CYSF Logbook 2024 - 25

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8TH GRADE

TOPIC: Reforestation with the help of Drones

PROBLEM/QUESTION

Problem:

Wed, Sept, 18/2024

Globally, on average we are losing 10 billion trees every year due to deforestation, and natural disasters such as wildfires. Us as humans cannot recover the damages done by these cataclysmic disasters. As a result, we are losing trees and forests faster than we can recover them. This leads to a loss of carbon capture, which contributes to climate change and global warming. Restoring our forests will help re-stabilize the climate.

In our project, we will be exploring the idea of helping restore our forests and ecosystems with the help of drones and technology. This will allow us humans to use this technology and plant trees faster, and more efficiently in hard to reach places, or places that humans can't reach. We will build a prototype of a seed-firing drone that will bring awareness to people all over the world about how technology can help fight climate change, and restore ecosystems.

Thur, Sept, 19/2024

Main Question:

Can Drone Technology be used for the plantation of trees?

Guiding Questions:

- What are wildfires, and how do they form?
- Impacts of wildfires.
    - Loss of forests
    - Increase in carbon emissions
    - Reduction in carbon capture
- What are the effects of wildfires on deforestation, and climate change?
- Does the loss of trees contribute to the increase in CO2 in the atmosphere?
- What is reforestation ?
- How can reforestation be achieved at the rate deforestation happens?

BRIEF RESEARCH

Causes and effects of deforestation:

Deforestation is an immense problem in the world. It is the clearing of trees and forests to make room for farmland, agricultural land, towns, and cities. As the demand for these resources grows, companies such as Walmart, Starbucks, and Mcdonalds benefit from deforestation, as deforestation allows the resources that they need to be made available. As the destruction of forests continues, on a large scale, it can add to the acceleration of climate change, Carbon capture reduction, biodiversity loss, and soil erosion.

National Geographic Society. "Deforestation." *National Geographic Education*, 20 August 2024, https://education.nationalgeographic.org/resource/deforestation/. Accessed 28 September 2024.

Lai, Olivia. "13 Major Companies Responsible for Deforestation." *Earth.Org*, 29 January 2023, https://earth.org/major-companies-responsible-for-deforestation/. Accessed 28 September 2024.

What are wildfires and their impacts?

Wildfires are wild fires which burn in many different ecosystems, which includes forests, grasslands or Savannas. These natural sisters are not limited to one specific place/environment. Wildfires most of the time start small and are intimately unnoticed, but are able to spread rapidly. They destroy everything in their path as they travel through areas.

Some impacts of Wildfires include:

1. **Air Pollution (Wildfire Smoke)-** Wildfire smoke can have big impacts on human health, because it is a mixture of multiple gases: ozone, methane, sculpture dioxide, nitrogen dioxide, carbon monoxide, particulate matter and more. These are all toxic air pollutants, which have horrible impacts on health and are greenhouse gases. These gases can go up into the ozone layer, helping create the greenhouse effect (which warms the planet). Wildfire smoke can cause burning eyes, runny nose, coughing, trouble breathing or illness like bronchitis. Furthermore, if you have respiratory and cardiovascular problems, it can make it worse.
2. **Water pollution-** Forest fires can have impacts on aquatic ecosystems, because ash and sediment in these ecosystems affects the water clarity and have a big impact on marine life.
3. **Destroying communities-** Due to wildfires thousands of peoples are forced to relocate. Not only this but wildfires can also ruin roads, power grids, homes and communication networks. Wildfires can also have impacts on cultures because some cultures have traditional practices like hunting or gathering.
4. **Ecosystems-** wildfires that are uncontrollable can reduce biodiversity because they eliminate key habitats and disrupt the interaction in ecosystems. Nevertheless, some ecosystems can benefit from these new ecosystems conditions created by the fire. Unless the fire is not controlled, which can burn through these ecosystems.

"Forest fires." *Ouranos*, https://www.ouranos.ca/en/climate-phenomena/forest-fires-background. Accessed 28 September 2024.

Government Canada. "Wildfire smoke and your health." *Canada.ca*, 6 June 2024, https://www.canada.ca/en/health-canada/services/publications/healthy-living/wildfire-smoke-health.html. Accessed 28 September 2024.

National Geographic Society. "Wildfires." *National Geographic Education*, 19 October 2023, https://education.nationalgeographic.org/resource/wildfires/. Accessed 28 September 2024

"Canadian Red Cross Home." *Canadian Red Cross Home*, https://www.redcross.ca/how-we-help/emergencies-and-disasters-in-canada/types-of-emergencies/wildfires/wildfires-information-facts. Accessed 28 September 2024

World (World Health Organization) Health Organization. "Wildfires." *World Health Organization (WHO)*, https://www.who.int/health-topics/wildfires#tab=tab_1. Accessed 28 September 2024

Solutions for deforestation:

What is Canada Doing?

Canada's Government is doing everything in their power to conserve and protect our forests, ecosystems and wildlife. There are strict rules and regulations in place to conserve our forests. There are some areas where some activities are restricted to conserve natural ecosystems. For example industrial activities such as harvesting, mining, and hydroelectric development are banned in 95% of Canada's protected areas and forests. All of this is done to ensure that our forests are protected, as there are 24 million hectares of protected forests in Canada, and 7% of the whole country is forests.

In 2021, a company named Flash forest, used drones to help with reforestation mostly in the provinces of Alberta and British Columbia. They have planted trees in Canada, the U.S and Europe. Flash forest owners are Mr. Jones, Cameron Jones (his brother) and Angelique Alström.

Government of Canada. "Government of Canada." *Conservation and protection of Canada's forests*, 4 April 2024, https://natural-resources.canada.ca/our-natural-resources/forests/sustainable-forest-manageme

nt/conservation-and-protection-canadas-forests/17501. Accessed 28 September 2024

Globe content Studio. "Canadian startup plants new forests in a flash, with investment from TELUS Pollinator Fund for Good." *The Globe and Mail*, 24 April 2023, https://www.theglobeandmail.com/business/adv/article-canadian-startup-plants-new-forests-in-a-flash-with-investment-from/. Accessed 7 October 2024.

Flash Forest, https://flashforest.ca/. Accessed 7 October 2024

Innovative solutions:

Aerial Seeding or Seed Firing drones have been used for agriculture and farming for many years. It reduces workload and increases the efficiency of farming methods. This type of technology is being used to help with reforestation today. Planting trees is a very popular way that us humans tackle climate change, but many planting projects always fall short of their goals. So Seed-Firing drones were invented to help humans and assist them in traditional reforestation methods, as well as boost tree planting rates.

1. When planting trees, scientists use special technology, artificial intelligence, and local indigenous knowledge to plant trees in a specific area that will thrive in today's climate and future warmer climates.
2. Using Aerial Seeding Methods, humans can also plant trees in remote and hard to reach areas. The drones do this as the follow a pre-planned route, and shoot out seeds using pneumatic air guns, or simply just by dropping the seeds.

To give the plant the best chance of survival, the seeds are covered in biodegradable pellets/pods with all of the nutrients that it needs to survive.

Asher, Claire, and Glenn Scherer. "New Tree Tech: Cutting-edge drones give reforestation a helping hand." *Mongabay*, 12 July 2023, https://news.mongabay.com/2023/07/new-tree-tech-cutting-edge-drones-give-reforestation-a-helping-hand/. Accessed 29 September 2024.

Susan Graham. "These seed-firing drones plant thousands of trees each day | Pioneers for Our Planet". Youtube, uploaded by World Economic Forum, 4 December 2019 https://youtu.be/nXophqU-rp4?si=VxHO5IwBh1aje5Qb. Accessed 29 September 2024.

Sat, Sept,28/2024

HYPOTHESIS

NAVNIR:

The importance of reforestation is crucial to maintain the climate, prevent the decrease in carbon capture, avoid biodiversity loss, and much more. But planting trees manually is very difficult, and not efficient. This is why many environmentalists, and engineers came up with the idea to create technology that will help with reforestation. What they came up with was a drone that would shoot out biodegradable pods containing the tree seed specific to that area. Over time, these trees will grow, restoring the loss that was caused by deforestation, wildfires, and much more. Our objective in this project is to create a cost efficient replica of these seed-firing drones, and showcase the wonders that technology can do to help us help the planet, and make things easier to do in our daily life.

