INDIAN INSTITUTE OF TECHNOLOGY
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DIC'S TERRACE FARMING ROBOT FOR HILLY AREAS

FINAL TECHNICAL REPORT

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Terrace Farming

Terrace Farming is the practice of cutting hills and mountain slopes to form terraces and the land is used in the same way as in permanent agricultural. Due to the limited availability of flat land, terraces are made to provide a small patch of level land.

Problems Faced in Terrace Farming

The main problem faced in the practice of terrace farming is the difficulty in using any machinery or animal power.

This problem arises due to the small width of the level land.

Solution

To solve the problem faced in the terrace farming, an efficient robot is designed.

The robot is made to help the farmers in terrace farming to perform various agricultural activities which require extensive investment of time and work by farmers and also solve the issue of farmers of not being able to use any heavy machine or animal power in farming due to nature of terrace farming which is in the forms of series of steps and the steps do not have enough width to allow any animal or machine to use on them.

It is a great help to farmers, improving their efficiency and saving them a lot of time and work.

The robot is designed keeping in mind the various activities that are performed on the field.

It is able to perform the various tasks which are listed below.

1) Climbing UP and DOWN the steps.

2) Ploughing

3) Seeding

4) Harvesting

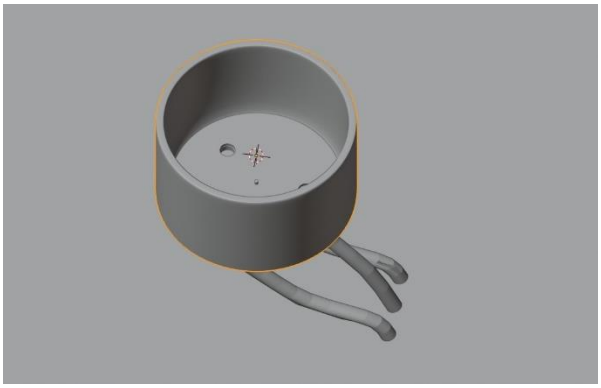
Activities Performed by The Robot

1) Ploughing

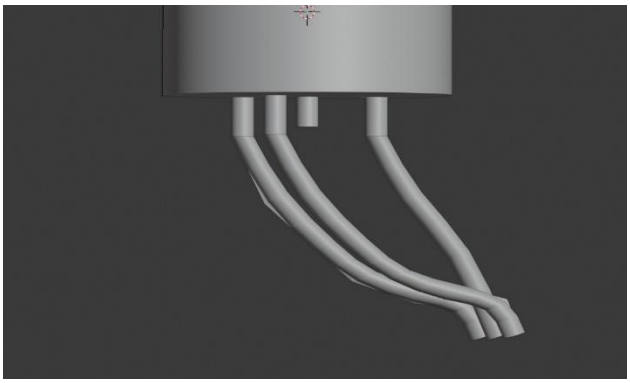
Ploughing is the operation of initial cultivation to loosen the soil using a tool called plough. This is done for preparing the soil for sowing the seed. Traditionally it has been done by dragging the plough by animals such as oxen. In modern times this is done using tractors.

The ploughing mechanism is being performed by designing a plough of metal and weight enough to pierce through the soil and can easily be dragged by the robot as shown in the pictures below. The plough is attached to the robot structure using hinges. The horizontal elbow of the plough is tied to a string which is passed onto a pulley. The pulley is used to make the plough retractable i.e. it can be lowered down to perform the activity of ploughing and later after the work is completed it can be moved upward. The pulley is connected to a motor having a high enough holding torque which can easily hold the weight of the plough. The position of the plough is chosen inside the robot rather than behind the robot to use the space efficiently and also to increase the length of ploughed field.

2) Seeding



Seeding is the operation of putting seeds in the soil after the soil has been ploughed. This is usually done by scattering the seeds by hand or mechanically over a large area. After this, the seeds are lightly buried. Seeds sown in this manner require 10%-20% more seeds and are distributed unevenly, which may result in overcrowding of the seeds.



The robot can perform the operation of seeding and also prevent the problems which are faced during seeding as described above.

