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AUTOMATED SUGARCANE NODE CUTTING MACHINE VIA IMAGE PROCESSING

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ABSTRACT

Sugarcane planting with traditional methods is costly, time-consuming and necessary compression of buds in the field is not achieved easily because of stalk planting in sugarcane. In tradition planting method, great human force and high volume of sugarcane stalk in hectare is required. To solve this problem and mechanizing of sugarcane planting, we suggest the application of machine vision system and Image Processing methods to identify nodes from sugarcane and to plant it as a seed by planting machines

Keywords: Image Processing, Sugarcane Planting, Automation.

I INTRODUCTION

India is a country which is dependent on Farming as a main source of income for many families. Farmers are thus primly important for us. In India agriculture has facing serious challenges like scarcity of agricultural labour, not only in peak working seasons but also in normal time. This is mainly for increased nonfarm job opportunities having higher wage, migration of labour force to cities and low status of agricultural labours in the society. Sugarcane is the world's largest crop 2010 Food Agricultural Organization (FAO) estimates it was cultivated on about 23.8 million hectares in more than 90 countries, with a worldwide harvest of 1.69 billion tons. Brazil was the largest producer of sugarcane in the world and India in second position. In our state i.e. Maharashtra, crops like Rice, Wheat, Sugarcane grow in majority. Sugarcanes are important part of it. Nearly 35 to 45 % of field is under Sugarcane only.
Sugarcane (*Saccharum* sp.) is a clonally propagated grass of the Gramineae family characterized by a high degree of polyploidy and is a crop of major importance providing about 65% of the world sugar. Reproductive tissue is harvested as the economic product in nearly all field crops but this is not the case in sugarcane. In sugarcane, the stalks are the harvested tissue and stalk size has a major influence on yield. There has been virtually some research reported on the variation in size of individual stalk internodes with position on the stalk and with crop growth.

In sugarcane agriculture, planting methods are based on slope and soil condition of land, wind direction, availability of water, etc. Normally sugarcane is planted by ridge and furrows method by using three eyed (budded) sets. For this

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method 3.5 to 4. MT seed is required per hectare. This method requires more seed and human force for planting hence it is costly. Instead of conventional method of planting, row method of sugarcane planting is used for maintaining optimum plant population. It is easy for management and gives high yield. It uses two eyed sets and planting is done by keeping 4 to 6 cm distance between two sets. This type of planting needs 2 to 2.5 MT seed per hectare.

Sugarcane planting with traditional method is costly, time-consuming, requires great human force and high volume of sugarcane stalk per hectares. Now a day's sugarcane planting machines are used to reduce the human force and time. However, these machines do not have control on cutting location. In uncontrolled cutting process 3 to 6 buds set may get planted instead of single bud. This ultimately results into more population of sugarcane stalk which affects the yield. Sometimes, cut may appear on the bud as well, which results into no germination of the bud and we lose the seed. Also, it has no facility to identify diseased node, so planting of diseased nodes affects the yield and quality of the sugarcane. In addition to proper controlled cutting of stalk, it is necessary to identify any disease in the node as it affects the yield and quality of the sugarcane. Unfortunately the traditional sugarcane planting machines do not have any such facility. This chapter deals with solutions to overcome these problems and talks about use of image processing method for seed selection.

II SUGARCANE HARVESTING METHODS

1. Manual method
2. Mechanized harvesting

In manual harvesting method harvesting of sugarcane is done manually with the help of human labours. Hand harvesting accounts for more than half of production, and is dominant in the developing world. In hand harvesting, the field is first set on fire. The fire burns dry leaves, and kills any lurking venomous snakes, without harming the stalks and roots. Labours then cut the cane just above ground-level using cane knives or machetes.

A skilled harvester can cut 500 kilograms (1,100 lbs.) of sugarcane per hour. But manually sugarcane harvesting is more labour intensive and as compare to machine harvesting the cutting speed is very slow .In Manual Harvesting to cut one acre of sugarcane 15-16 labours are required they take 3 days to cut one acre and involves harvesting of 60-70 tons per acre with labours being paid 500-550 Rupees per ton of harvest hence total cost of harvesting per acre comes up to 30,000-35,000 Rupees. Steps to be taken in Cut and Withdrawn methods

(a) It will be detracted
(b) The base will be cut
(c) Topped
(d) Sticks will be placed in a row.

