Automated Arecanut Tree Climbing Machine

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***Abstract*— The design and fabrication of arecanut tree climbing and spraying machine is presented in this paper. The device consists of a hexagonal base frame which supports all the components to be built upon. It is fitted with three DC motors - nylon tires with rubber grippers. A specially designed remote-controlled unit is mounted on the frame. Power from the battery is supplied to the motors using flexible wires. Movement of the dc motors and the spraying pump are controlled by the IR operated 8 channel relay system. To accommodate for change in the diameter of arecanut tree as the device moves up and down, a screw loaded mechanism is used for exerting sufficient tension required for gripping the tree.**

Keywords— ***Tree climbing machine, Arecanut, Spraying machine.***

I. INTRODUCTION

Researchers all around the world work on developing climbing machines, most of these climbing machines are capable of climbing regular structures like poles, walls etc. But a very few are capable of climbing trees, main reason being irregular surface and variation of diameter with length. It also requires greater agility and high maneuverability to be used as a product. Also, the bark of some trees may not be strong enough to bear the weight of the climbing device, hence conventional climbing machine cannot be used for tree climbing applications. Many trees like coconut tree, arecanut tree, and palm trees are so tall that climbing them becomes risky. Hence harvesting fruits and nuts and maintaining them becomes difficult. So, development of a unique tree climbing mechanism is necessary which may be used for maintaining and harvesting applications. In recent years, labor scarcity has emerged as one of the foremost challenges in farming. One crop that has been most affected by this is the arecanut. 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. As this involves really hard, physical exertion, younger generations of laborer's are losing interest, with potentially harsh implications for arecanut cultivation. The spraying is done in monsoon, while harvest time is typically in summer. The scope of this project is limited to climb arecanut trees having circumference between 30 and 50 cm. Therefore, maintaining sufficient friction force capable of handling the self-weight, maintaining the stability of the structure while in motion, reducing the total weight, and achieving the precise gripping are the important parameters that have to be considered. The machine should be capable of adjusting to the varying cross-section of the tree during upward and downward movements. The machine should grab the tree firmly to maintain its positions during the operation. The geared motor should be powerful enough to carry the payloads and weight of the machine. The tension maintained by the spring must be good enough to maintain the gripping force between the wheel and the tree. In this study, considering all the above parameters, a safe, reliable and efficient climbing and spraying machine is designed and fabricated.

II. DESIGN AND METHODOLOGY

The arecanut tree climbing and spraying machine works on basic principle of friction that is the relative lateral motion of two solid surfaces in contact. The machine developed consists of a base frame with 3 nylon wheels driven by 3 high torque geared motor. The machine is having a hexagonal shape, hinges are provided on each links for the movement of links with the variation in size of the tree. A screw is used to provide sufficient grip to the wheel on the tree according to the change in the size of the tree. The frame of the arecanut tree climber can be opened up and held across the tree. The setup is connected across the tree with the help of a brake cable. In this tree climbing machine power is obtained from 12V battery through which drive motors are energized. A relay system is used for the movement of the wheels. When the relay is switched on, the motor rotates the shaft which in turn rotates the wheels in clockwise direction. Due to the friction between drive wheel and the bark of the tree machine rises up along the length of the tree. The contact friction between the wheel and tree is maintained with the help of screw and grippers on the wheels. The only component which is in contact with the tree is the wheels which are made up of nylon. Hence it doesn't cause any damage to the bark of the tree. When the setup reaches on top of the tree the motor is made to stop by the key press in the relay remote-control unit. The tension of the spring helps to retain the machine at the required height. Then the wiper pump motor is switched ON by

other key press in the relay. Then the pesticide is being sprayed. This water pump is provided with 5V supply voltage. After which the pump is stopped, the whole setup is being brought back by changing the polarity of the switch so that the drive motor rotates in opposite direction there by making the wheels rotate in opposite direction. After reaching the ground the ground the setup is removed from the tree and attached to the next tree for spraying.

