AGRIROBOT

Agriculture Robot

Personal Information:

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SEMESTER:	**1ST**
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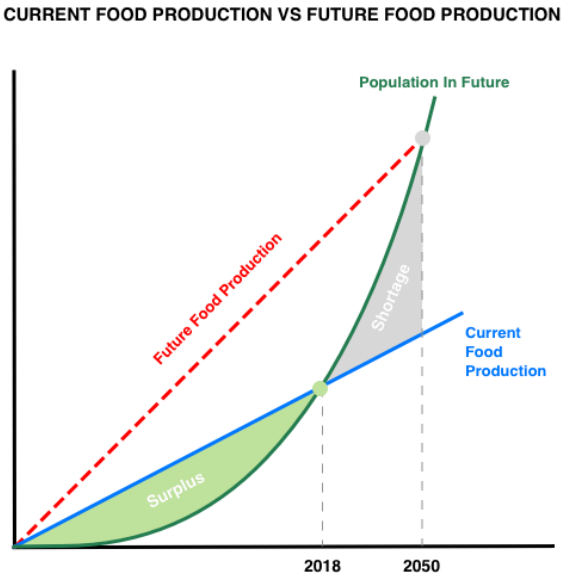
Introduction

Agriculture is the art and science of cultivating the soil and growing crops. Rapidly, increasing global population demand of higher food production.

Here, below graph **compares food production with growing population**.

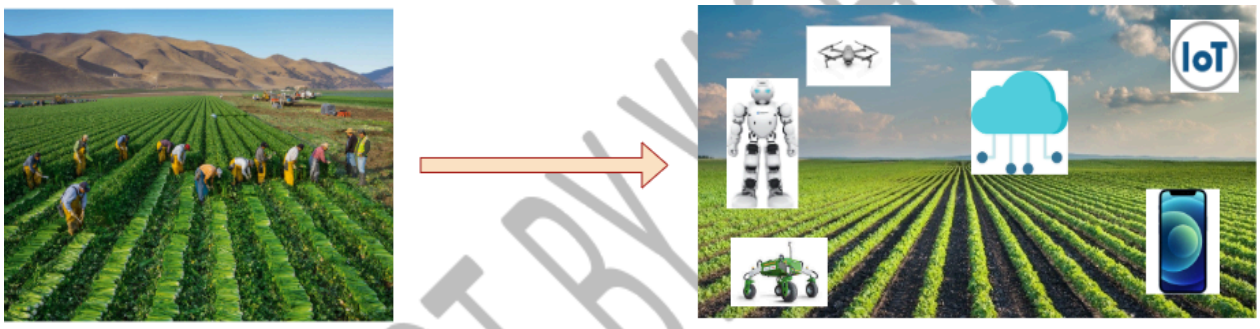


Graph itself says **how much food shortage world will face if we won't be able to increase food production.**

Feeding entire world will a huge challenge for farmers. Here, my project completely focuses on increasing food production rate with minimal human intervention.

Objective

The main goal is transformed human through farming to robot through farming.



Human through farming

Robot through farming

Farming will be done by the robot from seed sowing to harvesting. However, some kind of human intervention will always be there.

Goal to:

- **Reduce farmers work load**
- **Increase food production**
- **Less investment and risk**
- **More organic food**
- **Faster farming**

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Features:

- Soil analysis (testing)
- Soil monitoring
- Crop selection
- Seed sowing
- Crop monitoring
- Irrigation system
- Weed detection and remove it
- Insect detection and remove it
- Disease detection
- Harvesting
- Drone scanning and monitoring
- Farm monitoring
- Farm security

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agriRobot:



agriRobot

=



Surface agriRobot

+



Drone agriRobot

Cameras and Sensors on agriRobot:

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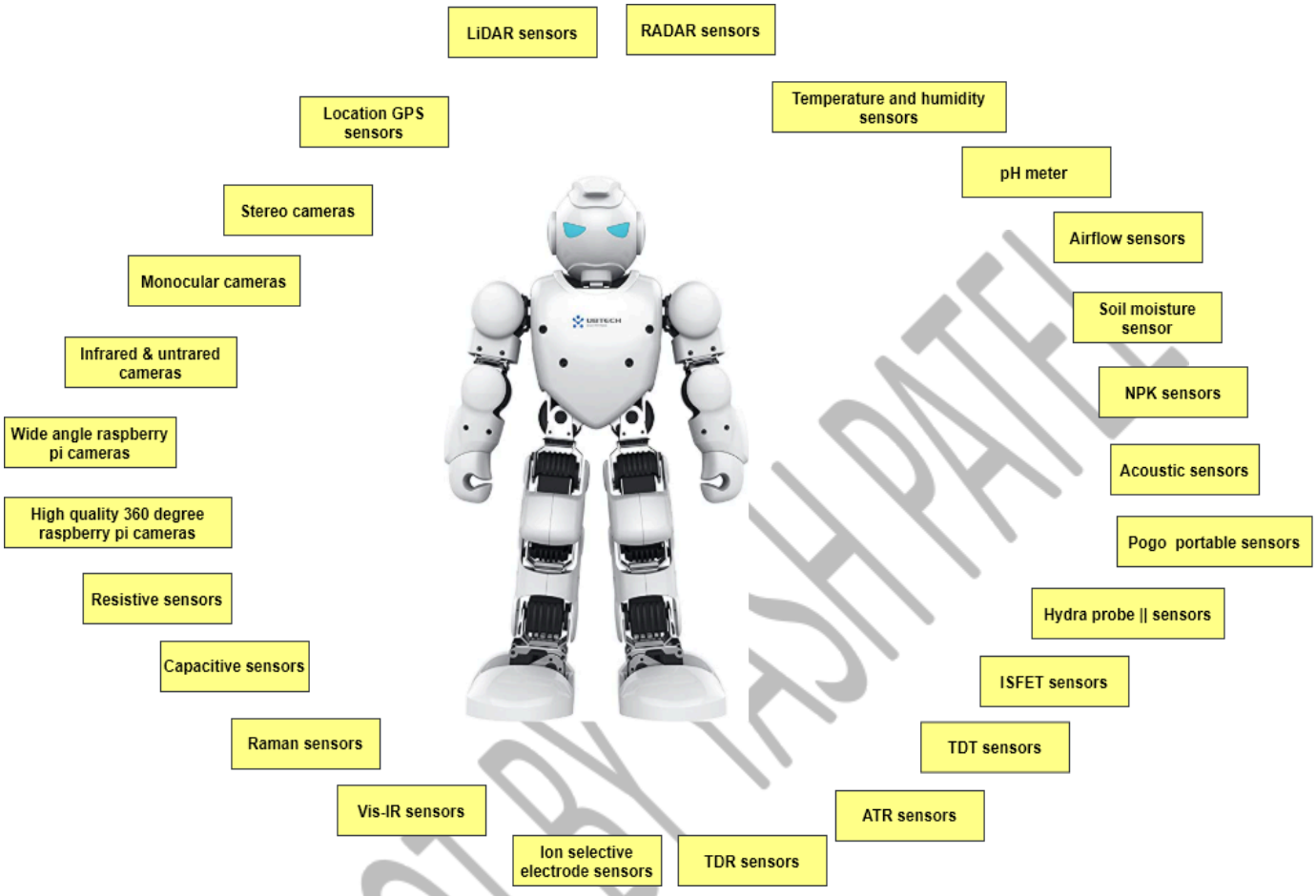

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Cameras:

- Stereo cameras
- Monocular cameras
- CCD and CMOS based Infrared and ultrared cameras
- Raspberry pi High quality 360 degree and wide-angle cameras (Sony IMX477, 300X Microscope Lens, 16mm Telephoto Lens, 6mm Wide Angle Lens)
- CCTV cameras
- Monitor screen (LED screen)

Sensors:

- Vis-NIR and Vis-MIR spectroscopy
- ATR (Attenuated total reflectance spectroscopy)
- Raman spectroscopy
- LiDAR and RADAR sensors
- Ion Sensitive field-effect transistor (ISFET)
- Ion selective electrode
- Soil moisture sensor
- Soil pH meter
- Humidity and Temperature sensors
- NPK sensors
- Airflow sensor
- Acoustic sensors
- Resistive Sensor
- Capacitive Sensor
- Time-Domain Reflectometer (TDR)
- Time domain transmissometer (TDT)
- Hydra probe II soil sensor
- Pogo portable soil sensor
- Location and GPS sensor
- Timer
- Proximity and ultrasonic sensor
- Infrared optical sensor

Motors, batteries and other equipment:

- Brushless DC motor (BLDC) / Permanent Magnet synchronous motor (PMSM)
- Battery (auxiliary)
- Traction battery pack
- Solar panels
- Thermal system

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- Electric traction motor
- Power electronic controller
- DC Convertor
- Transmission
- Lights
- Raspberry pi 4 model B kit
- Other robot designing equipment (such as wheels, fibers, mirror, etc.)
- Electronics equipment (wires, modules, resistors, transistors, capacitors, controllers, etc.)
- Mics and speakers

Oher important equipment:

- Seed sowing equipment
- Irrigation equipment
- Harvesting equipment

Technologies:

- Internet of things (IoT)
- Cloud computing
- Robotics
- Computer vision and Image processing
- Android mobile development
- Machine learning and Deep learning

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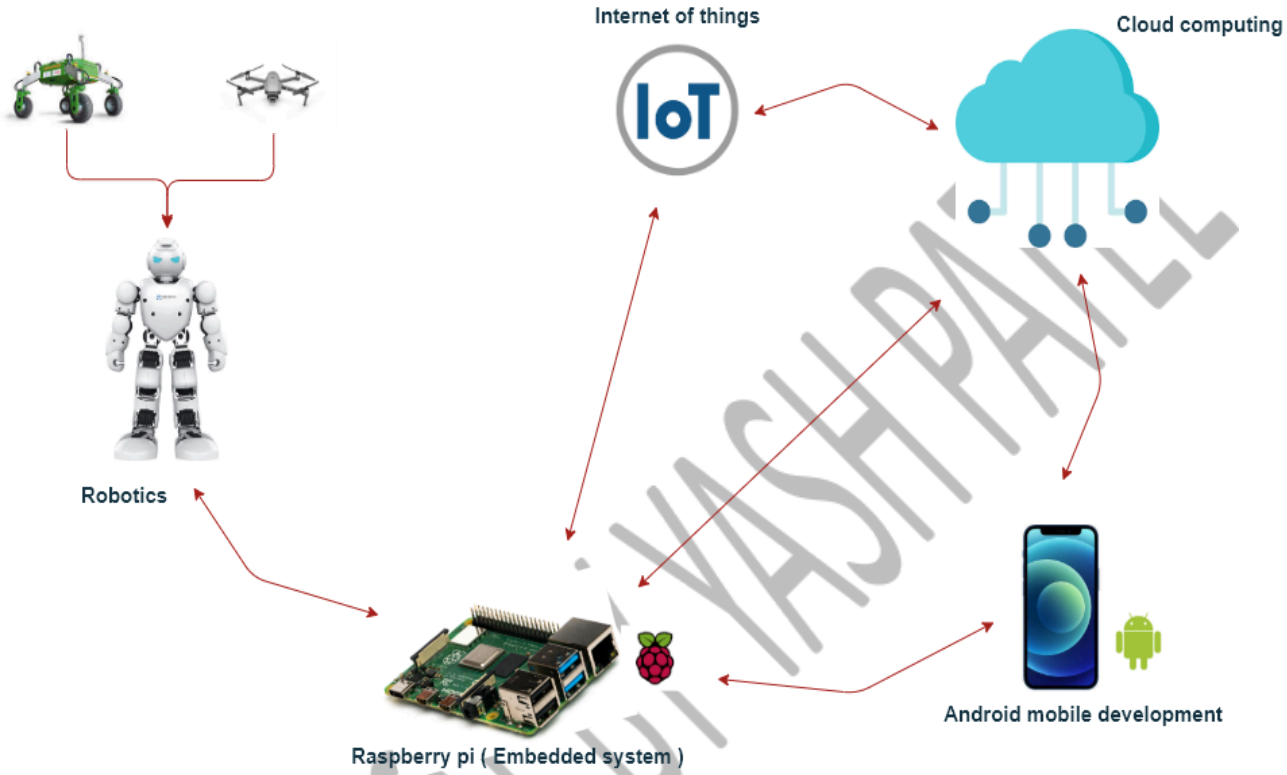
- Remote sensing and geographic information system (GIS)



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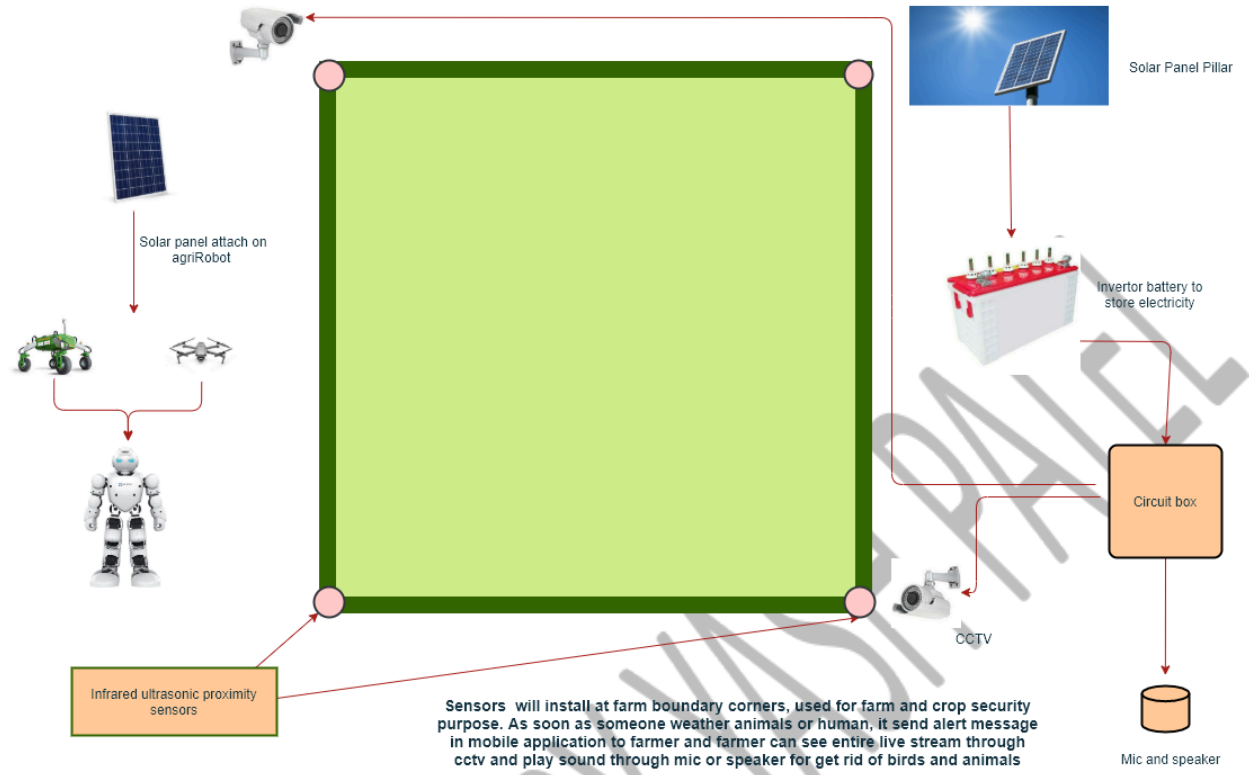
Farm view:



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Chapter 1: Soil Analysis and monitoring

Soil is a critical part of successful agriculture and is the original source of the nutrients that we use to grow crops. The nutrients move from the soil into plants that we eat like tomatoes. The healthiest soils produce the healthiest and most abundant food supplies. To meet crop needs throughout a growing season soil fertility must be consistently high.

