Automated Onion Sapling Bot

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Abstract*—Onion growing farmers are experiencing challenges in planting onion seedlings because of a shortage of farming labor during the planting of onion crops. The objective of the project is to design an automated onion planting machine. Thus, a need for an automated onion planting machine developed. This device plants onion plants at predetermined intervals between each plant automatically, without any human intervention. Developing an onion planting machine that automatically plants onions in a row, reducing farmers' labor costs and time, was a major factor in its development.*

Keywords—Automation, onion, bot, mechanism, etc.

I. INTRODUCTION

For the nation to improve its economic situation, it is important for agriculture to grow. In India, more than 70% of people are dependent on agriculture. By mechanizing the agricultural process, it is possible to reduce the costs of the farming process.For consumption purposes and also for export, onions are one of the most commonly used crops in India and abroad. Farming labour shortages during planting onion crops pose challenges for onion growers during the planting of seedlings. This must be addressed.

Seed planting by hand is one of the operations that are very labor-intensive and requires many laborers. However, this method has some disadvantages, such as low seed placement, variation in spacing, and serious back pain. It is possible to plant seeds using the conventional method, but it has many disadvantages, such as not having control of seed placement depth, not having uniformity in distribution of seed placement, losing seeds, and no proper germination of seedlings Moreover, they are not useful in ridge and furrow method. Conventional seed sowing machines are ineffective in ridge and furrow method and a large amount of seed is required.

Agricultural machines should have a simple design and be suited to all small farms. Complex technology should not be used. This is a basic requirement for an agricultural machine.Planting machines need to have flexibility to be used on different types of farmland. Manually operated template row planters were developed to improve plant efficiency and to reduce drudgery that was common in manual planting. The spacing between the seeds and the depth of the seed can be varied for seeds of different sizes. As well as increasing efficiency in seed planting, seed/fertilizer placement accuracy, it was made of durable and cheap physical materials which are affordable for all farmers. To make it easier for farmers and other users to operate, the handling, adjusting, and operating principles were simplified.

II. LITERATURE SURVEY

A. Pradip S. Gunavant, Vishal N. Gandhe, Vinayak Yadav, "Farm Mechanization by using Seed Planting Machine."

Here in this study efforts are taken to design and develop a seed planting machine which is suitable for ridge and furrow method and also plant the seed at specific distance with specific quantity and reduce the requirement of seed per unit area.

B. Abdulrahman, Mangesh Koli, Umesh Kori, Ahmadakbar, "Seed Sowing Robot"

The main aim of this is the automatic way of sowing the seeds. The seeds are sowed in a proper sequence which results in proper germination of seeds. This automatic way of sowing seeds using a robot reduces the labour requirement. Here the wastage of seeds has also been reduced to a greater extent. This system has been developed for the sowing of seeds in an automatic way.

C. Sumit Prajapati, Shubham Rai, Milind Mali, Manish Kumar, Abhishek Kumar, "AUTOMATIC TREE PLANTING ROBOT"

The research paper helps to decide the methodology for the design and fabrication of Tree planting bot. The mechanism used in our project is inspired by the one shown in this paper.

D. S.Panneerselvam, A.Rakesh, R.Saravana Kumar, S.Saravanan, "Design and Fabrication of Automatic Onion Planting Machine."

The design of the seed sowing machine is simple and the components used for making this are having moderate cost, only the sensors cost a bit. Drive shaft is used for the metering mechanism instead of pulleys and belt/conveyor system which reduces the cost. The shaft is driven by a DC motor which is coupled with the battery bank.

III. PROBLEM STATEMENT

After extensive literature survey we decided the problem statements:

1. Planting seeds and saplings is a time-consuming operation in the farming process. It also requires more labor.
2. Due to the shortage of labourers during planting onion crops, onion farmers face hurdles in planting onion seedlings. This must be addressed.
3. By contrast, the conventional method takes more time and leaves an uneven spacing between the saplings, which has an adverse effect on yield.
4. Onion sapling robots should be easy to construct and suitable for all types of farmers. They should have a simple design, and no complex technology should be used.

