PATENT DRAFT

ABSTRACT

Our proposed device is an intelligent autonomous rover for plant disease detection. It will be able to efficiently detect diseases in various plant species without any human involvement. Our rover has incorporated the latest technologies, including Artificial Intelligence, Machine Learning, and the Internet of Things to diagnose diseases accurately. The autonomous rover will move around in the farmland environment and identify the diseased plants using Computer Vision and Artificial Intelligence.

The mechanical design of our rover has been made to tackle the rugged, unduly and uneven surface of typical Indian farmland. Due to our mechanical design, the rover will easily tackle and overcome any obstacle coming in its path without losing its balance.

We have also designed and incorporated an advanced conveyer-collection and analysis system in our rover. A soil sample of the farmland will be collected and stored in a container built into our rover containing water. An analog pH sensor will then measure the pH value of the soil.

Earlier farmers used help from experts and agricultural scientists for analysing their crops for any disease, but our invention will make this process a lot easier and convenient. Using such an advanced and future generation agricultural rover will be a significant step forward to smart farming. It will improve the production quality and quantity of crops and also reduce the extensive labour work. Our invention's scope is to transform the agricultural sector using modern technologies to smarter India, enabling precision farming.

FIELD OF INVENTION

The current invention is a method of autonomously detecting diseased plants in farmland with the help of computer vision. The computer vision algorithm is developed over the PlantDoc dataset, where the output was binarised and trained over mobile net SSD.

The main scope of the invention is in the four-wheeled mechanical design of our rover and the conveyer-collection and analysis system which will check the pH value of the soil in the farmland in which it is operating giving insight and critical information to the farmer.

BACKGROUND OF THE INVENTION

Agriculture is the backbone of the Indian Economy, contributing over 70% of India's GDP. Many farmers are at a high risk of facing an agricultural loss predominantly due to diseases in their crops. Prompt and early detection of these high-risk diseases will undoubtedly result in a more productive yield. Plant diseases can severely affect farm production and result in high losses to the farmers. Manual identification of diseases in individual plants in vast farmland is very hard-handed and labour-intensive work. Examples of agricultural rovers are CN Pat No. US8381501B2 and KR102001517B1.

For instance Pat No. US8381501B2 is an agricultural robot system that has incorporated a method of harvesting, pruning, culling, weeding, measuring and managing crops. It uses autonomous and semi-autonomous robot(s) comprising machine-vision using cameras that identify and locate the fruit on each tree, points on a vine to prune, etc., or maybe utilized in measuring agricultural parameters or aid in managing agricultural resources.

Another instance is Pat No. KR102001517B1. In this invention, various types of working machines such as a lath the moulding machine, a planter, a vinyl clotter, a sprayer, and a harvester are exchangeably mounted so that the seeder is operated by its power.