There are **fourteen nutrients** that are supplied to crops from soil and fertilizer sources. Of these, **6** are generally considered **macronutrients**, while the rest are **micronutrients**. Macronutrients are used in relatively larger amounts by the plant; however, micronutrient deficiencies can be equally damaging to yield and profitability.

ESSENTIAL PLANT NUTRIENTS

Element	Chemical symbol by crop plants	Chemical forms absorbed	Source
carbon	C	CO_2	air
hydrogen	H	H_2O	water
oxygen	O	O_2, H_2O	air, water
PRIMARY NUTRIENTS			
nitrogen	N	NO_3^-, NH_4^+	soil solids*
potassium	K	K^+	soil solids
phosphorus	P	$H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-}	soil solids
SECONDARY NUTRIENTS			
calcium	Ca	Ca^{2+}	soil solids
magnesium	Mg	Mg^{2+}	soil solids
sulfur	S	SO_4^{2-}	soil solids
MICRONUTRIENTS†			
boron	B	BO_3^{3-}	soil solids
chlorine	Cl	Cl^-	soil solids
copper	Cu	Cu^+, Cu^{2+}	soil solids
iron	Fe	Fe^{3+}	soil solids
manganese	Mn	Mn^{2+}	soil solids
molybdenum	Mo	MoO_4^{2-}	soil solids
nickel	Ni	Ni^{2+}	soil solids
zinc	Zn	Zn^{2+}	soil solids

Soil testing is a critical component in determining those nutrients that are already available and those that may be in limited supply. Deficiencies will impact crop quality or yield and knowing these will assist in determining the amount and type of fertilizer required.

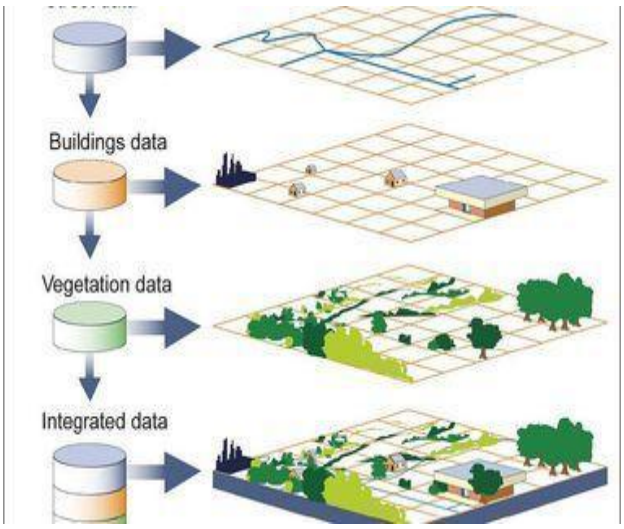
Nitrogen (N), phosphorous (P), and potassium (K) are the three main nutrients that are conventionally supplied by fertilizers and another determining parameter in soil analysis is **pH value**.

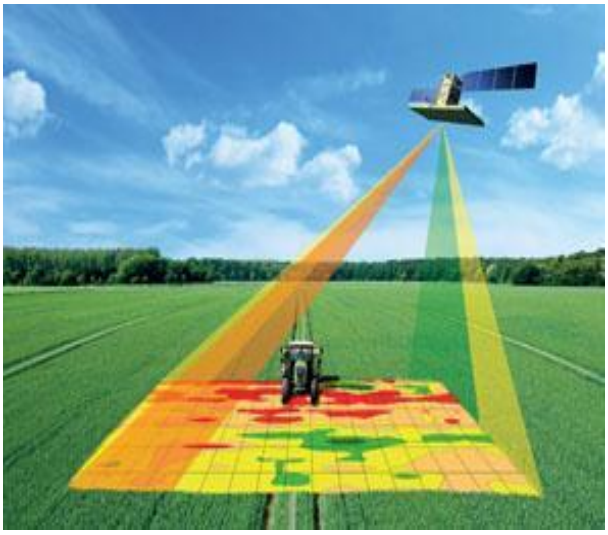
Determining soil nutrients:

1. Remote sensing and Geographic Information System (GIS)
2. Optical remote sensing methods
3. Electrochemical methods
4. Dielectric methods
5. Airflow
6. Acoustic

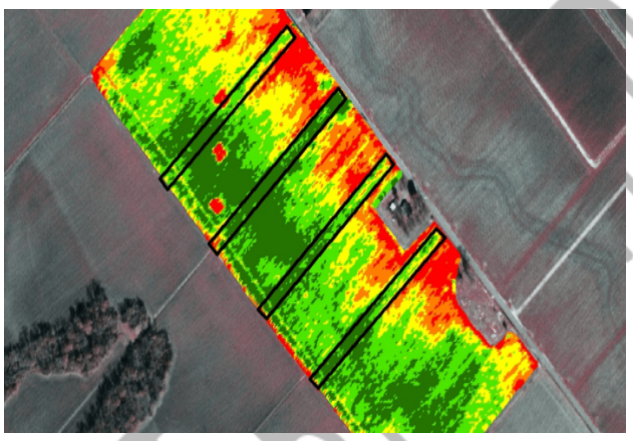
Remote sensing and Geographic Information System (GIS)

A geographic information system (GIS) is a computer system for **capturing, storing, checking, and displaying data related to positions on Earth's surface**. GIS can **show many different kinds of data through maps**, such as lands, farms and vegetation.

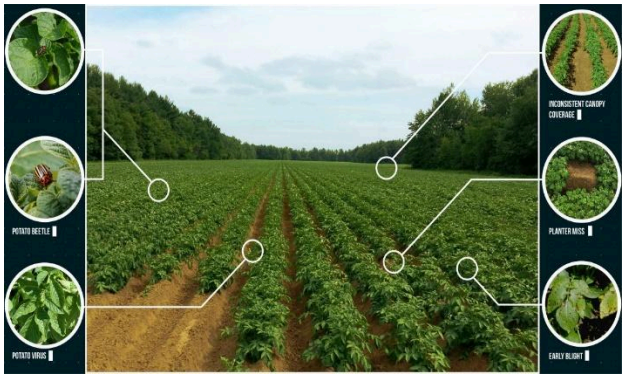


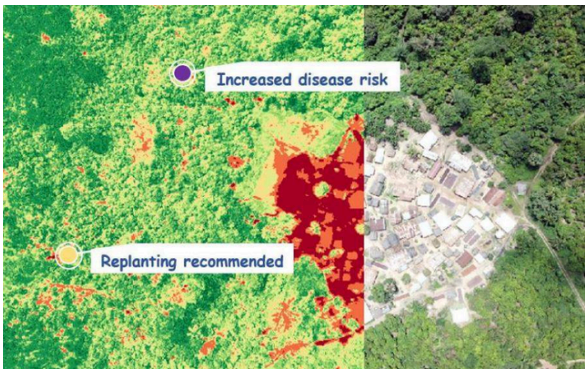


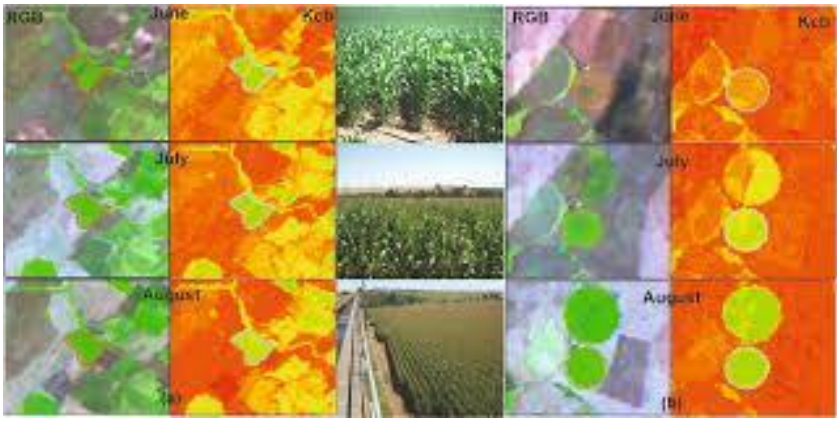




Remote sensing is **the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance** (typically from satellite). Special **cameras collect remotely sensed images**, which help researchers "sense" things about the Earth.