IV. OBJECTIVES

A. Providing alternatives to labour .

B. Uniformity in planting

C. Easy to repair

D. Save farmer's time

E. Smartly controlled

F. Cost effectiveness

V. METHODOLOGY

A. Mechanism:

a. Mechanisms for digging the soil & planting the saplings

b. Mechanism for something for putting sapling in a barrel.

B. Design:

a. Design by calculating various forces, torques and angular acceleration.

b. Deciding the power of the motor.

C. Analysis:

a. Static structural analysis of claw.

b. Static structural analysis of wedge.

D. Electronics:

a. Using microcontrollers for automation.

b. Using proteus to show the simulation.

VI. LINKAGE MODEL

Linkage software is used to decide the mechanism for the claw opening and also for deploying sapling.

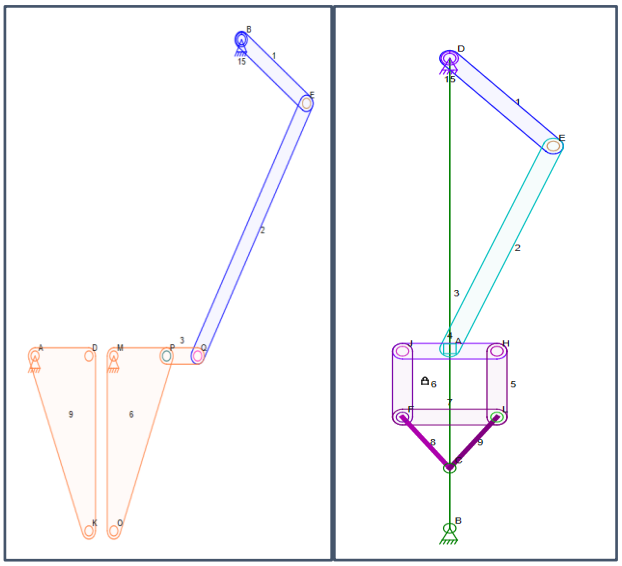


Fig. 1 *-a)Claw mechanism b)Mechanism to deploy sapling*

VII. DESIGN CALCULATION

Data:

1)Crank Radius = r = 75 mm
2)Connecting Rod = l = 300 mm
3)Transmission ratio = n = l/r = 300 / 75 = 4
4)Velocity of claw = v = 150 mm/sec
5)Time for slider crank rotation = t = 2 sec

Required angular velocity of motor,

$$\therefore v = w \times r \times (\sin\theta + \sin 2\theta/n)$$

For max Torque,

(sin²θ + sin²2θ/n) should be max, Max value of (sin²θ + sin²2θ/n) is 0.957 when θ = $\pi/4$

∴ 150 = w x 75 x (sin($\pi/4$)² + sin($\pi/2$)²/4)

w = 150 / 71.48 = 2.089 rad/sec

Here,
Energy required for slider crank mechanism = Change in potential energy of Claw mechanism

∴ Energy of motion = 2 x m x g x d

= 2 x 1 x 9.8 x 0.15

= 2.94 J

∴ Total Energy Required = Energy for motion + Shear Energy

= 2.94 + 0.07

= 3.01 J

∴ Power Utilized = Total Energy Required / t

= 3.01 / 2 = 1.505 W

∴ Input Power = T x w

where T = Torque of motor,

w = angular velocity of motor

Considering losses of 25% ,

0.75 x Input Power = Output Power

0.75 x T x 2.089 = 1.505

T = 0.694 N-m

T = 0.694 x 100 /9.8

T = 7.08 kg-cm

∴ Motor torque Should be more than required torque

Hence we consider a motor of 10 kg-cm approx.

VIII. CAD MODEL

Dassault system's Solidworks 2019 is used to make Computer Aided Design. There are 5 major components of the bot. 1) Distributor is to distribute the onion saplings, 2)Slider crank mechanism is powered by motor and is used to reciprocate the claw, 3) claw is to make a hole in soil and deploy sapling 4) The wheels are powered by DC motors and help bot to move forward. 5) The wedge is used to remove soil from the way.