TANVEER:

Wildfires and deforestation have many effects on the environment, humans and numerous communities, as we learned from our research. Deforestation and wildfires lessen biodiversity in ecosystems, this then increases global warming ads can have tremendous impact on climate change. This is why reforestation is something we should be working towards. In Canada, we can see that as a country, we have done plenty to help abilate forests that have been destroyed. We see this in our research where we know that Canada has made rules and regulations to help conserve forests. We want to create an efficient and fast way to plant trees in Canada and all around the world. With drone/prototype we may help many environments and communities to gain back their

forests, just like flash forest. Flash forest is a company with the same goal as us who have worked in Canada, the US and Europe using drones to help with reforestation. In turn, This will help teach many people about drones and the importance of reforestation, but also help us develop a prototype to help the planet and all ecosystems and communities in it.
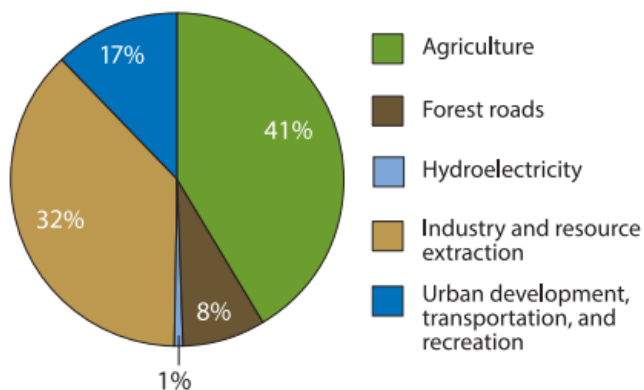
Mon, Oct,7/2024

RESEARCH

What does deforestation in Canada look like?

Deforestation is the permanent removal of trees and forests. This is done so that the land covered by this can be used for other purposes, such as agriculture, and other reasons like paper industries, and furniture made out of wood.

In Canada, we do clearcutting, and other harvesting practices to sustainably give the resources needed to companies so that we as citizens can have access to things such as paper products, and wood furniture.

There are also many reasons why deforestation happens in Canada, and this graph shows the multiple different causes of why it happens.

Causes of deforestation in Canada for 2010

- 41% Agriculture
- 1% Forest roads
- 8% Hydroelectricity
- 32% Industry and resource extraction
- 17% Urban development, transportation, and recreation

As you can see, agriculture is a huge reason for deforestation. This is because agriculture is a huge industry in Canada, and farms cover 62.2 million hectares of land.

"Deforestation in Canada—What are the facts?" *Forests and forestry*, March 2016,

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https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/36710.pdf. Accessed 7 October 2024.

Overview of Canada's agriculture and agri-food sector - agriculture.canada.ca, 27 June 2024, https://agriculture.canada.ca/en/sector/overview. Accessed 7 October 2024.

What does reforestation in Canada look like?

In Canada, there is a program called "TREE CANADA". It is a group of people that research and help recreate the lost forests. Tree Canada is an association that focuses on large hectares of damaged land. Then plant tree seedlings that are perfect for that area or province.

Why should we plant trees?

Trees have many benefits. For example Carbon (the process of capturing and storing atmospheric Carbon Dioxide), improving habitats, improving biodiversity, and increasing Oxygen in our air.

Not only that, but trees help with the fight against climate change. Through a process called photosynthesis, trees take in carbon dioxide, and use it for the tree's energy, and release a by-product, which in this case is oxygen.

"National Greening Program." *Tree Canada*, https://treecanada.ca/our-programs/national-greening-program/. Accessed 7 October 2024.

Trees Canada. "Restoring and Growing our forests." 24 October 2023, https://www.youtube.com/watch?v=f7KtZHv92ss&list=PL7phIB_fGFq-Jt1-halBQdmMf-l_-mJQF&index=1. Accessed 7 October 2024.

"Photosynthesis | Definition, Formula, Process, Diagram, Reactants, Products, & Facts." *Britannica*, 20 September 2024, https://www.britannica.com/science/photosynthesis. Accessed 7 October 2024.

TREES AND CARBON CAPTURE:

What is carbon capture/CSS?

CSS or carbon capture is the capture of Co2 emissions with the use of steel and cement production. In general, it is a process, which collects carbon dioxide (Co2) and takes the carbon dioxide somewhere with the greenhouse gas. This process may be a key component to reduce global warming. This is 3 step procedure:

1. Capturing the Co2 for storage- the carbon dioxide to split up Co2 from other gasses in the air.
2. Transport- the Co2 is then squeezed and moved through pipelines, road transport or ships to move for storage.
3. Storage- lastly, the Co2 is put into rock formations underground for permanent storage.

Trees do this by a process called photosynthesis, which converts CO2 from the air and turns it into breathable oxygen.

 "Journey to net zero stories | More stories." *National Grid*, https://www.nationalgrid.com/stories/journey-to-net-zero-stories. Accessed 7 October 2024

Thompson, Avery. "What Is Carbon Capture? | Carbon Capture and Storage." *Popular Mechanics*, 13 April 2018, https://www.popularmechanics.com/science/green-tech/a19645960/what-is-carbon-capture-storage-ccs/. Accessed 7 October 2024.

"Photosynthesis | Definition, Formula, Process, Diagram, Reactants, Products, & Facts." *Britannica*, 20 September 2024, https://www.britannica.com/science/photosynthesis. Accessed 7 October 2024.

How much carbon dioxide (CO2) do trees capture?

A tree absorbs anywhere between 10 and 40 kg of Co2 per year. To compare 1 kg of Co2 can fill a large beach ball (with a diameter of slightly over 1 meter). This means 0.83 - 3.3kg of Co2 captured per month. This can be based multiple factors:

- **The species of trees:** the different species can have varying growth rates, which can differ from patterns of carbon sequestration (the process of capturing and storing astrological Co2). A fast-growing species may see a lessening of carbon storage and on the other hand slower growing trees can show a gradual increase in the carbon storage
- **Environmental conditions:** some factors like soil fertility, water availability, sunlight exposer, and temperature, these conditions can impact tree growth and carbon uptake. The optimal conditions are preferred for faster growth and the higher carbon sequestration rates (the process of capturing and storing astrological Co2).
- **Disturbances:** natural or human activities disturbances including: fires, pests, or disease, these can interrupt the typical pattern of carbon sequestration (the

process of capturing and storing astrological Co2). Leading to temporary or perm at changes in carbon intake.

"What is carbon sequestration? | U.S. Geological Survey." *USGS.gov*, https://www.usgs.gov/faqs/what-carbon-sequestration. Accessed 7 October 2024.

"What is 1kg of CO2 equal to?" *Cogo*, 15 November 2022, https://cogo.zendesk.com/hc/en-gb/articles/8016117711641-What-is-1kg-of-CO2-equal-to. Accessed 7 October 2024.

Bernet, Ross. "How Much CO2 Does A Tree Absorb?" *One Tree Planted*, 25 July 2023, https://onetreeplanted.org/blogs/stories/how-much-co2-does-tree-absorb. Accessed 7 October 2024.

"Our Team — Hamerkop." *Hamerkop Climate Impacts*, https://www.hamerkop.co/team-hamerkop. Accessed 7 October 2024.

