DESIGN AND CONSTRUCTION OF A SUGARCANE BUD CUTTING MACHINE

A Project

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ABSTRACT

This project presents the design and development of an automated sugarcane cutting system that utilizes a combination of pneumatic actuation and microcontroller-based control to reduce manual labor and increase efficiency in sugarcane harvesting. The system is powered by a 220V AC input, which is stepped down to 24V DC using an SMPS, and further reduced to 5V DC using a buck converter to safely power the NodeMCU microcontroller and relay circuit. A 10k potentiometer is integrated into the system to manually adjust the switching speed of the relay, which controls a 24V DC solenoid valve. When activated, the solenoid valve regulates the air flow from an air compressor into a pneumatic cylinder. The pressurized air alternately feeds the upper and lower chambers of the cylinder, causing a continuous linear motion of the piston rod. This mechanical motion is harnessed to perform precise and repetitive cutting operations on sugarcane stalks. The system demonstrates how pneumatic mechanisms combined with low-cost microcontroller technology can offer a reliable and scalable solution for automating labor- intensive agricultural processes. By replacing manual cutting with a smart, sensorless control mechanism, this project contributes to the advancement of precision agriculture and supports the goal of developing sustainable, automated farming tools for improved productivity.

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CHAPTER -1

INTRODUCTION

1.1 Introduction

Sugar cane is considered as a main source of sugar product in Egypt and numerous countries around the world. The area of sugar cane in Egypt reached up to 332 thousand feddan, with an average product of 48.6 Mg/ fed. (CCSC, 2020) [1]. Broadcasting fashion has been applied in several countries to reduce human efforts. Sugarcane seedling planting in the nursery is done using the single bud, the sugarcane bud means gutted maxillary bud from cane stalk. These buds are less in size, fluently transmittable, fast-growing, and more provident seed material. Traditional hand-held slice tools of sugarcane buds produce a strain on the handstand thumb, beget destruction and it damages with slanting cuts, and are unable to deal with hard factory grafting [2]. Sugarcane transplanting has been recommended as an indispensable planting system for saving a considerable part of irrigation water that determines the expansion of the agrarian areas in the country. Drees in 2005 recommended that sugarcane transplanting g could be used as an indispensable system of sugarcane seedlings. The operation of the transplanting fashion to replace the traditional planting of sugarcane saves up two months of the crop product season [3].

The Sugarcane Bud Cutting Machine is an automated device designed to efficiently and precisely cut sugarcane buds, streamlining the process of propagation and improving overall agricultural productivity. By utilizing pneumatic components such as an air compressor, solenoid valve, and a pneumatic air cylinder, the system can automate the cutting motion with high precision and minimal human intervention.

The heart of the system is the NodeMCU microcontroller, which is responsible for controlling the entire operation. The NodeMCU interfaces with various components, including the solenoid valve to control air flow, and a relay to manage the activation of the pneumatic system. The 10k potentiometer is used for adjusting settings such as cutting speed or force, allowing operators to fine-

tune the machine according to the sugarcane's size and cutting requirements.

Power for the system is supplied by an SMPS (Switched-Mode Power Supply), ensuring a stable and efficient power output to the electronic components.

This automated system offers significant advantages in terms of consistency, speed, and efficiency when compared to manual cutting methods, reducing labor costs and increasing the scalability of sugarcane cultivation. With its ability to deliver precise cuts, the machine can contribute to better plant growth and higher yields, making it a valuable tool for modern agricultural practices.

1.2 Aims

Aims of a proposed system is:

- To automate Automation of the Cutting Process: To automate the process of cutting sugarcane buds, reducing the need for manual labor and increasing efficiency in the propagation of sugarcane plants.
- Precision and Consistency: To ensure precise and consistent cutting of sugarcane buds, improving the uniformity of the cut size, which directly impacts the success rate of plant growth.
- Increased Efficiency: To enhance the overall efficiency of the bud cutting process, speeding up the operation while maintaining high-quality cuts, thus reducing time and labor costs.
- Adjustable Cutting Parameters: To allow operators to adjust cutting speed and force via the 10k potentiometer, providing flexibility to accommodate different sugarcane sizes and types.
- Cost-Effective Solution: To provide a low-cost, automated alternative to manual cutting, enabling small to medium-scale sugarcane farmers to benefit from advanced agricultural technology.
- Improved Scalability: To offer a scalable solution that can be used in larger-scale sugarcane farming operations, allowing for mass propagation with minimal human intervention.
- Reliability and Durability: To design a robust and reliable machine with

a metallic frame and high-quality components, ensuring longevity and reducing the need for frequent maintenance.

- Sustainability: To create an energy-efficient system powered by an SMPS, contributing to environmentally sustainable agricultural practices by reducing energy consumption.

1.3 Objectives

The key objectives of the Sugarcane Bud Cutting Machine are:

- To design the machine using cost-effective materials and components, making it accessible to small and medium-scale sugarcane farmers, thus promoting wider adoption in the industry.
- To automate the entire cutting process, reducing the need for manual labor while maintaining flexibility for manual override when necessary.
- To design and construct a fully functional prototype that integrates all components, including the air compressor, solenoid valve, pneumatic air cylinder, cutting blade, and metallic frame, to achieve effective and reliable bud cutting.
- To program the NodeMCU microcontroller to control the operation for ensuring precise control over the cutting process and allow for automation.

1.4 Project Methodology:

The Project The development of the Sugarcane Bud Cutting Machine follows a structured methodology to ensure a systematic and efficient approach to design, development, and testing. The key steps in the methodology are as follows:

1. Requirement Analysis

- Understand the project's goals and specifications, including the cutting precision, required automation, and design parameters.
- Activities:

    - ✓ Identify the required components (air compressor, solenoid valve, pneumatic air cylinder, cutting blade, etc.).
    - ✓ Analyze the operating conditions (e.g., power requirements, environmental factors).
    - ✓ Define the necessary adjustments for different sugarcane bud sizes (e.g., adjustable cutting speed or force).

