



# Performance And Analysis of Battery-Operated Dual Axis Adjustable Plant Trimming Machine

Muthusamy K<sup>1\*</sup>, Dharshini V<sup>2</sup>, Ameer abdullah<sup>3</sup>, Kaviyasharonprincy<sup>4</sup>, Deenathayalaraja C<sup>5</sup>

<sup>1\*</sup>Assistant Professor, Department of Agricultural Engineering, Sri Shakthi Institute Engineering and Technology

<sup>2,3,4,5</sup>Students, Department of Agricultural Engineering, Sri Shakthi Institute of Engineering and Technology

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## ARTICLE INFO

## ABSTRACT

The cost of maintaining gardens on owned and public property is rising these days. In India two types of plant trimming methods are followed, like manual method and mechanized method. The traditional ways of garden trimming requiring manual labour are becoming obsolete. Manually about 10 to 15 labours are required for trimming an acre of plants. This paper depicts the development of battery operated adjustable plant pruning machine for ornamental plants and plants on divider of highways, that helps operator having effortlessness of work. In general, manually operated trimmers were just like simple and most common type is shearing of scissors. Manually operated trimmers need more time and effort from the operator because they are heavier and require more work to get to the proper height. The uniformity of trimming varies from one operator to another operator. Different operator will cut in different way. The main dictum is to trim the plants efficiently and reduce the drudgery to workers. In this work, a wheeled form trimming machine was mainly composed of three parts: a supporting frame, an adjustable system and blades. This machine consists of two blades, horizontal and vertical position. And the blade can be able to adjust up to 3 feet in both the directions. Furthermore, to test the efficiency of the machine, three different plants were chosen and trimmed by the machine and results showed that the overall efficiency was above 89%. As a result, the newly created trimming machine could precisely and adaptably satisfy the needs of plant trimming.

**Keywords:** Battery operated, Garden trimming, Ornamental plants, Trimming machine, Horizontal, Vertical

## 1. INTRODUCTION

In past and even now the manual trimming method is time consuming and human effort is needed for cutting<sup>[1]</sup>. Due to the high labour consumption, inefficiency and dangerousness to operations staffs, the traditional manual trimming cannot satisfy the requirement of the current trimming work in highways and in other places<sup>[2]</sup>. In-order, to reduce the time consumption and physical effort of operators machines were used widely<sup>[2]</sup>. The equipment's and machines which are used for gardening purpose and in nurseries are pruners or hedge trimmer machine<sup>[2]</sup>.

Currently, sanitation personnel are responsible for maintaining park plants, road green belts, decorative plants, and green plants on highways with the help of hand-held and backpack hedge trimmers<sup>[3]</sup>. According to statistics, trim quality requirement for an experienced worker varies from 50 to 60 square hedge per hour<sup>[4]</sup>. Many operators feel difficult to operate manual trimmers as the operator requires more efforts to lift the trimmer at suitable height and it's having very heavy weight hence, uniformity of cutting varies from one operator to another<sup>[1][5]</sup>. The operator has to be cautious while working because, the trimming results are closely related to the workers' operating experience<sup>[5]</sup>. Manual hedge trimmers are designed as large scissors or large pruning shears<sup>[6][9]</sup>. They do not need anything to operate and are cheapest/most environmental friendly but it requires more time<sup>[6][9]</sup>. Alternatively, Motorized hedge trimmers were designed to work faster and with less effort than manual ones<sup>[6]</sup>. Their cutting mechanism is similar to that of finger bar mower<sup>[6]</sup>. For hedge

trimming we need extra labour. Because of this the costing and work time increases and labours suffering from back pain so there is need to design a machine for trimming<sup>[6][9]</sup>.

Two essential parameters for designing a cutting machine for any material the cutting mechanism and the cutter blade design<sup>[11]</sup>. The reciprocating saw imitates the typical hacksaw's back and forth motion<sup>[11]</sup>.