BRIEF SUMMARY OF THE INVENTION

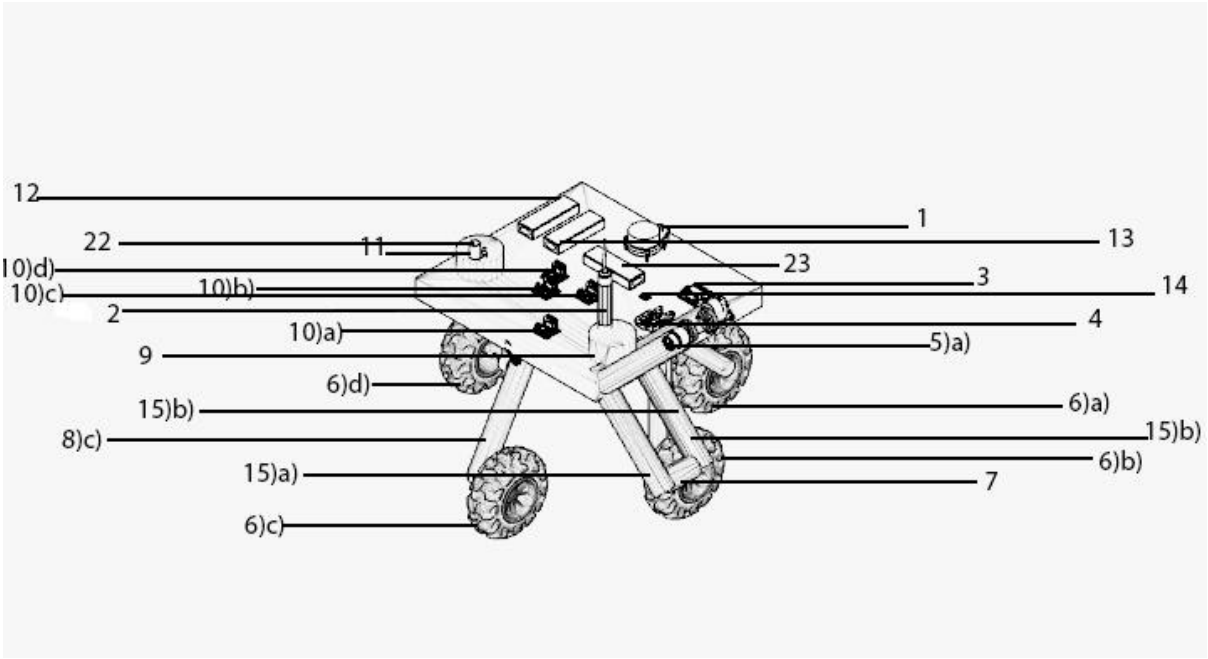
The current invention provides a method to autonomously detect diseases in various plant species without any human involvement and intelligently spray pesticides while traversing in the farmland. The rover also has a built-in conveyer-collection and analysis system. A conveyor which has been made out of a rubber tube will be attached in a slant position. Two pulleys attached to this conveyer powered by DC motors will rotate this conveyer mechanism in which a soil sample will be collected from the farmland and stored in the container on the rover and with the help of an analog water pH sensor, our invention will be able to calculate the pH value of the soil sample hence providing valuable information to the farmer/user.

As we all know farmland has rugged and uneven terrain. This makes the movement of any rover very complicated and creates chances for the rover to easily get unbalanced. Thus we have invented a four-wheeled rover to efficiently tackle and overcome this problem. To cross upheavals or craters in the ground we have attached a spring to the rover's front and rear wheel leg. The spring is connected to a low tensile strength wire attached to the rover body. This gives the rover's wheel leg two degrees of freedom enabling it to move to and fro and thus easily tackling any obstacles in its way. This invention has also given our rover the capability to climb stairs. The wheels are firmly attached to its legs. The material of the wheel legs has been used in such a way to make it sturdy. The two side-wheel legs are firmly attached to the rover's body and have not been given any degree of freedom.

The raspberry 4 is the main component of our rover. It is the slave computer, with a peripheral node running on the Arduino. The raspberry pi runs UBUNTU 20.04LTS, and has ROS Noetic installed for all the communication protocols. A node has been installed on the Arduino Uno board to communicate over serial with the raspberry pi4. The raspberry pi 4 is connected to an UBUNTU (preferably 20.04 LTS) machine with ROS (preferably NOETIC), which is the master machine and publishes all the data, to its IP. The whole robot has been programmed using ROS in Python 3.8 programming language, with custom messages and nodes.

An RP LIDAR A1 attached on top of the robot will have the entire map of the field, helping it decide the path between two points, avoid the obstacle, and prevent itself from damaging the existing crops and soil quality. It will trace the route in the field, move around the crops, and find the signs of diseases.

