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AUTOMATIC NURSERY SEED SOWING MACHINE

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Abstract: India is the second-largest producer of vegetables in the world. A major portion of the area under vegetable cultivation is now sown with costly hybrid seeds, for higher yields and quality. Since hybrid seeds are costly, it is necessary to achieve maximum germination with healthy plants. This is achieved by growing vegetable seedlings in plug trays and then transplanting them in the field. In this method, growing media is filled in trays and one seed is manually placed in each slot. After seeding, the trays are regularly watered. The main objective of our project is to bring low-cost automation in the seed sowing process in nurseries, to reduce labor. The seeds are sowed automatically by the machine in the individual slots in the tray. This is done using the Infra-Red sensor and other actuation mechanisms. The tray is placed in the conveyor which is operated by the motor and at a certain position of the tray on the conveyor, the cocopeat is filled up to half in each slot through a hopper. Then the tray is held there and the seeds are dropped from the top by a seed feeder arrangement. Then the remaining cocopeat is added.

Keywords: *vegetables, cultivation, nurseries, seed sowing, low-cost, reduce labor, automation, tray, sensor, actuation, cocopeat*

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I INTRODUCTION

A nursery is a place where plants are propagated and grown to the desired age. Some species of plants should be grown in a plug tray and after desired growth they are transplanted in the field. Manual System for seed sowing in nursery is inefficient in production. Additionally, for tray-based seed sowing, skilled labor is required which makes this process costly. There are existing mechanisms for seed sowing in trays but they are: bulky, require technical skills to operate and maintain, expensive, and usually need to be imported.

It is known that electronics makes any process accurate as well as efficient. We are going to tackle the existing challenges as a project under the Mechatronics domain. The machine performs stepwise operation in which the empty trays are put on a transmission mechanism i.e. a conveyor. These empty trays are filled with the potting mixture, then seeds are added. In the end some more amount of potting mix is added. This is achieved through a mechatronics based machine consisting of actuating motors, sensor, microcontroller and some mechanical components Farming is a huge sector in India but lacks automation & technical advancements. We want to contribute to its development. Small scale Nursery industry and farmers will greatly benefit from this project.

Challenges can be summarised as:

- For plants having very small seeds like chilly, tomato, etc. sowing is done in trays.
- The labor cost for this process is high.
- Manual sowing is slow.
- Wastage of seed, water, potting mixture.

Scope of the project:

- Designed for small scale nurseries, farmers.
- Compact and affordable.
- Seedling quality can be controlled.
- Transportation cost can be avoided.
- Easy to maintain.

II METHODOLOGY

The main objective of our project is to bring low-cost automation in the seed sowing process in nurseries so that the manual work can be reduced. The seeds are sowed automatically by the machine in the individual slots in the tray. PIC18f4550 microprocessor is the heart of this mechanism. It is a stepwise process, in which we are using the hopper, conveyor i.e. transmission mechanism, seed tray, cocopeat (which is a special type of material made up of dried coconut husk and used for nursery seed sowing), seeds (chili, tomato), etc. The following lines describe the entire working briefly. We load an empty tray (plug tray) on the rotating conveyor. When the tray comes in the IR region, the conveyor gets stopped. Then the upper mechanism i.e. the hopper (container of potting mixture i.e. cocopeat), and seed feeder mechanism starts. The flap is used to control the distribution of cocopeat from the hopper. And the seed feeder is a motor-driven mechanism that drops one seed simultaneously in each slot in the same row. After filling the first row of the tray, it moves forward and the next row undergoes the same previously described filling process. This process repeats for all the rows in the tray.

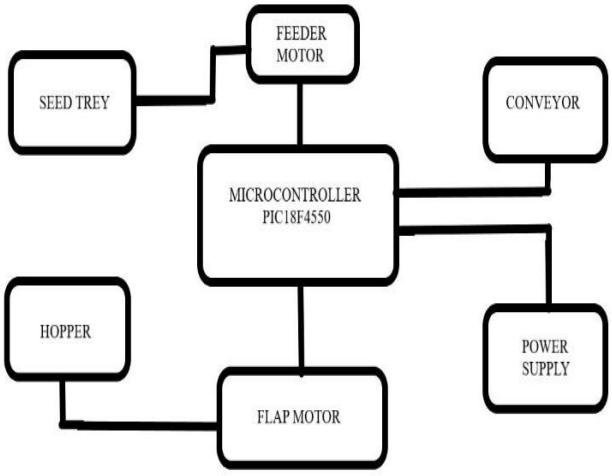

Figure 1 Block diagram of the system

III RESEARCH, SURVEY AND MEASUREMENTS

Research and Survey is one of the most important stages for the development of any system. We studied some existing mechanisms used for nursery seed sowing. These are: A) 'A 35' by demtec [1], B) 'Automatic nursery seeding machine' by TAIZY [2], C) Precision plug seeder [3] and more [4], [5]. After studying these mechanisms, we found some drawbacks.