Reciprocating saws, cold saws, universal tilt frame band saws, horizontal endless band saws, and abrasive saws are examples of common cutting machine types<sup>[11]</sup>. The reciprocating saw's gearing mechanism will move the saw blade back and forth across the material to be cut<sup>[11]</sup>. Faster cutting mechanism, better finishing, closer tolerances are the advantages of using rotary saw method<sup>[11]</sup>. With all these information and thoughts, battery operated adjustable plant trimming machine has been developed in this research work. This focusses on the as it possesses the highest uniformity of trimming of ornamental plants and highway plants. The fabricated machine is very convenient for the operator's usage.

## MATERIALS AND METHODS:

### 2.1 Components of machine

The battery operated adjustable plant trimming machine consists of the following components to full fill the requirement of complete operations of the machine.

#### 2.1.1 Battery

The machine is equipped with a rechargeable lithium-ion battery(12v), which provides the electrical energy required for operation. The battery is charged using an external power source when it runs out of power.



Fig .2.1 Battery

#### 2.2 Battery holder

A battery holder in a machine is a component or device used to securely hold one or more batteries in place within an electronic or mechanical device. The primary purpose of a battery holder is to securely retain the battery or batteries in a fixed position within the machine. This prevents the batteries from moving or shifting during operation, which could lead to electrical interruptions or damage. Battery holders are designed for easy battery replacement. They allow users or technicians to remove and replace batteries without soldering or other complicated procedures, which is particularly useful for maintenance and reducing downtime. They are an essential part of these machines, providing a convenient and reliable means to power them with batteries

#### 2.3 Blade

Blades are made from stainless steel due to its corrosion resistance and durability. Some blades feature a non-stick coating to prevent sap and other plant debris from sticking to the blade, making it easier to clean and reducing the risk of disease transmission between plants. These blades have serrated edges that grip the plant material, making it easier to cut through thicker branches. Regular cleaning, sharpening, and lubrication are essential to keep plant cutting blades in optimal working condition and to extend their lifespan.



Fig.2.2 Blade

## 2.4 Bearing blocks

Bearing blocks, also known as bearing housings or pillow block bearings, are mechanical components used to support and facilitate the rotation of a shaft or axle in various machinery and industrial applications. These blocks are designed to hold and secure a bearing, which in turn allows for smooth and controlled movement of the shaft. Bearing blocks are typically made of metal or other sturdy materials. They are designed to be rigid and robust to support the load and maintain the alignment of the rotating shaft. They consist of two main parts: the housing and the bearing insert. The housing is the outer part that provides the structural support, while the bearing insert, which is usually a ball bearing or roller bearing, allows the shaft to rotate with minimal friction. Bearing blocks are typically mounted on a base or support structure using bolts, screws, or other 19 fasteners. They are essential in situations where precise shaft alignment, support, and minimal friction are required for the machinery to function efficiently and reliably.

## 2.5 DC Motor

A DC (Direct Current) motor is an electrical machine that converts electrical energy into mechanical energy by using the magnetic fields generated by the flow of electric current. DC motors are widely used in various applications because of their simplicity, reliability, and ease of control. They can be found in a wide range of devices, from small toys and household appliances to industrial machinery and automotive systems. DC motors can be controlled by adjusting the voltage supplied to them. Higher voltage typically results in higher speed. Speed and direction can be controlled through various methods, including pulsewidth modulation (PWM) and feedback control systems.



**Fig.2.3DC Motor**

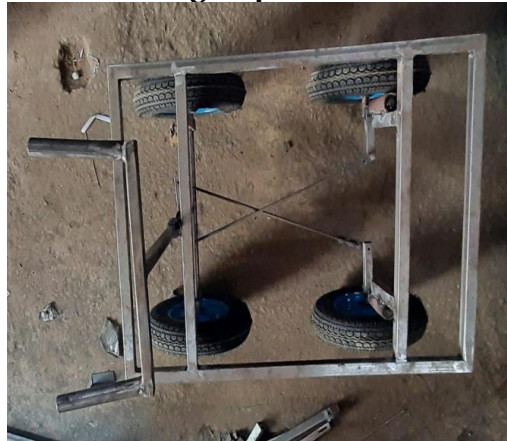
## 2.6 Gears

Gears are mechanical components used in machines to transmit and modify motion, torque, and speed. They are widely employed in a variety of applications, from simple hand-cranked devices to complex industrial machinery. Gears consist of toothed wheels that mesh together to transfer power from one part of a machine to another.

