DIC's Terrace Farming Robot

-By IIT Hyderabad.

Terrace farming robots are the need for the hour in the agricultural domain. The major benefit, of course, is the conservation of soil and water. Terraces reduce both the amount and velocity of water moving across the soil surface, which greatly reduces soil erosion. Terracing thus permits more intensive cropping than would otherwise be possible. However, the farmers are unable to get the maximum yield out of it. The terrace farming lacks proper tools and it is too difficult for animals to be transported to the steps of hills.

BENEFITS:

So the terrace farming robots will reduce the burden for farmers by being a self sufficient robot. These robots will make sure that proper distribution of seeds is done while ploughing,sufficient water will be provided and most importantly it will be able to move easily between steps of hills which greatly reduces the labour count.

AIM:

Our robot is a prototype and we are planning to implement the ploughing, sowing and watering tasks.

LIFTING MECHANISM :

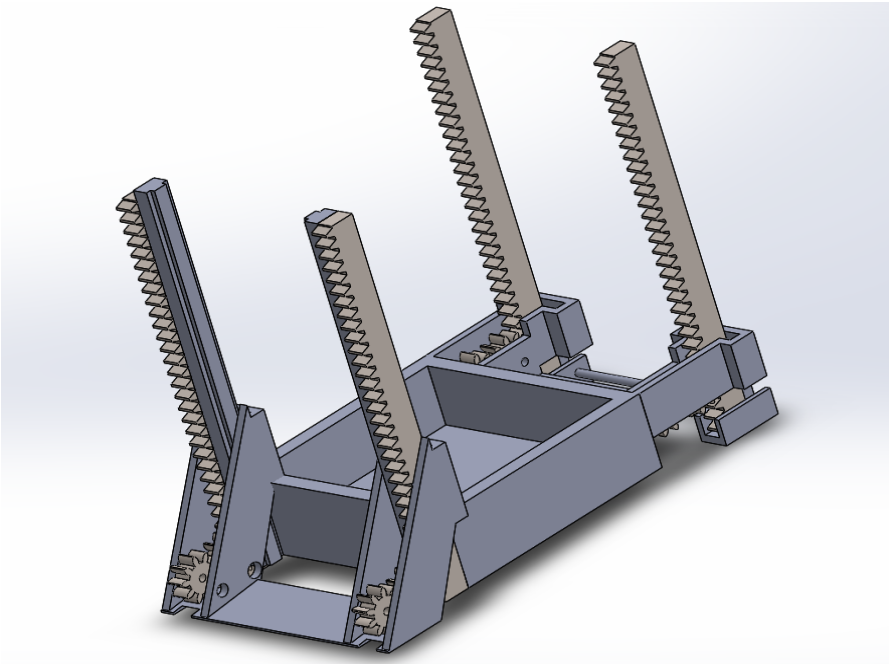
The lifting mechanism comprises of three parts:
1)Two supporting parts at back and front
2) One main body in middle.

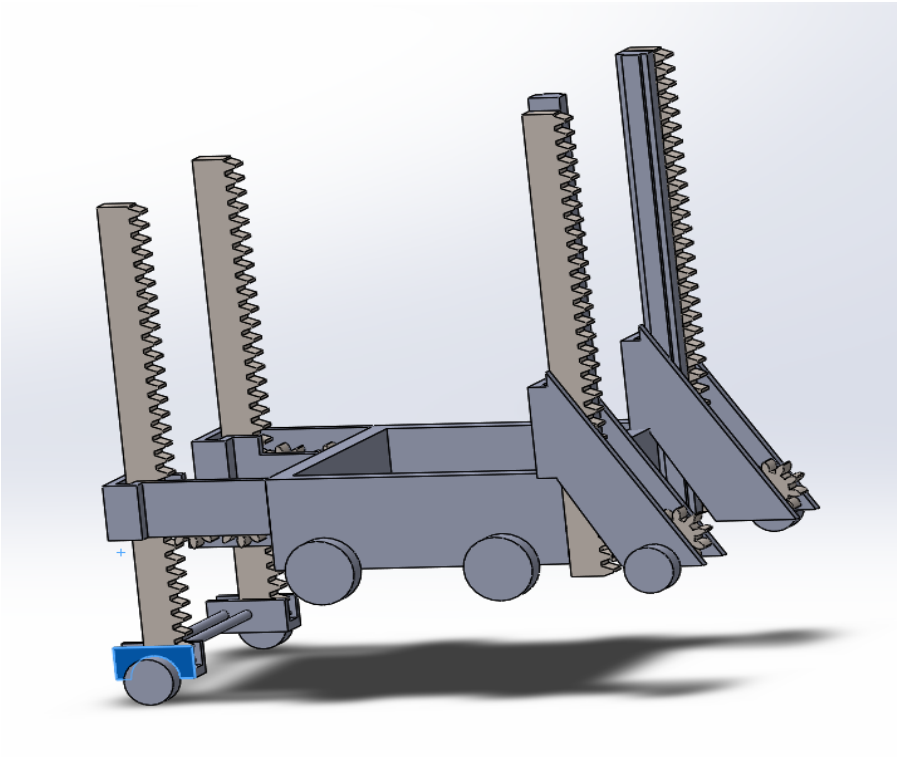
CLIMBING UP:

1)During climbing up,the front support member will go up to reach the height 40 cms using gears and pinion.
2)Now, The main body will lift up using gears and pinion present at the back side and reach the height 40 cms.During this lifting,the front and back part will support the the main body avoiding Toppling and roll over which provides stability to the bot which is the main concern of this problem statement .
And also,both back and front gears will lift up the main body.Thus, There is less power utilization In the process.
3) Now, back support part(weight is very less) is lifted up easily using the same gears.thus,the whole bot climbs up the step of height 40cms.

CLIMBING DOWN:

For climbing down, repeat the above process in reverse direction by changing direction of motor.





ADVANTAGES OVER OTHER MECHANISM:

1.)**Rocker bogie mechanism** - Even if it is most attractive choice but taking into consideration of the given area where soil area is thick,this mechanism has major drawbacks i.e it depends Heavily on the friction which is not reliable and if larger tires are used, then radius of wheel should be greater than 40cms which is not practical .

2.)**Linkage mechanism** - This mechanism lacks the main concern of the problem statement which is stability.

ANALYSIS:

1.)BENDING ANALYSIS - As the height is 40cms which can lead to bending of the front and back rack gear due to the weight of support parts.So, analysis is done through software Like -Ansys,solidworks etc.

2.)RACK AND GEARS ANALYSIS - As the rack teeth will support all the weight of the main body,so,it has to designed and analysed according to the weight of the main body(<= 4kgs).

3)CALCULATION OF GEAR RATIO AND MOTOR SPECIFICATIONS - Gear ratio and motor specification play an important role in providing required amount of torque and angular velocity

PLOUGHING, SOWING, WATERING AND HARVESTING MECHANISM:

We are planning to plough the fields and sow the seeds in it together. Both the things can be done separately too.The front side of the robot has a drill hexaplet which has 6 angular blades and which is different from the conventional plough. The hexaplet tool is constrained to move along two U-shaped holders which are positioned perpendicular to the bot surface as shown in the diagram with an up and down movement as it moves forward for better mixing of the soil .We have planned to implement this way because this reduces the resistance the robot suffers during movement.

The rotation of the tip makes sure that there is no accumulation of soil at the sides of plough. Also as our hexaplet tool comes up, there will be enough gap maintained for sowing seeds.As soon as the robot senses the presence of barren land, the plough which is initially inside comes out and it remains within soil till the robot completes its task of ploughing.

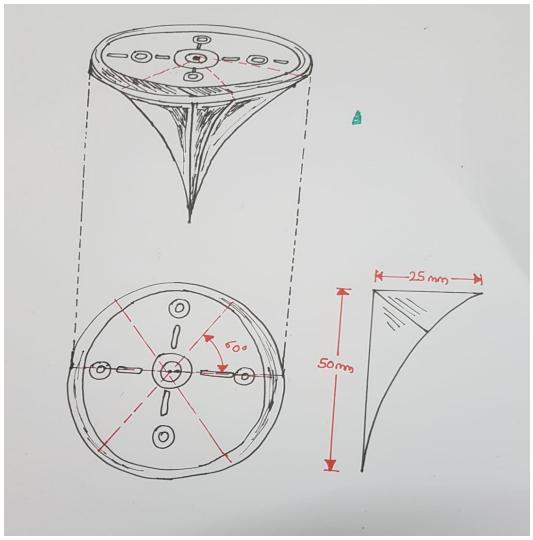
Now coming to the sowing tool, we have made a 3D-printed screw extruder with 40 mm pitch, enough to drop down seeds in a monitored way.

