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Coconut 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 mechanical frame is designed in fusion 360 software and is implemented using aluminum segments and threaded rods. It has two grippers driven by motors for holding. Locomotion of the robot is achieved using eight motors out of which four motors are used in two hands and two are used for upward and downward motion, and the other two are used to locomote the robotic arm. 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.*

Keywords: Coconut

I. INTRODUCTION

1.1 Overview

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.

1.1 Objectives

- The main objective of this project is to help farmers in the coconut industry.
- This project lets farmers to harvest coconut easily without any effort.
- With this coconut harvester we can eliminate the risk of getting hurt by falling down from the trees.
- This project helps us save the expense for the coconut harvesting.
- Be accessible to people with financial constraints and less technical knowledge.

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II. LITERATURE REVIEW

Design and Analysis of a Novel Tree Climbing Robot Mechanism (Aug 2020) By Ru-Gui Wang, Hai-Bo Huang, Yi Li, Ji-Wei Yuan

- In this paper, a novel tree climbing robot mechanism was designed, based on the tree climbing movement and posture of the primates.
- According to the screw theory, the DOF of the leg of the tree climbing robot is calculated.
- The forward and inverse kinematics equations of the tree climbing robot were established and solved.

A flexible tree climbing robot: Treebot - Design and implementation (May 2011) By Tin Lun Lam and Yangsheng Xu

- This paper proposed a novel tree climbing robot "Treebot" that has high maneuverability on an irregular tree environment and surpasses the state-of-the-art tree climbing robots
- Treebot's body is a novel continuum maneuver structure that has high degrees of freedom and superior extension ability.

Semi - Automatic Areca Nut Tree Climbing and Harvesting Robot By Eldhose Paul, Lovin Varghese, Ajo Issac John, George Jolly, Akash Paul Savio

- This project 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 cutting mechanism.

A Survey on Robotic Coconut Tree Climbers – Existing Methods and Techniques By Rajesh Kannan Megalingam, Sakthiprasad K M, Sreekanth M M, Gedela Vamsy Vivek

- In this study paper they analyse the problems associated with the shortage of human coconut tree climbers in – depth
- Features of such robotic systems and various unmanned robotic models are discussed

Design and Fabrication of Arecanut Tree Climbing and Spraying Machine By M. Tony, C. Johny, S. Sayooj, K. Yathish, J. P. Vas

- The design and fabrication of arecanut tree climbing and spraying machine is presented in this paper.
- The device consists of a triangular base frame which supports all the components to be built upon.
- It is fitted with three DC motors - nylon tyres with rubber grippers at 120 degrees each other for ease of the operations.

Shady3D: A Robot that Climbs 3D Trusses (Apr 2007) By Yeoreum Yoon, D. Rus

- This paper describes a truss climbing robot we designed and prototyped.
- The robot has a minimalist design with three motive degrees of freedom that enable movement along three-dimensional truss structures.
- This robot can form a six-degree-of-freedom structure by connecting to another identical module using a passive bar as a medium.

Dante II: Technical Description, Results, and Lessons Learned (July 1999) By John E.Bares, David S. Wettergreen

- Dante II is a unique robot that provides important insight into high-mobility robotic locomotion and remote robotic exploration.

Wallbot: An Agile Small-Scale Wall-Climbing Robot Utilizing Dry Elastomer Adhesives (June 2007) By Michael P. Murphy

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- This paper proposes a small-scale agile wall-climbing robot, which is able to climb on smooth vertical surfaces using flat adhesive elastomer materials for attachment.
- Using two actuated legs with rotary motion and two passive revolute joints at each foot, this robot can climb and steer in any orientation.

Survey of Robotic Arm and Parameters (January 2016) By Virendra Patildar, Ritu Tiwari

- This is a survey paper on a robotic arm and their development.
- It gives a technical introduction to some of the recent research work in this field.
- This is a working field of research in which there are a number of outstanding open problems and an area of exploration

DTMF based robotic arm design and control for robotic coconut tree climber (Sep 2015) By Rajesh Kannamegalingam, Trayesh Venugopal

- This research work focuses on wireless controlled robotic arm using DTMF (Dual tone multi frequency) technique.
- The arm is designed to be a part of a coconut tree climbing robot.

