MATEC Web of Conferences **392**, 01014 (2024) https://doi.org/10.1051/matecconf/202439201014
ICMED 2024

Revolutionizing Agricultural Harvesting with IoT Application

Udaya Sri Kakarla[1], *A*. Venkataramana[1], *S.*Gopinath[1], *K.*Shivaram[1], *K*. Yugendhar[1], *KVSL* Harika[2], *Saurav* Dixit[3]

[1]KG Reddy College of Engineering and Technology, Mechanical Department, India
[2]Department of CSE, GRIET, Hyderabad, Telangana, India
[3]Lovely Professional University, Phagwara, Punjab, India.

Abstract: Traditional agriculture labor is characterized by its labor-intensive nature, relying heavily on manual labor. This approach is time-consuming and often results in low yields. Manual labor is susceptible to errors, leading to compromised crop quality. Moreover, the traditional method incurs high costs due to the need to hire numerous workers. Overall, traditional agriculture labor is inefficient, costly, and prone to quality issues, highlighting the need for more efficient and modernized agricultural practices. The current harvesting process for leafy greens relies heavily on manual cutting and individual knotting of each bunch, presenting significant challenges in terms of efficiency, labor shortage, and consistency in quality control. This labor-intensive methodology not only consumes valuable time but also strains the workforce, leading to increased operational inefficiencies. In this study, we address these challenges by proposing an innovative and automated harvesting system tailored for leafy greens. By integrating cutting-edge robotics and advanced sensing technologies, our solution aims to streamline the harvesting process, mitigating labor shortages, and reducing workforce strain. The system's intelligent automation ensures uniformity in bunching, enhancing both efficiency and the quality of the harvested produce. Through this research, we anticipate a transformative shift in the leafy greens harvesting industry, fostering increased productivity, labor optimization, and improved overall operational performance.

Key words: Agriculture, IOT, Machines, Knotting, Griming, Harvesting

1 Introduction:

Traditional manual methods for harvesting leafy greens present significant challenges in terms of time consumption, labor burden, and quality control issues. The laborious process of cutting and knotting each bunch individually not only strains the available workforce but also introduces variability in quality due to inconsistent techniques. To address these challenges and meet the increasing demand for leafy greens, exploring innovative harvesting technologies and automated solutions becomes imperative. Automated systems, such as those utilizing the Arduino Nano microcontroller board, offer potential solutions by streamlining the harvesting process, reducing reliance on manual labor, and ensuring precision and uniformity. The Arduino Nano, known for its compact size and versatility, can be

1 Corresponding author : author@email.org

programmed for various agricultural applications, contributing to the efficiency and sustainability of leafy green production.

1.1. Agricultural impact

Agriculture's impact on society, the environment, and the economy is profound and complex. It serves as the primary source of food production worldwide, influencing food security by determining food availability, accessibility, and affordability. Economically, it is vital, especially in developing regions, providing employment and income while contributing to economies through exports and trade. However, unsustainable practices can lead to environmental degradation, including soil erosion, water pollution, and biodiversity loss. Sustainable farming methods offer solutions to mitigate these impacts, promoting environmental sustainability. Agriculture also contributes to climate change through emissions but can mitigate it through practices like agroforestry and carbon sequestration. Water resources are heavily impacted by agriculture, necessitating sustainable management. Rural development relies on agriculture, with investments in infrastructure and technology vital for poverty reduction. Biodiversity is affected by agriculture, but sustainable practices can conserve it. Overall, adopting sustainable practices is crucial to ensure food security, promote economic development, and safeguard natural resources for the future.

1.2. Work types:

1.2.1. Sowing:

Sowing in agriculture is the essential process of planting seeds into the soil to grow crops, crucial for achieving optimal germination and plant growth. It involves placing seeds at the correct depth and spacing in the soil, directly impacting crop yield and quality. Sowing methods vary from traditional manual techniques to modern machinery-assisted approaches, chosen based on factors like crop type, farming system, and environmental conditions. Overall, sowing plays a pivotal role in the agricultural cycle, setting the stage for successful crop production.

1.2.2. Weeding:

"Weeding" in agriculture refers to the process of removing unwanted plants, known as weeds, from cultivated fields or gardens. Weeding is essential for maintaining the health and productivity of crops by reducing competition for nutrients, water, and sunlight. Weeds can interfere with crop growth, decrease yield, and harbor pests and diseases.

