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Design and Development of Areca Tree Climber

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Abstract

The device for Areca tree climbing was designed developed and tested. The product was constructed to climb the areca tree by applying force on both the pedal alternatively. The product has two units LH and RH, each unit consist of a T-gripper assembly which locks the areca tree, a box -beam assembly which acts as a supporting member of the areca tree climber product, pedal assembly creates the up and down operation of the climbing unit. Initially the climbing unit is fitted at the base of the tree. When the force is applied on the pedal of RH climber unit it creates the grip through the steel wire rope that is connected from T-gripper to the pedal, thus creating the grip to lock the areca tree, The LH climber unit is now pulled up by using the handle that is attached to the T-gripper assembly. The areca tree is climbed to the maximum height by repeating the operation; the reverse operation is followed to descend the areca tree. The result showed that (a) The maximum height of 40 feet was climbed. (b) An average of 15-20 trees was harvested/sprayed by climbing the single tree.

Keywords:Arecanut, Tree Climber, Agriculture.

1. INTRODUCTION

The people in rural areas of Karnataka and Kerala mainly depend on agriculture for their livelihood. The main crops grown are Areca nut and coconut. 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 areca nut tree. Skilled areca nut tree climbers have become scarce and farmers are finding it difficult to spray the insecticides. 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 work efficiently to appeal to the majority.

In present days the climbing methods that are been used by the farmer are Rope climbing method and Rectangle wooden seat climbing method. Rope climber is economical and simple in design which consists of rope of length one meter twisted to the shape of the sandal, the user wear this sandal and climb the tree manually. In rectangle wooden seat climber the user hangs the wooden seat on his back and climbs the tree manually, once he reaches the tree top he ties the wooden seat to the 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 this regard (Eliahu Eliachar et al.,1994)invented a tree climbing device to climb up trees. The climbing unit connected to power source and to a PLC (programmable logic controller) wherein said climbing unit comprise of two pairs of arms and means for opening and closing said arms around the trunks and means for varying the difference between the pair of arms.

The operator has only to choose the designed destination up or down on the control box. In 2007 a climbing aid was invented (Neralic et al.,2007) 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 this two device was successful in climbing the tree, it was costly and was not affordable by the farmers. In summary although many device were invented to climb the areca tree it was not economical and user friendly. In this paper it is aimed to overcome these deficiencies.

2. COMPETITIVE TECHNOLOGIES

Although there are many existing robots that can climb walls or trees, there are currently no robotic devices for climbing and spraying/harvesting areca nut trees in specific. One drawback of these robots is they take much longer time to climb a tree than humans. One of the few specifically related devices have found in the survey is a climbing and spraying/harvesting device that aids in climbing a palm or coconut tree. The inventor(Eliahu Eliachar et al., 1994) asserts that his device ensures the user's safety and quickens the climbing process. However, the device does not ensure cost effective and an user friendly device therefore does not properly address the society's needs.

2.1Challenges

The current invention comes with many challenges. The device must attach to the base of the tree and be easily removable, the ropes must maintain adequate contact with the tree as the tree diameter decreases during ascension and a single user must control it to a height of approximately 40m. However, the ultimate goal is to climb the areca tree safely and efficiently.

2.1 Ergonomic Design Considerations

The International Ergonomics Association defines ergonomics as follows:
Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.Proper ergonomic design is necessary to prevent repetitive strain injuries, which can develop over time and can lead to long-term disability. Considering above criteria the proposed product has been designed to adjust to a wide range of users. These general ergonomic design considerations
include:

- Fixed Height Handles
- Diameter of Handle Grips
- Force Required to Maneuver

2.2Scope

- To reduce the climbing time and the power source requirement is one of the aims of the project.
- To design an Eco friendly product
- To overcome the wear and tear of the product it is desired to design a product with less repair and maintenance problems.
- There is a need to develop the product that can be operated by both men and women.