Harp plucking robotic finger (2012) By Delphine Chadefaux, Jean-Loic Le Carrou, Marie-Aude Vitrani , Sylvère Billout, Laurent Quartier

- This paper describes results about the development of a repeatable and configurable robotic finger to pluck harp strings. Eventually, this device will be a tool to study string instruments in playing conditions.
- We used a classical robot with two degrees of freedom enhanced with silicone fingertips.

Development of Smart Pesticide Spraying Robot By Pvr Chaitanya, Dileep Kotte, A. Srinath, K. B. Kalyan

- This paper details the design, production, and programming methodology of a pesticide spraying robot.

PWM Control of a DC Motor Used to Drive a Conveyor Belt (2014) By Livinti Petrua, Ghandou

- This work presents an experimental stand for the PWM control of a DC motor used for driving a conveyor belt.
- For supplying the DC motor an H-bridge has been used that allows the reversal of the motor rotation wise.
- The PWM signal is generated by an ARDUINO UNO board, equipped with an Atmega 328 microcontroller

Long range wireless communication by using arduino and HC12 Wireless Serial Module By Adnan M. Taha1, Adham Hadi Saleh, Ahmed Mohammed Ahmed

- HC-12 is a Half-duplex wireless serial Communication unit has a capability of creating wireless link between two end devices.
- In this work, HC-12 is presented and used for controlling any electrical devices inside the company, to establish the smart control system for company appliances.

Coconut Plucking Robot (march 2017) By Anagha Mohan, Anjana Prabhakaran, Lakshmi.K

- This paper is to find a design of a device that can harvest coconut- a mechanism for tree climbing and pluckin
- This system is so designed that it can be controlled by a common man as it does not involve complex procedure.

Design of Mobile Robot with Robotic Arm Utilising Microcontroller and Wireless Communication (Apr 2017) By .B. Alit Swamardika, I N. Budiastra, I N. Setiawan, N. Indra

- The purpose of this study is to design a prototype of a mobile robot equipped with a robotic arm which can be controlled by wireless technology

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Design and fabrication of wheeled pole climbing robot with high payload capacity By Sohail Khan and S Prabhu

- In this paper aims in designing of Pole Climbing Robot (PCR).
- These types of climbing robots can be used for inspection as well.
- In this robot pair the smart phone with Bluetooth module connected to embedded system.

Design and development of a low-cost pole climbing robot using Arduino Mega By H Khairam, Y M Choong, N S N Ismadi, W A F W Othman, A A A Wahab and S S N Alhady

- This article aims to design and fabricate an autonomous pole climbing robot, which can climb upward/downward a pole.
- The robot has two grippers at the top and bottom of the robot body, climbing along a pole by alternating release/grip mechanism.

Pole Climbing Robot Ankur Sinha

- This can ascend with bends and branches from 3D structures, and search the entire region of the structure

Design and Implementation Surveillance Robot Using ATmega328 Microcontroller By Anas f. Ahmed

- This paper introduces design and implementation a surveillance tanked robot based on Wi-Fi protocol and windows operating system
- The movement directions of the robotic tank are controlled by a GUI designed using visual studio development environment.
- The robot can transmit real-time video to the intended recipient.

III. EXISTING SYSTEM

The existing system includes several types of tree climbing robots. TREE BOT uses wheeled mechanism to climb trees. Such systems don't have a harvesting mechanism. Coconut tree climbing is a difficult task due to the structure of coconut trees. The existing system consists of consists of following hardware components such as designed mechanical frame, gear motors, springs, steel rods, grip wheels, batteries, switched-mode power supply and wires. The mechanical frame is hexagonal. It holds the motor wheels in it. It is accompanied by a set of springs (spring mechanism). The hexagonal frame's each side makes an angle of 120 degrees. Wheels are used for the movement of the mechanical frame in a trouble-free manner on the trunk of the tree. There are six wheels attached to the hexagonal frame. These wheels are arranged alternately to each other As the shape of the tree is not uniform on all sides, it is necessary to automatically adjust according to the tree's surface. The spring mechanism is to make the smooth operation of the wheel on the trunk of the tree.