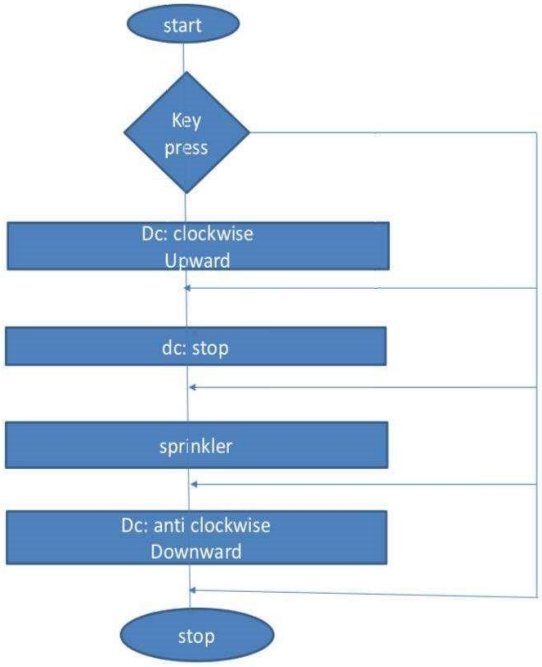


Fig 1. flowchart of working of the machine

III. CALCULATIONS

Force Calculation

Assuming weight of the machine,

W = 5.5 kg W = 5.5x9.81

W = 53.955 N.

Assuming coefficient of friction between tree and rubber grip, μ = 0.3

Actual Force to be lifted,

F=W/μ F=53.955/0.3

F = 179.85 N

Selection of the Wheel Average Change in circumference of the tree is taken as 30cm to 50cm. It was observed that the maximum circumference of an arecanut tree is 50 cm and minimum circumference at the top is 30 cm. 10 cm wheel is used in this machine for the torque restriction of the motor.

Length of Link

Length of each link is taken as 9''

Torque Calculation

Calculating motor torque,

Torque [Nm] = Mass [Kg] × g × Radius [m]

Torque = 8.5×9.81×0.05

= 4.169 Nm.

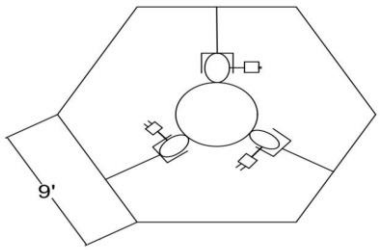
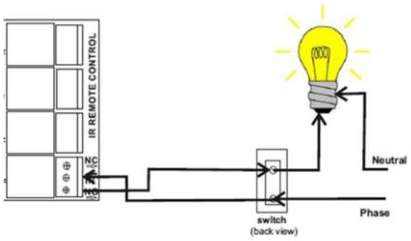


Fig 2. Line diagram of arecanut spraying and climbing machine

IV. SPECIFICATIONS OF PARTS USED

A. *IR remote control 8 channel*

Remote operation range is up to visible distance. Each relay can switch on and off. Receiver indicates output status by LED. Receiver operates from 12v ac or dc supply. Relay contact are brought out as screw terminal.



Transmitter

PIC16F630 is the heart of the transmitter used to send IR command to receiver. It also generates 38KHz carrier frequency. When any key not pressed the CPU work in SLEEP mode to reduce battery power consumption and wake-up only when any key pressed. To wake-up the CPU from SLEEP mode the CPU use interrupt on change feature which interrupted when the state on PORTA change then the program execution after an interrupt is at the interrupt vector, if the global interrupt is not enabled, the program starts executing the first line of code right after the SLEEP instruction. In the interrupt service routine, the software will scan the key that pressed and send IR command appropriate with key pressed.

Receiver

The receiver also uses PIC16F630 to control all function then. When power is applied to circuit the CPU will polling the IR input signal which is the output from IR decoder module (TSOP4838). After IR received the CPU decoding the IR command and turn ON the buzzer About 60ms. The output (relay) work as a toggle output thus when the right IR command decode complete the output will turn on and if the same IR command sent again the output will turn off.

B. *DC Motor*

DC motor when interfaced with microcontroller. That is, we can control the speed of motor, we can the control the direction of rotation, we can also do encoding of the rotation made by DC motor i.e. keeping track of how many turns are made by the DC motor etc. So, we can see DC motors are no less than a stepper motor. Here we are using gear DC motor with combination of gear to get a required Rpm simple gear combination which contains the shaft which is connected to gear box which is intern connected to shaft of the DC motor.

C. Water pump

This is light weight, small size, high efficiency, low consumption and low noise water pump. This pump required This pump required 5v ac supply to pump.

D. 5V power supply

Input Voltage AC 0-12 Output Voltages +5v Inputs and output connected to terminal blocks Maximum Load 0.750 Amps. This Power supply is Very useful for Embedded applications.

V. CONCLUSION

This arecanut tree climber is eliminating requirement of labor to climb the tree. The climbing rate (approximately10 feet/minute) of machine is quite high. Any unskilled person can operate the machine easily. Also, the machine is used to spray pesticides and to pluck the arecanut. As a future scope an additional camera can be connected.

ACKNOWLEDGMENT

The authors would like to thank the reviewers for their invaluable comments and counsels. Moreover, we would like to thank VVCE for their kind and effective cooperation during the experimental validation.

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