1.2.3. Harvesting:

"Harvesting" in agriculture referred to the process of gathering mature crops from the fields for consumption, processing, or storage. It marked the culmination of the growth cycle of crops and was a crucial step in agricultural production. The timing and method of harvesting depended on factors such as the type of crop, its maturity level, weather conditions, and intended use.

1.3. Technologies:

1.3.1. Germination:

Sowing Technologies in Agriculture Included Precision planting, Seed drills, No-till and minimum tillage, Seed treatments, Transplanting, Hydroseeding, Direct seeding, Variable rate seeding, Mechanical planters, Cover crop seeding These Technologies Played a Crucial

Role in Modern Agriculture, Aiding Farmers In Optimizing Crop Production, Conserving Natural Resources, And Improving Overall Farm Profitability And Sustainability.

1.3.2. Eradication:

Weeding Technologies in Agriculture included Mechanical weeding, Chemical weed control, Mulching, Flame weeding, biological control, Precision weeding, Cultural practices, Hand weeding, Cover cropping, Crop rotation These Technologies Were Employed in Weed Management to Maintain the Health and Productivity of Crops While Minimizing Environmental Impacts and Resource Inputs.

1.3.3. Harvesting:

Harvesting Technologies in Agriculture included Combine harvesters, Forage harvesters, Fruit and vegetable harvesters, Tree shakers, Straw balers, Grain dryers, GPS and precision harvesting, Automation and robotics, post-harvest handling equipment, Small-scale and hand harvesting tools these technologies were are used in agriculture for harvesting

2 Literature Survey:

[1] In their research at SHUATS, Allahabad, Anurag Patel, Raj Kishor Singh, and S.C. Moses evaluated a self-propelled reaper binder for wheat crop harvesting compared to manual harvesting.A study found the reaper-binder harvests crop at 0.025 ha/h with adjustable speed (1.9-2.55 km/h) while consuming 5.27 liters/ha fuel. Compared to manual harvesting (176 man-hours/ha), it significantly reduced labor (36 man-hours/ha) and losses (1.44% vs. 1.88%), highlighting its efficiency and resourcefulness.
[2] In the study that evaluated a reaper-binder's performance in rice crops by R. Jaya Prakash, B. Ashwin Kumar, G. Aravind Reddy, and K.V. S. Rami Reddy, the researchers concluded that the reaper-binder yielded satisfactory outcomes. Reaper-binder showed efficiency with 0.294 ha/h capacity and 67% efficiency at 3.6 km/h, but fuel consumption data specifically for the machine was not provided. Despite lacking that detail, it demonstrably performed well.
[3] In a study conducted by Deepali A., Dr. D. Y. Patil, Ajit S. Deokate, Mahesh B. Kadam, and Prashant L. Pandhare from Dr. D. Y. Patil College of Engineering and Innovation in Varale, Pune, the main objective was to design and develop a corn reaper machine aimed at maximizing efficiency. A corn reaper machine was designed and fabricated. It achieved 0.5 hectares per hour coverage area and consumed 5.27 liters of fuel per hectare, indicating good performance and fuel efficiency. The machine reduced harvesting costs compared to manual practices. However, the harvesting loss data is not available.

[4] TESFAYE OLANA TEREFE
“Design and Development of Manually Operated Reaper Machine” Discussed that the manually operated reaper machine holds immense significance for our
country, Ethiopia, despite its current absence from industrial and small-scale enterprise production. However, based on the design presented in this paper, it is feasible to manufacture the manually operated machine locally using readily available and affordable materials.

[5] Tejaskumar Patel, Prof. Chetan Vora, Prof. Vipul kumar Rokad.
“DESIGN AND ANALYSIS OF ARM OF REAPER AND BINDER MACHINE”

Discussed that we conducted a comparison between the deformations of two materials, Aluminum alloy and Mild steel. The results of the comparison reveal a significant reduction in maximum deformation, from 113.18 mm to 47.21 mm. This decrease in deformation directly contributes to minimizing the losses of cut stores that are collected

[6] Enhanced Learning Experience: Arduino facilitates experiential learning, allowing students to apply theoretical mathematics knowledge to real-world agricultural scenarios. This hands-on approach fosters a deeper understanding of mathematical concepts.

[7] Practical Application in Agriculture: Students can design and develop automated agricultural systems using Arduino, such as soil moisture monitoring or irrigation control. This practical application bridges the gap between theoretical mathematics and agricultural Practices.