The rover is fitted with IoT based Ultrasonic sensor HCSR04 for obstacle detection. It will be used to prevent rovers from ramming or crashing into the crop. The rover has also been attached with the Pi camera (5MP) which will capture the images of plants and feed them into the raspberry pi 4 micro-computer. Advanced Deep Learning and Computer Vision-based Object Detection algorithms have been deployed for disease detection. The computer vision algorithm is developed over the PlantDoc dataset, where the output was binarised and trained over mobile net SSD.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10)c)
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6)d)
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7

Fig-1

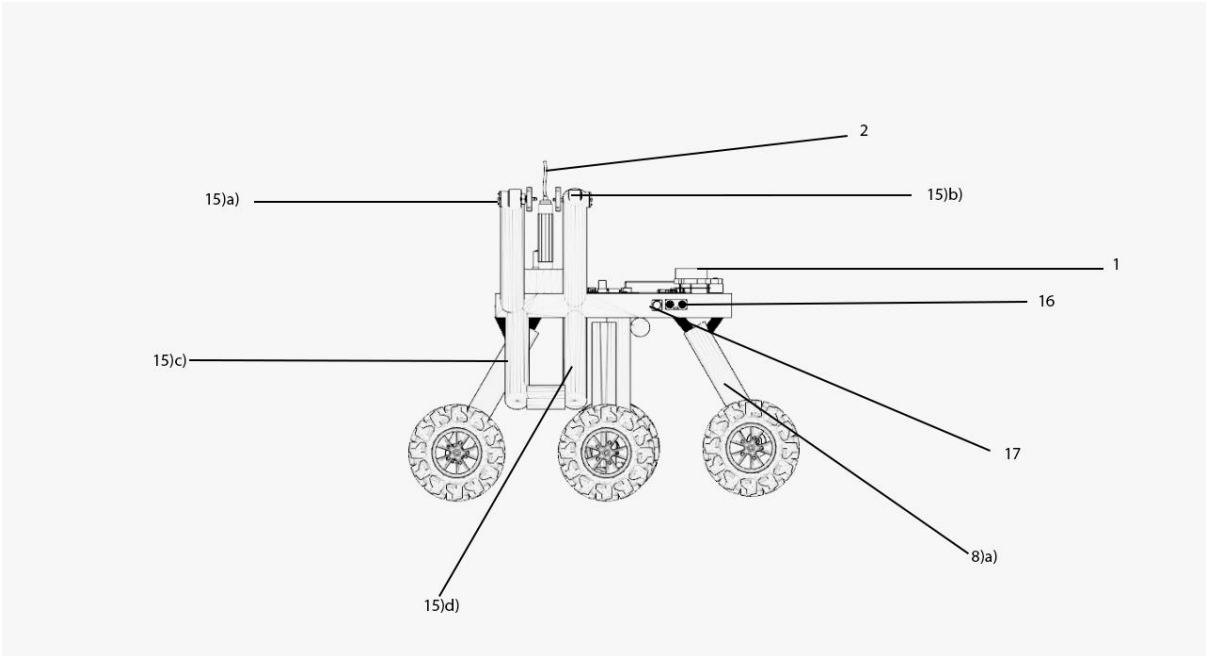
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Fig-2