Drawbacks of existing mechanisms/machines:

- High investment cost.
- Larger space is required.
- Trained personnel needed for monitoring and operation.
- Maintenance is costly.
- Periodic maintenance is required.
- Higher energy consumption.
- Not recommended for small scale production.
- Mostly imported, hence spare parts not readily available

Field survey:

This gave us an insight into practical farming methods and research [6].

- A visit to the Hightech Department, College of Agriculture, Pune.
- A visit to the DIY Lab, Vigyan Ashram, Pune.
- Visits to small scale shops related to Nursery industry raw materials.

Seed size analysis:

For precise design of seed feeding mechanism, it was important to study sizes of various seeds that are used in nursery seed sowing. We went through various available data for this purpose [7]. The following table was used as a reference while designing the seed feeder mechanism.

Table 1 Seed Size analysis used for reference

Seed name	*Diameter(mm)*
Beet	7.5
Cabbage	3.5
Carrot	3.5
Cauliflower	3.5
Corn	13.5
Cucumber	9
Lettuce	6
Okra	7.5
Onion	6
Pea	10
Radish	4

Tray Measurements:

Since trays play an important role in the seed sowing process, a study of dimensions of the tray was done to design the machine accordingly. The following measurements were noted:

- Number of total slots: 25 (5x5, Square plug tray)
- Weight of empty tray: 60-61 grams
- Side: 27 cm
- Height of tray: 5cm
- Opening of slot (Diameter): 4.7cm
- Bottom of slot (Diameter) :2.7cm

Figure 2 Measurements of dimensions of the tray

Cocopeat/ Potting mixture Measurements:

Correct amount of cocopeat is to be added below and above the seed for proper germination. For this purpose, we carried out the following measurements:

- 1 Tray slot filled partially (¾ of total height) contains 21-22 grams of cocopeat.
- 1 Tray slot completely filled contains 25-26 grams of cocopeat.
- Total cocopeat required to fill all the slots in the tray is 625 grams approximately.
- Total weight of tray after all slots are completely filled and seed is added is 687 grams approximately.

IV SELECTION OF ELECTRONIC COMPONENTS AND DESIGN, DEVELOPMENT OF MECHANICAL COMPONENTS

Since this a mechatronics based machine, it consists of two major hardware parts: Electronics and Mechanical.

Electronics components that are readily available in the market were thoroughly studied and components were selected accordingly.

- After studying various processors and controllers available, PIC18F4550 microntroller was selected based on our requirements [8]. It has the following features which make it best suited for our machine:

Table 2 Simplified features of PIC18F4550

PIC18F4550 – Simplified Features	
CPU	8-bit
Total Number of Pins	40
Operating Voltage	+4.0 to +5.5 V (+5.5V being absolute maximum)
Number of programmable I/O pins	35
Communication Interface	USB Serial Interface (23,24 PINS) [Can be used for programming this controller] Master/Slave SPI Serial Interface (7,26,33, 34 PINS) [Can be used for programming this controller] Programmable Serial UART (25,26 PINS) [Can be used for programming this controller] Two-wire Serial Interface(33, 34 PINS)[Can be used to connect peripheral devices like sensors and LCDs]
ADC Module	13channels, 10-bit resolution ADC
Timer Module	One 8-bit counter, Three 16-bit counter
Analog Comparators	2
PWM channels	4
External Oscillator	Up to 48MHz
Internal Oscillator	32KHz-8MHz Calibrated Internal Oscillator
Program Memory Type	Flash
Program Memory	32Kbytes[10000 write/erase cycles]
CPU Speed	12 MIPS
RAM Bytes	2KBytes
EEPROM	256Bytes
Watchdog Timer	Programmable Watchdog Timer with Separate On-chip Oscillator
Power Save Modes	Available

- For detection of presence of the tray, a sensor is required. Among various sensors that can detect the presence of an object we selected the IR(Infra-Red) sensor for our machine. It has the following features [9]:
  - Suitable for most electronic devices such as laptops, telephones, PDAs because of low power.
  - Presence/ Absence of light does not affect reliability.
  - Contact with object is not required for detection.
  - Because of beam directionality IR radiation, data does not leak.
  - Corrosion or oxidation does not affect them.
  - High immunity to noise.

Figure 3 IR sensor

- For the purpose of actuation, high torque and low speed D.C. (Direct Current) motors were used. These motors were driven by simple transistor based motor driver circuits.

Figure 4 Conveyor motor with shaft and gear box

- The mechanical part was designed and made according to the requirements and functionality of the machine from scratch. First they were designed and simulated using the SolidWorks software. The following figures show the software designs of the body frame, the seed feeder mechanism and the completely assembled machine.

