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Design and Fabrication of Sugarcane Harvester with Solar and Electric Power Integration

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Abstract: As a result of the world's enormous population, there is a need for large-scale agricultural product production. In India, agriculture is the main industry. There is a manpower shortage in agriculture in India. The need for agricultural products is rising daily, and because of the world's vast population, farm products must be produced on a massive scale. This is why labor wages are rising daily. The goal of this project is to create a small-scale sugarcane harvesting machine through design and construction. Reducing farmer labor and increasing agricultural product production are the primary goals. The device is made up of a battery, cutter, electric motor, solar panel, and various other systems. Utilizing this machine has been more efficient than harvesting by hand.

Index Terms **- Cutter, harvester, solar panel, DC motor, sugar cane, etc.**

INTRODUCTION

The scarcity of agricultural labor, both during peak working seasons and during regular times, is one of the major issues facing India's agriculture industry. This is because there are more high-paying non-agricultural job options and labor migration. The low position of agricultural laborers in society and their forced migration to cities. The largest crop in the world to grow is sugarcane. According to estimates from the Food and Agricultural Organization (FAO), 1.69 billion tons of sugarcane were harvested globally in 2010 from over 23.8 million hectares planted across over 90 countries.

India has the top spot in the world sugarcane production rankings, followed by Brazil. The act of cutting and collecting mature crops from the field is known as harvesting. A machine called a harvester is utilized. Due to its high sucrose content and ability to produce useful byproducts like molasses and bagasse (waste fibrous residue), sugar cane is a resilient crop that is grown in tropical and subtropical regions. The plant produces clusters of 1.25–7.25 cm prolonged, cylindrical stalks. In circumference and rising to a height of 6 to 7 meters. Cane stalks develop vertically until they are too hefty to support themselves. After then, it lies on its side and keeps expanding upward. As a result, a mature cane field develops a mesh pattern where it lies atop itself

Sugar is the primary product of sugar cane; liquor can be made by fermenting and distilling the residue. Bagasse is another byproduct; it is the leftover cellulose material from pressing that can be used as fuel and to make paper. The growing shortage of food for human use is not the only issue facing the sugar cane sector. Certain types of sugar and remnants of sugar give animals wholesome supplemental food, and the unprocessed ingredient and its byproducts are used to make a variety of economically significant items.

In areas where hand harvesting prevails, many of the injuries are machete related. These injuries can range from minor cuts to the severing of body parts. Also, the machete is the tool that is most commonly used by the less skilled workers on the farm or plantation. Keeping the machete sharp aids in reducing injuries, since with a sharp machete the worker does not have to swing as hard and can maintain better control over the machete. Working with cane also can causes injuries and cuts to the eyes. Since cane is grown in tropical and sub-tropical locations, workers also need to be concerned about heat-related health problems. This can be reduced by using the necessary protective clothing. These regions are also areas of high levels of sun exposure, which can result in various types of skin cancer conditions. Precautions need to be taken to limit or protect against sun exposure.

LITERATURE REVIEW

T. Moontree et al. [1]: This research paper focuses on the development of sugarcane harvester using small engine for farmers who are encountering problems of labor shortage. It is operated by 180 hp (134.28 kW) at 2500 rpm. Sugarcane was harvested for 12 months after planting with an average-stalk length of 1.8 m and average stalk diameter of 0.0254 m; each clump consisted of 8 to 12 stalks, the distance of each sugarcane row was 1.20 m.

Adarsh J Jain et al. [2]: They found that the mechanization of small-scale Sugarcane harvesting machine Different parts of a machine will be mounted on strong chassis. The wheels will be attached to this chassis so that it can be moved in the farm. The petrol engine is mounted on the chassis which provides the power to the wheels to move by means of a gear and chain mechanism and it also provides the power to the cutter. The shaft of the gear box and the shaft which is connected to the wheels are inter connected by means gear and chain mechanism to provide variable speed.

