Speaker Notes

(RuTAG) NORTH EAST's AGROBOT DESIGN INNOVATION CHALLENGE

### 2021-03-28

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**AARON (Backup: NAKUL)**

# Slide 01

* Hi everyone. Here’s a quick look at our design for the agrobot.

# Slide 03

* Being modular in design, our robot can carry out tasks such as sapling transplantation, weed removal, and seed metering not just on planes but also in hilly terrains.

# Slide 07

* The agrobot uses a 4-wheel drive with individual steering instead of a differential turning mechanism for more traction and less slippage on loose soil.
* Moreover, the steering motors can align the wheels in a staggered manner for braking.
* The robot features an adjustable chassis to alter wheel separation.

# Slide 13 (Video)

* The proposed bot can sow seeds of irregular sizes at an adjustable rate with uniform penetration into the soil.
* Given the physical characteristics of the seed, we calculate the seed shape index to decide the appropriate rotating disc for the metering mechanism.
* The plastic parts in the mechanism also reduce the possibility of damage to seeds.

# Slide 19 (Video)

* Here are the main features of the transplantation module:
  + Uniform plantation is incorporated, resulting in higher yield.
  + The bot can be refilled directly with a nursery seedling tray in which saplings have been grown.
  + The bot can also plant seedlings according to specified depths as required by the plant.

# Slide 23 (Mechanical vs Chemical, Traditional vs Precision)

* When we think of weeding, we first think of a mechanical weed removal technique.
* But successful mechanical weeding requires the complete uprootal and disposal of weeds, and hence extremely precise and complex mechanisms.
* Chemical weeding, being much faster, is also more scalable in medium-scale and large-scale farms.
* These reasons demand the need for using weedicides.
* We particularly promote precision spraying for increasing the efficiency of spraying and hence decreasing the farming costs.

# Slide 27

* The extra features of the agrobot include the use of renewable power sources, terrain mapping and the identification of water stagnation zones.
* Moreover, a cooperative ownership model can be adopted and custom hiring centres developed for ease of access to the agrobot.

# Q&A

INNOVATIONS

* We have an adjustable chassis and independent steering
* We have developed sowing capability for irregular seeds using controlled metering
* The design implements a full-fledged sapling transplantation mechanism for the given size class of robots
* We have implemented chemical weeding due to the cons of mechanical weed removal. The farmer may also use organic weedicides to reduce the injection of chemicals into the food chain.

DIMENSIONS OF ROBOT

* Dimension: 0.8m x 0.8m x 0.7m
* Weight: 55kg
* Speed: RPM is high. Can reach >2m/s
* Optimum speed considering our use case: 0.5m/s
* Ground clearance: 20 cm
* Battery: 2\*22Ah, 22.2V, 2hr endurance
* Steering motor torque: 42 kg-cm

CONTACT OF CROP WITH WEEDICIDE

* This also reduces the contact of the crop with the weedicide, even when the farmer chooses to use inorganic chemicals.

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**NAKUL**

A very good afternoon to one and all present here

# Slide 1

Let's start with some food for thought! What if our farmers do not need to carry out farming tasks in scorching sun or some extreme weather? Can't we use our so-called technological advances to help them with these seemingly trivial tasks.

Here we present our concept for The AgroBot to cater their needs.

Firstly let's see the major hurdles in farming related activities.

# Slide 2

Labor shortage, smaller land holdings, inferior farm yield and lower tendency to adopt new mechanisms are few of the many problems that AgroBot can help eliminate.

# Slide 3

With a modular design our robot can carry out tasks like sapling transplantation, weed removal, seed metering not only on planes but in hilly areas as well.

I call upon Yash to dive into the mechanisms in detail.

**YASH**

# Slide 4

So coming to slippage prevention system

# Slide 5

As our main target was to mechanise agriculture in hilly terrain , our bot has 3 salient features structurally modified wheels

manoeuvring and alignment on these slopes, the

4-wheel drive design with high ground clearance

The wheels consist of rigid-rim, wire-mesh tires that are connected to their axles by spokes. Metal cleats are also mounted on the tire to ensure better traction in the loose soil.