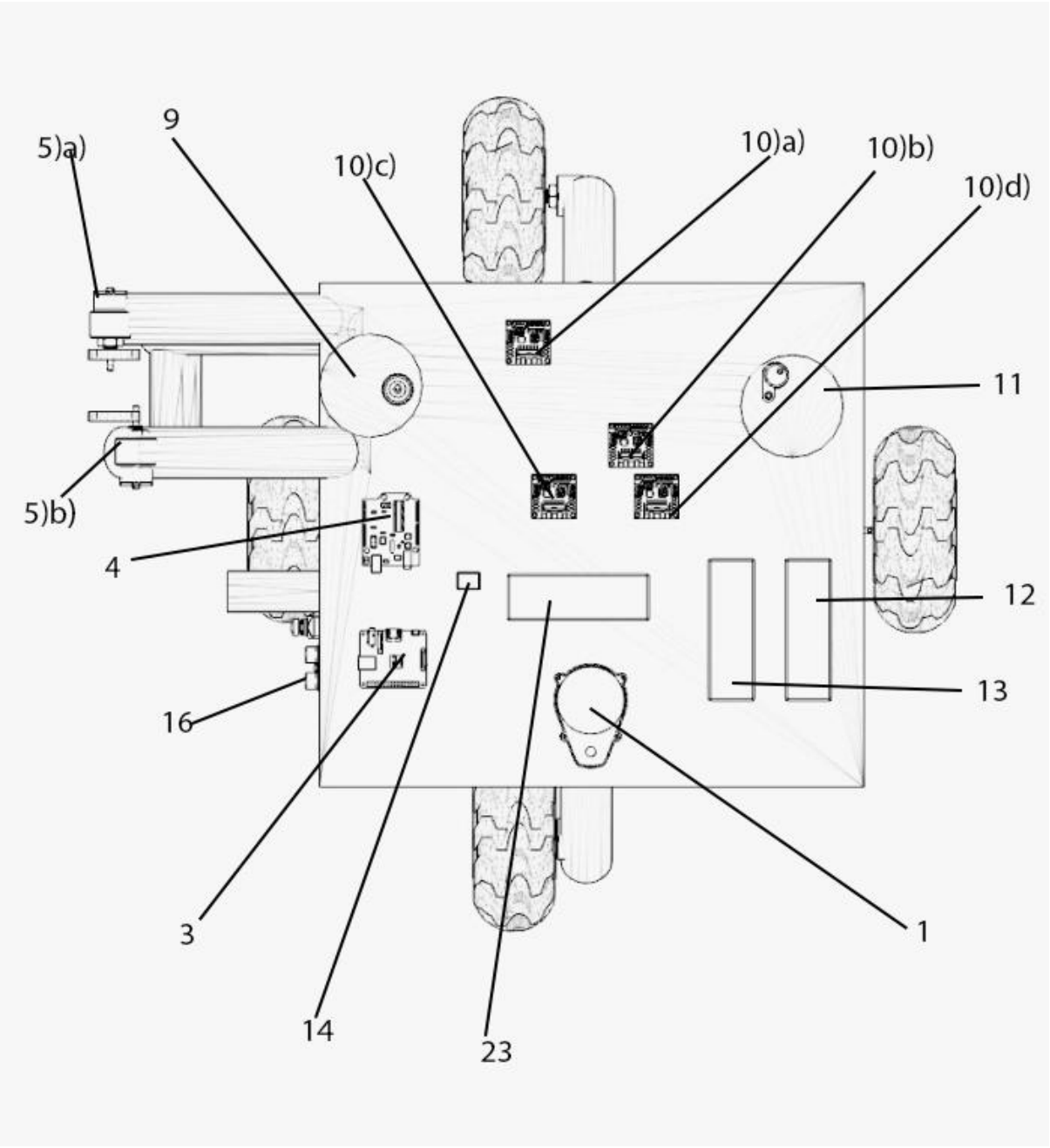

Fig-3

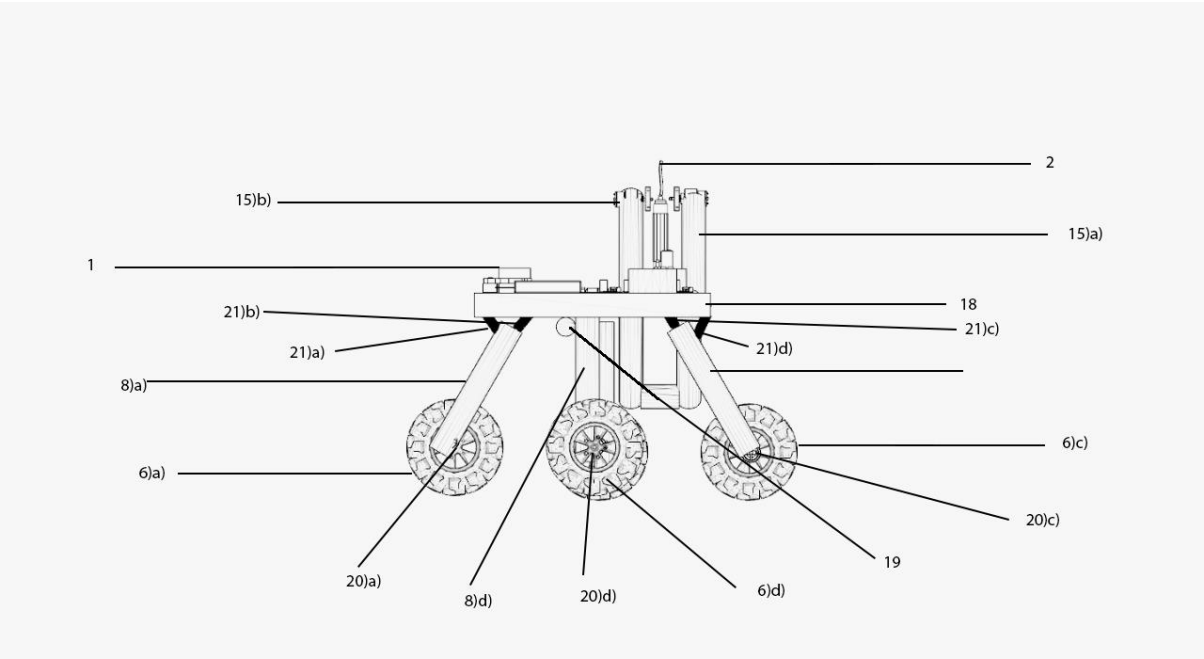
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