N.M. Pachkhande et al. [3]: This paper highlights the mechanization of small-scale Sugarcane harvesting machine. Different parts of a machine will be mounted on strong chassis. The wheels will be attached to this chassis so that it can be moved in the farm. The machine is pushed through the field manually to perform cutting action. The guides/ram is provided in front of machine to lift abruptly grown sugarcane.

Rohit J. Masute et al. [4]: This paper deals with the Chopper Harvester to cut the sugar cane at the base and then it is fed into the harvester where the cane is cut again into shorter pieces called billets with a size 20-40 cm. Harvesting using a Chopper Harvester will be more profitable than whole stalk Harvester under certain conditions. The process for a single unit of sugar cane chopper harvester generally be described as follows.

H. Taghijarah et al. [5]: This research was carried out to determine the effect of loading rate and internode position on shearing characteristics of sugar cane stalk. The experiments were conducted at three loading rates of 5, 10, and 15 mm min-1 and at ten internode positions down from the flower. Based on the result obtained, loading rate had significant effect on the shear strength and specific shearing energy of the stalk.

3D VIEW OF THE MODEL

Designing an electric sugarcane harvester using SolidEdge entails a meticulous and multi-stage process. It commences with a thorough conceptualization phase, where the requirements and operational parameters of the harvester are scrutinized against existing technologies and user needs. Sketching and initial design translate these insights into tangible layouts and schematics, offering a foundational blueprint for the subsequent digital modeling. In SolidEdge, each component is meticulously crafted using an array of 3D modeling tools, with considerations ranging from geometric precision to material properties and manufacturability. Assembling these components within the software involves intricate alignment and integration, ensuring seamless functionality. Furthermore, motion simulation tools enable engineers to validate the design's dynamics and optimize performance. Detailed documentation, including annotated drawings and assembly instructions, serve as a comprehensive guide for fabrication. Through this systematic approach, SolidEdge serves as a robust platform for the end-to-end development of an electric sugarcane harvester, ensuring not only its conceptual viability but also its practical realization with utmost precision and efficacy.