Center of gravity is tried to kept as low as possible

# Slide 6

Components of different

Adjustable rod : Adjust track and wheelbase

High ground clearance and low COG

# Slide 7

2 systems incorporated to avoid slippage

Control system and Mechanical system

4 wheel drive as the soil is loose to avoid slippage and it will give better traction

On high gradient surface the staggered alignment of wheel help in maintaining the position of the bot

**NAKUL**

# Slide 8

Now coming to the seed metering mechanism, this is an important task as we need to monitor the number of seeds soon at a location without wasting them.

# Slide 9

The design proposed by us can sow seeds of irregular varied sizes at a controllable rate with uniform penetration in the soil.

# Slide 10

The components of the mechanism are shown here. This includes a seed storage box, a continuously rotating disc with slots for seeds, mechanism to put the seeds appropriately in the slots and finally seed sowing pipe.

# Slide 11

Given the dimensions and phy characteristics of the seed we calculate a seed shape index which helps us decide the rotating disc to be used for the metering mechanism.

Of course these discs are easily replaceable.

The plastic parts in the mechanism reduce the chances of damage to the seeds.

# Slide 12

The mechanism as earlier seen in the picture follows this routine.

1) Seeds are first dumped into the hopper and later put into appropriate slots in the rotating disc which fall into delivery pipe

3) and finally the seeds are sown at uniform penetration through a pneumatics actuated delivery pipe.

# Slide 13

Lets watch a quick simulation of the working of mechanism

# Slide 14

With the angular velocity of rotating disc, forward velocity of robot and the state of pneumatics actuated delivery pipe we can control the number of seeds to be sown at what location.

This shows all the boxes for seed metering mechanism are thus checked.

# YASH

# Slide 15

Uniform plantation: equal spacing between plants ...gives higher yield

Refill the bot : Farmer can directly add the sapling trey from nursery into the bot

Plantation to required depth; as every plant requires different depth for growing optimally

# Slide 16

Seedling gripper : Mechanically holds the sapling and drops it into the seedling planter mechanism

The tray is moved through the motors as a conveyer belt

# Slide 17

The next modular accessory is transplantation,

The main features are

Firstly, the uniform plantation - which results in higher yield

Second, you can refill the bot directly with your nursery seedling tray in which you have grown your sampling

And last but not least it will plant the seedling according to the required depth

Coming to the mechanical part

It comprises two mechanisms

1st is seedling gripper & 2nd is a seedling planter

# Slide 18

The mechanism is way simpler,

It contains the gripper which grabs the seedling from the tray and drops it in the planter,

And at the same time another mechanism for moving the tray along the row when the seedling is removed from the hole, and when rows are finished the tray is moved down with the help of another mechanism

**AARON**

# Slide 20

* As we all know, weeds are a scourge for farmers.
* They reduce crop yield and even poison the soil.
* Weed removal is an essential requirement for any farmer and hence finds its way into our design.

**Slide 21**

* Our weed removal mechanism features the following characteristics:
  + Organic weedicides that nourish the soil can be loaded into the mechanism.
  + The farmer may spray both liquid and powder in a very precise manner.
  + This mechanism can also be used to sprinkle fertilizers to the plants.
  + And the nozzle of the mechanism is customizable to permit widespread spraying as well as focused spraying.
* Here are some details of our mechanism:
  + The 2-axis gimbal permits spraying throughout the region around the bot.
  + An atomizer is implemented as a very thin tube for spraying liquid weedicide.
  + The junction permits the mixing of solid and liquid with compressed air for precise and focused spraying.
  + An agitator can also be used to maintain smooth flow of powdered weedicide without clogging inside the pipes. We’ll also see more of this later.

**Slide 22**

* So what’s inside the junction?
  + The upper hole, that’s the smallest hole, is the atomizer through which the liquid weedicide comes out
  + The large middle hole is the input point for compressed air
  + And the hole in the bottom is where the powder comes in.
* For more control, there may also be a gate mechanism for the solid weedicide input and a valve for preventing the flow of compressed air into the liquid weedicide tube.