The seeding mechanism composed of a cylindrical container that is fixed on the robot. Inside the container, there is another container that will contain the seeds. This container has some holes on the bottom and is able to rotate. Several small holes are also made on the bottom of the cylindrical container and those holes are then covered with a pipe of similar diameter. When the holes of the two containers coincide, the seeds will flow through these pipes. The other end of the pipe is fixed behind the ploughs. This will improve the efficiency of the robot in two manners.

i) It will sow the seed uniformly and prevent any excess spread of seeds.

ii) The seeding operation is performed at the same time as ploughing, helping in saving energy and time.

3) Harvesting

Harvesting is the operation of cutting of fully-grown crops or plants. This is usually done by tools such as sickle or reaper on smaller farms. This is one of the most labor-intensive work.

On the larger farms also harvesting requires the use of very sophisticated machinery.

The Robot is performing the operation of harvesting by using cutters which are fixed at the front of the robot. The blades of the cutter are very sharp to prevent any bending or partial cutting of crops. The cutter is made by fixing three sharp blades on a circular disc which is then rotated using a high rpm motor. This design can effectively cut a plant of diameter upto 15 mm in a single stroke

4) Climbing Up and Down the Steps

Terrace Farming is performed on hills and mountain slopes by making steps of small level lands. Due to this the robot structure is designed in such a way it can both climb up and down the steps efficiently. The design is made keeping in mind the maximum height of steps can reach up to 40cm.

For performing this activity, 'Caterpillar Mechanism' is used in which the robot is made in three parts. The front, middle and back parts respectively. The front and back part are essentially sliders which are connected to a vertical chain that will drive them upward or downward according to need.

Climbing Mechanism

While climbing up,

1) The front part will be driven up by chains when it comes near enough the wall which is detected by ultrasonic sensors.

2) The robot will move forward until the wheels of front part land on the upper step and the middle part touches the wall of step.

3) Now, the chain will try to drive lower the front part and drive down the back part. Since the front and back are restricted from movement the force applied will cause an upward force on the middle part.

4) The robot will again move forward until the complete middle part is on the upper step and the back part is touching the wall.

5) Finally, the back part is driven upward and the robot moves forward until the whole robot is on the upper step.

While climbing down,

1) The robot will detect the ending of land on the back using ultrasonic sensors.

2) Then after moving slightly backward when the back part is completely mid-air. The chains will drive the back part down onto the lower step.

3) The robot will start moving backward until the middle part is in mid-air and the middle part is held in the mid-air by applying torque on both front and back parts.

4) The middle part is slowly brought down by driving the front chains.

5) Finally, the robot moves slightly backward until the front part is in mid-air and then it is brought down.

In this manner, the robot successfully completes the operation of climbing up and down.

Technology Stack Used

1) Body Framework

The robot body is made using white PVC pipes with an inner diameter of 1 inch. The design of the robot is shown below.

2) Hardware and Electronics

Wheels: For locomotion Omni wheels are used.

Motors:

1) Motors used in locomotion i.e. which are connected to omni wheels are Johnson Motors (60 rpm, 12V).

2) Motors which are used in sliding mechanism i.e. which are connected to chains using sprockets are Planetary Motors (500 rpm, 12V).

3) Motors used in cutters of harvester mechanism are 775 Motors (6000 rpm, 12V).

Motor Driver:

For all the motors used in locomotion and the chains the motor drivers used were: Hercules Motor Driver(6-36V,16Amp)

For controlling seeding and ploughing mechanisms the motor drivers used was: L298N(12V, 2Amp)

Sensors

1) Ultrasonic Sensors (HC-SR04)

Ultrasonic Sensors are used for Wall Detection during climbing and for robot positioning on the surface.

2) Colour Sensor (TCS3200)

Colour Sensor is used for detecting red and yellow zones.

Microcontroller

Arduino Mega 2560 is used as the microcontroller in this robot.

Cost Of Building Robot

Hardware Cost Estimate	Rs.17100
Mechanical Cost Estimate	Rs.37800
Total Cost Estimate	Rs. 54900

1)The Hardware costs include the costs of the sensors, 6 Hercules motor drivers, 1 L298N motor driver and the microcontroller used in the bot.

2) The Mechanical costs include the costs of 8 Omni wheels, 8 Johnson motors, 4 Planetary motors and the PVC pipes and the rest all parts used like the chains sliders seeder mechanism, plough etc.