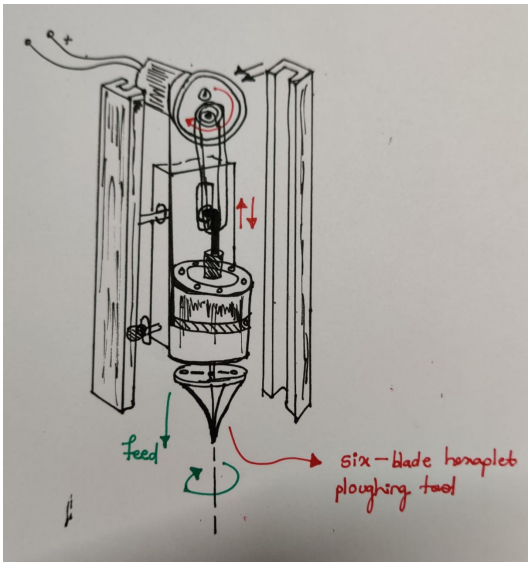
This screw extruder has 5 turns and is detachable as it is directly connected to a 5V 28BYJ-48 Stepper motor and will be just above the ground level over the ploughed soil, to maintain a proper ground clearance. This extruder has a cap on the end with a small hole opening that ensures that limited seeds fall in the ploughed region. The screw extruder mechanism will help the seeds to fall at specific intervals of time in a regulated pattern.

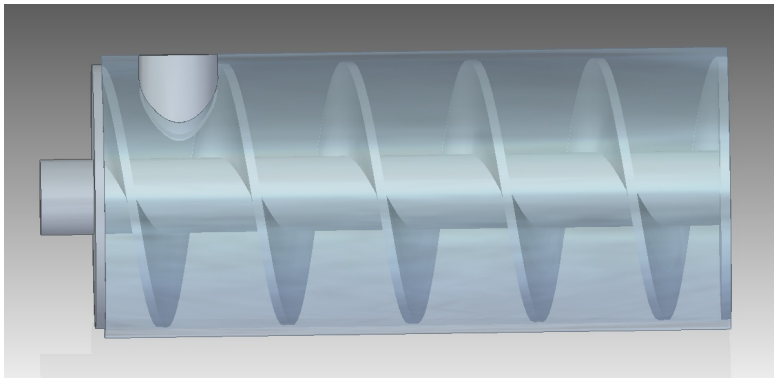
There is a wire brush at the end that covers the seeds which have been dropped.
This is attached at the end of the robot which completes the whole mechanism of sowing and ploughing.

Now for the harvesting part, we'll use a cross blade which can align itself and move longitudinally along the side of the bot so that it can quickly reach the potential crop stem and cut it.

For watering, we'll use a cup rotor on the top and some holes will be present at a particular radius on the cup uniformly such that water will fall in patterns of circles in a regulated as we can vary our range of water reach by changing the speed of the rotor.The rotor can also be tilted to a particular side so that we can water on that side only, not the other one.
In addition to this, we can also replace the cup from the rotor with a pesticide/insecticide cylindrical box with less number of side holes so that we can use the same rotor for spraying pesticides.







<u>AUTOMATION AND NAVIGATION</u>:

Key components- Ultrasonic sensors, gyroscope, raspberry pi, pi camera, hall magnetic sensors.

Assuming the bot placed in some random direction in the red zone, the following steps would be followed procedurally-

- Detection of the straight path- A couple of ultrasonic sensors mounted parallelly at the side body of the bot helps minimize the path difference, thus providing the right direction to move.
- The gyroscope is initialized with this direction thus aiding the bot to follow this straight path, through the feedback.
- On its way the bot does the job of ploughing, seeding(at regular intervals) and watering.
- An abrupt readings of another ultrasonic sensor mounted facing down helps detect any edge. After this the bot follows the algorithm to turn around.
- From there on, the bot returns to its starting point following the exact same procedure as above.
- Rotation of bot a quarter turn anti-clockwise, and then translation(which leaves the bot at the edge of the upper step), immediately follows.
- Bot then leverages the help of its tri-partitioned body and ultrasonic sensor to get down.
- Bot then detects the rows of plants and choose the direction to travel(which should be in between the rows of plants). It is also assisted by hall magnetic sensor which measures the distance travelled by bot based on the rotations of wheels.
- After choosing a direction the bot moves towards working on harvesting the plants and then return doing the same.
- Then the bot will turn towards the step depending upon the initial direction and climb up to the red zone.