Optical remote sensing methods

It uses **spectroscopy based on reflectance spectroscopy to identify the magnitude of reflected and absorbed energy by soil nutrient ions**. These sensors can simulate the human eye when looking at soil as well as **measure near-infrared, mid-infrared, or polarized light reflectance**. It can provide more information about single data points since reflectance can be easily measured in more than **one portion of the spectrum at a time**.

Optical sensors:

These sensors use light in order to measure properties of the soil. They are installed on satellites, drones or robots to determine clay, organic matter and moisture contents of the soil.

- Vis-NIR and Vis-MIR spectroscopy
- ATR (Attenuated total reflectance spectroscopy)
- Raman spectroscopy

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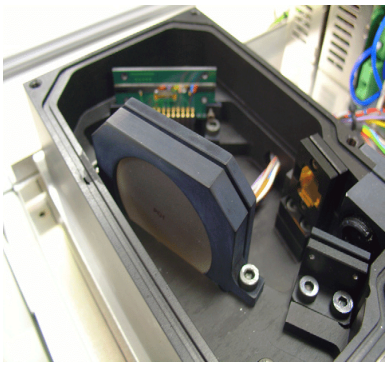
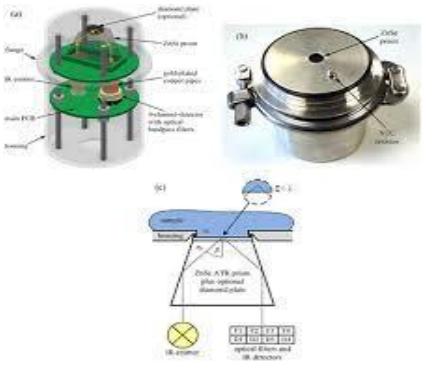
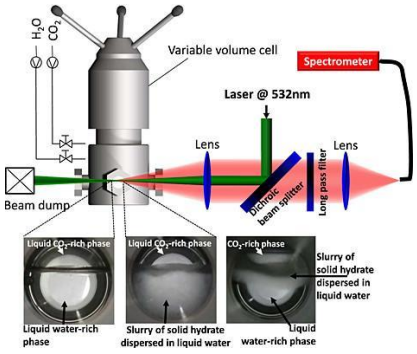






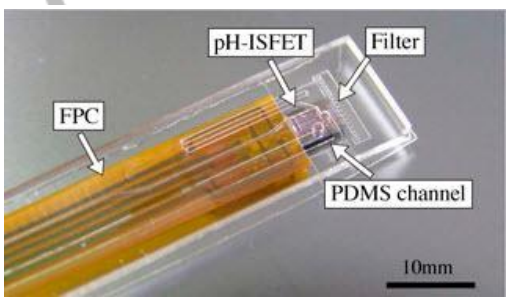
Electrochemical methods

It could provide the most important type of information needed for precision agriculture -**soil nutrient levels and pH value**. Electrochemical methods for **soil nutrient determination function by using ion-selective electrodes to initiate a current or voltage output that reflects the concentration of target ions.**

Electrochemical Sensors

These sensors help in gathering chemical data of the soils by detecting specific ions in the soil. They provide information in the form of pH and soil nutrient levels.

- Ion Sensitive field-effect transistor (**ISFET**)
- Ion selective electrode



Dielectric methods

Dielectric, insulating material or a very poor conductor of electric current. When dielectrics are placed in an electric field, practically no current flows in them

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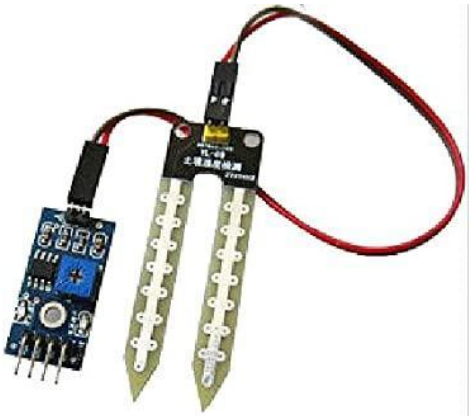
because, unlike metals, they have no loosely bound, or free, electrons that may drift through the material.

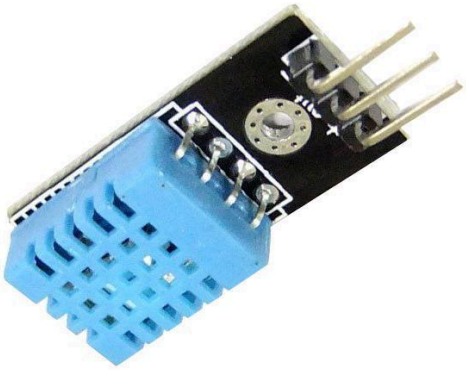
It can provide soil moisture, soil nutrients value, temperature, pH value, humidity and etc.

Dielectric sensors

1) Soil moisture sensor
2) Soil pH meter
3) Humidity and Temperature sensors
4) NPK sensors



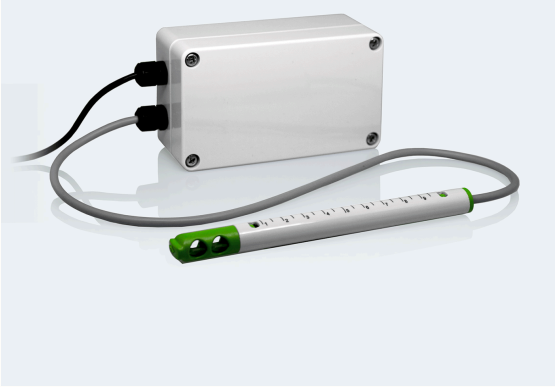






Airflow

Airflow sensor was used to **measure soil air permeability** on the go. The pressure required to squeeze a given volume of air into the soil at fixed depth was compared to several soil properties. Experiments showed potential for distinguishing between various soil types, moisture levels, and soil structure/compaction.



Acoustic

Acoustic sensors have been investigated to **determine soil texture by measuring the change in noise level** due to the interaction of a tool with soil particles. A low signal-to-noise ratio did not allow this technology to develop.