How does this impact climate change?
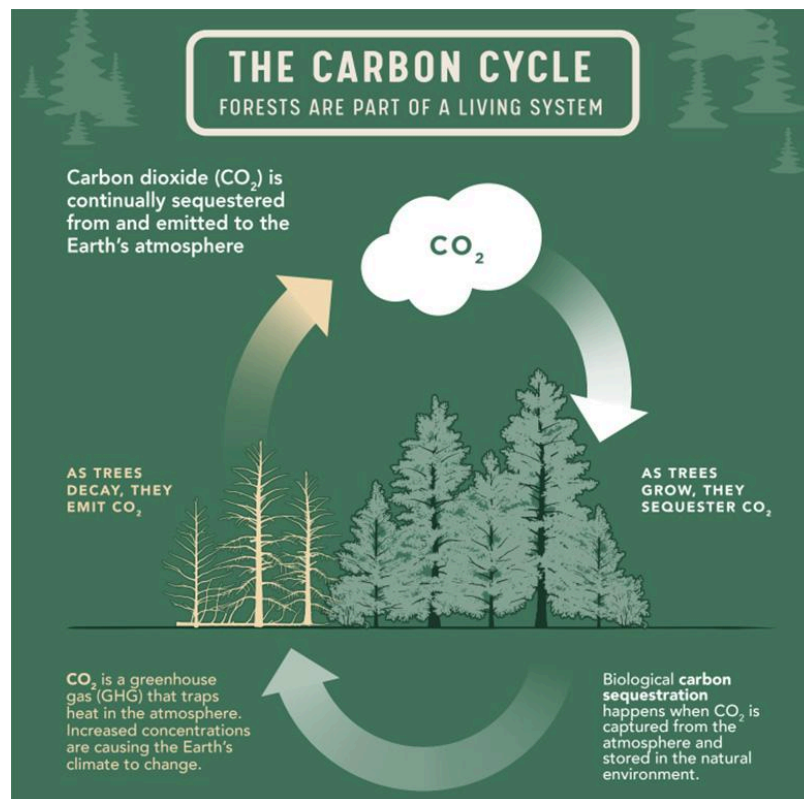
The carbon cycle- is a cycle is the constant movement of carbon from land, water and through the atmosphere and living organisms.

As you can see from the picture above forests are a vital part of the carbon cycle, with storing and releasing. This is a big part of the carbon cycle, looking at the global scale. Forests help Martian the Earth's carbon balance by capturing Co2 From the atmosphere as they grow.

As the trees grow, they help stop climate change by removing Co2 from the air, storing the carbon in the trees and soil. In turn, the excess product (oxygen) into the atmosphere). Even though forests release Co2 they take in way more carbon, in comparison with the release of Co2.

Forest carbon, 21 June 2024, https://natural-resources.canada.ca/climate-change/climate-change-impacts-forests/forest-carbon/13085. Accessed 7 October 2024.

As we are losing trees due to things such as wildfires, and deforestation, we are also losing organisms that can help with the fight against climate change. This is because trees intake carbon dioxide (which is one of the biggest reasons why our planet is warming up and causing catastrophic disasters like sea level rise). The carbon capture helps reduce the amount of carbon in our air and replace it with oxygen. This helps reduce the greenhouse effect, which in turn reduces the global temperatures, resulting in a decrease in climate change.

Lindsey, Rebecca. "Climate Change: Atmospheric Carbon Dioxide | NOAA Climate.gov." *Climate.gov*, 9 April 2024, https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide. Accessed 7 October 2024.

Tue, Oct, 8/2024

Are we planting trees as fast as we are losing them?

No, humans do not plant trees as fast as we are losing them. Even though yes, many people plant trees or donate to helpful organizations that also help with reforestation.

Every year, us humans plant close to 1.83 million (15, 250 trees every month). On the other hand, it estimated that humans cut/destroy 15 billion trees each year. To continue, from the start of human civilization the Earth's tree count has dropped by 46%. From satellite data we can conclude that there are nearly 400 billion trees around the world (something to keep in note the source is from 2015).

From another source written in 2020 Around 15 billion trees are cut down every year with about 5 billion trees planted to replace. I conclude that we lose 10 billion trees every year (to compare this to the size of a football field).

Pope, Alexandra. "What if we could plant trees as quickly as we cut them down?" *Canadian Geographic*, 29 August 2021, https://canadiangeographic.ca/articles/what-if-we-could-plant-trees-as-quickly-as-we-cut-them-down/. Accessed 8 October 2024.

"Tree Planting Statistics 2023." *Trees Down Under*, 27 December 2022, https://treesdownunder.com.au/tree-planting-statistics/. Accessed 8 October 2024.

"Deforestation Explained: Should We Cut Down Trees?" *Climate Transform*, 21 April 2022, https://climatetransform.com/deforestation-explained-should-we-cut-down-trees/. Accessed 8 October 2024.

Wilce, Matt. "How many trees are lost to deforestation every year." *Tree-Nation*, https://tree-nation.com/projects/inside-tree-nation/article/9739-how-many-trees-are-lost-to-deforestation-every-year. Accessed 8 October 2024.

What is a seed firing drone?

Seed firing drones is a relatively new developed technology that plants trees at a very fast rate. The drone drops seedling covered in a specially designed pod that gives nutrients to the growing seedling.

On average, a drone can fire 1500 trees everyday. This increases the chances of success, and allows for the maximum amount of trees to germinate.

"Startup using drones to replant B.C.'s burnt forests." *Business in Vancouver*, 25 October 2022, https://www.biv.com/news/resources-agriculture/startup-using-drones-replant-bcs-burnt-forests-8269370. Accessed 8 October 2024.

Nonko, Emily, et al. "Seed-Planting Drones Are Reforesting Canada With Lightning Speed." *Reasons to be Cheerful*, 27 February 2023, https://reasonstobecheerful.world/drone-tree-planting-reforesting-after-wildfires/. Accessed 8 October 2024.

The Weather Network. "Seed-dropping drone targets 100 million trees by 2024." *The Weather Network*, 19 Jan 2022, https://www.youtube.com/watch?v=F6j08_F-hvQ. Accessed 8 October 2024.

How do drones help reforestation?

Drones can help a lot with reforestation, these bullet firing seeds can drop these pods (which have tree seeds inside). They do this in an ordered route, working together with a singular human supervisor.

This saves time and is way more efficient, not only this but you will be able to plant more trees rather than planting the trees physically. Physically, not only would the planting take twice the time, but it would take more effort and man-power.
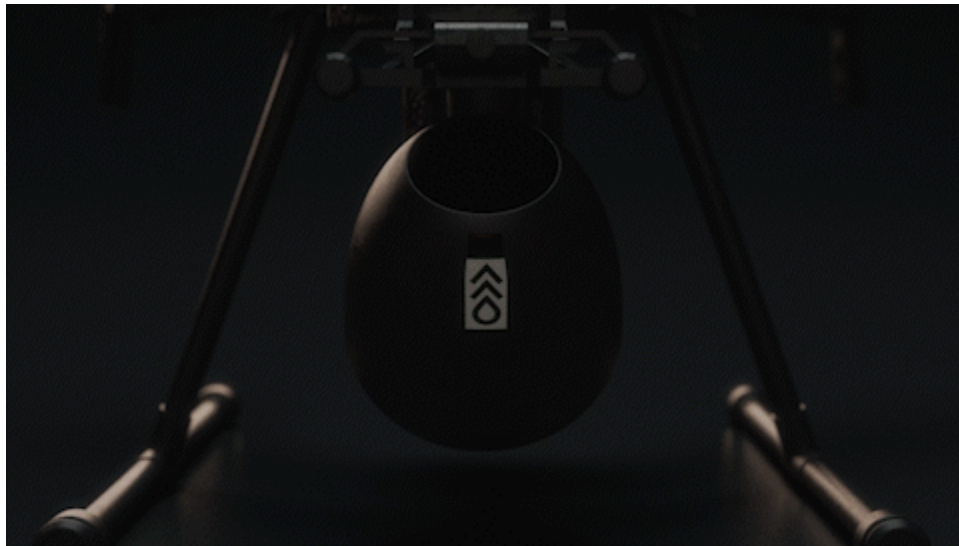
"Conservation news on Drones." *Mongabay*, https://news.mongabay.com/list/drones/. Accessed 8 October 2024.

Stout, Kristie Lu, and Andrew Millison. "Reforesting in a flash: these drones can plant trees faster than we can." *YouTube*, 10 August 2021, https://www.youtube.com/watch?v=27bOcWLbFa0. Accessed 8 October 2024.

What are the pods made out of?

Mostly, the pods that are used for these innovations are made up of biodegradable materials. These materials are safe for the environment, and animals, and consist of no harmful chemicals and toxins.