**Slide 23**

* The first thought that comes to our minds when we think of weeding is a mechanical weed removal technique. So, why haven’t we suggested that instead of weedicides?
* The complete uprootal, segregation, and disposal of weed are required for successful mechanical weed removal.
* This calls for an extremely precise mechanical arm mechanism that would be complex to implement and would put a dent in the wallet of the farmer. It would also be difficult to maintain in the rough conditions of a farm.
* Moreover, mechanical weed removal may even cause damage to crop roots.
* Finally, mechanical weeding is much slower in comparison to chemical weeding, which makes the latter much more scalable in medium-scale and large-scale farms.
* These reasons demand the need for using weedicides.
* But why not traditional weed removal? Why specifically use precision spraying?
* In terms of weedicide volume, precision spraying is 95% more efficient than indiscriminately spraying weedicides since it sprays only in areas that are detected to contain weed.
* While this saves a lot of weedicide and reduces costs for the farmer, it also puts smaller amounts of chemicals in the food chain even with inorganic weedicides, hence improving the quality of the crop.
* Finally, our weed removal mechanism may use computer vision to detect the location of weeds to prevent indiscriminate weeding which may lead to the removal of crops as well.

**Slide 24**

* The agitator is a basic mechanism that causes vibrations on the pipes.
* The mechanism works due to the unbalanced force that arises due to the unbalanced mass that is the semi-circular mass that is rotated using the DC motor.
* The agitator is placed midway between the gimbal mechanism and powder tank for optimal performance.

# Slide 25

**AARON:** So, what’s more? Let’s hear from Kaustubh and Nakul.

**KAUSTUBH:** Title

# Slide 26

Architecture: The DC battery powers the microcontroller which provides outputs to the motor driver and based on the inputs from the sensors. A solar module can be integrated for recharging the batteries.

# Slide 27

Extra features are

-> Renewable source of power: Hilly regions have **high solar irradiation** and a 200W solar panel mounted on the roof of the robot is enough to charge two batteries.  
Which is utilization of Solar irradiation

-> Gyroscope ground level alert: Using the **gyroscope of a smartphon**e integrated with a bot, the bot alerts farmers where water stagnation can occur .  
Which can map the terrain and help identify water stagnation zones with soil moisture sensors

-> All of this can be integrated into a smartphone application for ease of use.

Smartphone integration: Once a **farmer connects his smartphone, the bot becomes aware of farm layout**, crop type and farm activities to be carried from data in the smartphone. The ambient light sensor , gravity sensor , gyroscope, compass, camera, flash from a smartphone are available for bot to use.

3D printable parts: Several parts of the mechanism plastic made to prevent damage to seeds and saplings and can be modified as per required customisation.

-> Disease assessment on crops and light traps : The light trap mounted on the bot traps insects as it moves through the **farm at night**. The **continuous surveillance using a smartphone camera and a computer vision algorithm keep track of yellowing and rolling of leaves** and alert farmers with photos and crop location. Manual steering option: A handlebar at the back of bot gives full steering control with motor locomotion

# Slide 28

Cost issues are answered by implementing cooperative ownership model and custom hiring approach

Energy issues are answered by using renewable energy power.

Innovations can help reducing fixed and variable costs.

# Slide 29

The role of Agrobot in the rural sustainability triangle is explained in terms of economic, socio-cultural and environmental aspects.

Socio-cultural

Rural Social Condition: Due to migration of men to cities, women have to lead farm activities. The mahila mandals, self -help groups (SHGs) in several hilly states have the potential for women in the development of **cooperative ownership model and custom hiring centres** in hilly areas.

Food Quality:Low use of agro-chemicals indicates considerable potential for ‘organic’ agriculture.

Farmer Safety: high risk of work-related injuries, lung disease, noise-induced hearing loss, skin diseases, as well as certain cancers related to chemical use and prolonged sun exposure

Youth skills: micro enterprises development

Economic

Farmer Income: labour decrease, seed and other input cost,

Sustainable food products: diversify into more lucrative high value crops.

Food supply: subsistence farming into viable farming

ENVIRONMENT:

Soil/ water : New technologies prevent land loss to erosion, water pollution and enhances carbon sequestration.

Biodiversity: Local species of food products (species, fruits, vegetables\_ are conserved.