Flow of soil analysis:

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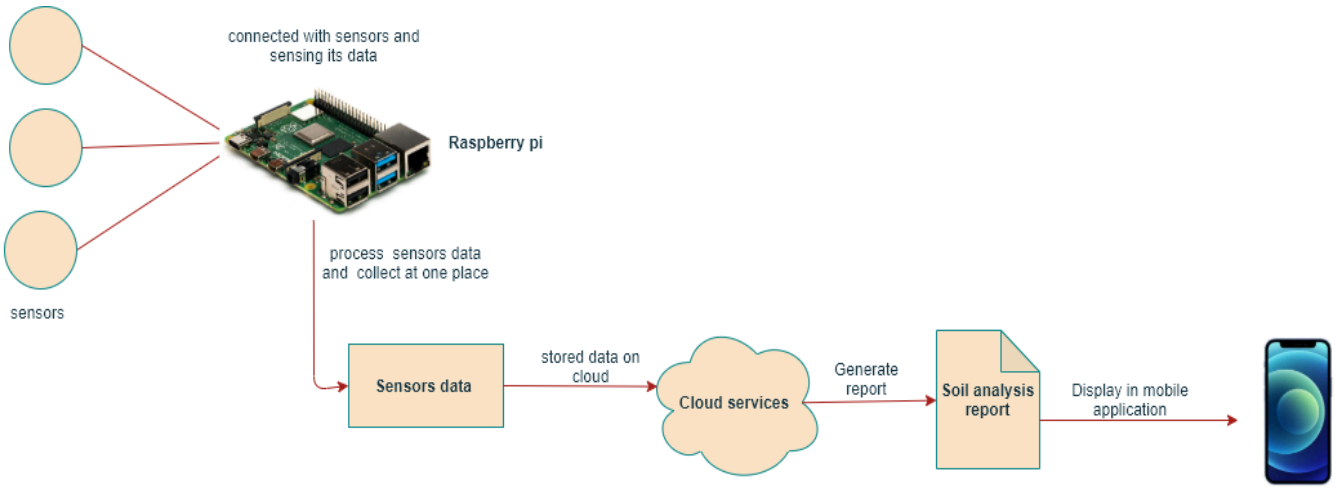

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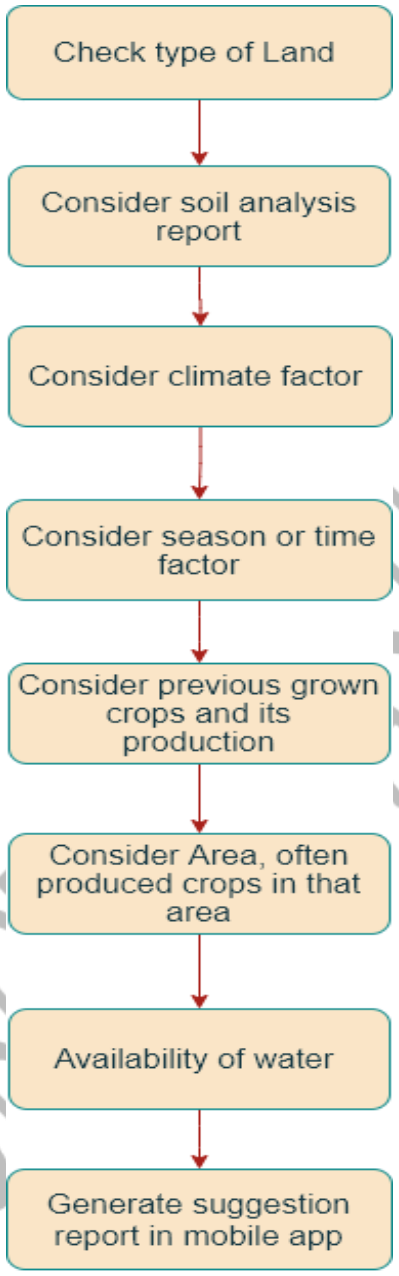
Chapter 2: Crop selection

Crop selection is the act of choosing which crops to grow. There are plenty of plants and among them which will have the best one, to decide it is a **very crucial decision** as it is an important part for **increasing productivity** and **profitability** to farmers.

How to Determine crop selection by agriRobot:



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What will suggestion report include:

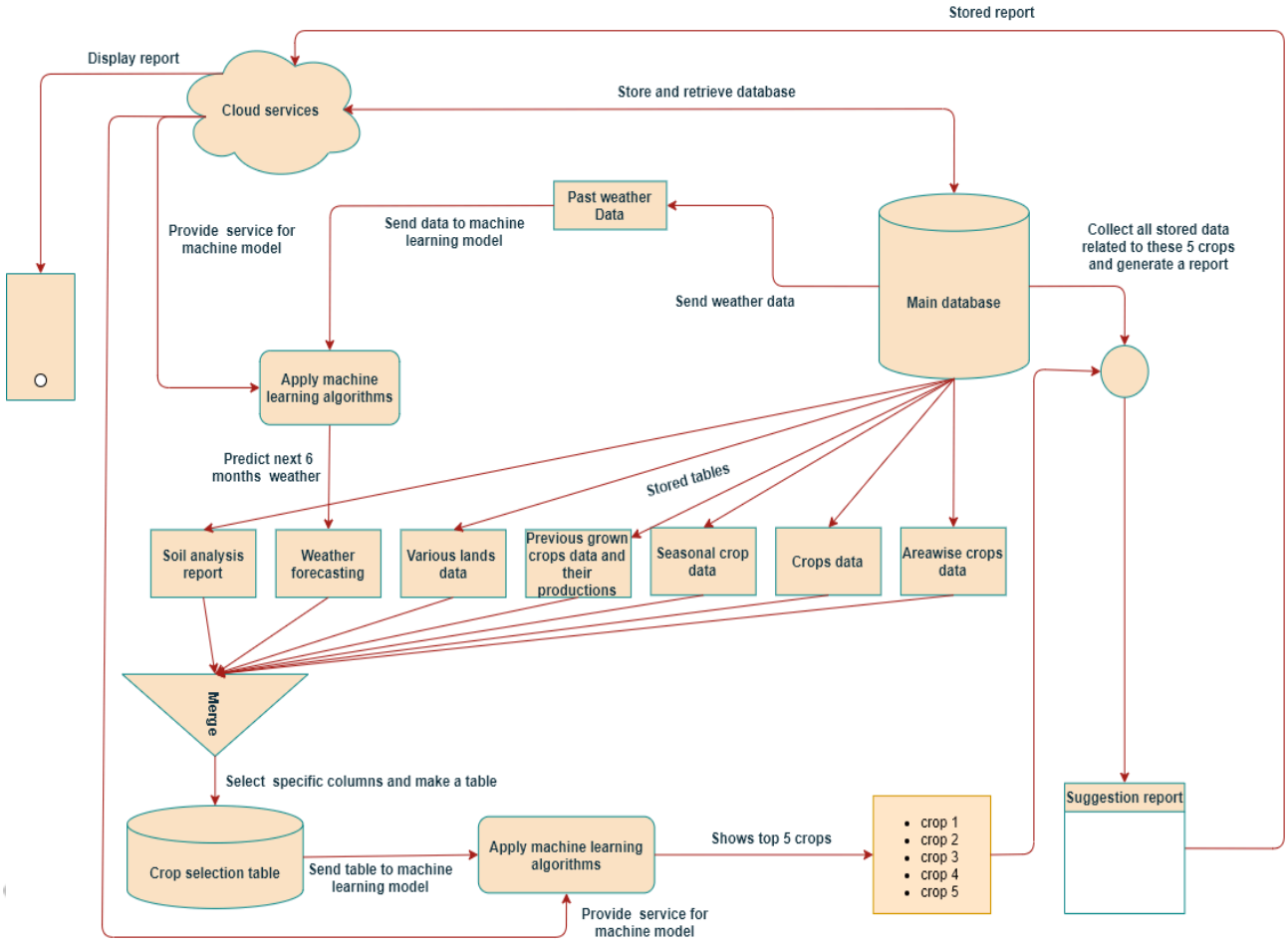
- Best five suitable crops with the most suitable seed variety for our farming condition
- Fertilizers will need to be added on the basis of soil analysis report to increase crop's productivity and quality for particular crop
- Entire process of each crop and how agrirobot will process it
- Prediction of harvesting time

- Prediction of crops production on the basis of land space (acre)
- Expected profit and risk.