Most pods are made with waste and biomass which cover the seedling and protect it from animals that would want to try and eat it. For example insects, rodents, and birds.

Flash forest, the company that we've already talked about. Their seed production includes: beneficial bacteria, fungi, minerals, and nutrients. With this production they are able to make 200,000 seed pods every day, this would mean 200, 000 trees everyday.
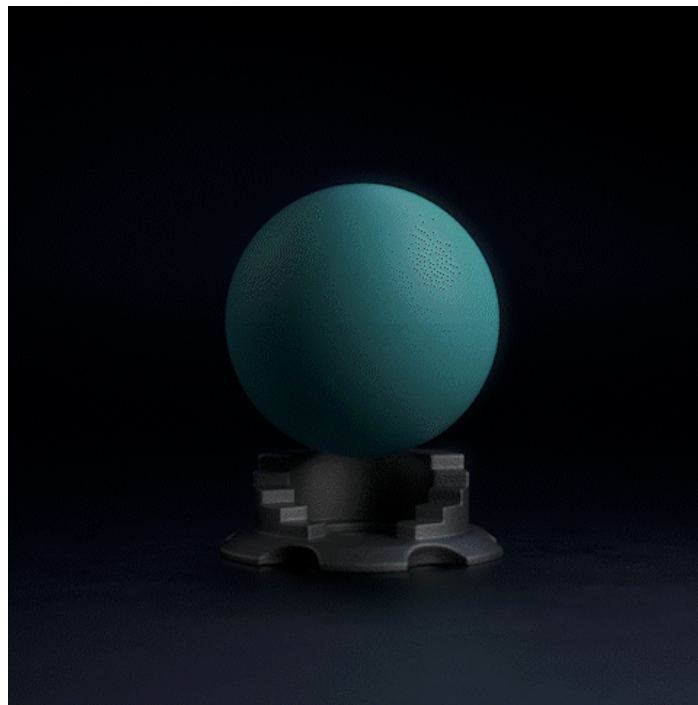
Schneider, Daniela. "These seed-firing drones are planting 40000 trees every day to fight deforestation." *Euronews.com*, 20 May 2022, https://www.euronews.com/green/2022/05/20/this-australian-start-up-wants-to-fight-deforestation-with-an-army-of-drones. Accessed 8 October 2024.

"Tech — Flash Forest." *Flash Forest*, 6 December 2022, https://flashforest@.ca/tech. Accessed 8 October 2024
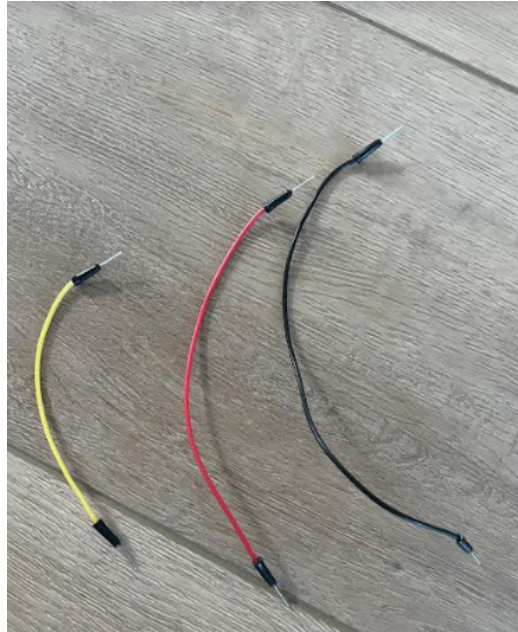
METHOD

Materials:

Material needed for the prototype: (we got all of our materials from Amazon).

- Arduino Board (image 3)
- Servo Motor (image 1)
- Hook-up Wires (image 2/7)
- USB Cable (image 4)
- IR receiver (image 5)
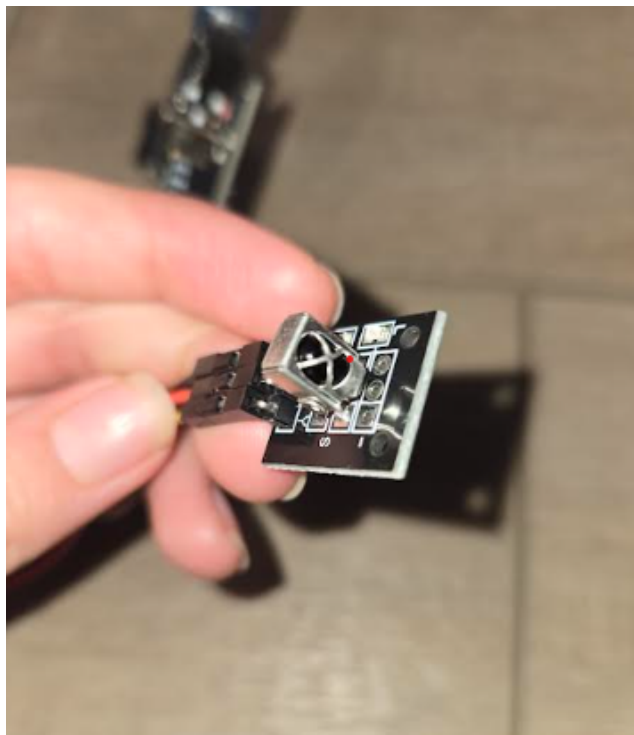- Remote Control (image 6)

1.

2.

3.

4.

5.

6.

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Material needed for the pod:

We will be using bio-waste as it is a cost effective, and easiest way to get the nutrients for the seed, and make sure that the pod is very durable as well.

- Orange peels (high in Nitrogen, Potassium, and calcium)
- Banana peels (high in nitrogen, and potassium)
- Blueberries (high in phosphorus)
- Avocados (high in magnesium and sulphur)
- Kiwis (high in sulphur)
- Fullers Earth (multani mitti)
- Water

"The Magical Power of Banana Peels in The Garden - Or Not." *Garden Myths*, https://www.gardenmyths.com/banana-peels-garden/. Accessed 2 November 2024

Spandana, Koti. "Which Fruits Are High in Calcium? 15 Calcium-Rich Foods List." *MedicineNet*, https://www.medicinenet.com/which_fruits_are_high_in_calcium/article.htm. Accessed 2 November 2024

"25 Magnesium-Rich Foods You Should Be Eating." *Cleveland Clinic Health Essentials*, 17 March 2023, https://health.clevelandclinic.org/foods-that-are-high-in-magnesium. Accessed 2 November 2024

American Kidney Fund. "Phosphorus." https://kitchen.kidneyfund.org/wp-content/uploads/2021/04/Phosphorus_Guide_090419.pdf. Accessed 2 November 2024.

Other Materials:

- Bowls
- Spoon
- Sieve
- Blender

Procedure:

Creating the Mechanism:

1. **Connect the Servo Motor:**
- We created the basic circuit for the mechanism

- The servo motor likely has three wires: **power** (red), **ground** (black), and signal (yellow), as shown in image
    - Connect the power wire to the 3.3V pin on the Arduino board
    - Connect the power wire to any **ground** (GND) pin on the Arduino board
    - Connect the signal wire to pin 9 on the Arduino board

A representation of this is shown in image 2

2. **Connect the IR receiver:**
- The IR recover has three wires, just like the Servo moter: power (red), ground (black, signal (yellow).
    - Connect the power wire to 5V pin on the Arduino board
    - Connect the ground wire to and ground (GND) pin on the Arduino board
    - Connect the signal wire to pin 11 on the Arduino board

Assemble the Final Mechanism:

- After connecting the servo metro and air reciter, the setup should look like image 3

UPLOADING THE CODE:

1.Install Arduino IDE:

- Install Arduino IDE software (this is the software we used but you could use another). This is what you can use to upload the code to Arduino board.
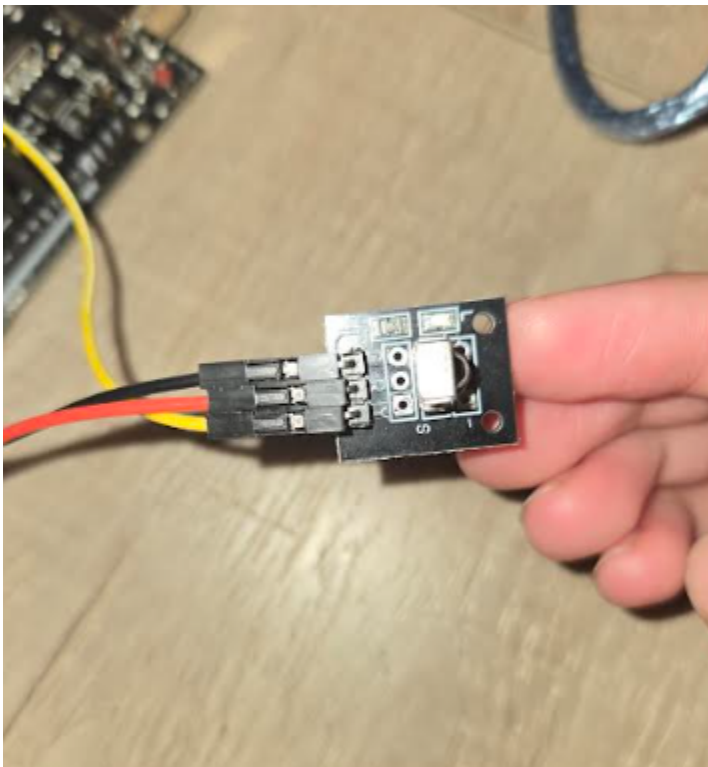
2. **Upload the code:**

- Connect the Arduino board to your computer using the USB cable (Image 4).
- Open the Arduino IDE, and click the check mark on the top-left of the screen to verify the code.
- Once done, click the right arrow next to the checkmatk to upload the code to the Arduino board
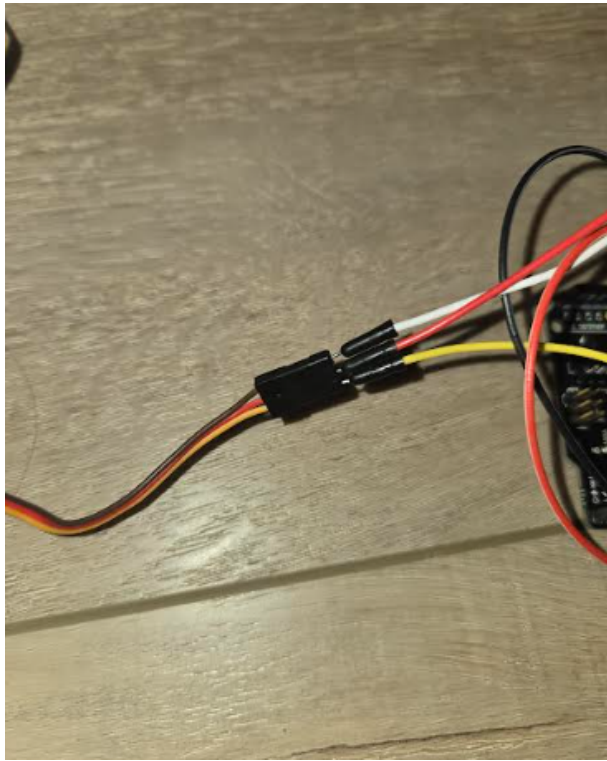
NOTES

- Make sure the connections are firm and secure to have no issues or errors in the testing
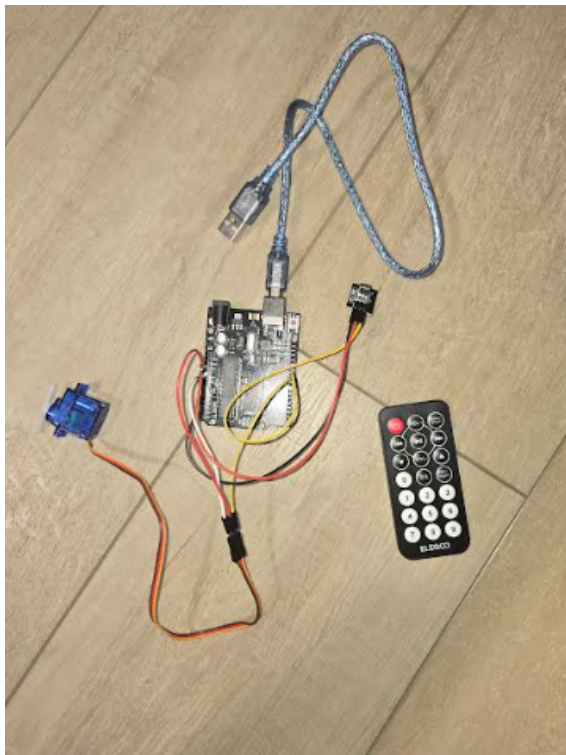- Make sure everything set up correctly

1.

2.

3.

Mon, Oct, 21/2024

- The second step is to upload the code onto the Arduino board.

To do this, you must attach the USB cord to Board, and then open a software program called "ARDUINO IDE". (you must install this into the computer)

Then, you must attach the USB to the computer, click the **CHECKMARK ON THE TOP LEFT HAND SIDE, AND THEN CLICK THE ARROW RIGHT BESIDE TO UPLOAD THE CODE ONTO THE ARDUINO BOARD.**

Nov, 2/2024

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Creating the pod:

1. **Blending the fruits**
- First take all of the fruits, cut them up and put them into the blender.
- ❖ Avocado: 8g (9.6%)
- ❖ Orange: 15g (18.07%)
- ❖ Banana: 36g (43.3%)
- ❖ Kiwi: 10g (12.04%)
- ❖ Blueberry: 14g (16.8%)

Total Weight was 83g, which created 15 pods for us.

- Start blending up the fruits, make sure that you shake and add a little amount of water to the moisture so it is easier to blend and mix together.
2. **Straining the Mixture**
- Pour the mixture out into the sieve (image 1) and strain to get rid of the extra water/moisture. This will prevent the pods from being to wet and to make sure that they keep there shape. Through make sure you are not removing to much of the fruit's pulp because that may take away from the nutrients.

3. **Shaping the Pods and Adding Seeds**

- **Shapping**- shape the mixture into circles about 0.6inch in diameter,(image 3 and 4) add place the seed right in the centre (image 5), for durability and strength of pods.
- **Drying in Refrigerator-** Then put them into the fridge to dry for 10 hours, this will give the pods more strength and make them more firm. Through this part length of this process can depend on the consistency of your mixture.
- **Sun Drying-** Then leave the pods to dry in the sun for 3-5 days, throughout this time period make sure the pods are turned regularly to make sure they dry evenly. You will also need to make sure that the sun drying does not dehydrate the pods.

4. **Coating with Fuller's Earth (Multani Mitti)**

- **Creating the Coating-** First make a mixture of multani mitti using water. Mis 2 cups of Fuller's Earth (Multani Mitti) into 1 cup of water, mix until you see a creamy consistency of the mixture.
- **Layering-** Then cover each of the pods with this substance, applying 2-3 layers to

the pods is needed because this will add impact resistance to the pods.

- **Drying after Coating-** you can leave the pods out in the to dry, jut like before. Another, but faster way to do this by using a blow dryer.

5. **Final Drying**

- If you need, you may do another 3-5 days of sundering. This will make the pods more stronger and durable for the drop.

Some thoughts to consider…

- **Moisture-** throughout the process make sure checking the moisture of the substance so that the substance does not get to watery and has a good viscous consistency
- **Fuller's Earth (Multani Mitti)-** Not all brands are all good of the fuller's earth you use so make sure you chose a good one. For example the one we chose was 'Teja'

1.

2.

3.

4.

5.

6.

7.

Dec, 06, 2024,

Since, we had many question about our prophecy we decided that I would ask the professionals, so I emailed Flash forest, Ki drone and Air seed. Out of these three only two responded, Flash forest and Ki drones.

Flash forest:

Dec, 9/2024

Putting it all together:

Mechanism:

Creating a barrier for Pods

<u>Materials Needed</u>

- Bottle cap (from a milk carton or any similar bottles)
- Adhesives (glue, tape or more)

- Water bottle (preferably Fiji or a similar strong bottle)
- Tools: scissors/exacto knife, soldering iron (if cutting with heat.