Fig-4

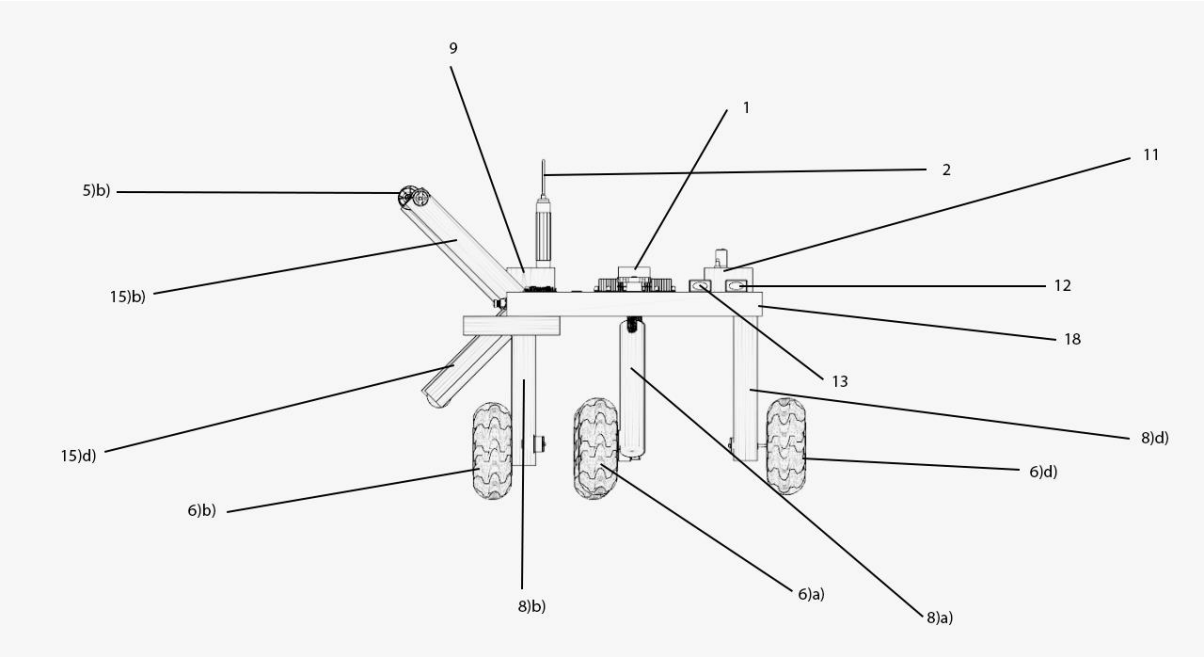
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Fig-5