2. Design Phase

- Design the overall structure and components of the cutting machine.
- Activities:

    - ✓ Frame Design: Create a sturdy metallic frame capable of holding all components securely, with proper alignment for the cutting blade and pneumatic system.
    - ✓ Control System Design: Design the control logic using NodeMCU. The system will manage the solenoid valve, pneumatic air cylinder, and cutting blade activation.
    - ✓ Pneumatic System: Design the air flow mechanism using the air compressor, solenoid valve, and pneumatic air cylinder to actuate the cutting blade with the desired force and precision.
    - ✓ Power Supply Design: Integrate the SMPS for stable power to the NodeMCU and other electronic components.

3. Component Selection and Procurement

- Select and acquire the necessary components to build the machine.
- Activities:

- ✓ Choose the air compressor, solenoid valve, pneumatic cylinder, cutting blade, and other hardware based on design specifications.
- ✓ Acquire the Node MCU microcontroller, relay, potentiometer, and other electronic components required for control and automation.

4. Assembly and Integration

- Assemble the machine by integrating all the components into a single working unit.
- Activities:

  - ✓ Assemble the metallic frame to house all the components securely.
  - ✓ Install and connect the air compressor, solenoid valve, pneumatic air cylinder, and cutting blade to ensure proper operation.
  - ✓ Integrate the Node MCU with relay and potentiometer for control and adjustments of the cutting process.
  - ✓ Set up the wiring and connections for the power supply using the SMPS.

5. Programming and Calibration

- Program the control system to automate and adjust the cutting process.
- Activities:

  - ✓ Program the NodeMCU to control the operation of the solenoid valve and the pneumatic air cylinder based on inputs from the potentiometer.
  - ✓ Implement a control loop to regulate the air pressure, cutting force, and blade movement.
  - ✓ Test the relay system to allow manual override and remote control of the machine.

- ✓ Calibrate the cutting blade to ensure it delivers precise cuts with adjustable speed and force.

6. Testing and Validation

- Test the machine for functionality, performance, and reliability.
- Activities:

  - ✓ Conduct initial testing to verify the operation of each component, ensuring the air compressor, solenoid valve, and pneumatic cylinder work in synchronization with the cutting blade.
  - ✓ Test the adjustable cutting parameters using the potentiometer, ensuring it can accommodate different sugarcane bud sizes.
  - ✓ Validate the overall cutting process to ensure consistent, clean, and accurate cuts.
  - ✓ Perform durability and stress tests to evaluate the machine's reliability in real- world conditions.

7. Optimization and Refinement

- Refine the system to improve efficiency and performance.
- Activities:

  - ✓ Optimize the air flow and cutting speed for different types of sugarcane buds.
  - ✓ Fine-tune the control algorithm to provide smoother operation and quicker response times.
  - ✓ Make necessary adjustments to the frame design or cutting mechanism based on test results.
  - ✓ Improve the power management to ensure longer operational times and reduce energy consumption.

8. Final Implementation and Demonstration

- Complete the final version of the machine and demonstrate its

functionality.

- Activities:

  - ✓ Assemble the final machine with all optimized components.
  - ✓ Conduct a full demonstration of the machine cutting sugarcane buds, showcasing its efficiency and ease of operation.
  - ✓ Ensure the machine operates autonomously and can be controlled manually if needed.
  - ✓ Provide documentation for the design, functionality, and maintenance of the machine.

9. Feedback and Future Work

- Gather feedback for future improvements and identify areas of potential development.
- Activities:

  - ✓ Collect feedback from users and stakeholders about the machine's performance, ease of use, and any challenges encountered.
  - ✓ Identify opportunities for further enhancements, such as integrating more advanced sensors or improving automation features.
  - ✓ Plan for scaling the design for larger operations or adding new functionalities like multi-blade cutting or automated bud sorting.

By following this structured methodology, the Sugarcane Bud Cutting Machine will be developed systematically, ensuring the machine meets the requirements for efficient and precise cutting while offering flexibility, durability, and scalability for agricultural applications.

CHAPTER-2

LITERATURE REVIEW

2.1 Literature Review

A literature survey on sugar cane buds cutting machines reveals several studies and developments aimed at enhancing the efficiency and productivity of sugar cane cultivation.

As we identified a skilled harvester can cut 500 kg (1,100 lbs.) of sugarcane per hour. But manual sugarcane harvesting is more labour intensive compared to machine harvesting as human cutting operation speed is very slow [4]. In manual harvesting, for cutting one acre of sugarcane 15- 16 labours are required and it takes 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 INR [5]. Each crop costs 2 to 3 rupees. Such crops are then harvested in soil. After a few days fully developed crop gets ready to sell. It has been observed that in rural areas most of the people cut the sugarcane manually. This consumes a lot of sugarcane and time to cut the buds [6]. So, we decided to manufacture a semi-automatic sugarcane bud cutting machine.

1. Design and Development of a Semi-Automatic Sugarcane Bud Cutting: This study presented the design and development of a semi-automatic bud-chipping machine for sugar cane propagation. The machine employs a combination of mechanical cutting and pneumatic mechanisms for precise bud cutting, resulting in improved efficiency and reduced labour requirements (Reference: International Journal of Agricultural and Biological Engineering)
2. Performance Evaluation of a Sugarcane Bud Cutting Machine: This research focused on evaluating the performance of a commercial sugar cane bud-cutting machine under different operating conditions. The study assesses cutting accuracy, speed, and reliability, providing valuable insights for

optimizing machine design and operation in real-world agricultural settings (Reference: Agricultural Engineering International: CIGR Journal).

3. Design and Fabrication of a Portable Sugarcane Bud Cutting Machine: This study presented the design and fabrication of a portable sugar cane bud-cutting machine suitable for small-scale farmers. The machine's compact design and affordability make it accessible to farmers with limited resources, contributing to improve propagation practices and increased yields (Reference: International Journal of Engineering Research & Technology).

