessed a rapid development in robotic technology. Different types of intelligent machines which facilitate various tasks in industry environment are becoming popular. This paper focuses on designing a low cost coconut tree climbing and harvesting robot. The kinematics and the motion of the robot are designed by referring to the motion of coconut harvester. The robot consists of two segments joined by a pair of threaded rods coupled to motors. The mechanical frame is designed in draft sight software and is implemented using aluminum segments and threaded rods. It has two arms driven by motors for holding. Locomotion of the robot is achieved using six motors out of which four motors are used in two hands and other two are used for upward and downward motion. The other part is a robotic arm for cutting down the coconuts. The robotic arm is attached on top of the climbing part. The operation of the cutting arm is done manually from the ground using a remote. The robot is automated using Arduino-Uno, motor H-bridge drivers, current and level sensors and other supporting circuits. The forward and the reverse motion of the motors are controlled by the Arduino through driver modules. Robot has automatic and manual functions fully controlled by the end-user. This paper has taken into account of the safety, reliability and the ease of use. A locomotion algorithm is developed to provide the robot with an autonomous capability for climbing. The prototype of the robot is implemented and tested successfully.

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1. Introduction

Coconut and Coconut products have been in use for decades and have become an essential part of day to day life all around the globe. But the percentage of population taking up coconut plucking as their means of living is steadily decreasing. Moreover coconut tree climbing involves a lot of risk. Autonomous coconut tree climbing robot is a solution for this. The applications and capabilities of the climbing robots differ according to their mechanical structure and design. Climbing robots should be able to deal with trees having difference surfaces and cross sections. Robot is capable of climbing trees and by modifying the robot the applications can be extended to cutting down coconuts, cleaning the tree tops and spraying pesticides according to the end effecter attached, which serves multi purposes. A locomotion algorithm was developed to provide the robot with an autonomous capability for climbing.

The aim of the project is to design a coconut tree climbing robot which can be replaced with the men climbing coconut trees. The robot should be able to control from the ground. The operation should be simple so that even an illiterate person can operate the robot with a little training. It should be safe to handle and at the same time, it should be eco-friendly and should not damage the tree it is climbing. And most importantly it should be simple and cost effective so that the normal people can afford it.

2. Mechanical Design and Implementation

The overall performance of the robot clearly depends on the mechanical design of the robot. The coconut tree climbing robot should be able to climb through the irregular surface of the coconut tree. After analyzing the various possibilities and interviewing various farmers, various methodologies were planned and analyzed and finally combined the advantages of all to build the final model. The front view and the top view of the final model are shown in fig. 1(a) and (b) respectively.

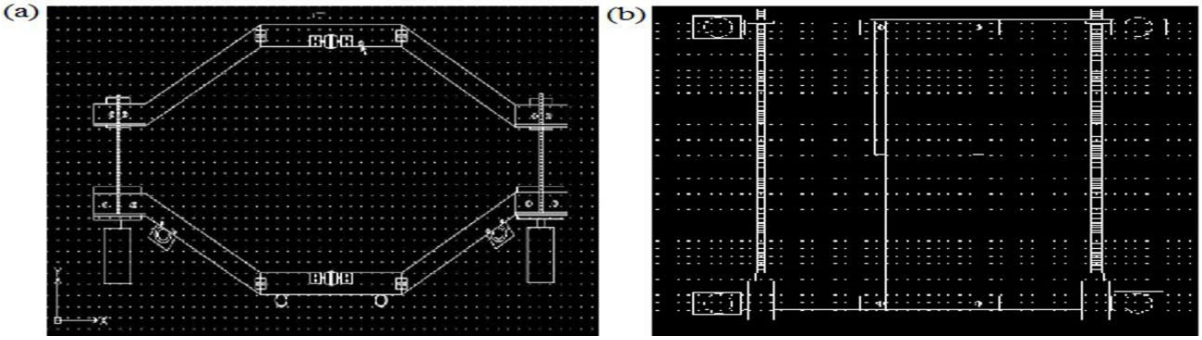

Fig. 1. (a) Top view; (b) Figure 2: Front view

Figure 1 shows the top view of the robot. The structure clearly shows the holding mechanism of the robot. A pair of such structures is provided at the top and the bottom of the robot. Figure 2 shows the front view of the robot. The two holding mechanisms in the top and the bottom are connected throw a pair of pistons and threaded rod-nut arrangement. This mechanism provides the required linear motion for the robot to climb. The whole mechanical body of the robot is made of aluminum L sections to reduce the weight.

The holding mechanism mainly consists of two structures connected through two threaded rods attached to the motors as shown in figure 1(a) [1]. The motors with the threaded rods are attached at one of the structures and the other structure consists of a nut which is properly aligned so that when the motor rotates, the threaded rod and the nut provide the to and fro motion. The structure to which motor is attached is fixed to the body and the other one is moving. As motor rotates, the moving part moves to and fro to hold and release. Due to the irregular surface of the coconut tree, small tires are provided for the smooth motion over the bark during climbing.

The vertical motion is also provided by the threaded rod and nut arrangement. [2]To provide the required