Betel Tree Climber

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Abstract- *The people in rural areas of Karnataka and Kerala mainly depend on agriculture for their livelihood. The main crops grown are Betel nut and coconut. Skilled betel nut 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 betel nut 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.*

I. INTRODUCTION

Betel nut 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. Betelnut 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, betelnut 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 betelnut 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.

1.1Objectives of the project

In an attempt to assist the climbers, an betel nut 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 betelnut tree climber will be able to harvest faster than present methods.

1.2 Literature Review

Primitive methods of harvesting the betel crop need for a new device. An experienced climber takes about2-3 minutes alone just to climb the tree (this doesn't include cutting the coconuts and the return trip). In more developed areas, methods of harvest and betel nut removal involving rope-climbing gears and spiked shoes are used, but are impractical and inefficient for use in large scale plantation harvesting.. In addition to pitiable wages, harvesters are looked down upon for doing the country's "unwanted" jobs. Hardly anyone aspires to become a betel nut harvester because of the unsafe conditions, low income, and social stigma, resulting in a virtual vacuum in the job market. Furthermore, most betel nut harvesters are currently men. This is because of the traditional idea of it being a "man's job" as betel nut harvesting is extremely strenuous. The goal is to create a device that would also allow operation by women and older teenagers (as no hard labor would be necessary), thus creating an additional income opportunity for poor families.

II.DESIGN OF BETELNUT TREE CLIMBER

2.1 Bearing

A ball bearing is a type of rolling-element bearing which uses balls to maintain the separation between the moving parts of the bearing.The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. Usually one of the races is held fixed. As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were rotating on each other.

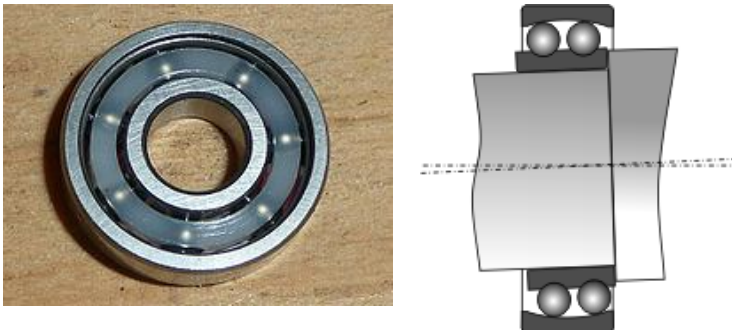


Fig 2.1.1: Ball bearing and self-aligning ball bearing

Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races..Self-aligning ball bearings are constructed with the inner ring and ball assembly contained within an outer ring that has a spherical raceway. This construction allows the

bearing to tolerate a small angular misalignment resulting from deflection or improper mounting.

2.2 Pulley

A pulley, also called a sheave or a drum, is a mechanism composed of a wheel on an axle or shaft that may have a groove between two flanges around its circumference. A rope, cable, belt, or chain usually runs over the wheel and inside the groove, if present. Pulleys are used to change the direction of an applied force, transmit rotational motion, or realize a mechanical advantage in either a linear or rotational system of motion. A belt and pulley system is characterized by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axes and, if the pulleys are of differing diameters, a mechanical advantage to be realized [4].

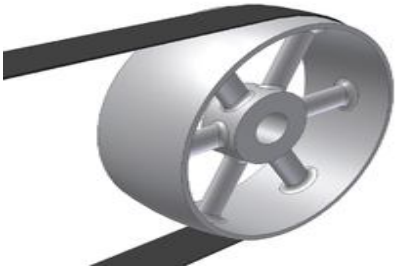


Fig 2.2.1: Pulley

2.3 Belt

A belt is a loop of flexible material used to link two or more rotating shafts mechanically. Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement. Belts are looped over pulleys. In a two pulley system, the belt can either drive the pulleys in the same direction, or the belt may be crossed, so that the direction of the shafts is opposite. Belts are the cheapest utility for power transmission between shafts that may not be axially aligned. Power transmission is achieved by specially designed belts and pulleys..They run smoothly and with little noise, and cushion motor and bearings against load changes, albeit with less strength than gears or chains.Belt drive, moreover, is simple, inexpensive, and does not require axially aligned shafts. It helps protect the machinery from overload and jam, and damps and isolates noise and vibration. Load fluctuations are shock-absorbed (cushioned). They need no lubrication and minimal maintenance. They have high efficiency (90-98%, usually 95%), high tolerance for misalignment, and are inexpensive if the shafts are far apart. Clutch action is activated by releasing belt tension. Different speeds can be obtained by step or tapered pulleys.

