International Journal of Research and Innovation in Engineering Technology ISSN: 2394 – 4854
Volume: 04 Issue: 09 Pages: 1 – 9

IJRIET

AN INVESTIGATION ON DESIGN AND DEVELOPMENT OF ARECANUT TREE CLIMBER

Sathrudhan Choudhary.V[1], Ajith Haridas[2], Vignesh[3], Mohammed Farooq[4]
[1]*Assistant Professor, Department of Mechanical Engineering,Dhaanish Ahmed Institute of Technology, Coimbatore*
[2,3]*UG Scholar, Department of Mechanical Engineering,Dhaanish Ahmed Institute of Technology, Coimbatore*
[4]*Assistant Professor, Department of Mechanical Engineering, PA College of Engineering, Pollachi*
E-mail-ID: [1]sathru07 @gmail.com

Received 10 January 2018, Revised 03 February 2018, Accepted 12 February 2018
Available online 17 February 2018

Abstract

The people in rural areas of Karnataka and Kerala mainly depend on agriculture for their livelihood. The main crops grown are Arecanut and coconut. For harvesting the nuts, and for spraying and applying insecticides on the crown, skilled labourers have to climb manually up the tree. Such a process looks easy, in reality it is a laborious and dangerous task. It requires skill to climb a arecanut tree. Skilled arecanut tree climbers have become scarce and farmers are finding it difficult to harvest the nuts. There are many equipments/ machines in the market to help the farmers in this regard. But they are not successful as the input for them is muscular power of the labour and it requires a person to physically climb the tree. There is no 100% safe arecanut harvesting device currently in the market. There is a need to invent a machine to address both efficiency and safety. The design of the device has to be simple enough for villagers to operate, yet work efficiently to appeal to the majority.

Here we are designing and fabricating motorized arecanut tree climber. The tree climber has a base on which the drive system is mounted. The power from the motor to the rollers is transmitted by using sprocket and chain drive. To obtain the required speed of the rollers a reduction gear box is used in between the motor and the rollers. The machine is placed around the tree and clamped to it using a swivel opening on one side of the base. Due to the weight of the motor, gear box and some extra mass concentrated on one end of the base the machine locks itself to the tree. Now the motor is switched ON to drive the rollers. When the rollers rotate gripping the tree, the whole setup is lifted along the length of the tree. After reaching the required height the motor is switched OFF. By having suitable auxiliary equipments for spraying pesticides, plucking the nuts on the setup and suitable controlling methods for those equipments the required job can be performed. Once the job is done the motor is made to rotate in the reverse direction to descend down the tree.

***Keywords**:* Arecanut Tree,Climber,Insecticides

1. INTRODUCTION

Arecanut is an erect, unbranched palm reaching heights of 12-30 m, depending upon the environmental conditions. The stem is marked with scars of fallen leaves in a regular annulated form. Arecanut almost always exist in cultivation; therefore, conditions of its natural habitat are difficult to assess. It however thrives in areas of high rainfall. Being a shade loving species, arecanut always does well when grown as a mixed crop with fruit trees. Raising a banana shade crop is even better as this supplements farmer's income. The majority of arecanut are harvested by climbing the tree and cutting the nuts down by hand. This process may seem simple; however, it is actually quite dangerous. In response, there is a genuine need to develop a device.

2. OBJECTIVES OF THE PROJECT

In an attempt to assist the climbers, an arecanut tree climbing device has been designed to meets the following goals

- It will be controlled from the ground.
- Both men and women will be able to operate the device.

The arecanut tree climber will be able to harvest faster than present methods

2.1 Competetive Technology

Although there are many existing robots that can climb walls or trees, there are currently no robotic devices for climbing and harvesting arecanut trees in specific. One drawback of these robots is they take much longer to climb a tree than humans.

One of the few specifically related devices we have found in our research is a climbing and harvesting device that aids in climbing a palm or coconut tree. The inventor asserts that his device ensures the user's safety and quickens the climbing process. However, the device still requires a person to physically climb the tree and therefore does not properly address the society's needs.

