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Sugarcane Cutting and Harvesting Mechanism

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***Abstract*:**

One of the most significant crops in India and many other nations is sugar cane. The Indian economy continues to be supported by the sugar cane sector. The goal of this project is to build and produce a sugar cane-cutting mechanism for harvesting the crop, which will save farmers' labor and boost output. Aspiring users may establish the groundwork for designing devices to utilize on their farms with the assistance of this project. Agricultural harvesting needs a lot of manpower, a lot of money, and takes a lot of time. Numerous issues with the cutting process must be resolved, and they are not simple. This mechanism has a very straightforward and practical design. The cutting mechanism for sugar cane is made to reduce labor and processing time. This cutting mechanism is easy to use. Anyone can handle this machine under any operating conditions. No skilled workers are required to operate this machine.

Keywords: Sugarcane cutting mechanism, Gripping mechanism, Cutting mechanism.

I. Introduction

Due to labor shortages during peak seasons as well as other times, agriculture in India is becoming a significant burden. Due to a variety of factors, the majority of folks are unwilling to work in the agriculture industry. This is mostly due to uneven work prospects with poor pay;a greater income package encourages individuals to go to cities, and society views farmers andtheir place in agriculture as low status. According to the Food Agricultural Organization (FAO), one of the major crops produced worldwide is sugarcane.

In more than 90 nations, sugarcane is grown on an estimated 23.8 million hectares, yielding 1.69 billion tonnes globally. In a recent poll, it was found that Brazil was the world's top producer of sugarcane, with India coming in at number two. Sugarcane is a suitable crop as per the climate requirements in India. Sugarcane is grown on around 2.8% of India's total cropped area. In 2015–16, India produced over 352 million tonnes of sugar. According to datafrom 2013–14, Uttar Pradesh, which has a 38.61 percent share of the nation's total sugarcane output, is the state that produces the most of the crop. The second and third largest states are Maharashtra and Karnataka, respectively. Other significant sugarcane producing states in Indiaare Bihar, Assam, Haryana, Gujarat, Andhra Pradesh, and Tamil Nadu.

According to a report, just approximately 30% of the equipment is employed by Indian farmers, compared to the majority of other foreign countries that use them. Indian farmers typically use manual techniques to harvest sugarcane. Also, manual harvesting is a bit slow process which is not suitable for this type of harvesting, since in sugarcane harvesting if the sugarcane is not transported to the mill as soon as possible the sugar content in sugarcanes decreases significantly. Even in well-run mills, it has been shown that a substantial proportion of sugar is lost during the interval between harvest and grinding. Per tonne of cane crushed, Indian sugar mills typically lose 10 to 15 kg of sugar. So a mechanism has to be developed which would reduce the whole working time from harvesting to transporting it to the mill. By providing Indian farmers with low-cost sugarcane harvesters, this project seeks to transform the current circumstance.

II. Objectives

- To reduce the human effort required for sugarcane cutting by developing manually operatedsugarcane cutting machines.
- To develop machines that have proper control of cutting location.
- To cut maximum sugarcane production in minimum time so efficiency will be increased.
- To develop a machine that is economical and suitable for an effective cutting and loadingprocess.

III. Literature review

[1] Drs. Sharad, S. Chaudhari. Their research intended to develop a tiny sugarcane crop that could be harvested with less work from the farmer and with higher agricultural output. The machine has a gasoline petrol engine and various modes. It is quicker and more cost-effective to chop sugarcane with this equipment than it is to actually harvest the crop. Both small and big farms can benefit from the device.

[2] S. Shankar, C. Maheswari, R. Gowtham, P. Kiruba, K. Mohansrinivas The created modeloffers an environmentally sustainable harvesting process while also lowering the cost of the current system. This technology demonstrates that it can harvest sugarcane crops at a reasonable cost. To construct this system, linear actuators and controllers like Arduino are used. The ground level is determined using an ultrasonic sensor.