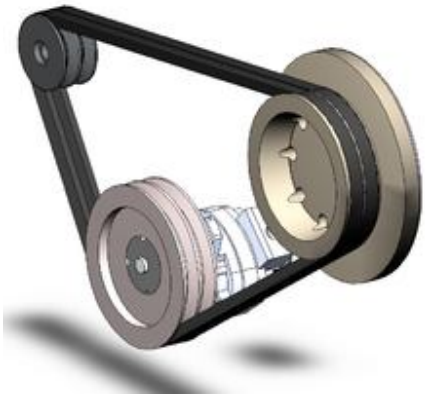


Fig 2.3.1: V-belt.

V belts (also known as V-belt or wedge rope) solved the slippage and alignment problem. It is now the basic belt for power transmission. They provide the best combination of traction, speed of movement, load of the bearings, and long service life. The V-belt was developed in 1917 by John Gates of the Gates Rubber Company. They are generally endless, and their general cross-section shape is trapezoidal. The "V" shape of the belt tracks in a mating groove in the pulley (or sheave), with the result that the belt cannot slip off. The belt also tends to wedge into the groove as the load increases — the greater the load, the greater the wedging action — improving torque transmission and making the vee belt an effective solution, needing less width and tension than flat belts. V-belts trump flat belts with their small center distances and high reduction ratios. The preferred center distance is larger than the largest pulley diameter, but less than three times the sum of both pulleys. Optimal speed range is 1000–7000 ft/min. V-belts need larger pulleys for their larger thickness than flat belts. They can be supplied at various fixed lengths or as a segmented section, where the segments are linked (spliced) to form a belt of the required length. For high-power requirements, two or more vee belts can be joined side-by-side in an arrangement called a multi-V, running on matching multi-groove sheaves. The strength of these belts is obtained by reinforcements with fibers like steel, polyester or aramid (e.g. Twaron or Kevlar). This is known as a multiple-belt drive. When an endless belt does not fit the need, jointed and link vee-belts may be employed. However they are weaker and only usable at speeds up to 4000 ft/min. A link v-belt is a number of rubberized fabric links held together by metal fasteners. They are length adjustable by disassembling and removing links when needed. [4]

2.4 Sprocket

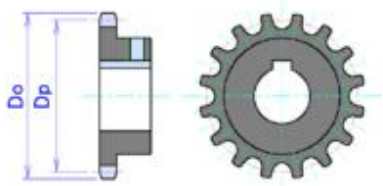


Fig 2.4.1: Sprocket.

A sprocket is a profiled wheel with teeth that meshes with a chain, track or other perforated or indented material. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley by not usually having a flange at each side.

Sprockets are used in bicycles, motorcycles, cars, tanks, and other machinery to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc.

2.5 Chain drives

Chain drives are positive drives so there is no slip. Hence the velocity ratio remains constant. Chain drives are suitable for small centre distances. Chain drives transmit power up to100KW and operating peripheral velocities up to 15 m/s. The velocity ratio can be as high as 8:1. A chain drive consists of a chain and two wheels, called sprockets. The sprockets are teethed wheels over which an endless chain is fitted [4].

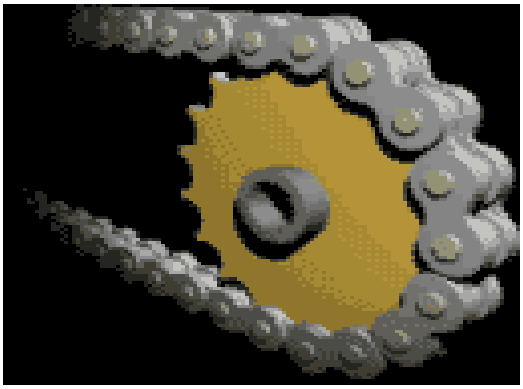


Fig 2.5.1: Chain.

The different types of chains used in power transmission are (1) Roller chain (2) Silent chain. Roller chains are the ones that are commonly used in bicycles, motor cycles, machine tools, etc. Silent chain is an inverted tooth chain which is extensively used for smooth and noiseless operations at low velocities.