## 2.7 Frame

The frame is the major structure which consists of DC motor, bearings and blades are fixed. This is made of mild steel material. Provisions are made to cover the bearings with grease. The machine frame, which is fabricated from mild steel parts, is torsion resistant machine cell used to house all the components. The frame will provide better resistance to vibrations. It is found that framed structure can resist vibrations effectively.



**Fig .2.4 Frame****Fig .2.5 Frame**

### 2.8 Mild steel pipe

A mild steel pipe is a type of steel pipe that is made from mild or low carbon steel. It is a popular choice for various applications due to its durability, affordability, and ease of fabrication. Mild steel pipes are primarily composed of iron (Fe) and a relatively low percentage of carbon (typically less than 0.3%). Small amounts of other elements like manganese, silicon, and traces of impurities may also be present. Mild steel pipes are known for their strength and durability. They can withstand a wide range of mechanical stresses. One of the key advantages of mild steel pipes is their excellent weldability.

### 2.9 Mild steel shaft

Mild steel shafts are made from low carbon steel, typically containing less than 0.3% carbon along with other alloying elements such as manganese, silicon, and traces of impurities. The low carbon content makes mild steel easy to weld, shape, and machine. Mild steel shafts exhibit a balance of strength and ductility. Mild steel shafts are relatively easy to fabricate, cut, shape, and machine using common tools and techniques. This ease of fabrication makes them suitable for applications that require customization and precision. Mild steel shafts are versatile and widely used mechanical components due to their ease of fabrication, strength, and affordability.

### 2.10 Switches

These 6A 250V AC switches are essential components in electrical systems, providing a means to control power to various devices and circuits. When selecting a switch for a specific application, it's crucial to consider factors like the current and voltage requirements, switch type, and contact configuration to ensure compatibility and safe operation.

**Fig .2.6 Switches**

### 2.11 Wheel

Wheel, a circular frame of hard material that may be solid, partly solid, or spoked and that is capable of turning on an axle.

### 2.12 Wiper motor

The core of the wiper motor is an electric motor that generates the mechanical power needed to move the wiper blades. This motor is usually compact and designed to fit within the vehicle's engine bay. Most wiper motors

offer multiple speed settings or variable speed control, Wiper motors are connected to the vehicle's electrical system, receiving power through a relay, switch, and wiring. They may also include safety features



**Fig .2.7 Wiper motor**

### **2.13 Wires**

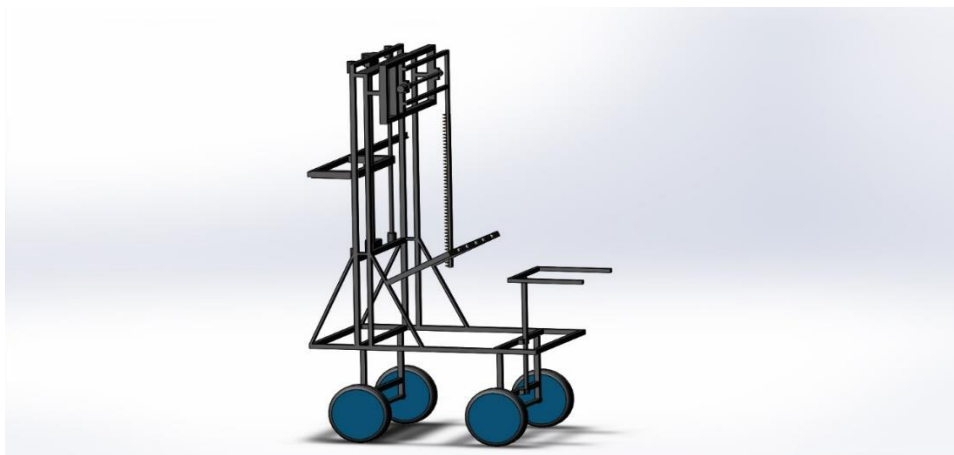
Electrical wires are typically made of a conductor material that offers low resistance to the flow of electric current. Electrical wires are vital components of electrical systems, serving as conduits for the flow of electric current. They come in various types and are selected based on their materials, sizes, insulation, and intended applications to ensure safe and efficient electrical transmission.