In recent years, the growing demand for automation in the agricultural sector has led researchers and engineers to explore innovative solutions for labor-intensive processes such as sugarcane harvesting. The integration of pneumatic systems has gained popularity due to their capability to deliver powerful linear motion, high-speed actuation, and reliable performance in dusty and harsh agricultural environments. Pneumatic cylinders, when coupled with solenoid valves and powered by air compressors, provide a clean and effective means of producing mechanical motion without the complexity of hydraulics. Studies have shown that the use of solenoid- controlled pneumatic actuators significantly enhances the efficiency of automated agricultural machines, as seen in industrial pressing and crop-handling applications. To operate such systems, a stable and regulated power supply is crucial; hence, Switched-Mode Power Supplies (SMPS) are employed to convert high-voltage 220V AC to 24V DC, which is further stepped down using buck converters to 5V DC to safely operate microcontrollers and relays. This reliable power management ensures uninterrupted performance of embedded control units like the NodeMCU, an ESP8266-based microcontroller that supports Wi-Fi and offers flexible interfacing with sensors, actuators, and control components. NodeMCU has been widely used in IoT-based smart farming projects for automating irrigation, weather sensing, and relay control systems, due to its low cost, programmability, and real-time data handling capabilities. In the proposed system, the relay switching is controlled using a 10k potentiometer that adjusts the frequency of solenoid valve operation, thereby controlling the air supply to the pneumatic

cylinder. Upon activation, the cylinder generates a mechanical force via its piston rod, which can be directed toward cutting sugarcane stalks efficiently and repeatedly. Literature suggests that such electromechanical and pneumatic integration can substantially reduce manual effort, minimize harvesting time, and improve the precision and consistency of sugarcane cutting mechanisms. Therefore, this project not only combines principles of electronics, pneumatics, and automation but also aligns with the global vision of smart agriculture and sustainable mechanization in farming practices.

CHAPTER-3

DESIGN AND METHOD

3.1 Experimental Equipment's

The proposed Heat Treatment Oven is made of several components and they are:

- Air Compressor
- Solenoid Valve
- Pneumatic Air Cylinder
- Cutting Blade
- Metallic Frame
- Node MCU (Microcontroller)
- Relay Module
- 10k Potentiometer
- SMPS (Switched-Mode Power Supply)
- Wiring and Connectors
- Air Hoses and Fittings
- Miscellaneous Tools and Materials

3.2 Hardware:

The Sugarcane Bud Cutting Machine requires several key components to function efficiently. These include an air compressor to provide the necessary pressurized air, a solenoid valve to control the air flow, and a pneumatic air cylinder to convert the air pressure into linear motion, which drives the cutting blade. The machine's structure is supported by a metallic frame, ensuring stability and durability. The operation of the machine is controlled by a NodeMCU microcontroller, which interfaces with a relay module to manage high-power components. A 10k potentiometer is included to adjust the cutting speed or force manually. To provide reliable power to the electronic components, an SMPS (Switched-Mode Power Supply) is

used. Wiring and connectors are needed to link all components together, while air hoses and fittings are used to transport compressed air. A pressure regulator ensures the correct air pressure is maintained for consistent cutting. Safety features such as emergency stop switches and protective covers are integrated to ensure safe operation. Finally, miscellaneous tools and materials are required for assembly, testing, and calibration of the system. [7]

3.2.1 SMPS

A 24V 5A SMPS (Switched-Mode Power Supply) is an electronic power supply that converts input power (usually from AC mains or DC) into a stable 24V DC output, capable of delivering up to 5 amperes of current. The "24V" refers to the output voltage required by many industrial or electronic devices, while the "5A" denotes the maximum current the power supply can provide. Using switched-mode technology, this power supply operates more efficiently than older linear power supplies by rapidly switching the input power on and off, minimizing energy loss as heat. As a result, it provides a compact, efficient, and reliable power source for systems that require stable DC voltage, such as industrial equipment, LED lighting, automation systems, and communication devices. In applications like the sugarcane bud cutting machine, the 24V 5A SMPS ensures consistent power delivery to the components, such as motors, sensors, and control systems, while maintaining energy efficiency.



Figure 3.1: SMPS

3.2.2 Node MCU

we use a NodeMCU or ESP8266 development Board which is transformation of ESP12E wifi module and containing the ESP8266 chip which capacity is 32-bit LX106 RISE. It supports RTOS and it can operate 80MHz to 160MHz with adjustable clock frequency. It contain 1280 KB RAM and also 4 MB of flash memory to store data and programs. In this module we find wi-fi and Bluetooth and deep sleep operating features that make it ideal for IoT Projects. This ESP8266 is a family of Wi-Fi modules developed by the Chinese company Espressif. [9]



Figure 3.2: Node MCU

3.2.3 Relay

The relay permits a small amount of electrical current to control high current loads. When voltage is supplied to the coil, small current passes through the coil, resulting in a larger amount of current passing through the contacts to control the electrical load. Relays are electrically operated switches that open and close the circuits by receiving electrical signals from outside sources. Some people may associate “relay” with a racing competition where members of the

team take turns passing batons to complete the race. The “relays” embedded in electrical products work in a similar way; they receive an electrical signal and send the signal to other

equipment by turning the switch on and off. For example, when you push the button on a TV remote to watch TV, it sends an electrical signal to the “relay” inside the TV, turning the main power ON. There are various types of relays used in many applications to control different amounts of currents and number of circuits.



Figure 3.3: Relay

3.2.4 Air Compressor

An air compressor is a device that converts electrical energy into compressed air, which is used to power pneumatic tools or systems. In the context of the sugarcane bud cutting machine, the air compressor provides the necessary air pressure for the pneumatic air cylinder to function. The compressed air moves the piston inside the cylinder, which in turn drives the cutting blade. It is important to choose a compressor with adequate power to provide consistent air pressure without overloading the system.