The isometric, side and top views are shown below:

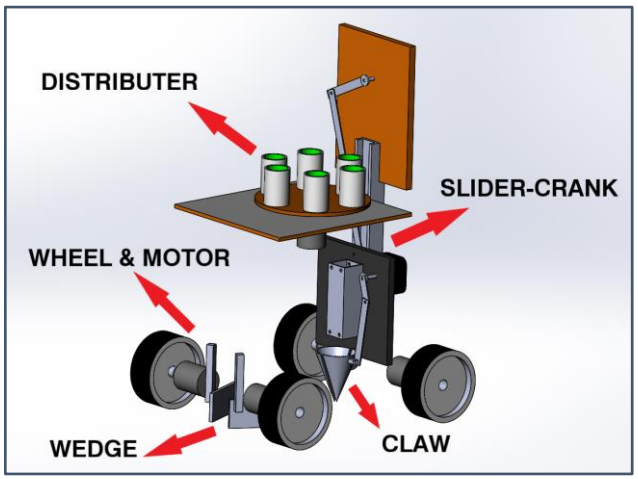


Fig. 2 - Isometric view

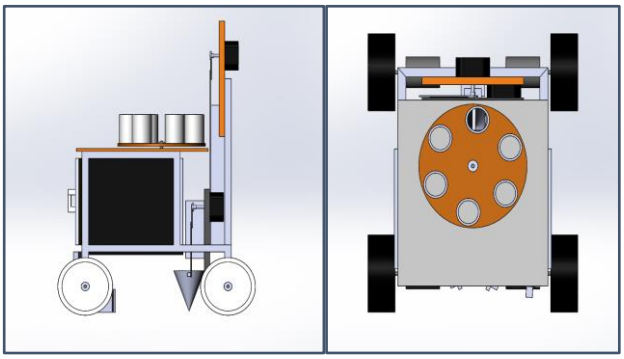


Fig. 3 -a)Isometric View b)Side view c)Top view

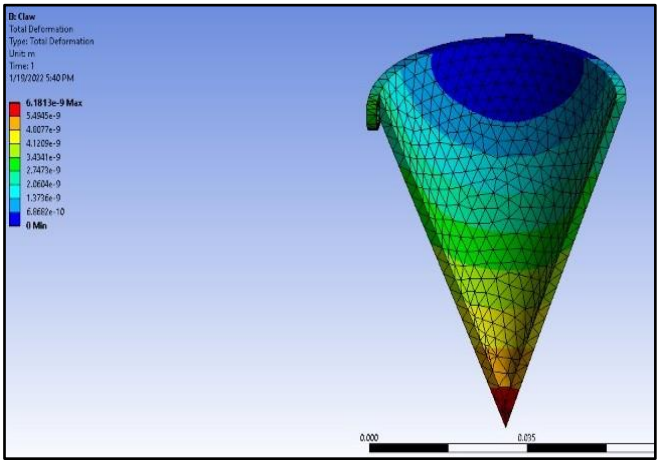
IX. ANSYS ANALYSIS

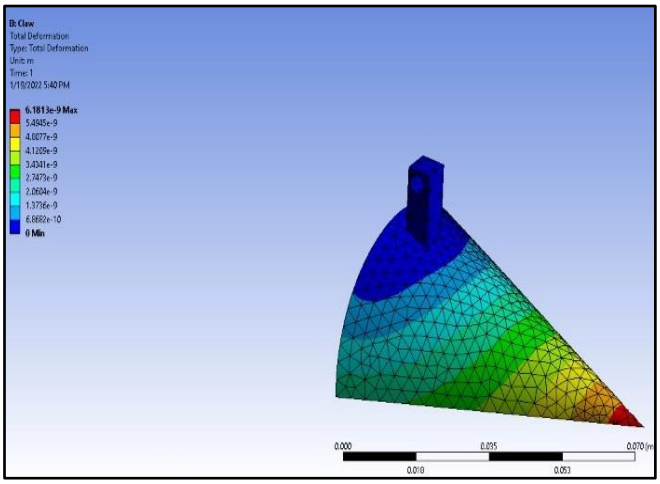
Here we did static structural analysis of claws. As claws move in downward direction, we have applied forces in upward direction to check the reliability of the claw and material we have used also to check the force distribution along the claw. We have considered the joint to the claw as a fixed joint due to the we also did bending moment analysis of the joint as well.