Technologies will be used:

1) Machine learning algorithms
2) Cloud computing
3) Android mobile application

How technically will happen:



Chapter 3: Seed sowing by agriRobot

Sowing is an art of placing seeds in the soil at particular depth for good germination of the seeds. Sowing plays a major role in Agriculture. Perfect sowing is placing the seed at a specific depth with the correct number of seed per unit are with good spacing between plant to plant and row to row.

Sowing Method

There are many seed sowing methods but agriRobot will use method for seed sowing is the combination of **dibbling** and **drilling** methods.

Dibbling method:

It involves the placing of **the seeds in the holes manually or with specific instruments known as dibblers**. Those dibblers can be operated manually by skilled labor or skilled farmers. The dibbler is the conical instrument in order to make proper holes while sowing of the seeds in the field. There are also small hand dibblers which several conical projects that are suitable for small size seeds. Dibbling method of sowing is time-consuming sowing method. This method of sowing is mostly used for sowing of the Vegetable Crops.

Drilling method:

The continuous flow of dropping the seeds in-furrow lines made by **the seed drilling machine and covering them with soil is the drilling method of sowing the seeds. The equipment used for drilling is known as a driller**. The driller may be either operated manually, mechanically or automated. The setting of seed metering is done before sowing for proper placement of the seeds in the furrow. We can use the driller for placing the seeds in two to three rows at once. There also exists a conventional method where one person makes furrows and drops the seed using driller and the other person covers the furrow with the soil either manually or mechanically.

Steps:

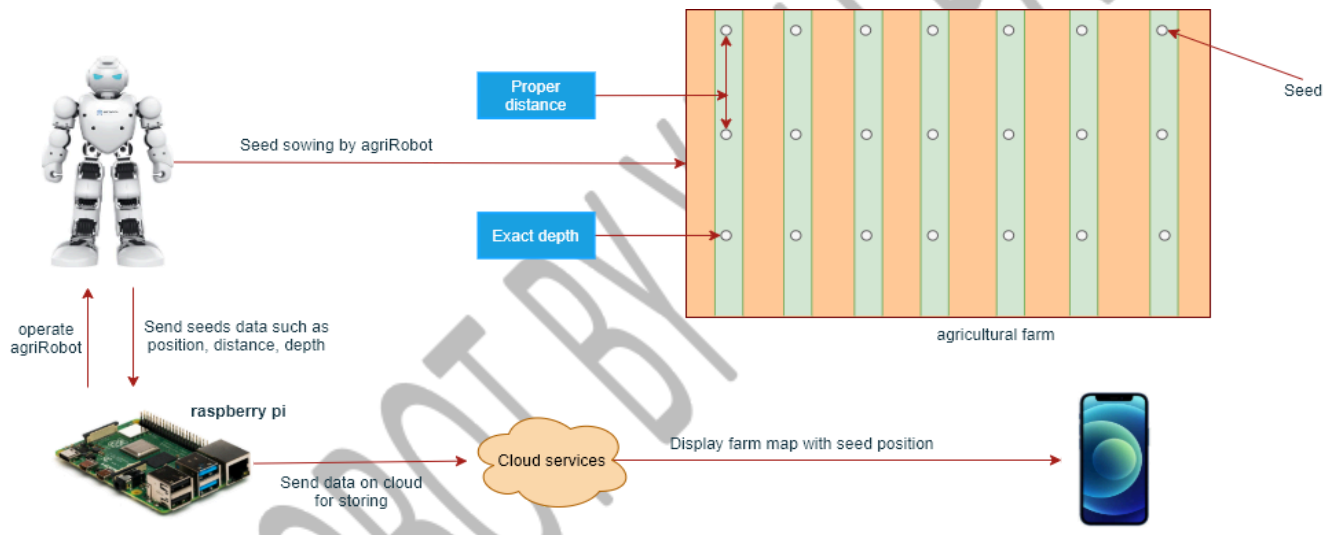
1. A seed drill sows the seeds uniformly **at proper distances and depths**.
2. It ensures that **seeds get covered by the soil after sowing**, thereby preventing damage caused by birds.
3. Sowing by using a seed drill **saves time** and **labor**.

AUDIT BY YASHRAJ

Advantages

- Seeds will be sown in the land at **proper depths** and also kept an **accurate distance**.
- The **exact positions of each seed will be stored in database** for later **analyzing and monitoring use**.
- **All seed sowing regarding information** will be shown in **mobile application**.
- This can **reduce labors work their cost and time.**

Flow of seed sowing:



Common equipment will be needed:

- Driller machine
- Water tank
- Seed Funnel

Chapter 4: Irrigation system

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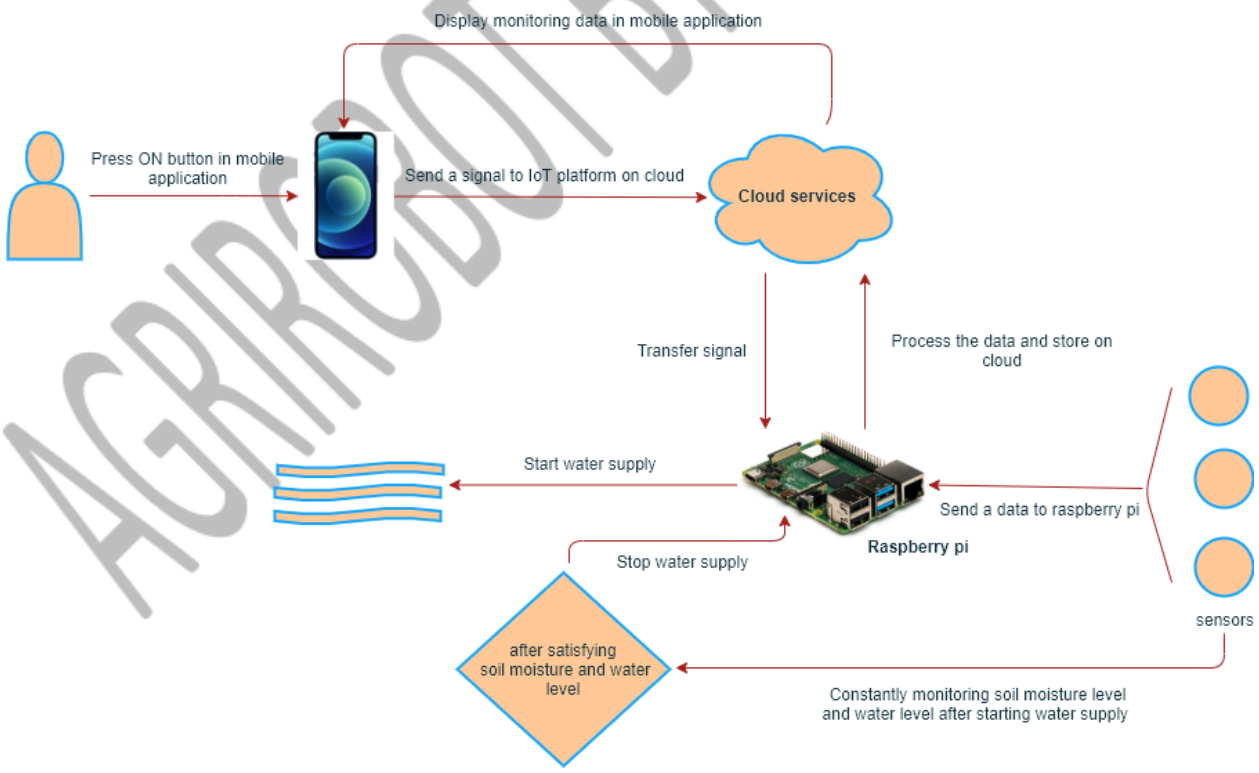
- There will be sensors placed into the land which will **constantly measures soil moisture level and notify to farmers in mobile application.** Farmers can able to **control irrigation system** by using mobile application.
- If farmers **click on ON button** in mobile application, here, **water supply will automatically start. Farmers no need to go to farm for just to start water supplying or motor and it will get automatically OFF after water will reach at in entire land and satisfying soil moisture level.**
- In case of no motor and **government water** supply, there will be **a kind of gate system which will open when ON button will be pressed**.
- And again, **all the data will be also stored on cloud** such as **how much water is needed, how much time water will take to reach on entire farm**, etc.