Figure 3.4: Air Compressor

3.2.5 Solenoid Valve

A solenoid valve is an electromechanical device that controls the flow of air or fluids in a system. It works by using an electromagnetic coil to move a valve, allowing or blocking the flow of air. In the sugarcane bud cutting machine, the solenoid valve controls the flow of compressed air to the pneumatic air cylinder. By opening and closing at precise intervals, it ensures that the cylinder's piston moves as needed to actuate the cutting blade, making it essential for the machine's automation.



Figure 3.5: Solenoid valve

3.2.6 Pneumatic Air Cylinder

The pneumatic air cylinder is a crucial component that converts compressed air into linear motion. Inside the cylinder, a piston moves forward or backward when compressed air is introduced, and this motion is used to drive the cutting blade. Pneumatic cylinders are often chosen for their efficiency, simplicity, and

ability to generate significant force in a compact form. By adjusting the air pressure, the force and speed of the piston can be controlled, making it ideal for applications like cutting sugarcane buds. [8]



Figure 3.6: Pneumatic air cylinder

3.2.7 Cutting Blade

The cutting blade is the physical component used to slice through the sugarcane bud. It is typically made of durable, sharp metal to ensure clean, efficient cuts. In the bud cutting machine, the blade is actuated by the motion of the pneumatic air cylinder, which pushes the blade down onto the bud. The blade must be strong enough to handle repeated use while maintaining sharpness for precise cuts. Proper alignment and safety mechanisms should be in place to prevent accidents during operation.



Figure 3.7: Cutting blade

3.2.8 10k Potentiometer

A 10k potentiometer is a variable resistor that can be adjusted to change its resistance, llowing the user to fine-tune the operation of the machine.



Figure 3.8: Potentiometer

In this case, the potentiometer is used to adjust parameters such as the cutting force or speed by altering the input sent to the NodeMCU. This allows the user to modify the machine's behavior based on the type and size of sugarcane buds being processed, offering flexibility and precision during operation.

3.2.9 Air Hoses and Fittings

Air hoses and fittings are used to transport compressed air from the air compressor to the solenoid valve and pneumatic air cylinder. These components must be durable and able to withstand the pressures involved in the pneumatic system. Flexible air hoses, made from materials like rubber or reinforced plastic, connect the components securely and without leakage. Proper fittings are required to ensure that the air flows efficiently and safely throughout the system.



Figure 3.9: Air Hoses and Fittings

3.3 Circuit Diagram

Here we included the Circuit diagram of our proposed system.

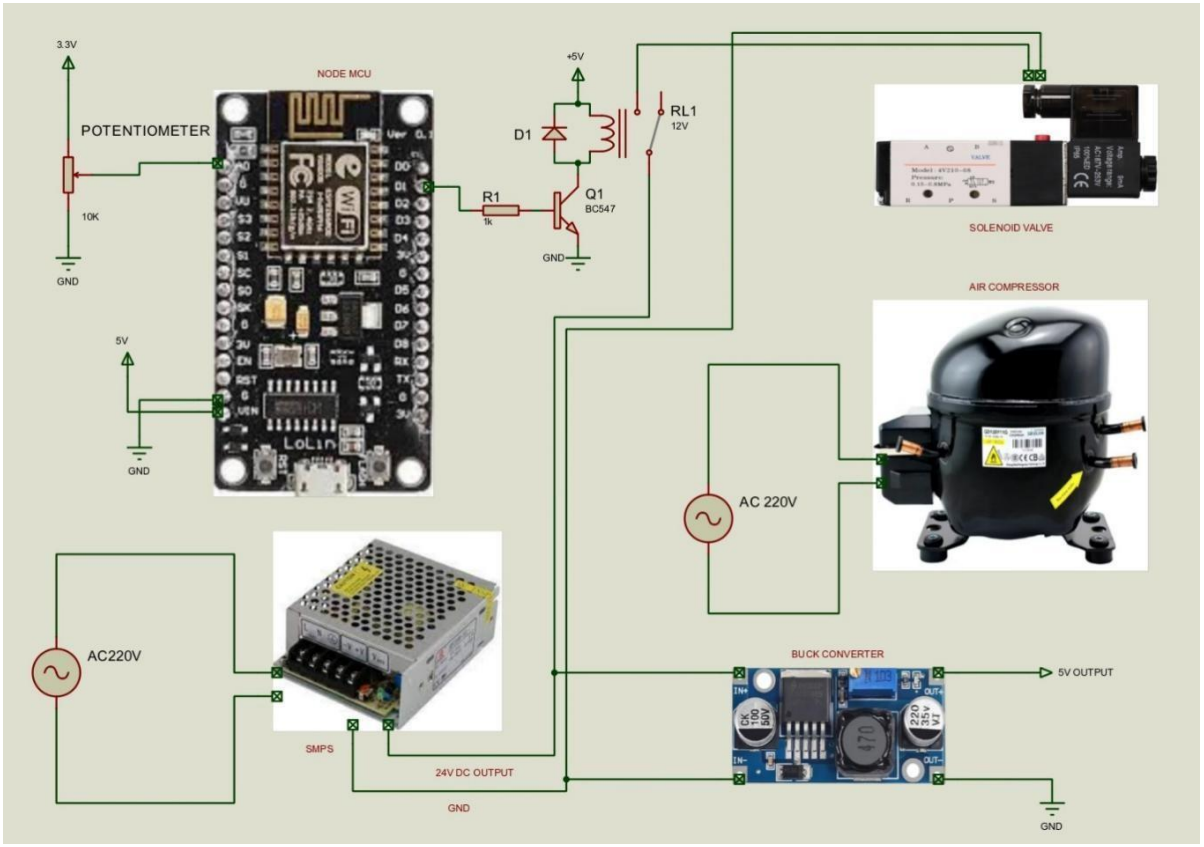


Figure 3.10: Circuit diagram of Proposed System.