TOP, FRONT & SIDE VIEW OF THE MODEL

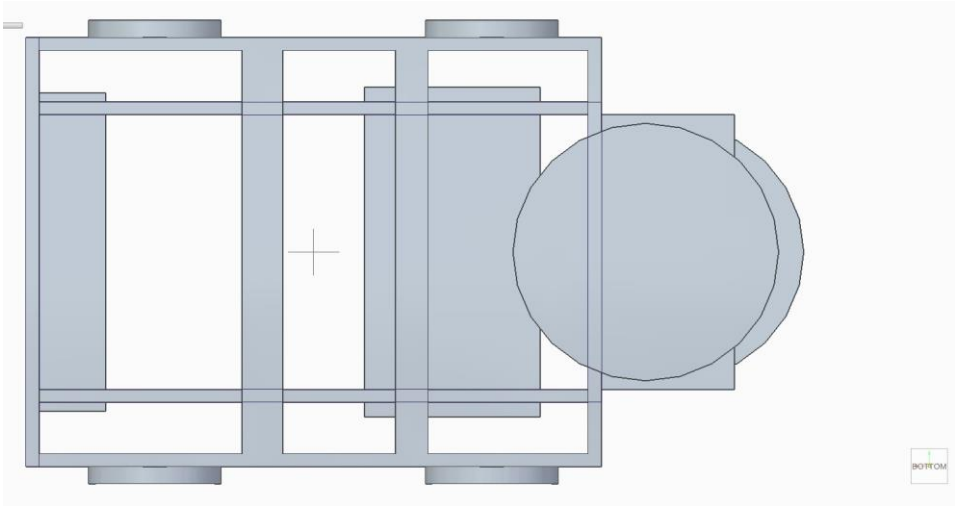


Figure: Top View

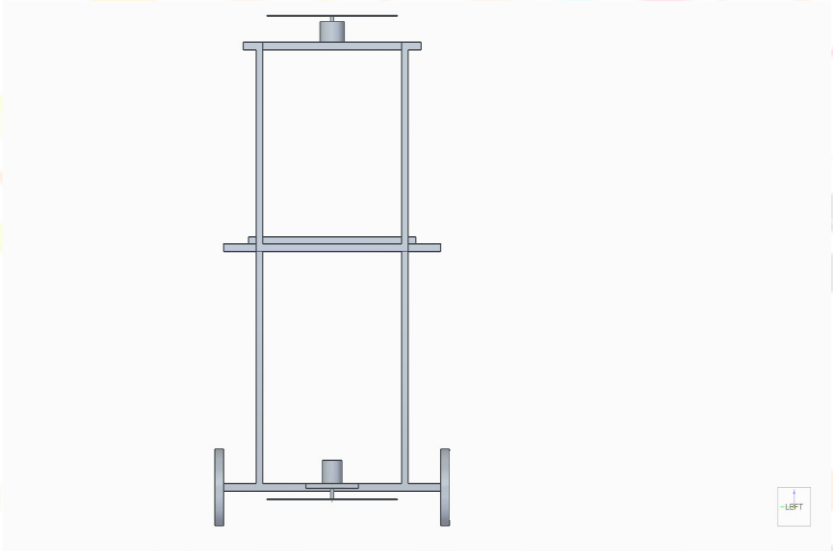


Figure: Front View

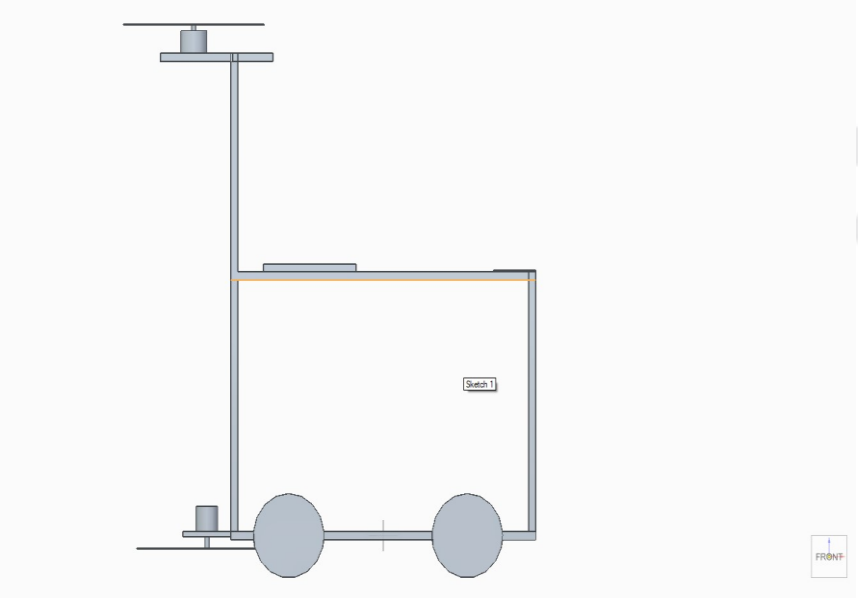
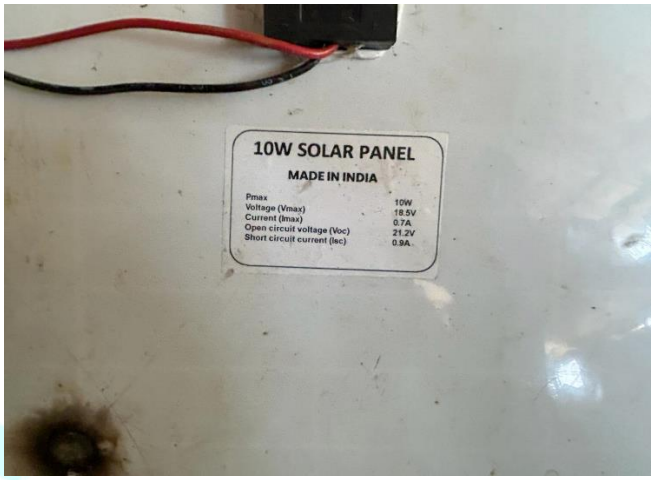


Figure: Side View

INDIVIDUAL PARTS AND SPECIFICATION

SOLAR PANEL



A solar panel, also known as a photovoltaic (PV) panel, is a device that converts sunlight into electricity using semiconductor materials. These panels typically consist of multiple solar cells interconnected within a frame. When sunlight strikes the surface of a solar panel, it excites electrons within the semiconductor material, generating an electric current. This direct current (DC) electricity can be used to power electrical devices directly.Our harvester incorporates a 10W solar panel, generating 18.5V and 0.7A of power to sustain its operations.