[3] Junming Hou, Jingbo Bai, Enchao Yao, And Hongjie Zhu This study tests and analyzes the cutter head parameter settings for the castor harvesting gear. The purpose of this study wasto use the harvesting device to improve the cutting efficiency of castor steams. Simulation is used to boost productivity. The trapezoidal cutter is preferable to the rectangle cutter, accordingto the simulation findings. When the cutter cuts the stem stage along with the slip angle, the effect of various blade angles and slip angles on the cutting quality is examined.

Methods of Harvesting Sugarcane

There are two main types of sugarcane harvesting techniques used in India. Both of these approaches have advantages and disadvantages.

Figure 1: Manually operated harvesting

Figure 1 represents how to harvest in person. In this approach, human actions assist in carrying out the harvesting process. Starting this method is the firing procedure. Only dried leaves can be held by fire; the remaining sugarcane is safe. The employees then start cutting the sugarcane just a little bit higher than the low level. Knives are used in the process of cutting. Studies show that talented workers can be reduced by almost half about 500 pounds in an hour.

As a result, it is determined that the actual harvesting procedure requires three days to thoroughly clean a one-hectare field and costs between 30,000 and 40,000 INR.

The real harvesting procedure has the following restrictions.

- Time management
- Staff shortages
- Effective work is not done
- Staff fatigue

Figure 2: Mechanized Sugarcane Harvesting

Figure 2 shows a mechanical harvesting method. The majority of foreign nations use a mechanized harvesting technique to harvest sugarcane. On a wider scale, this production method will perform better. This product will be more expensive and can cost between 3500 and 4000 Rupees per hour. It takes 6-7 hours to harvest one hectare. This approach requires

- Greater initial costs
- Greater operation costs
- This applies only to big products
- Skills jobs are also required.

IV. METHODOLOGY

The proposed system consists of 2 different mechanisms which would be really helpful in harvesting. First is the gripper mechanism which consists of two claws having a circular hole of 8mm diameter. The sugarcane will be gripped in this hole to secure it and relocate it.

The second mechanism is for cutting. The cutting mechanism will be situated below the gripper mechanism so as when the sugarcane is being held by the gripper, the blades on thecutting mechanism will cut it through.

When we give the power supply to the motor it starts to rotate and as the blades are connected to the shaft which is joined to the motor the blades start to move too. When these blades are rotated a large force will exert on the sugarcane stalks. This force helps to cut the sugarcane stalks efficiently.

The mechanism is controlled using Bluetooth and mobile applications to controlvarious actuators.

CAD Model of mechanism

Different parts of the Cad model

1. Gripper

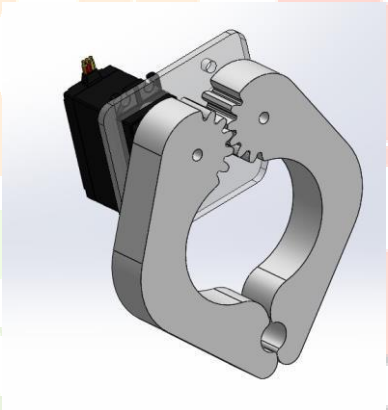

Figure 3: Gripper Mechanism

The gripper is one of the main components of this mechanism used to grip the canes. The feature of this gripper is it is a 3d printed gripper with PLA material. Mg 995 servo motoris used for gripping as well as to control the wrist movement of the gripper.

The gripper will first grip the sugarcane.

2. Cutting tool

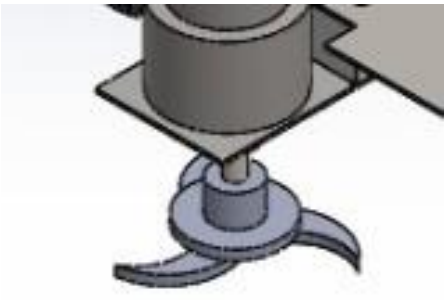

Figure 4: A cutting tool with three blades

As shown in fig.2 the cutter with 3 blades is used for cutting the sugarcanes accurately and effectively. This tool is connected to one shaft which is connected to the motor. A Johnsonmotor is used here to bring the blades into motion.