3. PROBLEM FORMULATION

The current available Areca Tree climber is not user friendly efficient and requires power supply to operate. To improve upon an existing system new design for a
simplified, economical climbing unit should meet the following goals:

1. To climb areca trees to maximum height.
2. To ensure safety by providing proper gripping.
3. To develop the product at minimum affordable cost.
4. To develop a product without compromising aesthetic& safety of the climbing mechanism
5. Device that can be operated by both men and women.
6. Repairs and maintenance problems are less

4. METHODOLOGY

For the Arecanut tree climbing device, the list of metrics are generated in way to contemplate each need in turn and to consider what precise, measurable characteristic of the product will reflect the degree to which the product satisfies that need. With that ideology, the various metrics of the product are elicited in association with the customer interpreted needs.Table 2 explain importance of the parameters consider in designing the climbing unit. The column 1 gives the serial .number of the parameters considered, the column 2 gives the need number from table II that are considered, column 3 gives the parameters considered in the design and column 4 mention the customer rating(0 -5), to the particular parameters, column 4 gives SI unites used.

4.1 Questionnaire Form Areca Tree Climber

Table 1 reflects questionnaire prepared based on the needs of the customer and also the user type.

5 Working Principle

The product has two units RH and LH as shown in figure (4)The human climber steps on the pedal of RH unit create the downward movement of the pedal, through which the steel wire rope is stretched and locks the areca tree. Now the LH unit is lifted up by pulling the handle attached to it to climb one step up the tree and the same process is repeated to create the climbing mechanism and to reach the required height. To descend the tree the pedal of RH unit is pushed down and the handle of the LH unit is also pulled down alternatively till the bottom of the tree.

TABLE 1: Questionnaire Form

CUSTOMERS	**INTERVIEWER(S):**
Date	Current Users
Willing to Follow	User Type
Current Need Statement	Interpreted Need
I need the Product to have good grip on	The climbing device is comfortable to

the tree	grip the tree
I need product to climb faster	The climber unit climbs as fast as human
I need the product with easy handling	The areca climber can be operated by both men and women
I need product with minimum weight	Climber unit is light enough to carry from tree to tree
The product should consume low power	The device is operated with no power
The product should ensure safety	T-gripper assembly is used for safety
The product should be cost effective	The climber is economical and affordable by farmers
I expect the product to be reliable	The climber is more reliable with better life
The product should reduce physical strain	The user can rest on pedal assembly
Reverse mechanism should not break down the climber unit	Reverse mechanism is safer for the climber unit
I need to reduce man power	One person can operate the product
The product should be easy to operate	The product is easy to operate
Affordable for farmers	Highly economical for farmers
Simple to operate	Very simple in design
Current system is not safe	The climbing unit is provided with grip
Current system cause physical strain to the user	The user can stand for 30 to 40 minutes with reduced strain

TABLE 2: List of Matrix for areca tree climber

Metric No.	Need No.	Metric	IMP	Units
1	4,12,10	Total mass	4	Kg
2	2	Speed	3	m/s
3	5,7,8,11	Unit product cost	4	INR
4	6,9	Complex in design	2	Kg
5	1,3	Ergonomics consideration	3	Subj.

6 DESIGN AND MANUFACTURING

6.1 Free body diagram for areca tree climber unit

The areca tree climber product is designed in detail and the selection of critical functional elements is performed. In the product under conception, the basic functional elements are the T-gripper assembly, Box Beam assembly and the pedal assembly units. The following sections give more insight about the computations involved to select the functional elements.

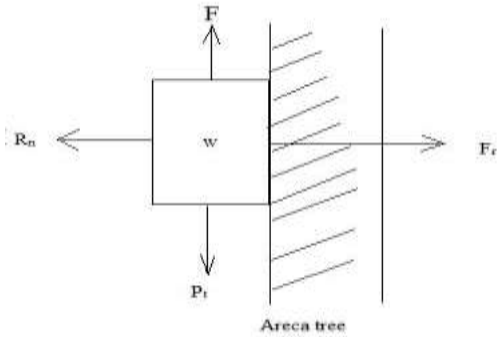

Figure3: Free body diagram for areca tree climber unit

6.2 Detail Design

The detail design of the areca tree climber is designed as follows**:**

$_f$ Frictional force in
$_a$ Applied Load in
$_t$ Total Load in
Weight of the gripper assembly in Kg
$_n$ Normal reaction
$_r$ Frictional resistance force
Force in
Tension in the wire

For Equilibrium of the body $_r = _n$ --------

f t ----------
Frictional Force is given by f= n
Substituting f n in Equation
n t
r t ……. n = r)
Total load
t a …….
t 70+1 71 (for Rubber 0.5 to 0.8)
r t
0.6r 118r 71
r 1160