1. **Cutting the bottle cap (Image 1)**

- Take the bottle cap
- Use scissors or any other tool to steadily cut the surroundings of the cap, to take of the part that twist around the bottle
- *Final shape* the cut should a circular and that can cover the opening of the bottle
- **WARNING**- if your a using a heta force to cut the the bottle cap make sure you are ways from flammable materials and wear protection

2. **Attach the Cap to the Servo motor (Image 2)**:

- Use a adhesive to attach the bottle cap to the servo motor
- Test the it by manually moving the servo motor to ensure the barrier open and closes smoothly
- **WARNING-** if using an heat source (hot glue gun) to attach it it can cause burn if directly touched on the tip

1.

2.

Prepare the bottle as the holder/carrier:

1.Chose your bottle:

- Make sure you chose a strong and durable water bottle
- Ensure the bottle is clean and dry before starting
- **WARNING-** if you are citing or changing the bottle make sure you don't cut yourself as the edges of the plastic can be sharp, so wear protection.

2. Plan the layout of the components:

- Place the **Arduino board** on the left side of the bottle
- Place the **IR sensor** on the right side(or anywhere it makes sense with your bottle)
- The **servo motor** should be positioned where it can function the barrier nicely, which we would be likely near the top

- Make sure that **all the parts** are comfortably laid out and make sense

3. **Test the design-**

- Before you glue or attach anything make sure you are Fit correctly and make sure there aren't any tight spaces

1.

January 3/2025
Creating an attachment to the drone:

1. Creating holes

   - To do this, you will either need a drill, or heat
   - Create 2 holes on two sides of the bottle (image1)
   - Insert a zip tie threw and close it (image 2)
   - Insert another zip tie around the drone's legs, and attach it to the previous zip tie (image 3)

This will create a strong bond between the mechanism and drone and will prevent it from falling off.

The final structure should look simliar to image 4. (There is a stand/platform visable in the image, but it is not needed for this project. It is just for display purposes.)
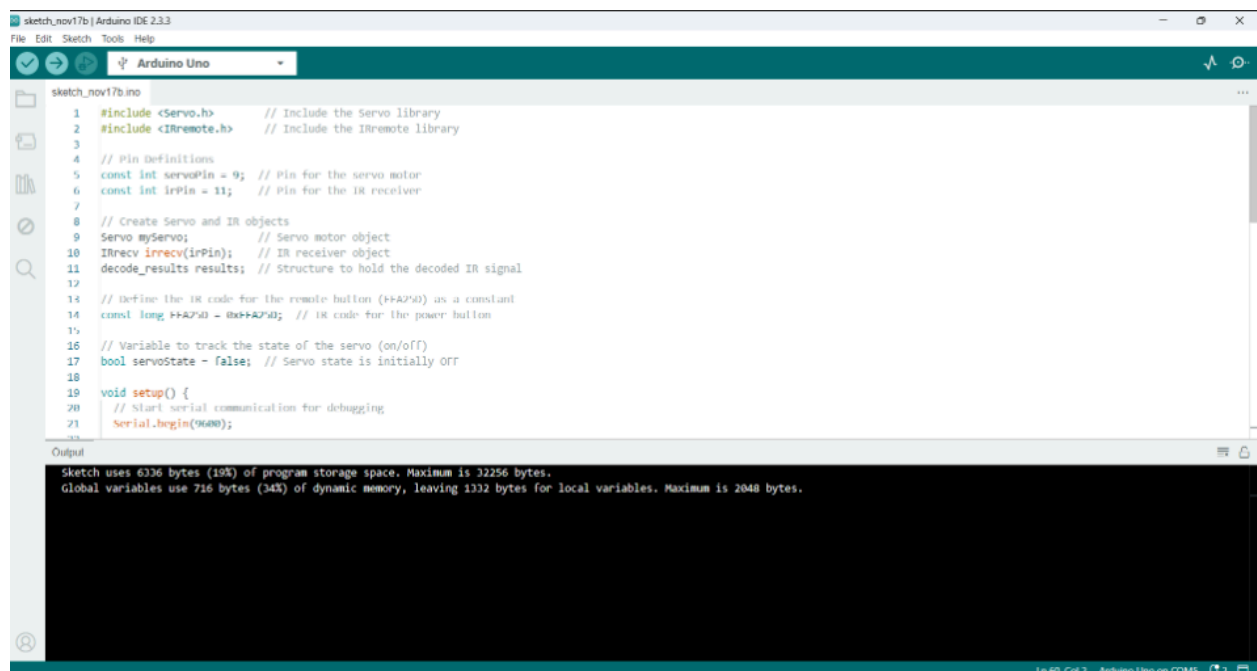
1.

2.

3.

FINAL IMAGE

4.

Code:

This is the code that we used to the programing of the seed mechanism used to shoot out pods with the seeds:


```
sketch_nov17b | Arduino IDE 2.3.3
File Edit Sketch Tools Help

  Arduino Uno

sketch_nov17b.ino
1   #include <Servo.h>        // Include the Servo library
2   #include <IRremote.h>     // Include the IRremote library
3
4   // Pin Definitions
5   const int servoPin = 9;   // Pin for the servo motor
6   const int irPin = 11;     // Pin for the IR receiver
7
8   // Create Servo and IR objects
9   Servo myServo;            // Servo motor object
10  IRrecv irrecv(irPin);     // IR receiver object
11  decode_results results;   // Structure to hold the decoded IR signal
12
13  // Define the IR code for the remote button (FFA250) as a constant
14  const long FFA250 = 0xFFA250;  // IR code for the power button
15
16  // Variable to track the state of the servo (on/off)
17  bool servoState = false;  // Servo state is initially Off
18
19  void setup() {
20    // Start serial communication for debugging
21    Serial.begin(9600);

Output

Sketch uses 6336 bytes (19%) of program storage space. Maximum is 32256 bytes.
Global variables use 716 bytes (34%) of dynamic memory, leaving 1332 bytes for local variables. Maximum is 2048 bytes.

                                                                    Ln 60, Col 2   Arduino Uno on COM5
```
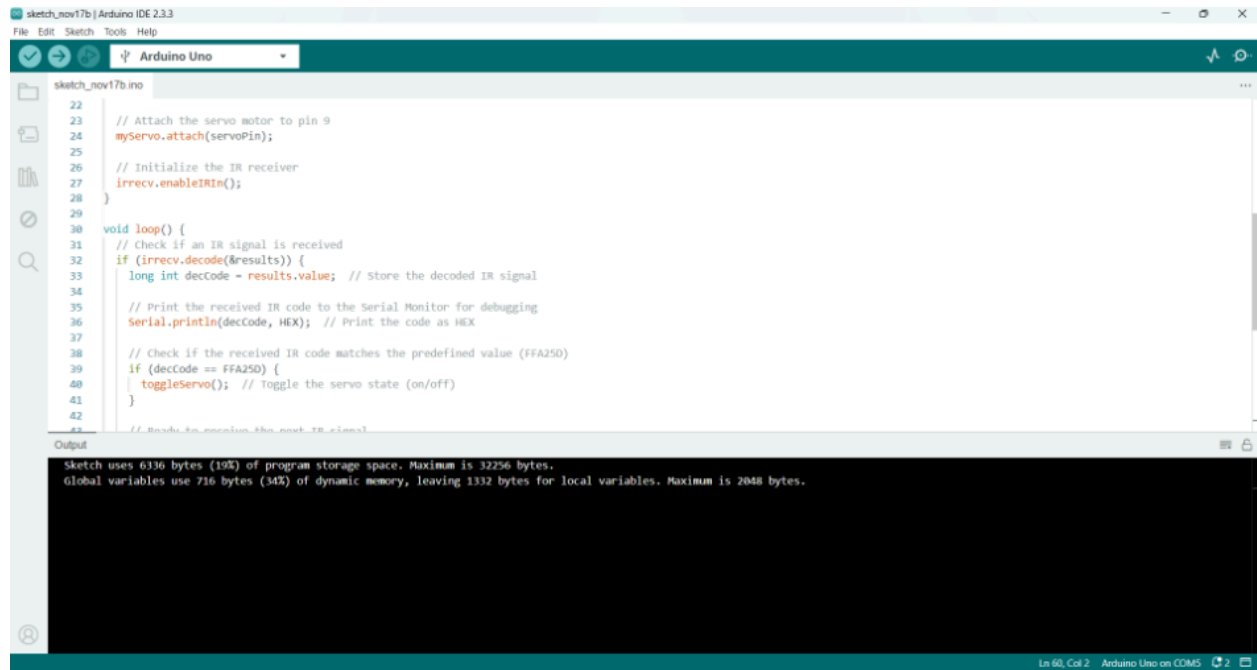
41