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Now days in many countries mechanical sugarcane harvester is used for sugarcane harvesting. It is fully automated. It requires very less time for cutting sugarcane around large area. Many foreign company involved sugarcane manufacturing like john deer, new Holland. In mechanization now by using large scale harvesting machine takes about 6-7 hours for harvesting one acre averaging about 60-70 tons with labour costing around 3,500- 4,000 Rupees per hour hence the total cost of harvesting per acre comes up to 20,000-25,000 Rupees. Mechanical harvesting of sugar cane can be done in two ways:

2.1 Using Whole stalk Harvester

The whole stalk harvester, also known as soldier harvester, method was one of the most popular means of sugar harvesting in Louisiana until 1992, when the "chopper harvester" surpassed it in popularity. The method essentially involves cutting the entire cane right to its base, removing the top, and placing the canes into heap rows. The rows of canes are then burned to remove trash and leaves and a bell grab loader loads them into a trailer to be transported to the sugar mill. This method was not fully embraced as it included a number of disadvantages, including not being able to handle lodged canes and cane over 120 tons. This method did not work on slopes that inverted 10 per cent or more. Cutters embraced the system because it was cheaper to put to work than the chopper system, it was easy to do, and less frequent losses were associated with it.

2.2 Using Chopper Harvester

This method is similar to whole stalk harvesting in that the entire cane is cut, topped, and deposited into the machine, bottom ended. The canes are cut into billets measuring 656 feet (200 m) in length by mesh rollers or rotor knives and then burnt. Dirt is removed from by an extraction mechanism. The billets travel up a conveyor, which sends them through a secondary extractor.

Manual harvesting method is:

- Time consuming
- Less profit
- Shortage of labour
- Labour fatigue
- Mechanized harvesting is
- High initial cost
- High operating cost
- Area require for operation is more
- Skilled worker is require
- Applicable for only large areas

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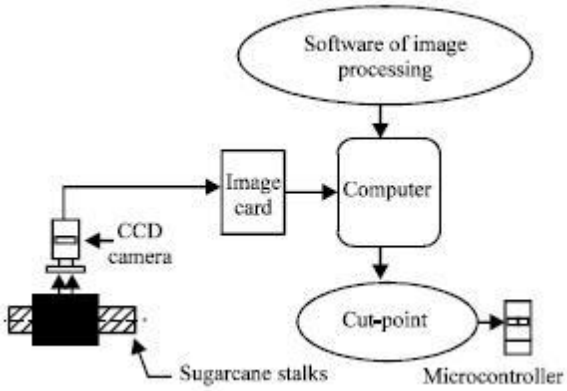
2.3 Application of image processing techniques in the characterization of plant leaf:-

A plant leaf characterization system based on a personal computer. This system uses a digital scanner to acquire leaf images with a resolution of 150 dpi. These images are afterwards processed in order to compute some leaf characteristic parameters, such as: leaf area and perimeter, existence of holes, width and length. With the implemented algorithms the errors between the measurements and the real values were typically less than ∓3% and ∓2.5% for the area and linear measurements, respectively. These tests and results were realized using sets of known size images and leaf images that were measured with the proposed system and with a commercial calibrated leaf area system Li-Cor from Delta-T devices**.**

III BLOCK DIAGRAMS AND WORKING

3.1 Image Processing Method for Node Selection

Sugarcane stalk consists of segments called joints as shown in Figure. Joint is made up of a node. Node is a place where the bud, growth ring, leaf scare and root primordial are located. Growth ring and leaf scare forms continuous edges and root primordial appear as alternative dot. Inter node distance (distance between two successive nodes) plays important role in deciding water stress and diseases in the sugarcane.



the signal to actuator to cut the node. Cutting is carried by using linear actuator. Pneumatically operated linear actuator is made with the cutter at the end, cuts the node. The node cut by cutter is carried by collector. If node is not present (or defected node) is not sensed by camera, so no cutting operation is carried, it is forwarded to another collector.