Here we make sure 220V AC supply to SMPS to get 24V DC output. Then we will use here a Buck converter that will provide 5V DC output. This 5V DC Voltage will be used here to make sure power supply for our Node MCU and Relay. Here One 10k Potentiometer is used to control the switching speed of relay. When Relay will be make switching at that time Solenoid Valve will be switching here. This Solenoid Valve is operated by 24V DC that's why we used here a 24V SMPS. Here one Air Compressor is used that will provide air pressure to Solenoid Valve and after switching it will distribute that air force to Pneumatic Cylinder. When Cylinder will get air force from upper and Lower side continuously then it will make a mechanical moving

Energy from this Piston Rod movement. This pressure will be used here to cutting Sugarcane automatically.

3.4 Block Diagram

Here we included the block diagram of our proposed system.

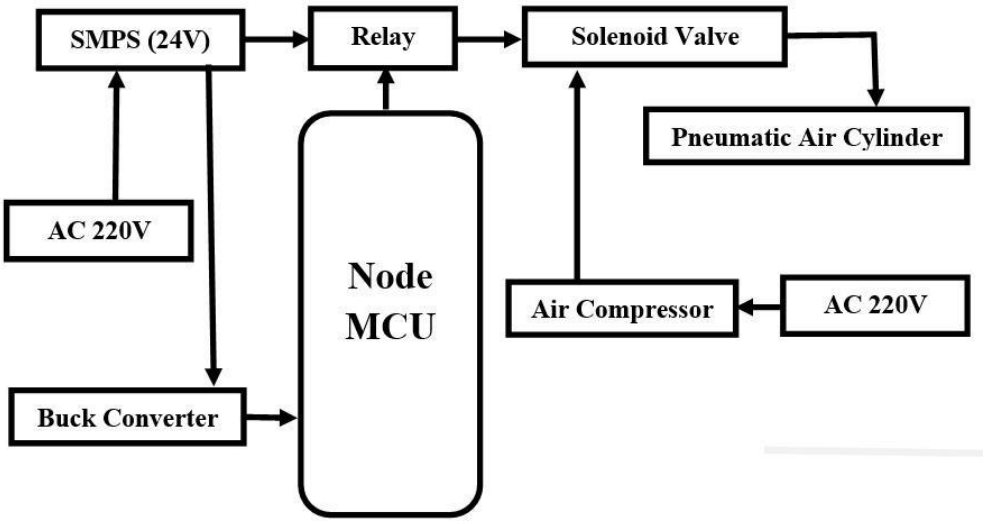


Figure 3.11: Block Diagram of Proposed System.

Here we make sure 220V AC supply to SMPS to get 24V DC output. Then we will use here a Buck converter that will provide 5V DC output. This 5V DC Voltage will be used here to make sure power supply for our Node MCU and

Relay. Here One 10k Potentiometer is used to control the switching speed of relay. When Relay will be make switching at that time Solenoid Valve will be switching here. This Solenoid Valve is operated by 24V DC that's why we used here a 24V SMPS. Here one Air Compressor is used that will provide air pressure to Solenoid Valve and after switching it will distribute that air force to Pneumatic Cylinder. When Cylinder will get air force from upper and Lower side continuously then it will make a mechanical moving Energy from this Piston Rod movement. This pressure will be used here to cutting Sugarcane automatically.

3.5 Full overview

This is the Full overview of our Proposed system.

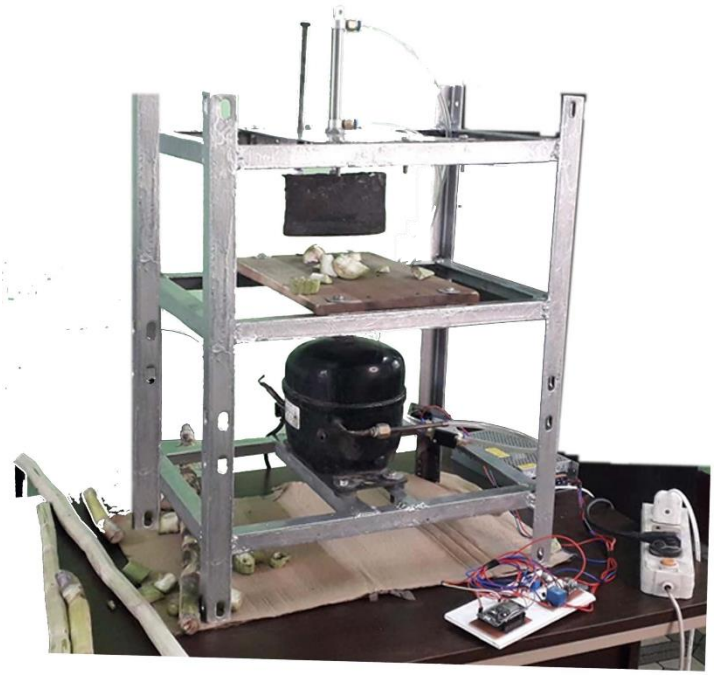


Figure 3.12: Full overview of Proposed System.

3.6 Applications

Applications The Sugarcane Bud Cutting Machine has a wide range of applications, primarily in agriculture and industrial settings, where it enhances efficiency and reduces labor-intensive tasks. Some of the key applications include:

Sugarcane Farming:

The primary application of the sugarcane bud cutting machine is in sugarcane farms. It automates the process of cutting sugarcane buds, which are essential for planting and propagation. Traditionally, this task is done manually, which can be time-consuming and labor- intensive. The machine reduces human effort, increases speed, and ensures uniform cutting, improving productivity and crop quality.

Agricultural Automation:

The machine is part of the broader trend of automation in agriculture, which aims to reduce the dependence on manual labor while increasing efficiency. By using a pneumatic air cylinder to control the cutting motion, the machine offers a more precise and consistent cutting process compared to human labor. It can be integrated into other farming systems for tasks like harvesting, seeding, and crop management.