Flow of irrigation system:



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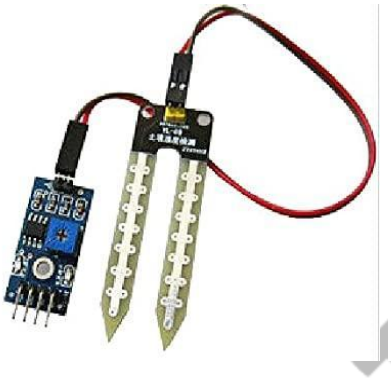
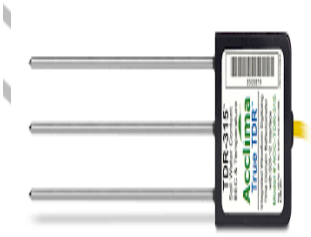
Sensors:

1. Resistive Sensor
2. Capacitive Sensor
3. Time-Domain Reflectometer (TDR)
4. Time domain transmissometer (TDT)
5. Hydra probe II soil sensor
6. Pogo portable soil sensor













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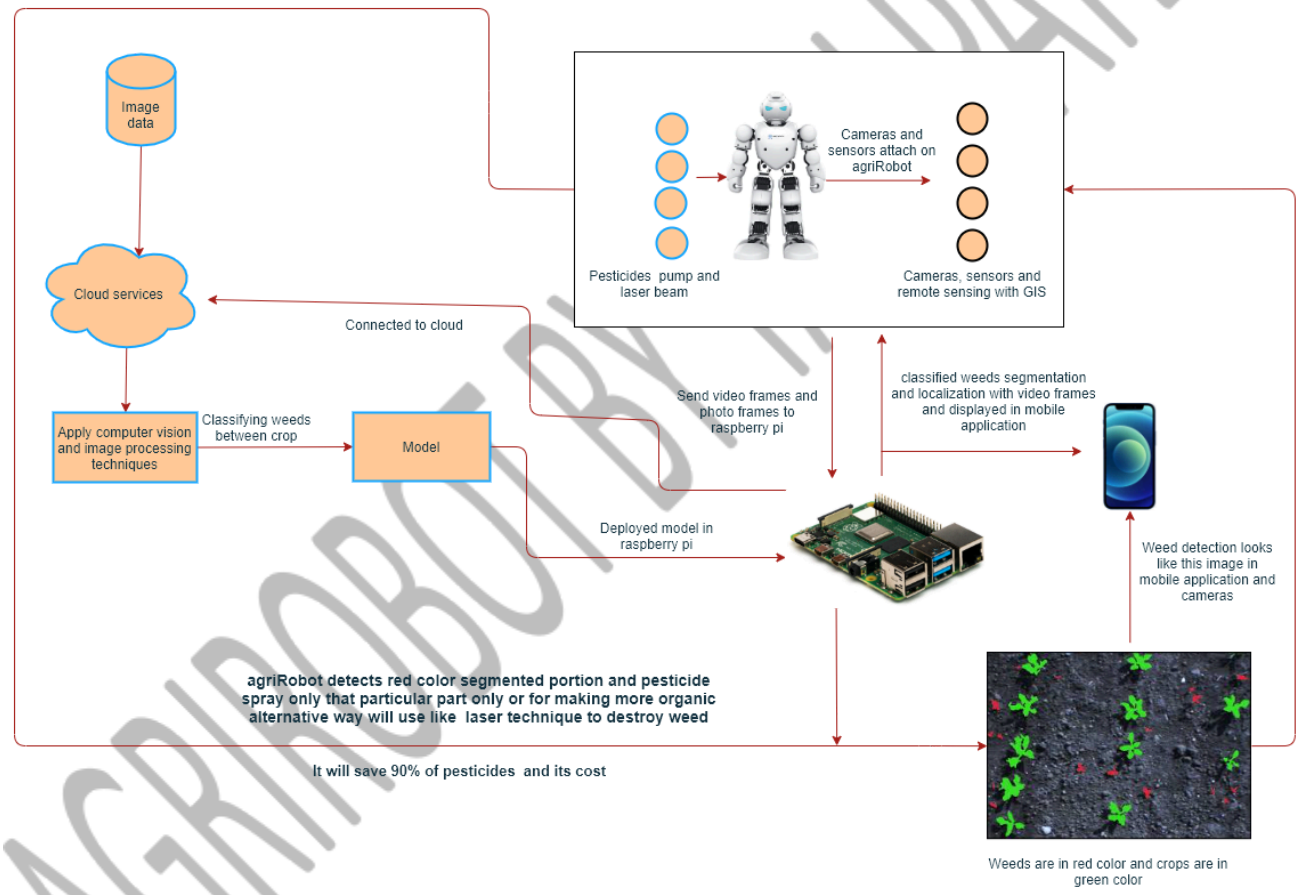
Chapter 5: Weed detection and Insect detection

Weeds are **the unwanted plants which grow in the soil**. These **compete with the main crop for food, water and sunlight**. It **decreases the agricultural productivity**.

How agriRobot will help to destroy it:



Approaches to remove weed:

- Pesticide spray (Save 90% pesticides and its cost)
- Laser technique

It will only spray or laser on particular part where weeds will detect so it will be produced more organic and high-quality food.

AGRIROBOT BY HARDIK PATEL

It will also store position where weed often find to make better improvement in future.

Cameras will need to be installed on agriRobot for detecting weed:

- Stereo cameras
- Monocular cameras
- CCD and CMOS based Infrared and ultrared cameras
- Raspberry pi High quality 360 degree and wide-angle cameras (Sony IMX477, 300X Microscope Lens, 16mm Telephoto Lens, 6mm Wide Angle Lens)
- LiDAR and RADAR sensors

Techniques to be applied for classifying weeds

- Object detection
- Image processing techniques (filtering, styling, etc.)
- Computer vision
- Image segmentation
- Machine learning and deep learning
- Remote sensing and GIS

Insect detection

- Through cameras, robot will be roaming around land and monitoring the crop if it will **identify various insects which are damaged the crop and herbicides on them**.
- It will also **take photos of them and store that position** where it will find insect for the future use or for the improvement.
- All this **information will be shown in the mobile application**.

Same approaches, process, flow, techniques, cameras, and sensors will use in weed detection that will also be used to detect and remove insects.

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Chapter 6: Diseases detection and crop monitoring

- agriRobot will be roaming in farm and checking **crop leaves, its colors, its growth, its health level, its nutrition quantity, perform tissue analysis,** etc. and **stored** all the information on cloud.
- Based on this information, it will **try to predict whether crop is healthier or not?**
- **will there any chance to spread any kind of disease into it? if so, it will alert to the farmer and also give some suggestion like spray pesticides or add fertilizers to stop it to spread and maintain crop health.**
- If disease is already spread then also it will inform to farmers with appropriate guidance.

Also, it will collect all information and store it for future improvement or analysis purpose and also display stored information in mobile application in the form of reports which will include:

- crop growth report
- crop health report
- weekly and monthly comparison report
- disease detection report
- soil monitoring report
- soil analysis and testing report
- weed detection report
- insect detection report and many others.