2.6 Gearbox

Gearboxes, also known as enclosed gear drives or worm gear speed reducers, are mechanical power transmission drive components that can drive a load at a reduced fixed ratio of the motor speed. The output torque is also increased by the same ratio, while the horsepower remains the same (less efficiency losses.) A 10:1 gearbox outputs approximately the same motor output horsepower, motor speed divided by 10, and motor torque multiplied by 10. Similar performance metrics are provided by 20:1 gearboxes and other ratios.Worm gearboxes contain a worm-type gear on the input shaft, and a worm-type mating gear on the output shaft. Worm gearboxes also change the drive direction. With a single start worm, for each 360° turn of the worm, the worm-gear advances only one tooth of the gear. Therefore, regardless of the worm's size (sensible engineering limits notwithstanding), the gear ratio is the "size of the worm gear - to - 1". Given a single start worm, a 20 tooth worm gear will reduce the speed by the ratio of 20:1. With spur gears, a gear of 12 teeth (the smallest size permissible, if designed to good engineering practices) would have to be matched with a 240 tooth gear to achieve the same ratio of 20:1

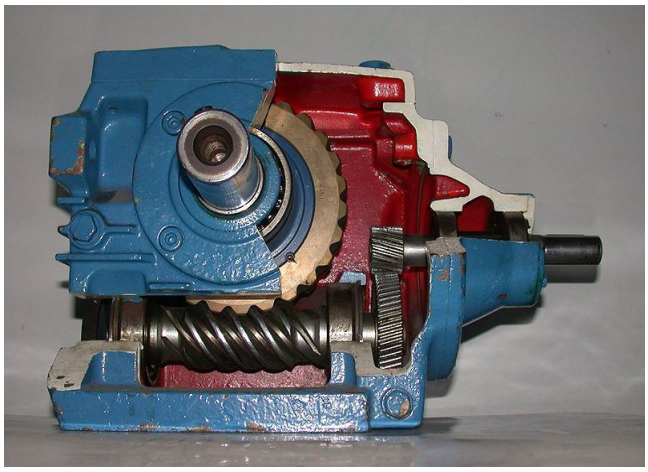


Fig 2.5.6: Gear box.

Therefore, if the diametrical pitch (DP) of each gear was the same, then, in terms of the physical size of the 240 tooth gear to that of the 20 tooth gear, the worm arrangement is considerably smaller in volume.There are three different types of gears that can go in a worm drive.

The first are non-throated worm gears. These don't have a throat, or groove, machined around the circumference around either the worm or worm wheel. The second are single-throated worm gears, in which the worm wheel is throated. The final type are double-throated worm gears, which have both gears throated. This type of gearing can support the highest loading.

III.SELECTION OF MATERIALS

3.1 General

The main parts of the Motorised betelnut 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.

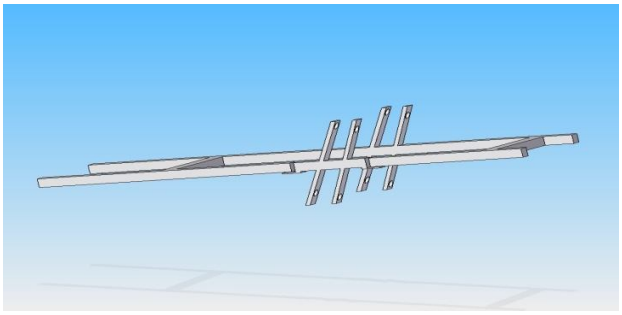


Fig 3.2.1: Base

3.3 Roller

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.

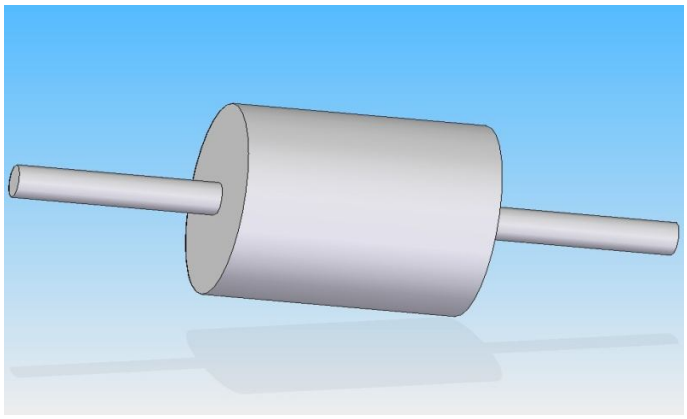


Fig 3.3.1: Roller

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.