Considering the advantages of STP method of plantation and experience of agricultural researchers the proposed work starts with assumption that the sugarcane node is said to be normal if:

1. The difference between two consecutive nodes is less than 30 % .
2. There is no crack on stalk.

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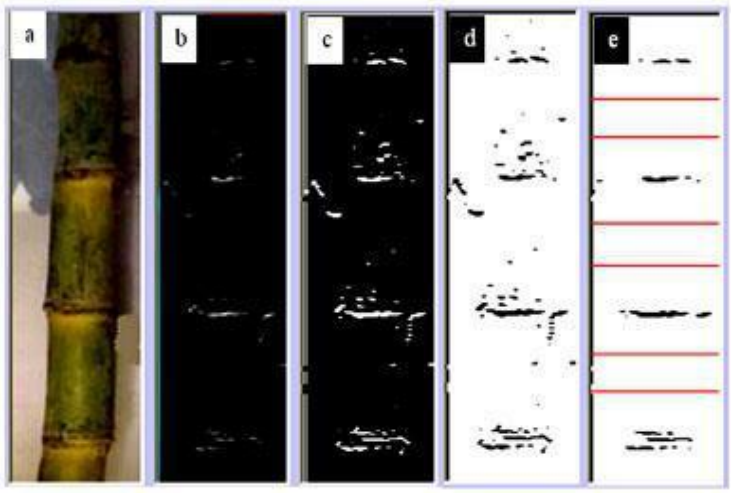


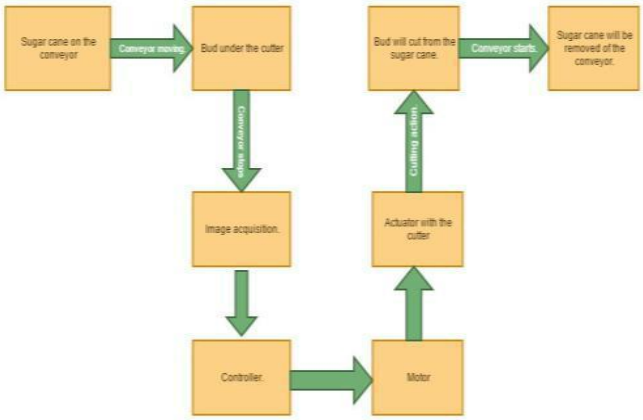
Fig. Block diagram for image processing for selection of sugarcane node

The proposed methodology of identification of normal nodes is elaborated in Figure

The system consists of following important components

1. Personal Computer (PC),
2. Charged Coupled Device (CCD) camera and Lighting system,
3. Control system and Cutter,
4. Conveyor belt drive system.

3.2 Working



With reference to the diagram shown above, sugarcane which placed on conveyor is moved over conveyor by rotating the conveyor system. The node of sugarcane is sensed by camera (Which is attached at the end of conveyor). By the image processing principle, electronic controller senses the image and compares it with reference image. When the node is present, controller sent

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3.3 CAD Views of proposed prototype.

Fig. Front view

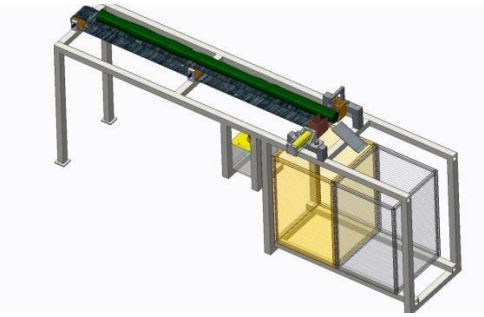

Fig. 3D View

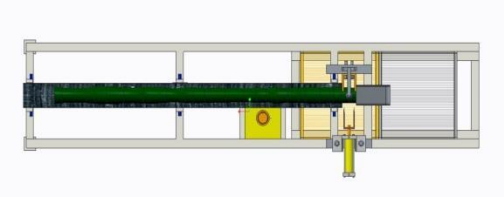

Fig. Top View

IV CALCULATIONS

Sugarcane properties and values

Cutting resistance= 0.5 N/mm2

Max. Dia. of cane= 40mm

Max. Cutting force required= 628.32 N

We are using pneumatic cylinder. So the cylinder and piston must exert the pressure above 0.5 N/mm2 or 5 bar pressure.