Large-Scale Farms:

On large-scale sugarcane farms, the manual cutting of buds is impractical due to the scale of operations. The machine provides an efficient solution, enabling faster bud cutting and reducing the need for multiple workers. This increases the overall operational efficiency of sugarcane farming operations, especially in regions where labor costs are high.

Research and Development in Agriculture:

Research institutions working on the development of improved sugarcane strains can use the sugarcane bud cutting machine to obtain uniform bud samples for experiments. The machine allows for precise, reproducible bud cuts, which is essential in research environments where consistency is key to obtaining accurate results.

Nurseries and Plant Propagation:

In nurseries and other plant propagation businesses, the machine can be used for the rapid multiplication of sugarcane crops. By automating the bud cutting process, the machine helps

maintain high standards in plant propagation, ensuring uniformity in the buds that are being prepared for sale or further growth.

Sustainability and Labor Saving:

By automating a task traditionally done by hand, the sugarcane bud cutting machine contributes to sustainability by reducing the manual labor required for sugarcane farming. It also lowers the risks of repetitive stress injuries for workers and reduces the time spent on this task, enabling workers to focus on other high-value tasks.

Integration with Modern Farming Systems:

The machine can be integrated with other automated systems for modern farming, such as irrigation systems, pest control, and fertilization systems. Through integration with systems like the NodeMCU (Microcontroller), the machine can be monitored and controlled remotely, enhancing its versatility and control in precision agriculture.

Overall, the sugarcane bud cutting machine enhances efficiency, safety, and productivity in agricultural operations, particularly in sugarcane farming, by automating a critical yet labor- intensive task.

CHAPTER - 4

RESULTS & DISCUSSION

4.1 Data Sheet

- Lenth of cuter blade =14.2 cm
- Weight of cutter blade = 599 gm

➢ Test No. 01

Necessary Data from a sugarcane sample 1:

Diameter of sugarcane stalk =2cm
Distance between two buds = 10cm
Average circumference = 8.4cm
Width of the bud = 1.2cm
Total buds number in stalk = 10
Cutting Depth = 2cm
Feed Rate of sugarcane (How Quickly Cut) = Times between two buds cutting = 2.5 sec

❖ **Cutting pressure = 90 psi**

Observation No.	Time (Sec)	Number of cutting Buds	Number of Damaged Buds	Cutting speed (time/ Bud no.)
01	10	(04)	(0)	2.5 s
02	15	(05)	(0)	3 s
03	20	(08)	(0)	2.5 s
04	25	(09)	(0)	2.778 s

Table : 01

Test no. 02

Necessary Data from a sugarcane sample 2:
Average circumference = (5.9 + 6 + 6.1)/ 3 = 6 c.m
Space between two buds = 12.2 c.m

❖ **Cutting pressure = 60 psi**

Observation No.	Time (Sec)	Number of cutting Buds	Number of Damaged Buds	Cutting speed (Time/ bud no.)
01	10	(04)	(0)	2.5 s
02	15	(05)	(0)	3 s
03	20	(06)	(0)	3.33 s
04	25	(08)	(0)	3.125 s

Table : 02

❖ **No damaged bud in each of observation, Each of Bud cut in a single stroke.**

4.2 Result

Here we will show the operational output of our proposed system System.

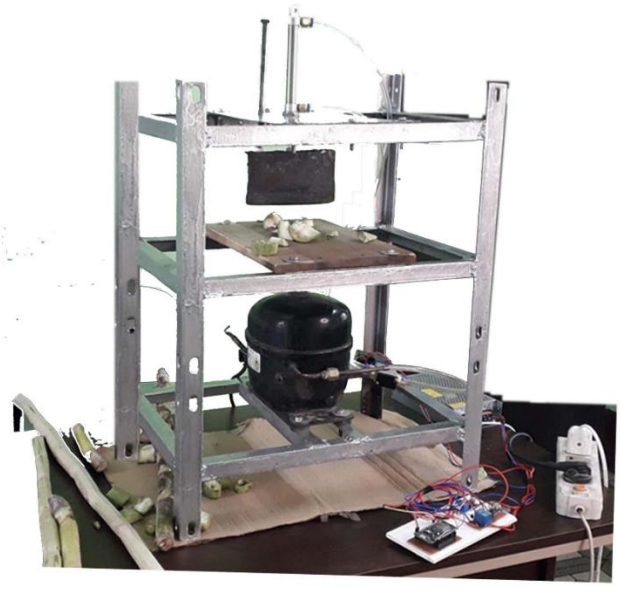


Figure 4.1: Full Overview of Proposed System.

#cutting speed of the cutter blade in 4 different observation was(when cutting pressure was at 90psi):

1) obs-01: cutting speed = 2.5sec/bud
2) obs-02: cutting speed = 3sec/bud
3) obs-03: cutting speed = 2.5sec/bud
4) obs-04: cutting speed = 2.77sec/bud

#cutting speed of the cutter blade in 4 different observation was(when cutting pressure was at 60psi):

1) obs-01: cutting speed = 2.5sec/bud
2) obs-02: cutting speed = 3sec/bud
3) obs-03: cutting speed = 3.33sec/bud
4) obs-04: cutting speed = 3.125sec/bud