IV. PROPOSED SYSTEM

The proposed system uses gripping mechanism to climb the trees. This method improves the stability of the robot. It consists of threaded rods along with the grippers to climb the trees. Due to the efficiency of this mechanism it can sustain the different structures of the tree. The grippers and threaded rods are activated using gear motors. The entire system is controlled by Arduino board and powered by batteries. Live camera feed can be obtained for monitoring the robot activity in the top. The robot uses a 3- axis robotic arm which is highly useful and provides great reach around the tree. Two robotic arms have been setup at different positions to reach around the trees and harvest the coconut from all sides. The camera system is a separate system which is attached to the arm. This robot can be controlled using a remote controller. This remote controller has a range of 1Km. The remote consists of 3 joystick controllers based on potentiometer. These joysticks give analog signals to the controller and this signal are sent to the main controller.

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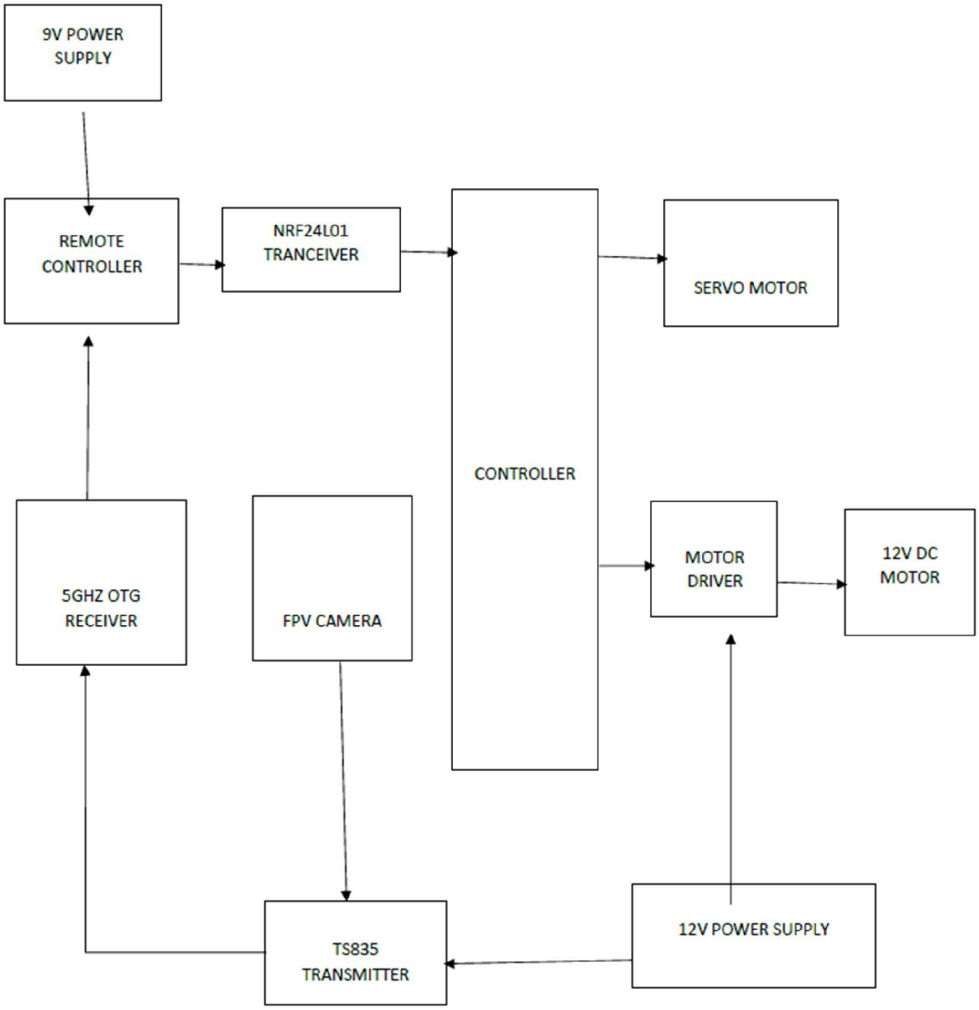
4.1 Block Diagram



V. SOFTWARE EXPLANATION

5.1 ARDUINO IDE:

The Arduino Integrated Development Environment (IDE) is a cross platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards. The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, avrdude is used as the uploading tool to flash the user code onto official Arduino boards. Arduino IDE is a derivative of the Processing IDE, however as of version 2.0, the Processing IDE will be replaced with the Visual Studio Code-based Eclipse Theia IDE framework. With the rising popularity of Arduino as a software platform, other vendors started to implement custom open source compilers and tools (cores) that can build and upload sketches to

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other microcontrollers that are not supported by Arduino's official line of microcontrollers. In October 2019 the Arduino organization began providing early access to a new Arduino Pro IDE with debugging and other advanced features.