## **3.DESIGN OF THE MACHINE**

The conceptual design and isometric view of plant trimming machine were done with SolidWorks software and it is analysed and the conceptual design is shown. The isometric view of the plant trimming machine is shown in Fig.3.1 & 3.2



**Fig 3.1 Front view of the machine**



**Fig 3.2 Overview of the machine**

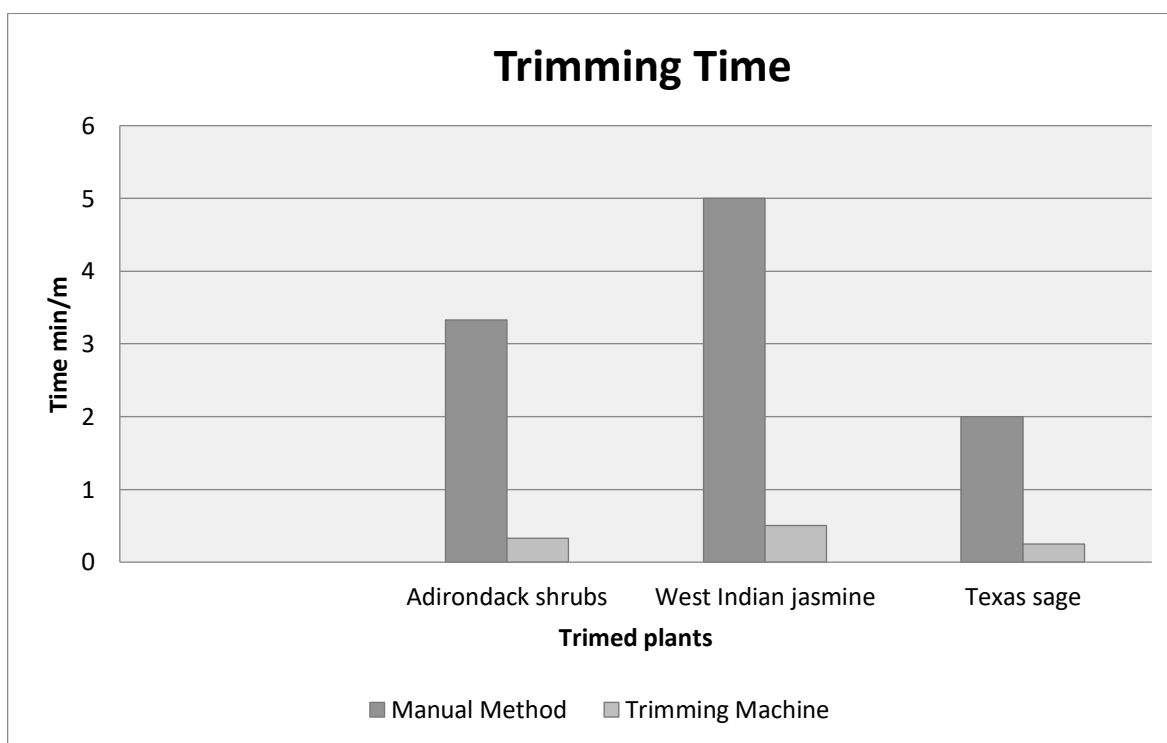
#### 4. WORKING PROCEDURE

A battery-operated dual axis adjustable plant trimming machine works on the principle of converting stored electrical energy from a battery into mechanical energy to drive the cutting mechanism. The machine is equipped with a rechargeable lithium-ion battery(12v), which provides the electrical energy required for operation. The battery is charged using an external power source when it runs out of power. Inside the machine, there's an DC motor that serves as the primary source of mechanical power and a wiper motor is used for enabling back and forth motion of blades. When the machine is turned on, the motor receives electrical energy from the battery. The motor drives a transmission system, which consist of gears and toggle switches. This transmission system is responsible for transferring the rotational motion from the motor to the cutting mechanism. Five toggle switches are mounted on the frame for cutting and adjusting operations. First switch is used to initiate the operation of the machine. The second switch initiates the vertical motion blade, while the third switch activates the horizontal motion blade, allowing for back-and-forth movement. The fourth switch is used for adjusting the width of the vertical blade, while the fifth switch is used for adjusting the height of the horizontal blade.