File Edit Sketch Tools Help

```
22
23      // Attach the servo motor to pin 9
24      myServo.attach(servoPin);
25
26      // Initialize the IR receiver
27      irrecv.enableIRIn();
28    }
29
30    void loop() {
31      // Check if an IR signal is received
32      if (irrecv.decode(&results)) {
33        long int decCode = results.value;  // Store the decoded IR signal
34
35        // Print the received IR code to the Serial Monitor for debugging
36        Serial.println(decCode, HEX);  // Print the code as HEX
37
38        // Check if the received IR code matches the predefined value (FFA25D)
39        if (decCode == FFA25D) {
40          toggleServo();  // Toggle the servo state (on/off)
41        }
42
43        // Ready to receive the next IR signal
```

Output

```
Sketch uses 6336 bytes (19%) of program storage space. Maximum is 32256 bytes.
Global variables use 716 bytes (34%) of dynamic memory, leaving 1332 bytes for local variables. Maximum is 2048 bytes.
```
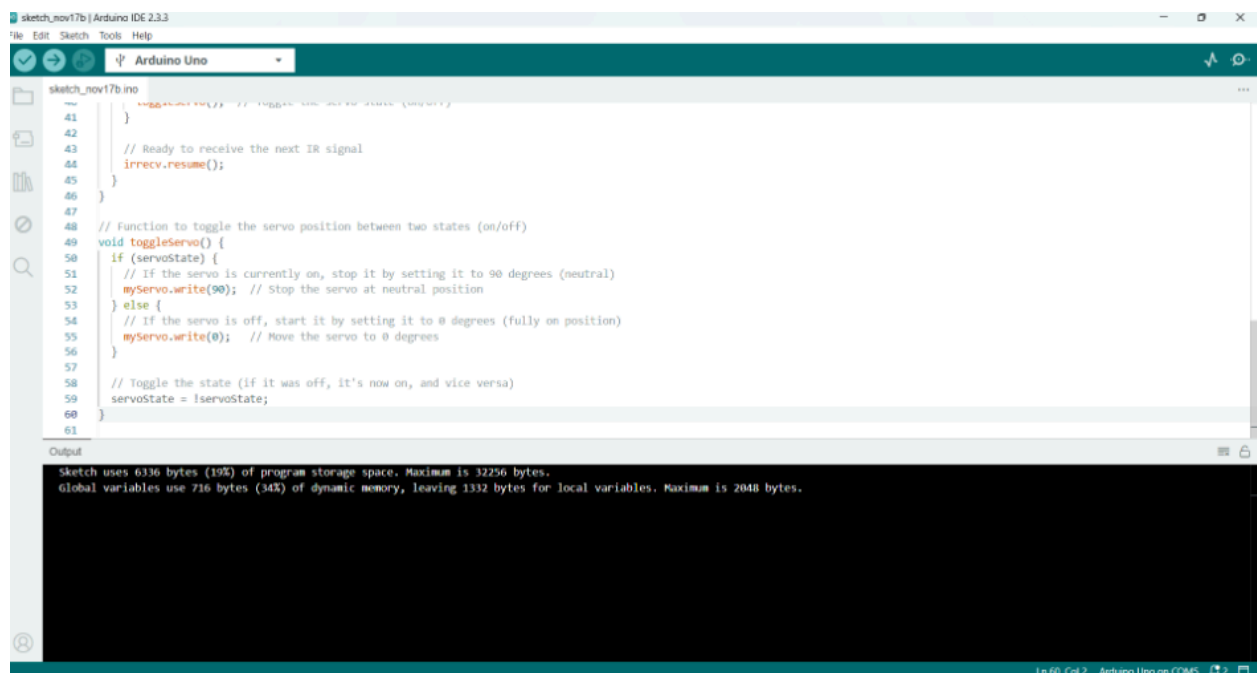

File Edit Sketch Tools Help

```
41        }
42
43        // Ready to receive the next IR signal
44        irrecv.resume();
45      }
46    }
47
48    // Function to toggle the servo position between two states (on/off)
49    void toggleServo() {
50      if (servoState) {
51        // If the servo is currently on, stop it by setting it to 90 degrees (neutral)
52        myServo.write(90);  // Stop the servo at neutral position
53      } else {
54        // If the servo is off, start it by setting it to 0 degrees (fully on position)
55        myServo.write(0);   // Move the servo to 0 degrees
56      }
57
58      // Toggle the state (if it was off, it's now on, and vice versa)
59      servoState = !servoState;
60    }
61
```

Output

```
Sketch uses 6336 bytes (19%) of program storage space. Maximum is 32256 bytes.
Global variables use 716 bytes (34%) of dynamic memory, leaving 1332 bytes for local variables. Maximum is 2048 bytes.
```

(Rough copy of analysis)

Seed Planting Using a Drone:

1. **Seed drop Mechanism**

The seeds are dropped onto the solid ground, but over time they can naturally travel into the soil. This makes a more gradual and natural process.

- **Seed spacing-** the seeds are planted at a distance of 2.5 meters apart, which is an ideal distance for the pine seeds
- **Drop Mechanism-** The delivery uses gravity to drop the seeds, the system is designed to make sure there is minimal damage. The impact of the seed drop is safe and does not cause the seed any harm.

2. **Safety and Stability**

Tye drone used for planting is easy to control and move, wich ensures safety throughout the operation

- **Control-** the drone is simple to navigate
- **Safety-** the drone's design did not have any risk to any property and people. There were no accidents or property damage

3. **Drone Specifications**
- **Range-** the drone can operate at a range of 15 meters, allowing to cover a good amount of area for seed planting in a single flight.

4. **Germination Rate**

The predicted germination rate of the seed is between 15% and 20%. With the best conditions, the germination rate can be closer to 25%

- **Estimated Germination Rate-** We predict that 15%-25% of the seeds will sprout, depending the conditions of the seeds will germinate

ANALYSIS AND ROOM FOR IMPROVEMENT

The dorne performs pretty well, but some minor inconsistencies could be seed placement can sometimes occur.

- The **speed delivery** system worked as intended and the seeds were approximately 2.5 meters
- **Mechanical performance** had no major issues

1. **Speed and spacing calculation**

The dorne works at

Drone was driven mechanically and did run into any issue.

Now to figure out the distance that the pods will be planted at

(5m/s)/ (pods/s/2)= 2.5m

So when a seed is dropped, it will travel 2.5m, meaning each seed should be planted at a 2.5m distance

ANALYSIS

Dec, 26/2024

Analysis of Model:

Once we built the mechanism, we started testing it, and analysing how it works. Thesen are the main categories:

- Speed of how many it can plant.

- germination

- type of seed

- pods

  - Falling speed of the pod.
  - Success rate of germination.
  - Number of pods per unit of time

TEST THAT WE RAN

(Number of pods that fell out per secondon average)

Number of times tested	Amount of Pods that fell
1	2
2	2
3	2
4	1
5	2
6	3
7	1
8	1
9	2
10	3

DRONE DESIGN AND ENGINEERING:

Payload system:

The payload system worked very well. It successfully placed all of the pods in the correct

estimated location (around 2.5 meters apart), which was originally planned. It was mechanically operated and encountered no issues during the pod planting process. The pods did not land exactly where they were supposed to, but they were still placed close to the intended spots. To conclude, the overall planting proccess was done efficently and effectively.