SOLAR CHARGE CONVERTER

A solar charge controller is a device that helps manage the charging of batteries in solar power systems. It's like a traffic cop for electricity, making sure everything flows smoothly. When sunlight hits solar panels, they generate electricity, but this can vary. The charge controller regulates this electricity, ensuring the battery gets just the right amount of charge without getting overcharged or drained. The harvester is equipped with a 12V/24V, 20A solar charge controller, regulating the flow of energy from the solar panel to the batteries for efficient power management.

DC MOTOR & CUTTER

A DC motor is a type of electric motor that runs on direct current (DC) electricity. It converts electrical energy into mechanical energy, generating rotational motion. When electricity is supplied to the motor, it creates a magnetic field in the stator, which interacts with the magnetic field of the rotor, causing it to rotate. The harvester utilizes a 12V DC motor with specifications of 10.5A and 130W, providing reliable power for its operation.

CUTTER

The cutter of a sugarcane harvester is a critical component responsible for harvesting the sugarcane stalks from the field. It typically consists of a series of rotating blades or discs that cut the sugarcane stalks at the base, separating them from the roots and foliage. These blades or discs are powered by the harvester's engine or a separate hydraulic system, allowing them to efficiently slice through the dense cane fields. The design of the cutter may vary depending on factors such as the size and type of sugarcane being harvested, as well as the specific requirements of the harvester. The harvester features a cutter with a diameter of 12 cm, ensuring precise and efficient cutting of sugarcane stalks during operation.

BATTERY

A battery is a device that stores and releases electrical energy through a chemical reaction. It consists of one or more electrochemical cells, each composed of positive and negative electrodes (anodes and cathodes) immersed in an electrolyte solution. When a battery is connected to an electrical circuit, a chemical reaction occurs within the cells that releases electrons, generating an electric current. The harvester includes two 12V, 8A batteries, which not only store power but can also be charged using solar energy, enhancing the harvester's sustainability and independence from conventional power sources.

FRAME

The frame of a sugarcane harvester serves as the structural backbone of the machine, providing support and stability for all its components while withstanding the rigors of field operations. Typically constructed from sturdy materials such as steel or aluminum alloys, the frame is engineered to withstand the weight of the harvester's components and the forces encountered during operation, including the vibrations and impacts associated with traversing uneven terrain and cutting through dense sugarcane fields.

FINAL MODEL

The final model of the electric sugarcane harvester represents a significant advancement in agricultural machinery, offering enhanced performance, efficiency, and sustainability for sugarcane harvesting operations. Through innovation, collaboration, and a commitment to excellence, this state-of-the-art harvester helps meet the evolving needs of the agricultural sector while promoting environmental stewardship and economic prosperity.

CONCLUSION

India's agricultural sector is always expanding. However, for agriculture to succeed, new technology must be incorporated into planting, threshing, and harvesting processes. The automated sugarcane harvesting device has drawbacks like as farms cover a greater area, they need more labor, fuel, and upkeep. The machine is excessively expensive. The goal of this project is to develop and build a small-scale sugarcane harvesting machine in order to get around these restrictions The potential applications of E-sugarcane harvesters are bright as long as the agricultural sector adopts cutting-edge technologies and sustainable methods. As environmental stewardship gains importance, E-sugarcane harvesters powered by systems that are electric or hybrid have the potential to significantly lower the carbon footprint that comes with using conventional harvesting techniques. It is anticipated that developments in battery technology will improve these devices' energy efficiency and increase their range of operation.

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