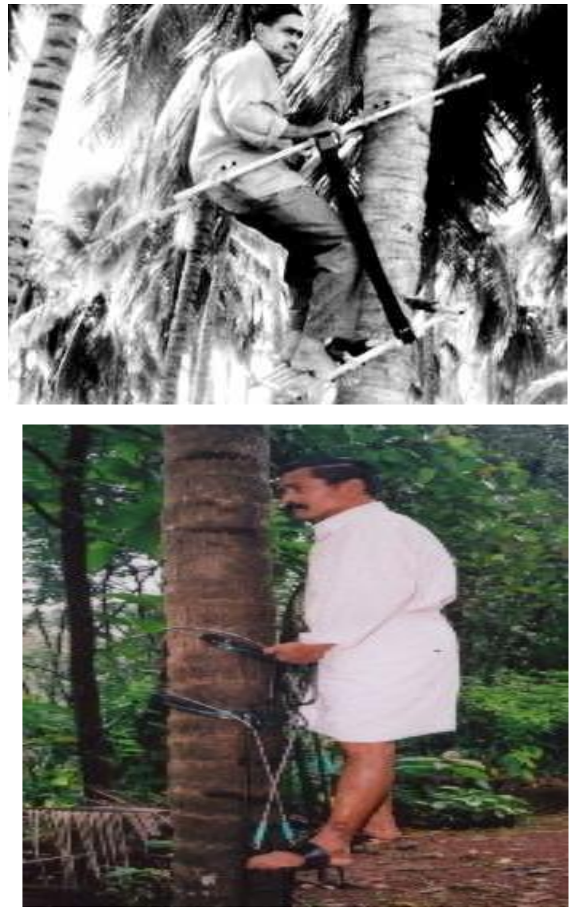


Figure: 1 Coconut tree climber

2.2 Field research

Since the best way to understand real problems is to interact directly with people. We visited some nearby areca farms and consulted farmers about the present methods of harvesting the crop. We also had a demonstration of present climbing method and insecticide spraying techniques and equipments. From their method of climbing to their way of dressing, has given our team a helpful insight to tree climbing in villages.

When current harvesters were asked if they would welcome some sort of climbing device that would aid their work and not require them to continue climbing towering palms. The answer they got was a definite "yes."

Figure: 2 Arecanut harvesting

2.3 Challenges

The current invention comes with many challenges. The device must attach to the base of the tree and be easily removable, the wheels must maintain adequate contact with the tree as the tree diameter decreases during ascension, and a single user must remotely control it to a height of approximately 30m. However, the ultimate goal is to mount a camera and actually harvest arecanuts. Once the basic tree climber is completed and it can ascend and descend a tree successfully, we will face three more major challenges as we embark on the harvester design: the lack of vision as the device climbs upwards, the development of a multi-axis robotic arm for harvesting, and finding an actual fruit-bearing Arecanut tree. The lack of vision requires the human operator on the ground to have live video signal from a camera mounted on our device. Further, developing the robotic arm to harvest the arecanuts is a difficult engineering task and will require a great deal of time. Finally, testing the prototype on actual arecanut trees will be difficult.

3. DESCRIPTION OF THE PARTS

3.1 Main Parts

The main parts of the Motorized areca nut tree climber are Base, Roller, Bearing, Sprocket and chain, Pulley and V-belt, Motor, Gear Box

The base and rollers are manufactured using mild steel. Mild steel is the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications. Low carbon steel contains approximately 0.05–0.15% carbon and mild steel contains 0.16–0.29% carbon, therefore it is neither brittle nor ductile. Mild steel has a relatively low tensile strength, but it is cheap and malleable; surface hardness can be increased through carburizing. It is often used when large quantities of steel are needed, for example as structural steel. The density of mild steel is approximately 7.85 g/cm3 and the Young's modulus is 210,000 MPa (30,000,000 psi).Low carbon steels suffer from yield-point run out where the material has two yield points. The first yield point (or upper yield point) is higher than the second and the yield drops dramatically after the upper yield point. If a low carbon steel is only stressed to some point between the upper and lower yield point then the surface may develop Luder bands

3.2 Base

The base is constructed using two angular plate which is welded together to form square cross-section. The chassis will fit around the tree, on this chassis the motor, gearbox, rollers, bearings are mounted. It is clamped to the tree using a swivel opening hinged on one side. The base also has plates projected to hold the small rollers to keep the device in alignment on moving up or down. one of the roller is placed on one extreme end of the chassis ,the motor and the gear box on another extreme end. Maximum amount of load of the parts on the chassis is concentrated on the end where motor and gear box is mounted.