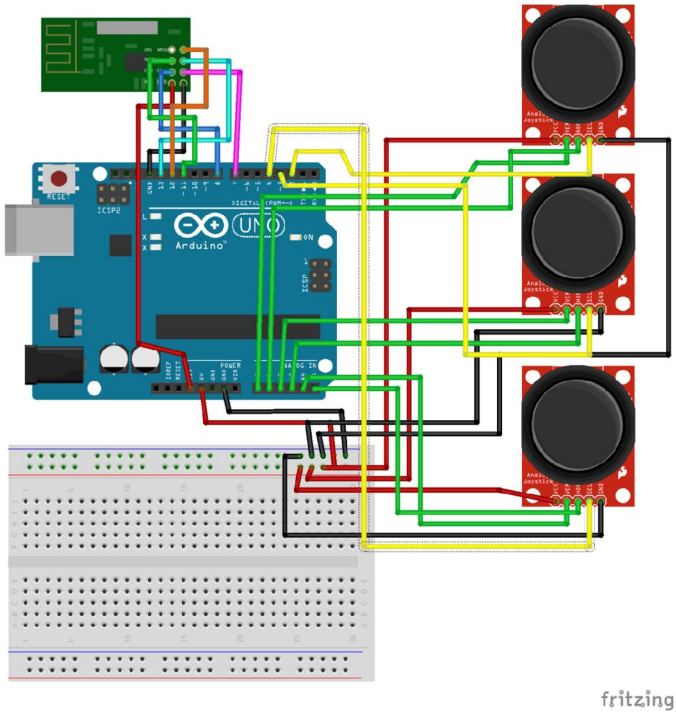
5.2 GO FPV

GO FPV is an application software for android devices. It is used to display the live camera footages from the FPV camera to the smartphone display. For using this application your device must support OTG configuration. You will need a UVC OTG receiver before using this application. This application not just allow you to view the camera feed but also let you to record the entire camera footage for later reference. The interface of the application is very simple, whenever you open the application after connecting the OTG receiver via the USB cable a popup notification to select the camera device will be shown. After selecting the camera, we need to select the right channel from the OTG receiver. Then the camera footage can be viewed seamlessly. It also shows the signal strength in the form of a graph. The real-time footage can be viewed without any noticeable lag, it is also depended on the signal strength and the type of OTG receiver and transmitter. It can not only display the video footage but also the audio captured.