Figure 4.2: Cutting Blade is on the Wooden Frame in Cutting Position

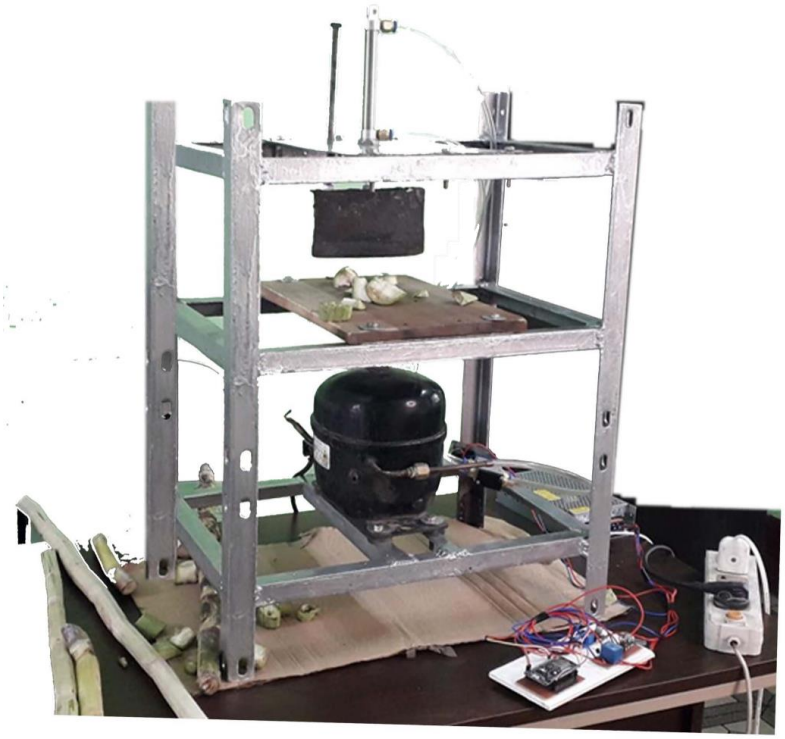


Figure 4.3: Cutting Blade is Upper of the Wooden Frame in Release Position.



Figure 4.4: Sugarcane cutting after 3 times.

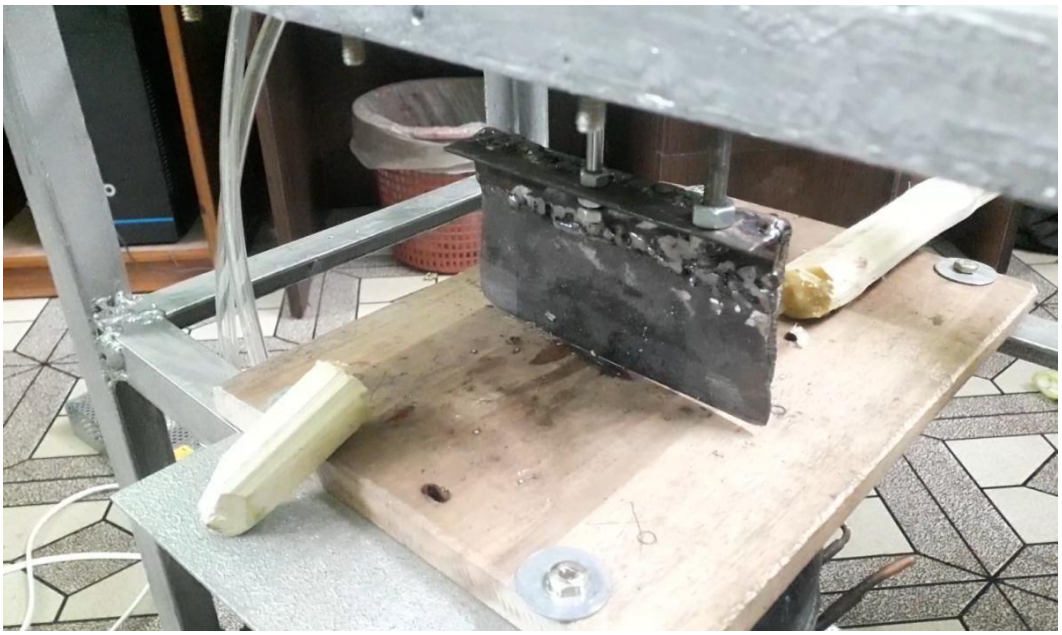


Figure 4.5: Cutting part is separated from main sugarcane.

4.3 Discussion

Here,we can see that when observation was for short time segment(10sec & 15sec) cutting speed became almost similar in both test(when cutting pressure was 90psi & 60psi).But when we took data comparatively for long time segment(20sec & 25sec) then,there was seen a difference in cutting speed between two tests(when cutting pressure was 90psi & 60psi).

Now,we can describe the comparison between two tests in one statement in such a way that when we decreased the cutting pressure from 90psi to 60psi then cutting speed became comparatively low.So,alternatively if we want to increase the cutting speed of the cutter blade, we can do it by increasing the cutting pressure. So, cutting pressure play a vital role in increasing or, decreasing the cutting speed of the cutter blade.

Advantages

The Sugarcane Bud Cutting Machine offers numerous advantages that significantly enhance the efficiency and productivity of sugarcane farming. By

automating the labor-intensive process of cutting sugarcane buds, the machine drastically reduces the time and effort required compared to manual methods. This increased efficiency leads to a substantial reduction in labor costs, making it a cost-effective solution for farmers, especially in regions with limited access to affordable labor. The machine ensures consistent and precise cutting, which helps in producing uniform buds, ultimately contributing to better plant growth and higher crop yields. Furthermore, the controlled cutting force applied by the machine prevents damage to the buds, enhancing crop quality and promoting uniform growth. The machine also improves worker safety by minimizing the physical strain and risk of injury associated with manual cutting. With the ability to operate continuously, it increases overall productivity, allowing for more buds to be processed in less time. Additionally, features such as remote monitoring and control, along with the flexibility to adjust parameters like cutting force, make the system adaptable to different farming needs. Overall, the sugarcane bud cutting machine offers significant benefits in terms of efficiency, consistency, cost-effectiveness, and safety, making it a valuable tool in modern agricultural practices.