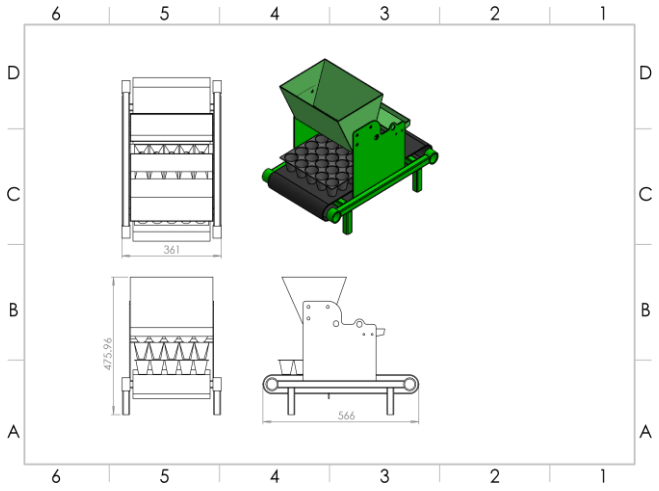

Figure 5 Body frame design

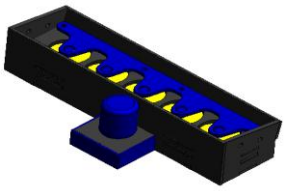

Figure 6 Seed feeder mechanism design

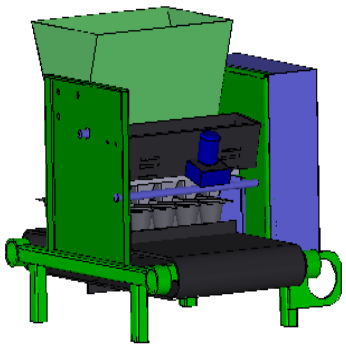

Figure 7 Automatic nursery seed sowing machine complete assembly

- Various mechanical components perform various tasks in cohesive working of the machine [10]. The following table summarizes these components, their descriptions, materials used to make them and the task they perform.

Table 3 Mechanical components summary

Part Name	Description	Material & Quantity	Work
Base	Angle welded	Mild Steel 1	To support whole system
Side Plates	Sheet Laser cut CNC Bend	Mild Steel 2	To support all components
Coco Peat Bin	Sheet Laser cut CNC Bend and welded	Mild Steel 1	To hold Coco Peat
Belt	Stitched	Canvas 1	Transmission of tray
Cup tray	Pre-Fabricated	Plastic 1	For seedlings
Coco Peat Holder	Laser cut CNC Bend and welded to pipe	Mild Steel 1	To hold Coco Powder
Seed feeding Unit	Laser cutting and pasted	Acrylic 1	To pour seed in synchronised manner
Lower feeding Unit	Sheet Laser cut CNC Bend and welded	Mild Steel 1	Pour seed and Coco Powder in trays
Water spray	Pipe with holes	Mild Steel 1	To sprinkle water On tray
Side cover	sheet cut and bend	Mild Steel 1	To hold all system And aesthetic purpose

V BACKEND DEVELOPMENT

Proper programming of the microcontroller is required to bring out smooth functionality of the machine. It controls and coordinates functioning of all the components in the machine. In backend programming we used embedded c programing using MPLAB X IDE v5.30 and XC8 compiler v1.41 [8]. The following is the algorithm for the code which is self-explanatory:

START

Conveyor start

IR detection (conveyor stops for some delay).

flap open (some amount of cocopeat falls into the tray)

flap close

feeder mechanism on (drops seeds in the tray)

feeder mechanism off

flap open (remaining cocopeat falls into the tray)

flap close

STOP

Conveyor starts again.

This process keeps looping till all the rows in the tray are filled.

VI CONCLUSION

After thorough research, analysis and practical implementation of the Automatic Nursery Seed Sowing Machine we derived the following conclusions:

- Automatic Nursery Seed Sowing machine replicates the seed sowing process through automation effectively.
- It increases productivity and decreases labor cost.
- It is cheaper than existing machines and requires smaller space.
- It has lesser energy requirements and can be easily transported.
- With some minor changes in design, it may also be used for large scale activities.
- Integration with IOT will further enhance its capabilities.
- Small scale automation allows farmers to maximize yields using minimum resources, such as water, fertilizers and seeds.
- This is an attempt exploring non-traditional technologies to improve global farming using innovation.

- Integrating sensors, electronics, control and power systems, and ICT engineering for agriculture plays a major role in improving food supply and sustainable energy production without burdening the limited fertile land bank and environment.
- As technology grows day by day, we infer that no sector can remain untouched by automation including farming.

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