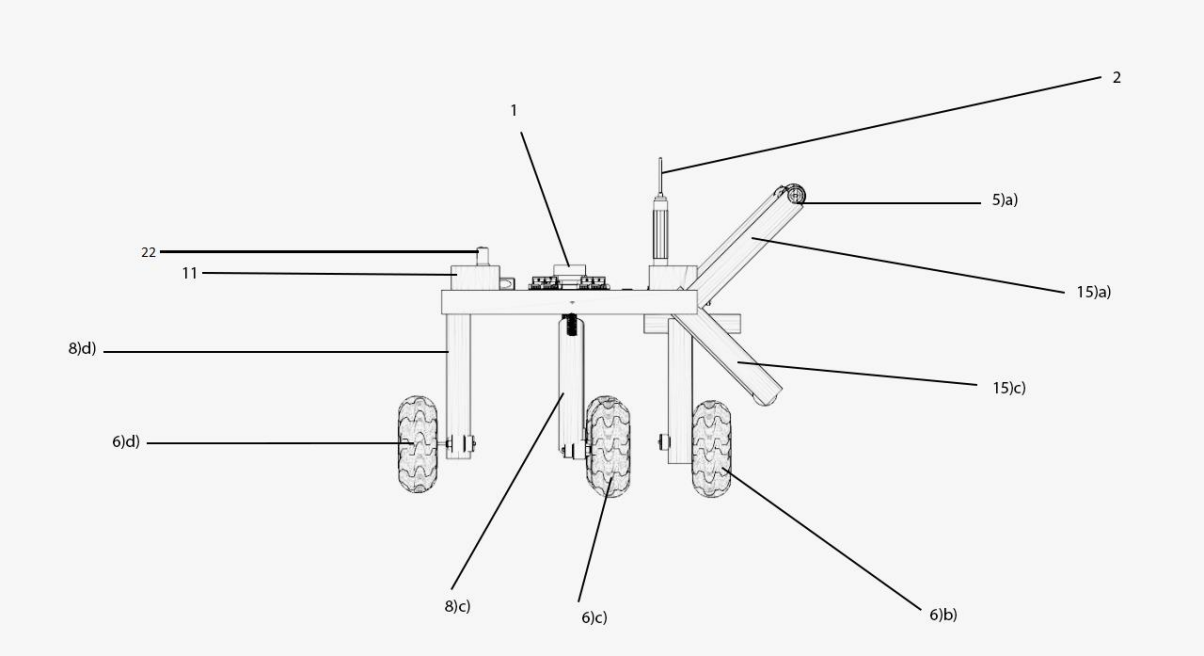

Fig-6

BRIEF DESCRIPTION OF SEVERAL VIEWS OF DRAWING

Fig1 is the top diagonal view of the rover which showcases all the electronic components which have been attached on the top of the rover body along with its mechanical structure.

Fig2 is the right-hand side view of the rover where the ultrasonic sensor HCSR04 and Pi cam (5MP) are attached.

Fig3 is the top view of the rover which showcases the entire electronic components along with two containers one which is for pesticide spraying and the other one which is for storing the soil sample.

Fig4 is the left-hand side view of the rover.

Fig5 is the front view of the rover which emphasizes on the novel mechanical design.

Fig6 is the rear view of the rover which emphasizes on the novel mechanical design.

DETAILED DESCRIPTION OF INVENTION

RP LIDAR A1**[1]** is based on laser triangulation ranging principle and uses high-speed vision acquisition and processing hardware. It is used to create a point cloud of the surroundings using laser beams, which are captured using ROS, and is used for map creation. The robot then localises itself inside the map, and is used for obstacle collision avoidance and helps the rover in navigating in the field.

pH sensor**[2]** circuit board with this, needs 9 V DC supply. The probe gets connected to the circuit board and output pins are connected to an Analog pin of Arduino. pH sensor has two electrodes. The electrode that does the most important job, which is called the glass electrode, has a silver-based electrical wire suspended in a solution of potassium chloride, contained inside a thin bulb (or membrane) made from a special glass containing metal salts (typical compounds of sodium and calcium). The other electrode is called the reference electrode and has a potassium chloride wire suspended in a solution of potassium chloride.

