DESIGN AND FABRICATION OF TREE PRUNING MACHINE

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ABSTRACT
The design and fabrication of tree pruning machine is presented in this paper. The device consists of rectangular frame of mild steel material which supports all the components to be built upon. It is fitted with two drilling machine motors, four wooden rollers with rubber grippers. A stationary stainless steel blade is mounted on the frame. Power is supplied to the motors and the movement of the machine is controlled by a remotely controlled electromagnetic switch called relay controller. A spring loaded mechanism is provided to give flexibility to the machine while climbing the tree. The device has been tested and found it safe, reliable and efficient. Hence, it reduces the problem in climbing and cutting the branches of the tree.

Keywords: rectangular frame, drilling machine motors, wooden roller, spring

INTRODUCTION
There are more than 100,000 species of trees globally. But few of them offer the strength and beauty suitable for fine cabinetry and furniture, and only handful are used in furniture making. Such furniture trees used are oak, alder, mahogany, teak, redwood, pinewood, etc.

Tree pruning is necessary to produce and maintain healthy, aesthetically pleasing plants. Accomplishing this objective requires proper methods, techniques, and tooling. Branches of the trees are considered as one of the safety hazard. If it is not cut frequently, it may lead to property damage to vehicles, falling on electric cables and also endangers human life. At first, traditional methods to cut the branches of the trees are introduced which was time consuming and manual labour cost was high. Later modification was done which has eased the burden of farmers.

Yasunaga Suezaki[1]developed a tree pruning machine having an elevating body detachably mounted to a standing tree and a cutting unit detachably mounted on the body and capable of rotating around the periphery of the body comprising at least three sets of wheel units mounted on the body and capable of moving radially towards and away from the tree, each including a plurality of upper and lower wheels for elevating the body vertically on the tree, an interlocking mechanism for interlocking the wheel units to each other for simultaneously moving the wheel units by the same radial distance, and a pressure equalizing mechanism having springs for biasing the wheels of the respective wheel units equally against the surface of the tree. Thus, even if the tree T varies in diameter, the pruning machine A cuts the branch t at the root while stably and reliably climbing the tree T and automatically descends the tree T when the tree pruning work is finished.

K.M. Ismail and K.A. Al Gaadi developed (2006) [2] developed to mechanize the pruning operation conducted on the petioles of the palm trees. The performance of the machine was tested in the laboratory on petioles at different petiole moisture content (MC). Power, energy and time required for cutting were the three criteria considered to evaluate and test the machine’s performance. The results showed that both energy and time required for cutting were proportional to the petiole MC.

A project was conducted by the students of the college KLE DR. M S SHESHGIRI COLLEGE OF ENGINEERING AND TECHNOLOGY [3], about the design and fabrication of portable tree pruning machine. It is developed to lessen the human effort and efficiently. This machine is portable and can be carried easily to the point of application. It is carried and controlled by humans i.e. there is human involvement to control it.

The main purpose for introducing this machine is to cut the branches of the furniture trees trunk of the tree is given importance for making furniture. Cutting the branches hence provide necessary nutrients for the growth of trunk. By introducing the tree pruning machine, it helps to maintain aesthetically pleasing plants. It requires less time and maintenance cost is less. It doesn’t require skilled labours i.e. setting up and running the machine doesn’t involve human effort. The machine is fast and reliable and doesn’t require skilled operators to do the process. The speed and the operation of the tree pruning machine is controlled and adjusted by the relay controller.

MACHINE DESCRIPTION

The developed tree pruning machine shown in fig. 1 with its dimensions illustrated in fig. 2 was designed so that the burden of the farmers to cut the branches of the tree can be reduced. The total weight and size of the machine are considered in designing the machine. The weight and of the machine were maintained at 12kg. The machine was designed utilizing two universal drilling machine motor with a power of 650W at 2900rpm. The motor is used to run the roller by transmitting power to bevel gear which in turn runs the roller. Here 4 rollers are used to climb the tree and power is given to the diagonal opposite roller to avoid slip while climbing. The machine is having a frame which is of two equal halves and is fitted together by bolts. Springs are provided so that the frames of the body are more in contact with the tree.

The material used for the machine’s frame is mild steel because of excellent machinability. Here a sharp stationary stainless steel blade of equal halves are employed to cut the branches of the trees. With the help of drilling motors to drive the rollers, at high speed the branches of the trees are cut off.
CALCULATIONS

1. CALCULATING THE FORCE

Assuming weight of the machine, W = 12 kg

\[ W = 12 \times 9.81 = 117.72 \text{ N} \]

Assuming coefficient of friction between tree and wheels, \( \mu = 0.3 \)

Actual force to be lifted, \( F = \frac{W}{\mu} \)

\[ F = \frac{117.72}{0.3} = 392.4 \text{ N} \]

Therefore, limiting friction is equal to weight acting on the machine.

2. CALCULATING THE TORQUE

Calculating motor torque

Torque, \( T = \text{Force} \times \text{Radius} \)

\[ T = 392.4 \times 0.06 = 23.544 \text{ Nm} \]

3. CALCULATING MINIMUM TORQUE TO LIFT THE MACHINE

Assuming acceleration due to gravity to lift the machine, \( g = 12 \text{ m/s}^2 \)

Torque = \( m \times g \times r \)

\[ T = 12 \times 12 \times 0.06 \]

\[ T = 8.64 \text{ Nm} \]

SPECIFICATIONS AND FUNCTIONS OF PARTS

1. Motors

Two drilling machine motors are utilised in this machine to drive the roller which are placed diagonally opposite to each other to avoid slip condition. Universal motor is employed in this machine. It is meshed with a gear which drives it and in turn drives the rollers. Specifications are given below

Power, \( P = 650 \text{ W} \)

Voltage, \( V = 220 \text{ V} \)

Speed, \( N = 2900 \text{ rpm} \)

2. Rollers

In this machine four rollers are employed. The roller used is of a wooden material. The rollers are of two hemispherical cup shapes with rubber grippers are placed on it. Two wheels which are diagonally opposite to each other are driven so that the slip conditions are avoided.

3. Relay controller

Power is supplied to the motor. The speed and the movement of the machine are controlled by a
remotely controlled electromagnetic switch called relay controller. Two switches are provided to control the upward and downward motion of the roller. Speed regulators are employed to regulate the speed while climbing the tree.

4. Cutters

A sharp stationary cutter of stainless steel material is employed and placed on the machine. The designed machine climbs the tree and the cutter cuts off the branches due to the speed of climbing the machine.

5. Gear

Bevel gear is used in this machine. Bevel gears are mounted on the shafts that are 90 degree apart. Drilling machine's gear is meshed with another gear which is 90 degree apart to drive the roller.

RESULT

Based on the designed tree pruning machine, testing was conducted. By introducing this machine, it was found that the branches are cut off thus reducing the time required to do the same when manually employed. It has been efficient and reliable thus avoiding the dependence of manual worker.

CONCLUSION

In our opinion, tree pruning machine serves as the apt solution to cut the branches without the requirement of skilled operator to do the same. The risk of safety hazard can be reduced to minimum such as branches falling on the electric wires, property damages such as falling on cars and affect life of humans. Hence time required to climb and cut the branches are reduced.

FUTURE SCOPE

This machine can be made more flexible by using springs of higher stiffness. By employing high stiffness spring, it gives the machine more flexibility for climbing different types of tree. Introducing a rotary cutter and climbing the tree at slow speed, branches of higher thickness can be cut off. Thus this machine can be used widely.

REFERENCE


[5] Variable stiffness type magnetic vibration absorber to control the vibration of beam structure, FB Sayyad and ND Gadhave