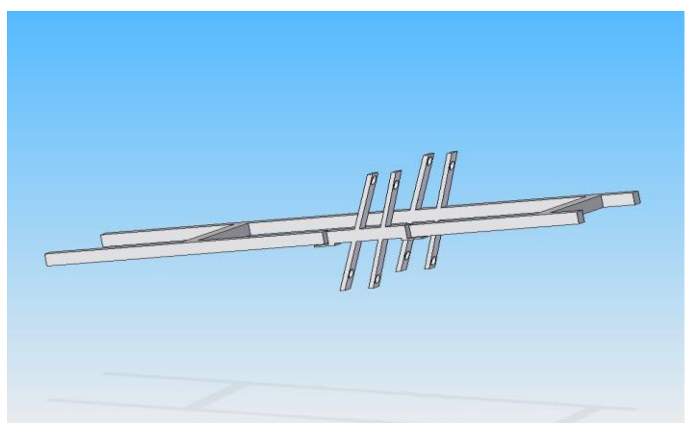


Figure: 3 Base

ISSN: 2394 – 4854
Pages: 1 – 9

3.3 Roller

This is the part which will be in direct contact with the tree. While these rollers are rotated by supplying power, the whole devise ascends to the required height to perform required job. By rotating the rollers in reverse direction the device is made to descend. The diameter of the rollers is 140mm and length is 155mm. A shaft of 25.4mm diameter is made integral to the rollers.

To create friction between the rollers and the tree, the rollers rubberized. Generally for gripping purpose natural rubber is used. For special purpose and working in very hot and working in very hot temperatures Nitryle rubber is used. The Rollers are made from natural rubber. The Natural Rubber is having high carbon contents which will give the rollers tight bonding nature and having the ability of high resistance to wear and tear. This roller is has flexibility also to take over the friction. Moreover it is having a hardness of 60 to 65 degree so it can with stand high resistance to wear and tear

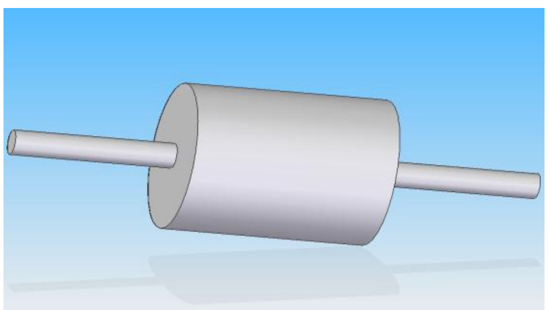


Figure: 4 Roller

3.4 Bearing

Bearings are mounted on the chassis where ever the rollers are to be fixed. The bearing hole diameter is 25.4mm. Here we have used self alignment bearing so as to keep this rollers attached to the tree.

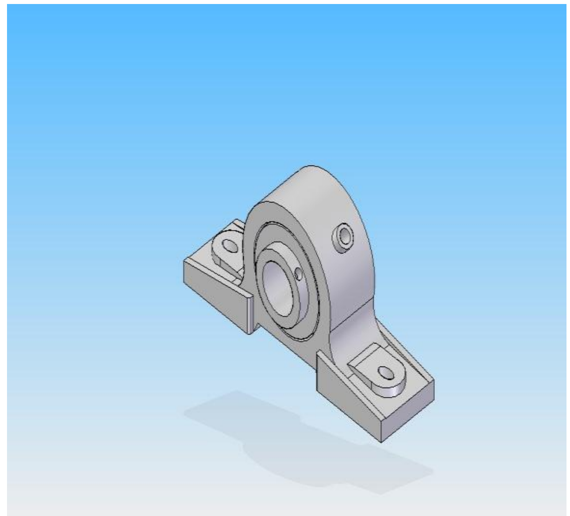


Figure: 5 Bearing

3.5 Sprocket and chain

Two sprockets of each 100mm diameter and with 22 teeths are used. One gear is mounted on gear box shaft and the other is mounted on the shaft connected to the roller on the opposite end of the chassis to the motor.

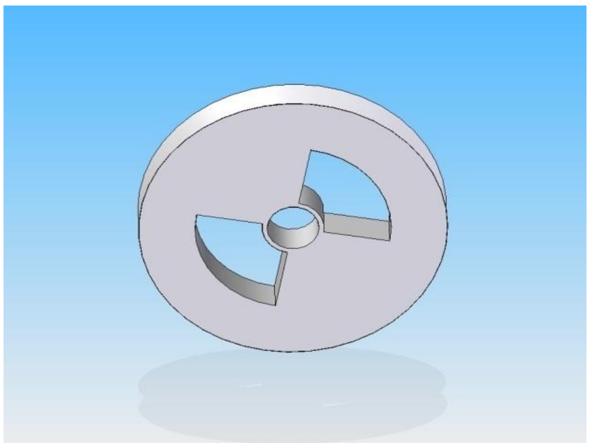
Chain is used to transmit power from one shaft to another using sprockets. Chain drive causes less slip thus maintaining constant velocity ratio.