Minimum wire rope diameter
t 1568 (t tensile strength of

steel wire rope in)

1568

For steel bar rope

r
(Resistance force developed on wire rope tension in the wire rope)

y 1568/2 t/2

y 784)

Working Stress maximum stress/Factor of safety

784/4 196

r y
1160 y
1160 4 196 X

6.3 Design Considerations

The product is capable of gripping the tree, climbing the tree to the required height. The areca tree climber unit LH/RH is as shown in the fig (4). It mainly consist of a T- gripper, peddle, gusset, rod handle support and box beam

Figure4: Areca tree main climber assembly Lh/Rh

The main assembly is divided into three sub assemblies

- T Gripper Assembly
- Pedal Assembly
- Box Beam Assembly

The product is completely designed and modeled in Uni-graphics NX7.5 package. The drawings are made using AutoCAD 2011 CAD package. Figure 5 shows the 3D model of the Areca tree climber with an identification of critical functional elements.

Figure5: T-gripper assembly

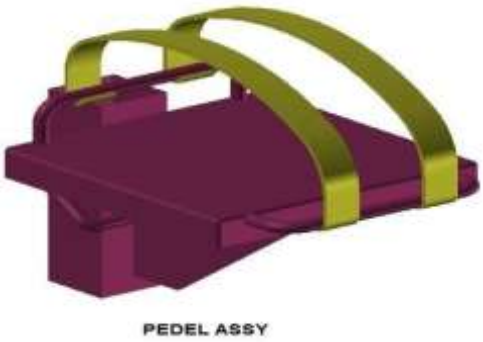

Figure6: Pedal assembly

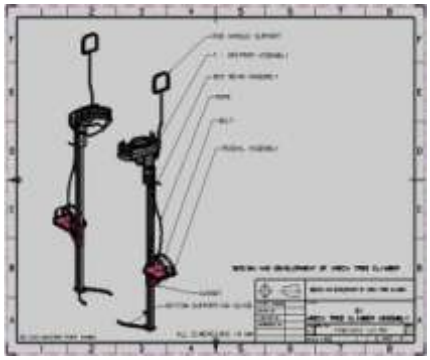

Figure 7. Product Implementations

8 Product Testing and Result

The prototype manufacturing is followed by the prototype testing and the results are tabulated as shown in table 3. The prototype was tested for concept verification; in an areca field at channenahalli, Bangalore. The Areca tree climber was initially positioned and fitted at the bottom of the areca tree which took about 1 minute. In the next step the person positioned on the climber and started climbing the tree and reached an height of 40ft in 3mins so totally the climbing product took an average time of 2 to 3 minutes to climb an height of 40m. The gripping of the product was tested at different heights of 10ft, 20ft, 30ft and at 40ft as the climber ascends the tree the diameter of areca tree reduces and the climbing product had good grip at all heights. The weight of the areca tree climbing unit LH is 2.5 kg and RH is 2.5 kg the totally it weighs 5 kg.

TABLE 3:Time taken to reach required height

Weight of person(kg)	Diameter of tree (mm)	Height reached (ft)	Time taken(min)
50-70	350	25	1.5
50-70	300	35	2.5
50-70	250	40	3

9 Conclusion

The product areca tree climber replace the common technology used today especially for areca trees. The Product can reach to any desired height without risk to a person or damage to the surface of the tree and harvest/spray chemicals at different angles without any risk. The price of the proposed device can be low enough for the climbers to afford. The device according to the present invention will be able to do the work faster, cheaper and much more safely for a much lower price.

After testing the prototype on an areca-tree climber the following points are achieved:

- The design is efficient in climbing the tree very smoothly without damaging the tree.
- The design is simple. An unskilled labour can operate the machine safely and efficiently.
- Climbing the single tree, an average of 15 to 20 trees can be harvested/sprayed.
- This project concludes that the areca-nut tree climber is a safe, reliable, efficient and which reduces the risk in climbing the areca -nut tree to a good extent.
- The design of the device is simple enough for villagers to operate, yet work efficiently to appeal to the majority.

10 Future Enhancement

- Weight of the product can be reduced by manufacturing the base using strong light weight material.
- Wheels can be used for easy movement of the climber on the tree.
- Automatic mechanism at affordable cost can be achieved.

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