#### 5. TESTING AND ANALYSIS

S.no	Name of the plant	Trimming Time(min/m)	
		Manual method	Trimming machine
1	Adirondack shrubs	3.33	0.33
2	West Indian jasmine	5	0.5
3	Texas sage	2	0.25

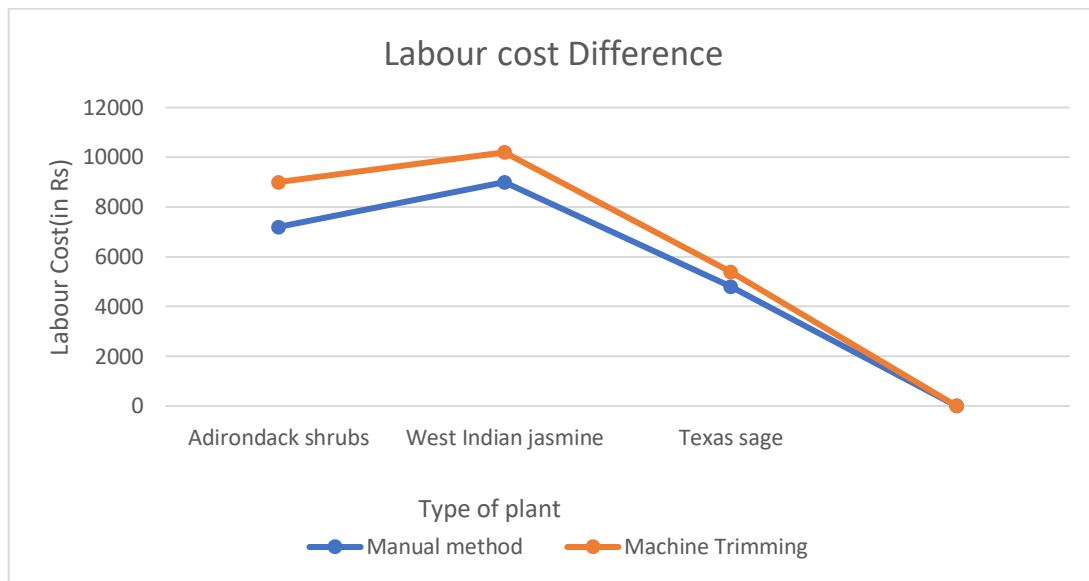
**Table.1 Comparison of trimming time between manual method and trimming machine**



**Fig 5.1 Comparison of pruning time**

S.no	Name of the plant	Labour cost(Rs/day) (for 2km)	
		Manual method	Trimming machine
1	Adirondack shrubs	7200	1800
2	West Indian jasmine	9000	1200
3	Texas sage	4800	600

**Table.2 Comparison of labour cost between manual method and trimming machine**



**Fig 5.2 Comparison of labour cost**

**Manual Method**

**Trimming Machine**



**Fig 5.3 Comparison of uniformity**

## 6. RESULT AND DISCUSSION

A battery-operated plant trimming machine could potentially increase efficiency compared to manual trimming methods. A comprehensive assessment would need to be conducted to evaluate the overall cost-effectiveness of implementing battery-operated trimming machines compared to traditional methods. This analysis would consider factors such as the initial investment cost, ongoing maintenance expenses, labour savings, and potential increases in productivity and yield. Conclusion, while battery-operated plant pruning machines hold promise for improving efficiency, reducing labour costs, and enhancing precision in pruning operations. Additionally, ongoing technological advancements may continue to improve the performance and capabilities of such machines in the future.

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