After the sugarcane is gripped the cutting blade will be actuated and the sugarcane will get cut.

3. Container

Figure 5: Container

After completing the action of gripping and cutting the canes, the gripper will ungrip and place the sugarcanes into the container shown in the image. This container will load the sugarcanes in trucks by the use of conveyor belts so that the goods will reach the desired placein less time. Because of this, the glucose in the sugar will be properly utilized in order to increase productivity and efficiency.

V. COMPONENTS

Component Name	Specifications/ Dimensions	Application/ Use
L298 motor driver	chip: Double H bridgeL298N	To control speed and direction of DC motor
Johnson motor	Torque: 12 kg-cm Rated RPM: 200	Used to rotate the shaft on which blades are mounted
Bluetooth module HC 05	ency: 2.4 GHz ISMband	To replace the cableconnections
Arduino Uno	Operating Voltage: 5V	ead the i/p and to send theo/p to actuator
Servo motor (mg 995)	Operating Voltage: 4.8V Speed: 0.20sec/60 Range: 180	For gripping and wrist movement of gripper
Lead acid battery	Voltage: 12V Capacity: 5.0Ah	To supply power
Buck convertor	itching Frequency:150KHz	To control servo motor

HAND CALCULATIONS

Gear and wrist motor calculations

Module 1

A single claw traces an arc of 14.4 mm to get an angle of 55 degrees.

S = 14.4mmθ = 55°

r = (S * 360) / (2*π*θ)

= (14.4*360) / (2*3.14*55)

= 14.99 = 15 mm = 0.015m

No of teeth (z) = pcd X m = 15 * 1= 15Mass of gripper assembly

= 147.45 gm

= 0.147 kg

The torque required to rotate the gripperτ = Fr

τ = 0.147 * 9.8 * 0.112τ = 0.16 Nm

τ = 1.64 kg cm

Time (assumed) = 3secw=dθ/dt

= 55/3 = 18.33 rad / secw = (2 * π * n) / 60

n = (w * 60) / (2*π)

= 22*60 / 2*π

= 175 rpm

So as per the torque (1.64 kg-cm) and RPM 175 requirement, a white geared DC motor withtorque 2kg-cm and RPM 200 is selected.

Gripping force and motor calculations

Gripping force = (mgfs) / μ

Where the mass of weed = 10 gm (approx)Coefficient of friction for ABS = 0.05

The factor of safety is considered as 1.5Gripping force = (0.01*9.8*1.5) / 0.05 Fg = 2.94 N