VI. HARDWARE IMPLEMENTATION

6.1 Circuit Diagram

6.1.1 Transmitter Circuit



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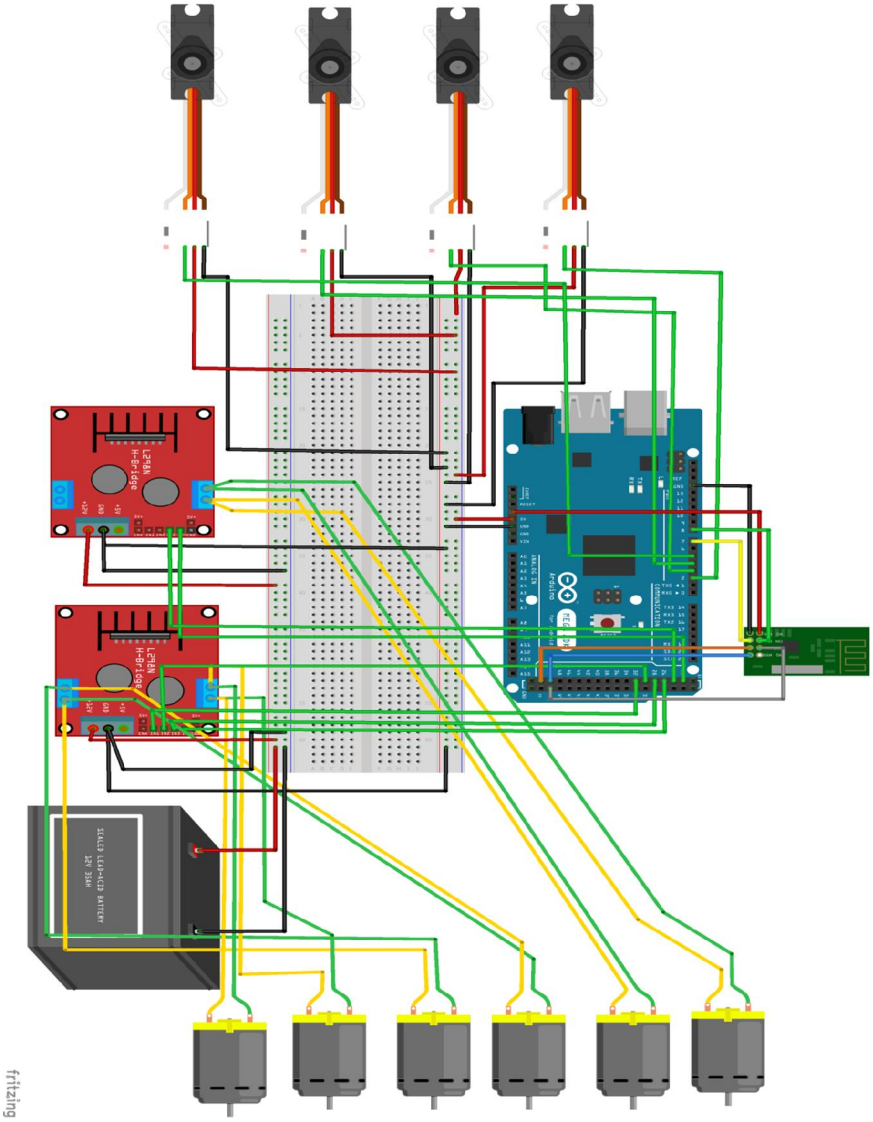
6.1.2 Receiver Circuit:



6.2 Components

- ARDUINO MEGA
- ARDUINO UNO
- NRF24L01
- ANALOG JOYSTICK
- L298N MOTOR DRIVER
- MG90 SERVO MOTOR
- 12V DC MOTOR
- TS835 TRANSMITER
- SKYDROID UVC OTG RECEIVER

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- 600 TVL FPV CAMERA
- 10uf CAPACITOR
- 12V RELAY
- 12V LED
- JUMPER CABLES

VII. WORKING

The working of the system includes two mechanism

- Climbing mechanism
- Harvesting mechanism

7.1 Harvesting Mechanism

It has two links and two joints. The end effector consists of a rotating cutter for cutting down the coconuts. This model has comparatively less weight and does not disturb the stability of the system. Being a simple design, this system actually is quite stable. Also, this model is the most cost efficient. But having just limited degrees of freedom, the model would while reaching the coconut bunches grown in a very complex manner on top of the coconut trees.

7.2 Climbing Mechanism

The system uses gripping methods to climb up the tree. It consists of 6 motors for climbing up and down. Four motors are used to actuate the grippers and other two is used to perform a linear motion. The pair of 2 motors are operated at equal interval of time, and in between the other two motors are operated when the first four motors are in rest position. ie, one pair of gripper is pressurized towards the tree to grip and the other pair is released. When the gripper is tightened to the tree the linear actuator is activated. This process is repeated to climb the tree.

VIII. RESULT

The project has been assembled successfully and the trials have been made successfully. The project could climb the tree seamlessly via a remote controller from a long distance. The harvesting mechanism also worked fine. The robot was able to harvest coconuts from the trees. The live transmission of camera footage was successfully done and the footage was able to view through mobile phone with the use of GO FPV app. The project was able to controll even from inside of a room.

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IX. CONCLUSION

The paper presents the design and implementation of a low cost autonomous coconut tree climbing and harvesting robot. By considering the advantages of different models of mechanical frames, a final model is selected and implemented. The selected model is automated using Arduino Uno, drivers, sensors and other supporting circuits. The prototype of coconut tree climbing robot is made and tested successfully.

X, FUTURE SCOPE

As far as the future scope of the project is concerned, we could replace the camera with an IR camera and an IR torch for enabling night vision. We could also add one more axis to the robotic arm to increase the reach. A revolving mechanism can be added to the harvesting mechanism to reach every part of the tree with a single arm. We could also add a coconut collecting system along with the harvesting mechanism. Then we can add wheels to navigate through the entire field. AI system can be included to determine tender coconut and coconut and harvest the required one automatically without human intervention.

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