4.1 Calculation of Pneumatic Cylinder:-4.1.1 Forces acting on cylinder:-

Piston Area (A):-

$A = (\pi/4) \times D^2$

$= (\pi/4) \times (25 \times 10^{-3})^2$

$= 2.01 \times 10^{-4}\ m^2$

Piston rod Area (a):-

$a = (\pi/4) \times d^2$

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= $(\pi/4) \times (10 \times 10^{-3})^2$

= $7.85 \times 10^{-5}\ m^2$

4.1.2Force during extending stroke:-

P = F/A

$6 \times 10^5 = F/ (2.01 \times 10^{-4})$

F= 120.6 N

Mass = F/g

= 120.6 / 9.81 Mass = 12.29 kg

4.1.3 Force during retracting stroke:-

P = F / (A-a)

$6 \times 10^5 = F / (2.01 \times 10^{-4} - 7.853 \times 10^{-5})$

F = 73.47 N

Theoretical force at 6 bar when advancing of piston = 125N

Piston rod threading end = M10 x 1.5 pitch

4.1.4 Node Cutting rate

It has been observed practically that time required for image processing and actuation of the actuator takes about 2 seconds for a single node to cut. The length of the belt in our project is about 1000 mm, which accommodates 7 nodes approximately.

Therefore, for 7 nodes 14 seconds are required for 1000 mm length of sugarcane. With respect to above calculation, near about 1800 nodes can be cut in 1 hour continuously with the help of our model.

Criterion	***Feature***
Stroke	*100 mm*
Piston diameter	*25 mm*
Piston rod diameter	*10 mm*
Piston rod thread	*M10*
Speed range	*50 – 800 mm/ sec*
Assembly position	*Any*

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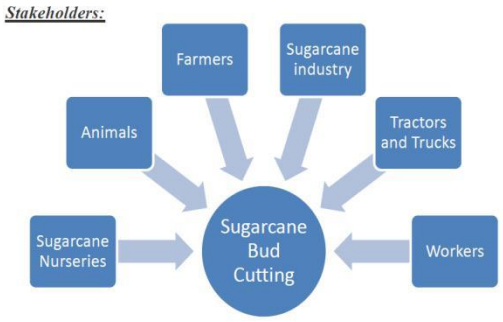
Piston-rod end	*Male thread*
Design structure	*Piston, Piston rod*
Variants	*Single-ended piston rod*
Operating pressure range	*1 - 6 bar*
Endurance pressure	*9 bar*
Mode of operation	*Double-acting*
Criterion	*Dried compressed air, lubricated or un-lubricated*
Temperature range	*-20 °C to + 80 °C*
Piston rod diameter	*Germanischer Lloyd*
Design structure	*With accessories*

Table 1. Cylinder Specification

V FUTURE SCOPE

In recent years, agriculture has become less popular. Hence, the lands acquired by farmers are more and implement large scale cultivation. Hence, to manage and tend the farms labour required will increase, thus opening a market for automation based equipment for farming. This computer vision based machine will automate the basic task of cutting the sugarcane bud which is used for plantation of sugarcane. In the coming years, the product will get popular along with other products which will modernize the agriculture.



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VI CONCLUSION

The main aim of this review paper is to have a proper understanding of different aspects of present harvesters as well as different harvesting practices to reduce the efforts which were put in by farmers in terms of money, labour, time, physical efforts for optimum performance. Above discussed parameters will definitely provide the basic ideas associated with sugarcane harvesting. Sincere efforts must be made to design a suitable harvester in order to provide more profit, stability in terms of economic considerations and machine to be design will help Both whom having small or big farms and definitely farmer can overcome the labour crises problem.

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