The results obtained from Ansys static structural analysis are as follows:

1. Pressure Analysis of Claw

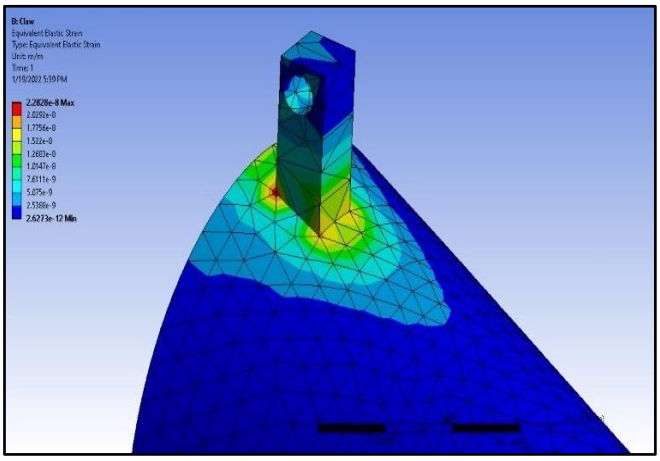
The downwards force is applied, the maximum deformation is observed at tip and has magnitude of 6.18e-9 m.





2. Bending Moment Analysis of Claw Joint

The claw joint is a critical part and has a risk of getting bent. The bending moment analysis of the claw joint shows the distribution of strain and maximum strain is observed at the corner which has magnitude of 2.28e-8 m/m.



X. CIRCUIT AND ELECTRONICS

In the circuit we used the following components:

1.Arduino Mega

2.Bluetooth (HC-05)

3.Motor driver(L293D)

4.Motor (DC & Stepper)

We used four dc motors for the motion of the bot. We are controlling these four motors using the motor driver mentioned above. We also used three stepper motors for performing the sowing operation. These three stepper motors are also attached to three different motor drivers. The Bluetooth module we used (HC-05). HC-05 Bluetooth Module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup.

Solidworks simulation result of motors:

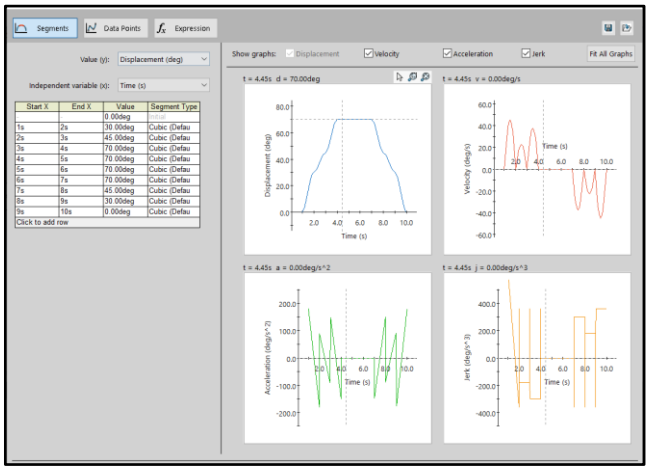


Fig. 5 -SCM motor

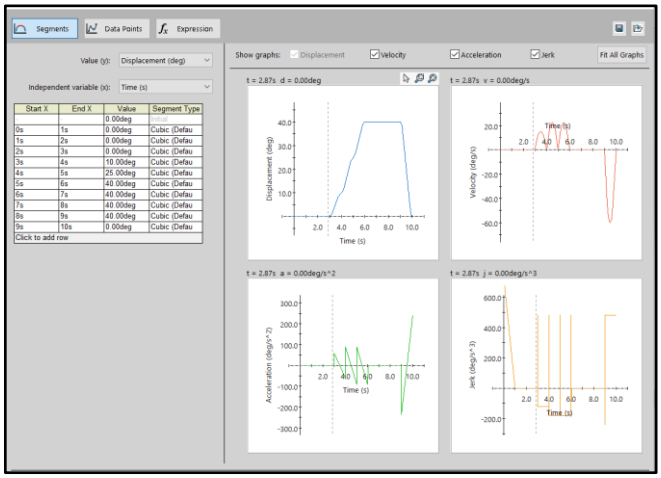


Fig. 6 -4 bar mechanism motor

An Application is developed to control the motion and direction of the bot. MIT app developers helped us to develop an app. Agri Bot is an app where the user needs to connect the bluetooth module with the smartphone. Once that is done, it opens a simple user interface where the user gets different buttons to give different commands.

The circuit explained earlier has been shown below. Once the app and modules are connected, the results gets reflected in the simulation.

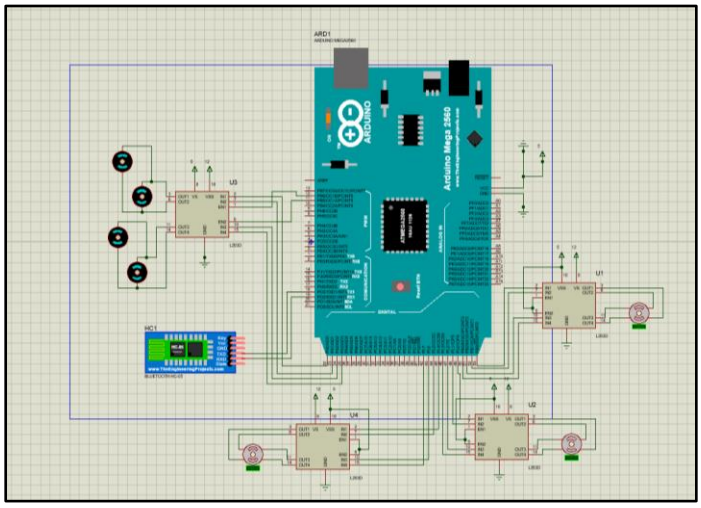


Fig. 7 -Proteus simulation

COST ANALYSIS

Estimated cost of material:

Sr. No.	Part Name	Weight	Rate/kg/m	Total Cost
1	HSS Material	3 Meter	210/- (m)	210/-
2	Wooden Plank	1 kg	180/-	180/-
3	Nut & Bolts	-	55/-	55/-
			Total	**445/-**

Estimated cost of parts:

Sr. No.	Part Name	Quantity Required	Rate/Unit	Total Cost
1	Arduino MEGA 2560	1	800/-	800/-
2	Bipolar NEMA 17	3	500/-	1500/-
3	Motor Drivers	2	80/-	160/-
4	DC Motor	4	180/-	720/-
5	MF Rainbow Wires	1(Set)	50/-	50/-
6	Lead Acid Battery	1	600/-	600/-
7	Wheels	4	50/-	200/-
			Total	**4030/-**

Total project cost = Cost of material + Cost of parts

= 4030 + 445

= 4475/-

CONCLUSION

By adapting the sapling plantation machine, the purpose of the tractor will be achieved. Up until now, the tractor was the main vehicle for nourishment. The sapling plantation machine can be put to use to increase their productivity. scale farmers at affordable prices. This technology must be promoted and made accessible to small-scale farmers at an affordable price. Raw materials can also be used to manufacture the machine, which significantly reduces cost and allows it to be manufactured in a workshop near you. The only expense would be electronic devices. Through the use of this machine we can achieve a flexibility of distance and control vary the depth for different seeds.

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