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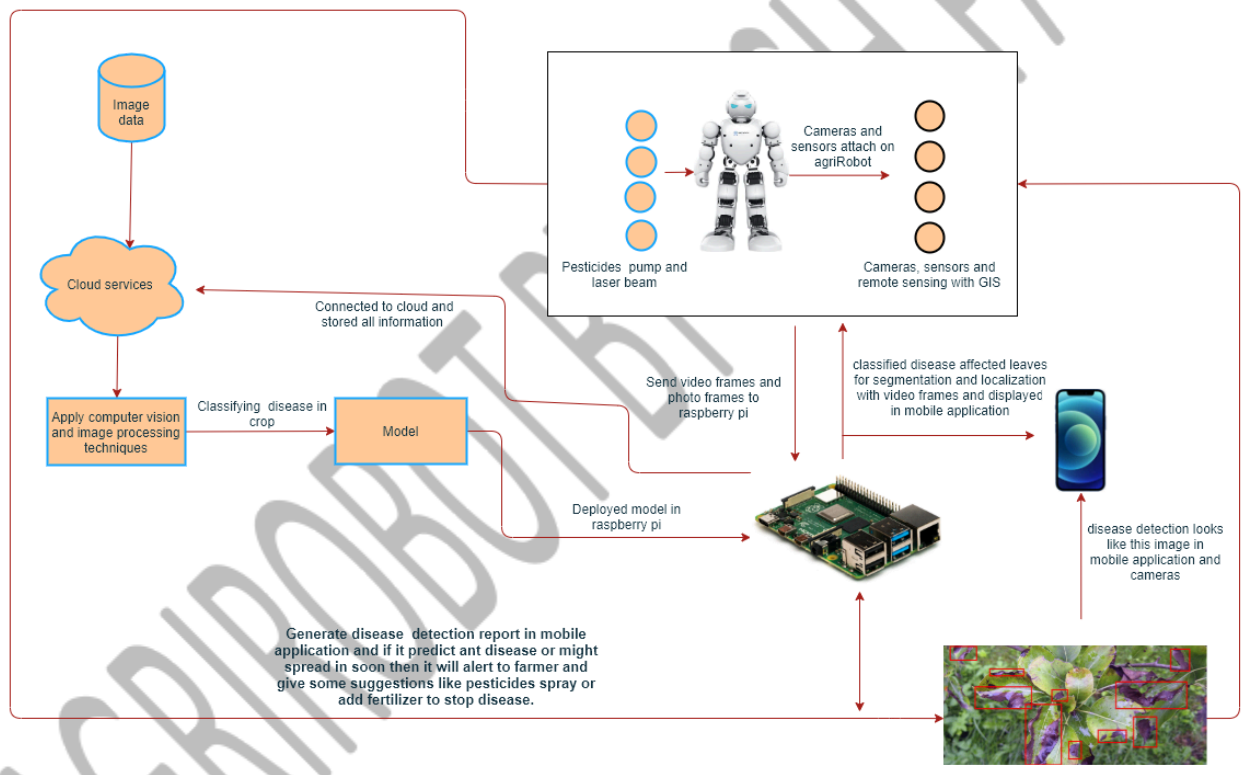
Flow of disease detection:



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- LiDAR and RADAR sensors

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Techniques to be applied for classifying diseases

- Object detection
- Image processing techniques (filtering, styling, etc.)
- Computer vision
- Image segmentation
- Machine learning and deep learning
- Remote sensing and GIS

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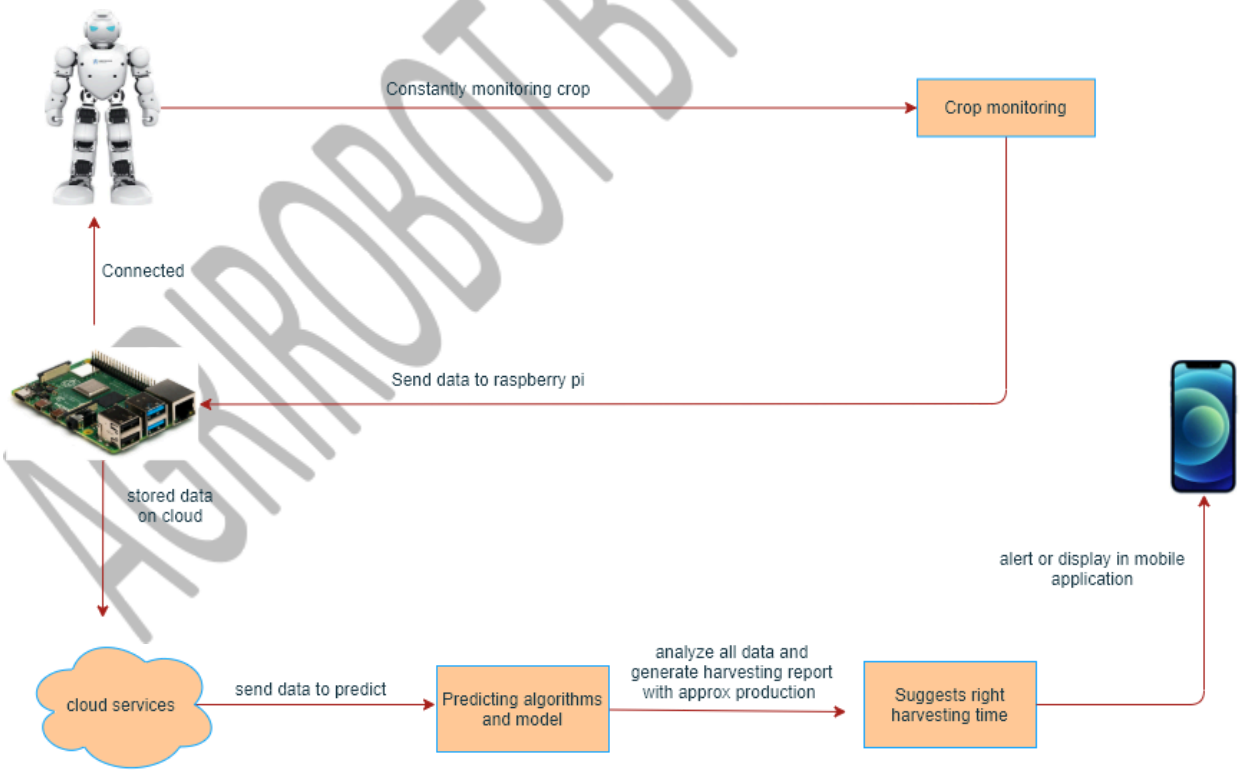
Chapter 7: Harvesting

Harvesting is **the process of gathering a ripe crop from the fields.**

Flow of harvesting:



- It will suggest best harvesting time period for the crop by analyzing its health, quality, nutrition value.
- agriRobot will help to harvest crop such as **pluck vegetables and put all of them in different baskets by its size, color, quality and nutrients.**

Cameras will need to be installed on agriRobot for detecting ripe crop:

- Stereo cameras
- Monocular cameras
- CCD and CMOS based Infrared and ultrared cameras
- Raspberry pi High quality 360 degree and wide-angle cameras (Sony IMX477, 300X Microscope Lens, 16mm Telephoto Lens, 6mm Wide Angle Lens)
- LiDAR and RADAR sensors

Techniques to be applied for classifying crops

- Object detection
- Image processing techniques (filtering, styling, etc.)
- Computer vision
- Image segmentation
- Machine learning and deep learning

Common equipment:

- Plucker
- Baskets

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Estimated Cost for phase 1 only (earlier stage):

- Total cost: 16,000,00 Rs
- Sensors: 2,00,000 Rs
- Solar Panel: 30,000 Rs
- Raspberry PI 4 Model B with kit: 10,000 Rs
- Cameras and screens: 3,00,000 Rs
- Robot manufacture equipment: 4,00,000 Rs
- Motors, Batteries and other equipment: 5,00,000 Rs
- Others electronics equipment (jumper wires, irons, etc.): 1,00,000 Rs
- Cloud computing (1 year): 60,000 Rs

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This amount is just for the earlier stage of my project. I will let you know for phase 2 after some achievement will be accomplished.

Thank You.

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