a_r = r * w * w

= 0.103 * 18.33 = 34.60

Force required to activate both the clawsF= 2*m*a*r

F = 2 * 0.030 * 34.60 = 2.076 N

Torque requirement for a gripping mechanismτ = (Fg + F) * r

τ = (2.94 + 2) * 0.103τ = 0.5166 N-m

τ = 5.267 kg cm

VI. RESULTS AND DISCUSSION

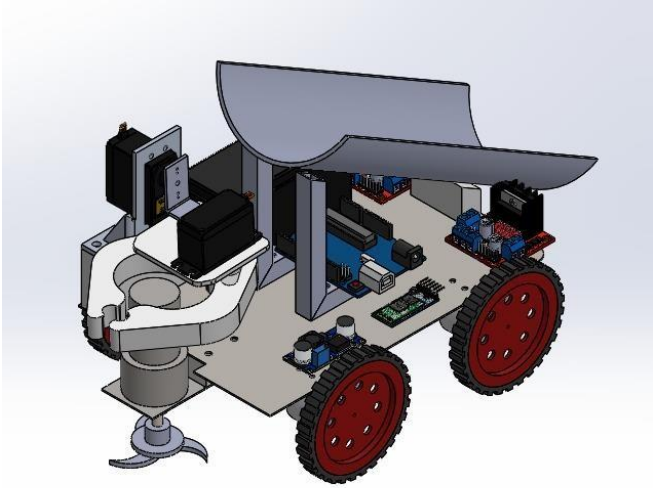

Figure 6: Assembled CAD model of the mechanism

The above figure has presented the whole assembly of mechanisms. Along with the main hardware parts such as the gripper, cutting tool, and container some electronic components arebeing used.

Proposed system

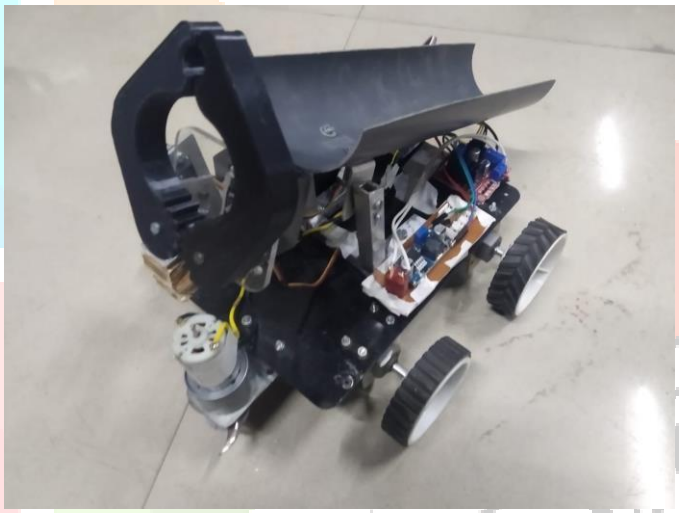

Figure 7: Proposed System

The mechanism was tested multiple times using prototyped sugarcane. We have conducted multiple trials and tested our robot, we found out that our robot is working in the right conditionand is gripping and cutting the prototyped sugarcane. The mechanism is also loading the sugarcane in the container which would eventually load it over the conveyor belt.

VII. LIMITATIONS

- Modifications to the design that are suggested in small-scale sugarcane harvesting
- The spacing between the two claws of the gripper should be adjustable to grip different sizesand numbers of sugarcanes.
- In the real machine, the cutting tool's height should be one foot from the ground.
- For simple operation, the machine should be as light as possible.
- The mechanism is able to cut sugarcanes one by one only.

ADVANTAGES

1. There will be a reduction in the amount of labor needed to cut canes.
2. Cane cutting will need less time.
3. A skilled person is not required for cutting canes and Farmers can overcome the labor crisisproblem

4. Maximum canes will be chopped in the shortest amount of time, increasing efficiency.

VIII. FUTURE SCOPE

Agriculture has lost some popularity in recent years. As a consequence, farmers now own more land and engage in extensive farming. As a result, more people will be needed to manage and tend the farm, creating a market for agricultural equipment built on automation.

The simple process of cutting the sugarcane and transferring it to the conveyor may be automated by this equipment.

This mechanism can be implemented on a tractor or any other vehicle to cut and harvest sugarcane without manual effort. This mechanism while implemented will consist of two sub- mechanisms, the gripping mechanism, and the cutting mechanism. The gripping mechanism works just like we hold the sugarcane with our arm so any gripper can be used to achieve the gripping mechanism. The cutting mechanism can be achieved using any other cutting tool suchas a chain saw.

IX. CONCLUSION

This design allows for more efficient cutting of the sugarcane field. Compared with manual harvesting, half of the harvesting time and the need for labor is reduced. The cost of harvesting is reduced by more folding compared to hand harvest.

Taking safety as a prime consideration, this device is safer in all respects. Thismechanism will be able to cut the canes and load them to conveyor belts without manual effort.

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