Raspberry Pi**[3]** is the main control unit of the robot, which runs Ubuntu 20.04LTS and ROS as the master node. It is connected with the RP Lidar for Simultaneous Localisation and Mapping, with the Arduino uno**[4]** micro-controller, using serial communication, which runs a ROS node. The raspberry pi further controls the pi camera**[17]**,which performs object detection for detecting disease in plant leaves using mobilenet ssd, which is trained on binarised plantdoc dataset. The raspberry pi controles the gps module**[14]** and logs the cordinates of the field. The raspberry pi is povered using a lipo battery**[12]**. The pi drives the four motors **[20]**, which are connected using two motor drivers **[10a]** and **[10b],** which control the front and the right and the back and left wheels **[6a, 6b, 6c, 6d]** respectively. Finally the pi also powers the conveyor system motor **[5a, 5b]** connected using motor driver [10c], which help in throwing the soil sample in the ph measurement chamber **[9]**.

The arduino uno micro-controller controlls the analog ph sensor, the pesticide spraying system, which is controlled using a submersible water pump **[22]** (driven using motor driver **[20d]),** inside the container **[11]** containing the pesticide solution to be sprayed, through a soft tube silicone tubing **[19].** The arduino also calculates the distance from the leaf using an ultrasonic sensor **[16].** The microcontroller also powers a 3.3v DC motor fan, which helps in mixing soil with water for accurately measuring ph in the chamber. Battery 2**[13]** which is 11.2V powers the motors The 9V battery**[23]** powers the pH sensor. Battery 1**[12]** is a 5 V battery which powers the raspberry 4.

The conveyor belt lies on the motors **[5a, 5b],** which have a plough shaped metal strip attached to it, which moves along the belt. When the plough reaches the ground, lifts a soil sample, which it throws from the top position, near the motors into the pH measurement chamber.

The robot is made of an acrylic board**[18],** which is joined to two plastic hollow cylinders at the centre by means of nuts and bolts , and two hollow cylinders, at angle of 30 degrees from offset or the vertical, using the two springs**[21a, 21b, 21c, 21d]** each. The springs allow the motion of the legs in the front and back directions, while also help in generating restoring torque, and bringing them back to mean position and help in stabilising the robot. The conveyor belt system includes a hollow fixed cylindrical pipe **[7]** over which the conveyor belt rotates.

CLAIMS

1) Mechanical Design

The four-wheeled rover whose front and rear wheel legs have been connected with springs and a low tensile strength wire giving it a freedom of movement of two enables the rover to easily tackle and overcome the challenging rough and unduly terrain of farmlands. The side wheels have been fixed giving the robot additional balance.

2) Conveyer-Collection System

A conveyer system has been made for collecting a soil sample from the farmland. A rubber tube has been used as a conveyor which rotates with the help of two pulley powered by DC motors and a metal scoop is attached at the lower end of the conveyor mechanism which will scoop out the soil sample. This mechanism is a novel point to our rover.

3) pH value calculation of the soil sample

After the conveyor-collection system collects and stores the soil sample in the container, an analog pH sensor will calculate the mixture of water and soil sample. Water will be stored in the rover initially and a motor attached to a fan will stir the mixture well.

4) GPS based Coordinates Feedback

The GPS-module fitted rover has the ability to send the diseased plant's specific coordinate location to the farmer. Using GPS, the rover will provide location-specific vital parameters such as information about the pH level. It will be very beneficial to a farmer cultivating in a vast field.

5) Disease detection and collision avoidance

The rover is fitted with IoT based Ultrasonic sensor HCSR04 for obstacle detection. It will be used to prevent rovers from ramming or crashing into the crop. Pi cam (5MP) has been used to capture the images of plants and feed them into raspberry pi 4 and with the help computer vision algorithms it will be decided whether the plant is diseased or not.