[8] Interdisciplinary Approach: Integrating Arduino into both agriculture and mathematics teaching promotes interdisciplinary learning. Students explore mathematical concepts like data analysis and statistics within the context of agriculture, fostering a deeper appreciation for both subjects.

[9] Engagement and Motivation: Arduino projects in agriculture capture students' interest and motivation by providing tangible results and encouraging creativity in solving agricultural challenges or mathematical problems.

[10] Hands-on Learning: Arduino enables practical, hands-on learning experiences in agriculture, allowing students to apply mathematical principles in real-world contexts, enhancing their understanding.

3 Methodology:

A circular saw blade, composed of a steel body and durable carbide teeth, measures 25 mm in diameter and boasts 24 teeth for efficient cutting. Mounted on a base plate, this cutter blade, as it's often called, is driven by a motor to perform its primary function: slicing through materials. The blade rotates anti-counterclockwise, facilitating the collection of cut leaves. Beneath the base plate, a conveyor belt follows a tangential path at an angle of roughly 15-18 degrees, effectively transporting the severed leaves away. The conveyor belt is driven by a system of guides arranged on the base plate. Additionally, pushers mounted on the base plate assist in gathering the cut leaves. These pushers operate via a cam mechanism that ensures efficient collection and prevents jamming. The cam mechanism itself synchronizes with the motor for coordinated operation.

4 Design:

Fig. 1. Orthographic presentation of

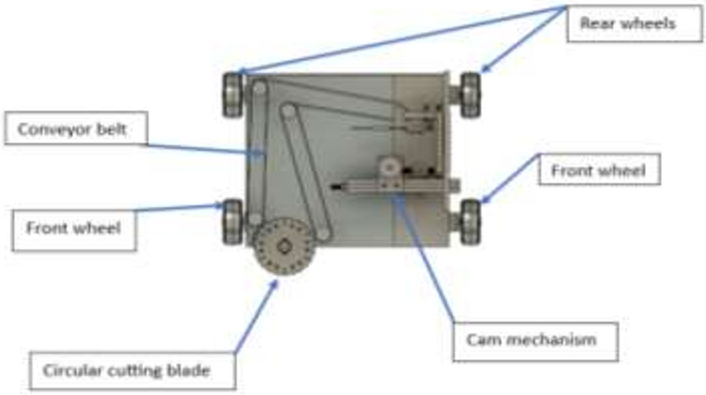


Fig. 2. Top view and it parts

Durability: The Harvester should be designed to withstand the demands of agricultural environments, including exposure to dust, moisture, and rough terrain.

Efficiency: The machine should be capable of cutting and binding crops quickly and without damage, minimizing losses and maintaining crop quality.

User-Friendly Interface: The Harvester should have an intuitive interface, making it easy for operators to set parameters and monitor the bundling process. In both cases, the Revolutionizing Agricultural Harvesting with Iot Application would need to be designed with compatibility in mind. They should be able to seamlessly integrate into existing agricultural machinery, such as tractors or combines, or be standalone units capable of performing their tasks independently.

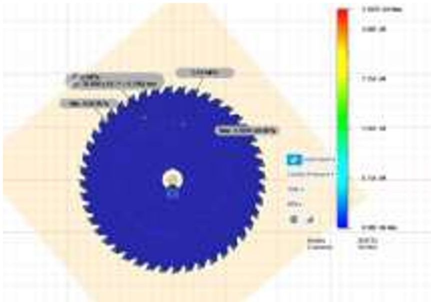
Design Optimization: We have observed many existing designs after all observations we had come up with the design which is optimized we had adopted the best parameters from the existing design and we tried some modifications for enhancement of the designs.

4.1. IOT Coding:

```
#include <Adafruit_Sensor.h>

#include <Adafruit_TSL2561_U.h>

#include <Ultrasonic.h>

#define TSL2561_ADDR 0x39

Adafruit_TSL2561_Unified tsl = Adafruit_TSL2561_Unified(TSL2561_ADDR, 12345);

#define TRIGGER_PIN 9

#define ECHO_PIN 10

Ultrasonic ultrasonic(TRIGGER_PIN, ECHO_PIN);
```

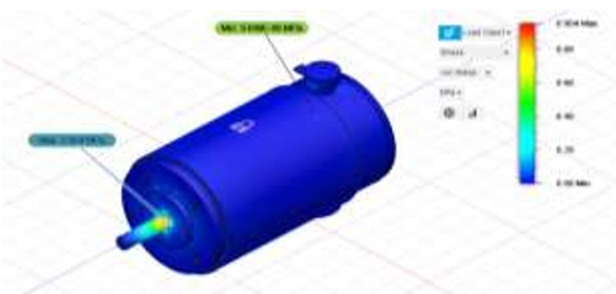
5 Analysis:

Static stress of Circular saw:



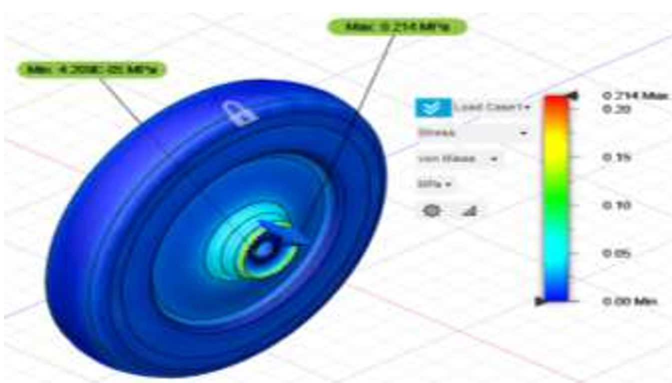
S.No	Values	Safety Factor	Stress	Displacement	Reaction Force	Strain
1	Max	150	7.735	9.474	1.37	4.49
2	Min	25	2.084	0	0	0

Simulation on Motor Results:



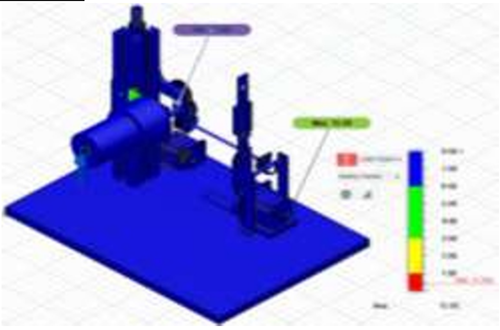
Sl.no	values	Temp	Heat flux
1	Min	26	0
2	Max	40	4E-09

Static Stress of Caster wheel:



Sl.no	values	Safety factor	Displacement	Reaction force	strain
1	Min	15	0	0	0
2	Max	150	9.51	4.905	1.136E-05

Static Stress of Knotter:



Sl.no	values	Safety factor	displacement	stress	Reaction force	strain
1	Min	0	0	0	0	0
2	Max	1.5	0.325	1.309E	3.9	1.73E06

Specifications:

S.No	Component	Material	Specification	Weight
01	Circular Saw	Steel	Diameter=25cm	0.709kg
02	Motor-3 Pieces	Steel	DC motor 12V, 5A and max rpm = 3000 rpm.	0.5692kg
03	Base Frame	Steel	Length=60cm, width = 60cm	2.323kg
04	Caster Wheel (No-2)	Rubber, mild steel.	Diameter of wheel = 14.923cm, top plate Length = 11.43cm, Top plate width =10.16cm, Overall height = 19.015cm, Wheel width = 5.08cm.	2.256kg
05	Conveyor belt	Rubber	Length= 18 cm	1.320kgs
06	Binding	Plastic & steel		1.506kgs

5.1. Calculations:

Circular saw specifications:-

Number of teeth's	24
Radius	0.41 ft
Diameter	0.81 ft

Material	Carbide(tooth), steel (body)
Circumference	2* π*r (2.57 feet) approximately
Width of cut	0.025 cm
Blade velocity	Distance/Time =33/60 = 0.55 ft/sec
Cutting speed	r(2*π*N/60) = 0.41*2*3.14*1000/60 =86.31 ft/min Cutting speed/hr = 5182 ft/hr. For converting to the square feet = 5182/4 = 1295.5 sq ft/hr. For converting to the square Yard = 1295.5/9 = 143.9 sq yards/hr.

Time consumed for 1 Gunta by following: 1 Minute --- 2.398 Square yards minute --- 121 Square Yards X = 121/2.398 X= 50.43 mins

Total Power Consumption:-

Power is calculated (P)	Voltage * curr$\boldsymbol{a^2 + b^2 = c^2}$ent For three motors 3*(V*I) 3*(12*4.9) =177 W/h

6 Result & conclusion:

The paper presents a novel approach to addressing the challenges of traditional manual leafy green harvesting by introducing an automated harvesting system utilizing the Arduino Nano microcontroller board. This system incorporates a circular saw blade for efficient cutting, a conveyor belt for leaf transportation, and pushers for effective collection. The methodology outlines the design and functionality of the harvester, emphasizing durability, efficiency, user-friendliness, and design optimization. The integration of Arduino Nano-based automation technology into agricultural harvesting shows promising results in terms of streamlining the harvesting process, reducing labor dependency, and ensuring precision and uniformity in leafy green production. Overall, the presented automated harvesting system offers a viable solution to improve the efficiency and sustainability of leafy green production. Further research and development in this area could lead to widespread adoption of automated harvesting technologies, contributing to enhanced productivity, reduced labor burden, and improved quality control in agriculture.