Figure: 6 Sprocket

3.6 Pulley and V- belt

Two pulleys of diameter 55mm and 175mm are mounted on the motor shaft and gearbox shaft respectively. Belt drive is used to transmit power between motor and gearbox.

Here we have used V belt to transmit power from motor to gear box. V belts are trapezoidal in section and are used in high power transmission.



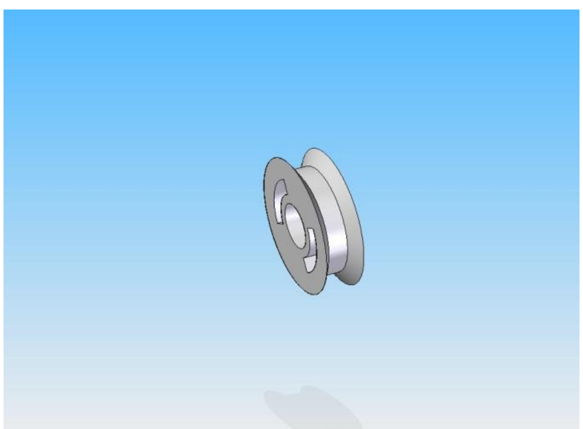


Figure: 7 Pulley

3.7 Motor

A 1HP single phase AC electric motor is used. Power from the motor is transmitted to gearbox using pulley and belt drive arrangement. The motor runs at RPM of 1440.

3.8 Gearbox

To achieve the reduction of required speed 1:20 ratio gearbox is used. It contains worm and worm wheel.

Antiparticles bind with each other to form antimatter just as ordinary particles bind to form normal matter. For example, a positron and an antiproton can form an anti-hydrogen atom. Physical principles indicate that complex antimatter atomic nuclei are possible, as well as anti-atoms corresponding to the known chemical elements. To date, however, anti-atoms more complex than the anti-helium have neither been artificially produced nor observed in nature. Antimatter in the form of anti-atoms is one of the most difficult materials to produce. Antimatter in the form of individual anti-particles, however, is commonly produced by particle accelerators and in some types of radioactive decay.

4. DESIGN CALCULATION

In this chapter the design and calculations of parts used in the project are done, in order to select the suitable material and to specify the dimensions of the parts.

4.1 Power calculations

Force assumed is 1500N. Taking μ=0.4.

Actual force to be lifted $F=F'/\mu$ …… (1)

$F=1500/0.4=3750N$.

Power= $(F*v)/1000$ ……………………(2)

$= (3750*0.17)/1000$

where, $v=(\pi DN)/60000$ ……..…(3)

$=(\pi*150*22)/60000$

=0.6375KW=0.172m/s.

Speed calculations

Speed of the motor N1=1440rpm.

Reduction achieved after using gear box

N1*D1= N2*D2 …….(4)

Where D1 is the diameter of the pulley on motor.

D2 is the diameter of the pulley on the gear box.

ISSN: 2394 – 4854
Pages: 1 – 9

N1/N2=D2/D1

1440/N2=17.5/5.5

N2=453 rpm(Speed of the pulley on the gear box)

Using a ratio of 1:20, speed of the sprocket on the gear box is = 453/20=22.65rpm

Reduction ratio of pulley. I=I'*I"

63.6=I'*20

I'=<u>3.18</u> ∴ the reduction due to pulley is 1:3.18

Design of base

Figure: 8 Moment diagram

Calculating the bending moment:

$M_A = 2\times 9.81 + 2\times 9.81 \times 0.49 + 13 \times 9.81 \times 0.79$

$= \underline{114.09\text{ N-m}}$

$M_B = 2\times 9.81 \times 0.3 + 13 \times 9.81 \times 0.6$

$= \underline{82.4\text{N-m}}$

$M_C = -2\times 9.81 \times 0.3 + 13 \times 9.81 \times 0.3$

$= \underline{32.373\text{N-m}}$

$M_D = 2\times 9.81 \times 0.6 + 2 \times 9.81 \times 0.3$

$= \underline{17.658\text{N-m}}$

Taking the biggest moment i.e., M_A= <u>114.09N-m</u>

We know that, $\frac{M}{I} = \frac{\sigma}{c}$ …… *(5)*

Where M= bending moment

I= moment of inertia

σ= stress

c = distance from neutral axis to the extreme fibre.