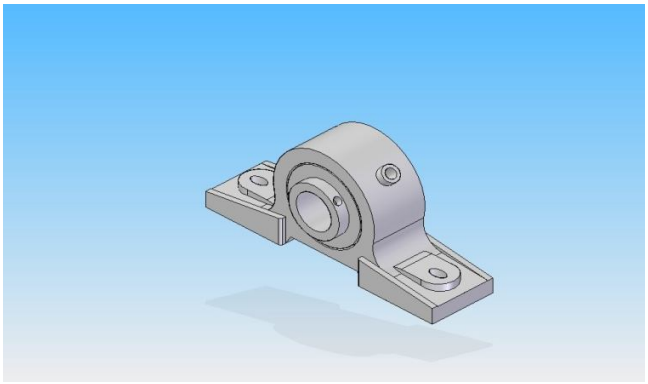


Fig 3.4.1: Bearing

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.

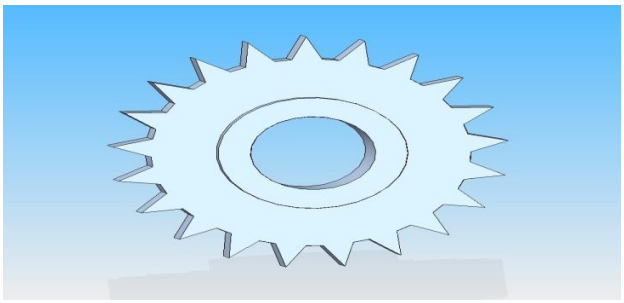
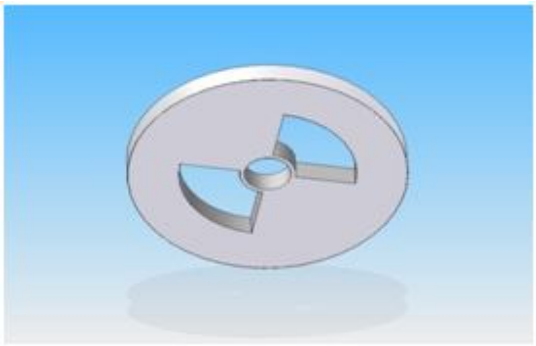


Fig 3.5.1: Sprocket

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.



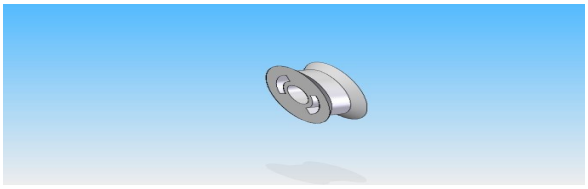


Fig 3.6.1: Pulley

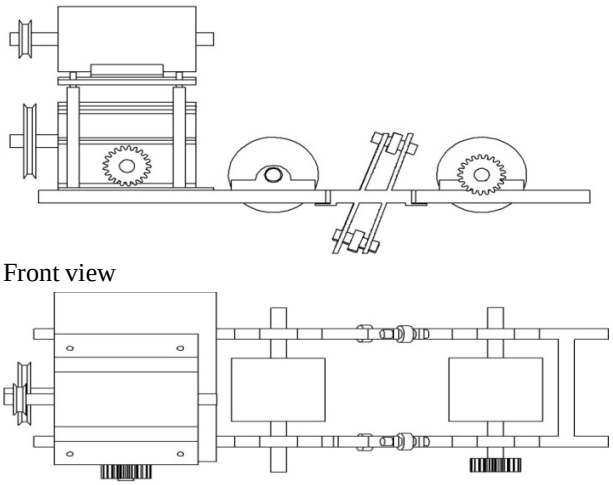
3.7 Motor

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.

V.WORKING PRINCIPLE



Front view

Top view - Orthographic views of Motorised Betelnut tree climber

5.1 General

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.

5.2 Methodology

Here we are designing and fabricating motorized betelnut 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 betel 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.

5.3 Summary

The working principle explained in this chapter helps the common man to understand the working of Betelnut tree climber. This chapter is also like a user manual.

VI.CONCLUSION

After testing the prototype on an betel 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 betelnut tree climber is a safe, reliable, efficient and automatic tree climber which reduces the problems in climbing the betelnut tree to a good extent.

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