7 Future scope:

The future of automatic agriculture looks promising as advancements continue to enhance efficiency, versatility, and affordability of machines, making them more accessible to farmers. With ongoing technological growth, further innovations are anticipated in the agricultural sector, resulting in even more efficient and productive machines. By integrating Arduino programming into existing automatic machinery, there's potential for fully automating agricultural harvesting, thus revolutionizing the industry with IoT applications.

References:

1. Performance Evaluation of Self-propelled Reaper Binder for Harvesting of Wheat Crop by Anurag Patel and Raj Kishor Singh and S.C. Moses.
2. Performance Evaluation of Reaper Binder In Rice Crop By R. Jaya Prakash, B. Ashwin Kumar, G. Aravind Reddy And K.V. S. Rami Reddy
3. Field Evaluation of Selfpropelled Reaper Binder In Wheat Crop By Amol Gore, Yuvraj G. Kasal And Sachin Shinde.
4. Tejaskumar Patel, Prof. Chetan Vora, Prof. Vipul kumar Rokad. Design and analysis of arm of reaper and binder machine
5. Design and Analysis of Universal Reaper Machine Sachin Kumar, Sharma Gautam Kumar, Prashant, Vivek Tyagi Vineet Pal and Saurabh
6. Design And Development Of Corn Reaper Machine By Deepali A. Dr.D.Y.Patil , Ajit S. Deokate ,Mahesh B. Kadam , Prashant L. Pandhare Dr.D.Y.Patil College Of Engineering And Innovation,Varale,Pune
7. Modification And Performance Evaluation Of Self-Propelled Reaper M M Rahman*, M M Hossain** And Akm S Islam
8. Tejaskumar Patel, Prof. Chetan Vora, Prof. Vipul Kumar Rokad. Design And Analysis Of Arm Of Reaper And Binder Machine
9. Design And Fabrication Of Agricultural Crop Reaper By Bharat M. Madake, Rajkumar S. Gore, Amruta M. More, Akshay J. Bhalsing And Vaibhav R. Kukade.
10. Performance Evaluation And Economics Of The Reaper Binder For Harvesting Paddy In Bangladesh M.G.K. Bhuiyan
11. Design And Fabrication Of Agricultural Crop Reaper 1. Shravan U. Burade 2. Rohit S. Ghatule 3. Varad G. Kannadkar 4. Neel V. Sonawane.
12. Performance And Cost Economics Evaluation Of Different Types Of Reapers Binder For Harvesting Of Wheat In Satma District Of Madhya Pradesh, India J. Himanshu Rao And Balveer Singh Meena.
13. Modification Of A Reaper-Binder By Bahmas, O.T. Shreen F.Abd El- Hameed And Heba A. Lotf
14. Performance Evaluation Of Battery Powered Reaper
15. Performance Evaluation Of Reaperbinder For Wheat Wabi Tafa, Degefa Woyessa, Ashebir Tsegaye

16. Design, Manufacturing And Testing Of Crop Reaper Prof. Mr. R. L. Dhakne, Mr.Shrirang, M.Pimparkar, Mr.Dinesh V.Kamble, Mr.Akshay, S. Bharati ,Mr. Gaurav A. Wagh
17. Design And Development Of Manually Operated Reaper Prof P.B Chavan, Prof D.K Patil Prof. D.S. Dhondge.
18. Design And Development Of Manually Operated Reaper Machine Tesfaye Olana Terefe.
19. Design And Analysis Of Universal Reaper Machine Sachin Kumar, Sharma Gautam Kumar, Prashant, Vivek Tyagi Vineet Pal And Saurabh
20. Field Performance Evaluation Of A Power Reaper For Rice Harvesting Ni Ni Aung, Win Pa Pa Myo, Zaw Moe Htet
21. Field Evaluation Of Self-Propelled Reaper Cum Binder Through Front Line Demonstration In Wheat Crop In Indore District Of Madhya Pradesh Jitendra Singh