To come up with the conclusion that the seeds should land at this distance, we came up with an equation:

(1m/s) / (PODS/s) = (m)

- PODS/s represent the rate at which the pods fall.

- 1m/s represents the drones constant speed

- m is the distance that the drone travels before the pod hits the ground or in other words the disantce that the pods are predicted to fall.

we changed it to (5m/s) / (PODS/s = 2) = (2.5m) to fit our requirments.

Seed placement:

The pods were dropped directly on top of the soil, but are excpected to gradually settle beneath the surface over time. The distance at which the seeds were planted was perfect to the tree species that is being planted, which is pine. The planting mechaniam, which is mainly powered by the force of gravity, helps ensure that the seeds are safley droped and suffer no damage. Overall, the system was proved to be reliable, and safe, even though the slight variation in placement.

SAFETY AND STABILITY:

The drone that we used for this project provided safety and stability during navigating and maneuvering. It was very easy to control, which allowed for a safe flight from start to finish. Most importantly, the drone did not cause any damage to people or property, proving the fact that it is safe. To conclude, the drone's performance was very good, creating a sense that it is safe and efficient and making it a very good tool for this project, and the function that it is being used for.

DRONE:

The drone that we used for this had a maximum range of 150 meters. This provided a a reliable and functional radius for the task. This range allowed for a good coverage of land, ensuring the drone could reach required areas without any limitation, allowing for an efficient and effective system. This range could also allow it to go very high, which could help avoid obstacles which could potentially interfere with its purpose. Overall, the drones range of 150 meters allowed for a safe, stable, efficient, and effective flight.

(We used the **Holy Stone HS110D – FPV RC Drone with 720P HD Camera)**

GERMINATION AND SUCCESS RATES:

To assess the success rate of seed germination, we used the following equation:

(# of seeds germinated / total seeds) * 100 = germination success rate

 Then we changed it to $(5-25)/100 \times 100 = 15\text{-}25\%$ to fit our requirements.

This calculation that we made was based on several factors that influence that seed growth and success rate of germination in Canada. The country's challenging environmental conditions which include cold winters, long periods of snow, and extreme weather (droughts, heat waves) can pose a serious risk to a seed's germination chances. The short growing seasons, and intense competition from other plants, as well as herbivory, pests and disease can also contribute to the reduced likelihood of successful germination. Even though the pods provide some nutrients and protection from these threats, the environmental challenges result in very low probability of the seed germination. This is why forest restoration using drone technology uses large yields of pods to increase the chances of seed germination. Over all, this calculation reflects all aspects that could affect seed germination.

January 3/1015

Novelty

The design that we came up with has a purpose to support reforestation efforts and increase the trees being planted to help fight the battle against climate change, resort habbitats, etc. Currently, there are many companies that create these seed-firing drones at a large scale. For example FlashForest. These companies create, manufacture and start

planting trees and other flora to help with forest restoration efforts at a faster and afficent pace. While the technology used for these ambitious projects is showcased, one of the main components is missing: the pod design. Most companies use bio waste and things like that. Taking inspiration, we came up with a pod design that uses materials efficently. Our pod consists of compost that is dried and covered in Fullers Earth to protect, and perserve the seed until the drop. This is crucial for the survival of the seedling, and helps boost up the success rate of germination. To conclude, this work helps fill a slight gap in the world's current knoweldge about seed firing drones and could make a effective tool for furture applications.

January 1,2025

Application

The main application of this project is to use drone technology for wide-reaching and defined reforestation efforts. This will help with the increasing rate of deforestation and the loss of ecosystems due to natural disasters. With all this deforestation, we need innovative solutions. This seed-firing drone prototype can be sent to regions that are difficult for humans to access, including: mountainous terrains, remote areas or disaster-stricken zones.

Comparing this to a human planting trees, it is much faster and more efficient. For example using drones we can

- Promote biodiversity- by using technology to plant trees, in different areas, it can I power others to found to make it even more efficient, faster and overall better
- Support Carbon Capture- restoring forests faster can help with mitigating climate change and will reduce the effects of global warming

Finally, our project's aim is to highlight how technology, specifically drones, can be a sustainable solution to one of the most pressing environmental challenges of

our time.

Not only that but the pods that we designed can be efficiently made using the compost collected by the green bins.

January, 4/2025

Future Scope:

As the project grows, the seed-firing drones/technology holds a large potential to revolutionize reforestation. By scaling up the technology and partnering with others and improving our design. Our project could enhance our project and plant millions of seeds annually. With this people could learn about different ways to help with reforestation, and drones play a central role in reforestation efforts.

Advancement in drone/technology

As we go into the future, technology is only improving and getting better. So one of the ways we could improve our drones is by getting drones from the military and repurposing them to our advantage. This will also make this more sustainable.

- Longer flight durations- military drones are designed for long missions and adapting themselves, and they can improve the coverage of the land and the planting efficiency
- Heavy payloads- military drones are designed to carry heavy loads. So they will be able to hold twice the much as pods and even water delivery systems
- Environmental Intelligence Gathering- military drones can be changed to gathering data on the seeds and see how they are owing and give information for making the designs of the pods even better

If we also design an artificial intelligence (AI), we will give drones the ability to assess the continent of the seeds and environment like soil quality, climate and

the health of the ecosystem.

- Predictive Analytics- this will allow us to find the best locations for planting which trees, improve growth and the cosystems

Global collaboration and Expansion

With making partners and going into this industry and making connections, we could improve this project and make the world a better place. It will also make us known in

- Partnerships- this project can expand through partnerships with NGOs, and different companies and with these it will promote sustainable ways to manage the land
- Campaigns- With the reforestation, we will also educate the public and everyone we can about climate change and how we should restore ecosystems and make the Earth better

In summary, our future scope for this seed-firing project is not just about restoring forests and ecosystems. We will also revolutionize how we approach climate change and restoration of ecosystems. With the advancements made everyday, drones could become a large-scale of reforestation.

CONCLUSION

In our project, our objective was to create an innovation that enhances reforestation and restoration of ecosystems, and helps with carbon capture. We found this important device to make because every year we lose around 15 billion trees every year, but only 1.9 billion are planted. So we made this prototype to enlighten the world on restoring ecosystems and how we need to make changes. This seed-firing drone can bring enlightenment to the world and if improved, maybe it could plant even more seedlings and plant in different rough terrains.

The model that we made addresses the problem superbly. The way that it works is that the drone carrying the mechanism flies at around 5 meters per second. Then, as the latch (which is controlled by a remote that sends IR signals to open the latch) opens, it starts

dropping seeds, around 2 pods per second. And at a distance of 2.5 meters. This means that in an hour, this seed-firing drone can plant roughly 7200 pods. This can help with forest restoration efforts, and boosts the amount of trees being planted. In turn, this helps face many global problems such as habitat loss, carbon-capture loss, and much more.

This seed-firing drone is a distinctive model of technology in reforestation efforts. From the organic pods inside the model and the innovative technology gluing it together it is quite unique. The pods we made are fully organic, in the middle is the seed and around it is a pull of fruits and vegetables rich with nutrients best for germination (including bananas, kiwi and avocado). After this for the strength of the pods we coat it with Fuller's Earth, this makes the pod firm and sturdy.

Even though this is a great model, many improvements can be made to the design. Firstly, the drone is not a great model, as stated in our future scope using drones such as micro and nano drone/drones primarily used in the military.these drones will help with heavy loads, and speed.Secondly, is a better adhesive to connect all the parts, to make sure everything is secure and won't fall in flight. Overall, improvements can be made with the drone and device, but with our limitations (not having superior equipment, a lab to work with and more) this is a substantial model.

This project has been a very valuable learning experience for us. We gained good knowledge about forest restoration using drone technology. We are proud of our innovation as it is realistic and efficient, and how big of an impact this concept can have on the whole world. The problem that we started with is faced with this innovation. Considering that it can plant around 7200 seeds in an hour is impressive, even if it is not fully refined and industrialised. We hope that in the future, we can continue refining this model, and bring it to the attention of others how seed-firing drones are a big step forward in forest restoration efforts, and the fight against climate change.

January 3/2025

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