I=$\frac{BH^3 - bh^3}{12}$ [2] …..*(6)*, assuming the ratio $\frac{B}{H}$=1

Now, I=$\frac{B^4 - b^4}{12}$

We have, B-b=2t , assuming t=<u>1.2mm</u>

$$\therefore B - b = 2.4$$

B=2.4+b. substituting this value in the equation for I.

I=$\frac{(2.4+b)^4 - b^4}{12}$

Solving

$(2.4+b)^4 = b^4 + 23.04\times b^2 + 4.8\times b^3 + 23.04\times b^2 + 530.84 + 110.5\times b^2 + 4.8\times b^3 + 110.5\times b + 23.04\times b^2$

$$\therefore I = \frac{9.6 \times b^3 + 179.62 \times b^2 + 110.5 \times b + 530.84}{12}$$

But $\frac{M}{I} = \frac{\sigma}{c}$

$$\therefore \frac{114.09 \times 12 \times 1000}{9.6 \times b^3 + 179.62 \times b^2 + 110.5 \times b + 530.84} = \frac{110}{2.4 + b}$$

$\therefore \text{b} = 21.6\text{mm}$

By standardizing and availability, we take b=<u>23mm</u>

$\therefore \text{h} = 23\text{mm}$

Then, B=2.4+b=2.4+23=<u>25.4mm</u>.

Design of shaft

Bending moment calculations:

Horizontal bending moment:

$M_A = 5.260 \times 105 - 2.63 \times 210 = 0.$

$M_B = -2.63 \times 210 + 5.26 \times 105 = 0$

$M_C = 2.63 \times 105 = 276.15$ N-mm

$M_D = 0$

Vertical bending moment

$M_A = -2.63 \times 210 + 6510 \times 260 = 1.692047 \times 10^6$ N-mm

$M_B = 6510 \times 50 = 0.3255 \times 10^6$ N-mm

$M_C = 2.63 \times 105 = 276.15$ N-mm

$M_D = 2.63 \times 260 + 2.63 \times 50 = 815.3$ N-mm

Resultant of bending moment:

$M_{RA} = \sqrt{0^2 + (1.692047 \times 10^5)^2} = 1.692047 \times 10^5$ N-mm

$M_{Rc} = \sqrt{(276.5^2 + 276.15^2)}$ = 390.3 N-mm

$M_{RB} = \sqrt{0 + (0.3255 \times 10^6)^2} = 0.3255 \times 10^6$ N-mm

$M_{RD} = \sqrt{815.3^2}$ = 815.3 N-mm

Considering moment $M = 0.3255 \times 10^6$ N-mm

We know that TORQUE $T = \frac{9.55 \times 10^6 \times P}{N}$ *…..(7)*

Where P is power =0.75KW, N=22 RPM

$T = \frac{9.55 \times 10^6 \times 0.75}{22} = 325.5 \times 10^3$ N-mm

We know,

$d_o = \left[\frac{16}{\pi \times \tau_{max}}\left(c_t \times M + \sqrt{(c_t \times M^2 + c_t \times T^2)}\right)\right]^{\frac{1}{3}}$ [2]

$d_o = \left[\frac{16}{\pi \times 320}\left(1.5 \times 0.325 \times 10^6 + \sqrt{((1.5 \times (0.325 \times 10^6)^2 + 1.25 \times (325.5 \times 10^3)^2)}\right)\right]^{\frac{1}{3}}$