Disadvantages

While the Sugarcane Bud Cutting Machine offers numerous benefits, there are several disadvantages to consider. One of the primary challenges is the high initial cost, as the machine requires a significant investment in components like the pneumatic system, air compressor, and control electronics, making it less affordable for small-scale farmers. Additionally, the machine involves ongoing maintenance and repair costs, with components such as motors and solenoid valves requiring regular upkeep, which can increase operational expenses over time. Another potential issue is the dependency on a compressed air supply, meaning that if the air compressor fails or the air pressure is inadequate, the machine may malfunction, disrupting operations. The complexity in operation also poses a challenge, as the system requires proper training to operate efficiently, and farmers may struggle with troubleshooting or adjustments, particularly if the machine incorporates advanced features like IoT integration.

Furthermore, the machine's design might not be easily adaptable to different crop types, which limits its versatility. Power consumption is another drawback, as the machine relies on a stable power supply, and inefficient energy use could lead to higher operational costs. Additionally, there is a risk of over- reliance on automation, where workers may lose manual skills and struggle to perform tasks without the machine in case of a breakdown. Lastly, the size and mobility constraints of the machine may pose difficulties in navigating farms with rough terrain or limited space, making it less practical for farms with irregular layouts or smaller operational areas. Despite these challenges, addressing these issues could make the technology more accessible and practical for a broader range of agricultural operations.

CHAPTER - 5

CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

In conclusion, the Sugarcane Bud Cutting Machine offers a promising solution to the labor- intensive and time-consuming task of cutting sugarcane buds. By automating this process, the machine enhances efficiency, consistency, and productivity in sugarcane farming, reducing the reliance on manual labor and lowering operational costs. Its ability to ensure precise and uniform cuts leads to better crop quality and higher yields, which is crucial for sustainable farming practices. Furthermore, the integration of advanced technologies like pneumatic cylinders, solenoid valves, and microcontrollers allows for greater control, safety, and ease of operation.

However, there are some challenges, including the high initial cost, maintenance requirements, and dependency on compressed air. These factors may limit its accessibility for smaller-scale farmers or those in regions with limited resources. Additionally, the machine's complexity and adaptability to different crops could present obstacles to widespread adoption.

Despite these drawbacks, the Sugarcane Bud Cutting Machine represents a significant step toward modernizing agriculture through automation and innovation. With further improvements in design, energy efficiency, and cost-effectiveness, this machine has the potential to become an indispensable tool for the future of sugarcane farming and other agricultural applications. Its integration into the farming process could not only improve productivity but also contribute to more sustainable and efficient farming practices globally.

5.2 Future Scope

The Sugarcane Bud Cutting Machine has significant potential for advancement and integration with emerging technologies, expanding its scope in the agricultural sector. Below are some areas for future development:

Automation and AI Integration: The future of the sugarcane bud cutting machine lies in further automation, incorporating artificial intelligence (AI) and machine learning algorithms. These technologies could be used to analyze sugarcane plant conditions and adjust the cutting mechanism accordingly. For example, AI could enable the system to detect the optimal bud for cutting based on size, health, and growth stage, enhancing precision and efficiency.

IoT Integration for Remote Monitoring: Integrating the machine with the Internet of Things (IoT) would allow real-time monitoring and control via mobile or web applications. This could provide farmers with remote access to the machine, enabling them to monitor performance, adjust settings, and even troubleshoot issues remotely. Sensors could be added to track various parameters such as cutting force, air pressure, and machine performance, offering valuable data for predictive maintenance and operation optimization.

Energy Efficiency Improvements: Future versions of the sugarcane bud cutting machine could incorporate solar power or energy-efficient technologies to reduce operational costs and improve sustainability. With solar panels or alternative green energy sources, the machine could operate autonomously, reducing the need for external power sources, which is especially beneficial for rural areas with limited access to electricity.

Robotic Arms for Enhanced Precision: By adding robotic arms or automated manipulators, the machine could achieve greater precision in cutting, handling, and even planting sugarcane buds. This would allow the machine to adapt to different planting styles, soil conditions, and bud characteristics, further improving the consistency of bud cuts and their placement.

Integration with Drones for Field Surveillance: The use of drones for aerial surveillance could be integrated with the cutting machine to provide real-time field data, such as identifying areas with higher sugarcane growth or assessing plant health. Drones could help optimize the machine's path by mapping out regions where buds need cutting, ensuring more efficient use of time and

resources.

Enhanced User Interface: The machine's user interface could be upgraded to offer more advanced features, including touchscreens, voice commands, or even augmented reality (AR) for

easier operation and monitoring. A more intuitive user interface would make it simpler for farmers to adjust settings, view system diagnostics, and track performance metrics without needing advanced technical knowledge.

Adaptation to Different Crops: While designed for sugarcane, the technology behind the bud cutting machine could be adapted for use with other crops that require bud cutting or similar tasks, such as bamboo, citrus, or certain vegetables. This adaptability would broaden the machine's market and application scope, making it more versatile and cost-effective for various agricultural industries.

Autonomous Navigation: Future models could feature autonomous navigation capabilities, where the machine can move autonomously across the field without manual intervention. Utilizing GPS, sensors, and mapping software, the machine could navigate the field, identifying sugarcane plants that need to be cut and executing the task with minimal human input.

Predictive Maintenance: By incorporating predictive maintenance algorithms, the machine could notify operators of potential mechanical failures or necessary maintenance before they become major issues. Sensors embedded in the machine could monitor the performance of key components like the pneumatic cylinder, cutting blade, and air compressor, allowing for proactive repairs and minimizing downtime.

Scalability for Larger Operations: The sugarcane bud cutting machine could be designed for scalability, catering to larger-scale farming operations. By increasing the cutting capacity, air compressor size, and automation features, the machine could handle larger fields more efficiently, potentially reducing the need for multiple machines or teams of workers.

In summary, the future scope of the sugarcane bud cutting machine is vast, with opportunities for technological integration, improved energy efficiency, and adaptability for a broader range of applications. As the agricultural sector continues to embrace automation and smart farming practices, innovations in this area will further enhance the machine's capabilities, making it a vital tool for the future of crop cultivation and farm management.

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