d_o = 25.38 mm

By standardizing,

d_o = 25.4 mm

Therefore the shaft diameter is taken is 25.4 mm

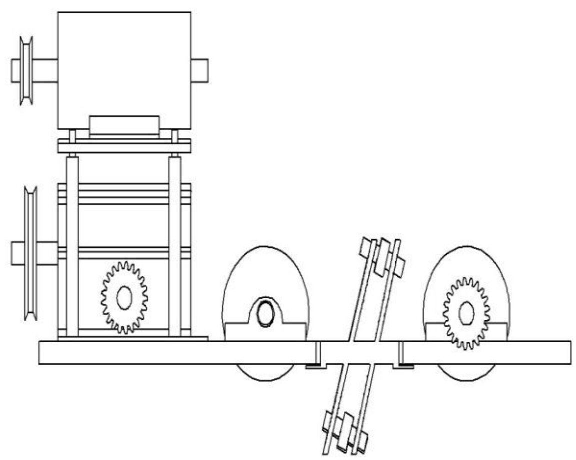


Figure: 9 Front view

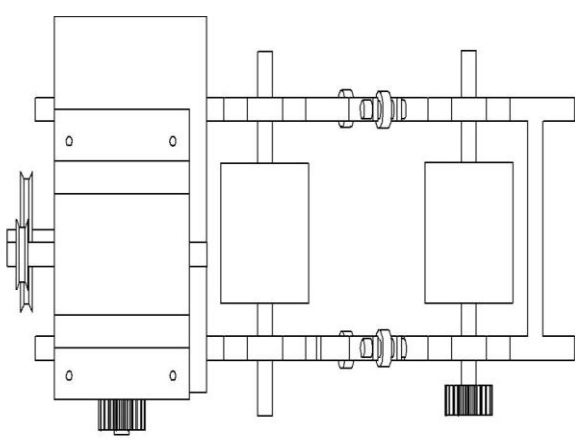


Figure: 10 Top view

5. WORKING PRINCIPLE

A simple methodology of the operation of the project is explained in this chapter. This is essential so that a common man can understand the working of the project

5.1 Methodology

Here we are designing and fabricating motorized arecanut tree climber. The tree climber has a base on which the rollers are fitted using self aligning bearings at a distance as the diameter of a standard areca tree. On one extreme end of the base, gear box and above that the motor is mounted. The power from the motor to the rollers is transmitted by using sprocket and chain drive. To obtain the required speed of the rollers a reduction gear box is used in between the motor and the rollers. The pulley on the motor shaft and the pulley on the gear shaft are connected using a v-belt, by this the speed is reduced a ratio of 1:3.18. Further the gear box reduces the speed by a ratio of 1:20. Now the rollers will rotate at a speed of 23 rpm. A chain runs on the sprockets mounted on the gear box shaft and the roller shaft.

The machine is placed around the tree and clamped to it using a swivel opening on one side of the base. Due to the weight of the motor, gear box and some extra mass concentrated on one end of the base the machine locks itself to the tree. Now the motor is switched ON to drive the rollers. When the rollers gripping the tree, rotates, the whole setup is lifted along the length of the tree. After reaching the required height the motor is switched OFF. Once the job is done the motor is made to rotate in the reverse direction to descend down the tree.

6. CONCLUSION

After testing the prototype on an areca tree we found that:

- The design is efficient in climbing the tree very smoothly without damaging the tree.
- The tree climber doesn't require a human to physically climb the tree, hence reducing the danger to the climber.
- The design is simple and appealing to the majority. An unskilled labour can operate the machine safely and efficiently.
- By installing properly designed sprayers or cutting device many number of trees can be harvested in a single climb thus increasing the efficiency.

So, we conclude that the motorized arecanut tree climber is a safe, reliable, efficient and automatic tree climber which reduces the problems in climbing the arecanut tree to a good extent.

6.1 Future Enhancements

- ❖ Weight of the device can be reduced by manufacturing the base using strong light weight material.
- ❖ Proper balancing should be done for the device to lock itself to the tree and for the smooth travel of the device up the tree,
- ❖ The shape of the rollers can be changed to convex so as to increase the contact surface between the tree and the rollers. Instead of the flat rubber on the rollers, grids would increase the friction between tree and rollers.
- ❖ The design can be modified to have one more dummy roller above the present dummy roller to form a triangular configuration. This reduces the risk of the assembly falling down during operation.
- ❖ On the upper portion of the base a multi-axis robotic arm for harvesting, i.e. spraying pesticides, plucking the nuts, can be developed and fixed.

References

[1] J.Sharana Basavaraja, Design and Development of Areca Tree Climber,International Journal of Research in Mechanical Mechatronics and Automobile Engineering, Vol. 1, Issue 2, pp 83-90 21,Sep, 2015

[2] M. Tony, Design and Fabrication of Arecanut Tree Climbing and Spraying Machine, Journal of Mechanical Engineering and Automation, p-ISSN: 2163-2405 e-ISSN: 2163-2413 2016; 6(5A): 93-96

[3] Prakash Karamari, Slow Tree Climbing Robot Analysis of Performance, International Research Journal of Engineering and Technology, Volume: 02 Issue: 06 | Sep-2015 p-ISSN: 2395-0072

[4] R.Praveenbabu, Tree Climbing Robot, International Journal of Innovative and Emerging Research in Engineering, Volume 4, Special Issue 1, NCIAR2k17, p-ISSN: 2394 – 5494