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Technical Design Document

This design paper details every mechanism that the college team for Robocon at VIIT has considered, considering both the mathematical and manufacturing points of view for the parts involved. It includes explanations and CAD drawings that are backed up by the right physics and maths.

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R1 Robot

1. Seedling Picking and Planting:

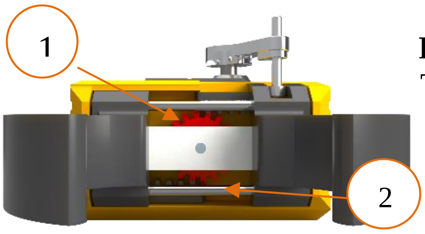


Figure 1

Picking:
The seedling mechanism consists of a gripper with **2 racks and a pinion [1].** As the pinion rotates, the racks connected to the individual claws move linearly and the gripper opens to grab the seedling. We have also provided **guiding rails [2]** which give a better path to the claws.

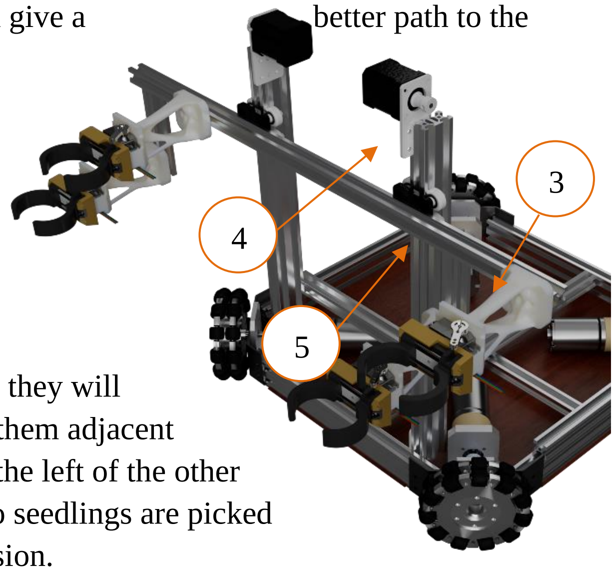


Figure 2

Placing:
The grippers are mounted on a **horizontal extrusion [3]** that is actuated in the y-direction using **stepper motors [4]**. The mechanism mimics a linear actuator where a 20-tooth pulley mounted on the stepper drives a belt that is attached to a **gantry plate [5]**. To maximize efficiency and preserve time we attached two additional grippers on the horizontal extrusion as well. Each pair of grippers is placed at 500mm as they will grab two alternate seedlings from the seedling rack and place them adjacent to the Planting Zone. The second pair of grippers is placed to the left of the other two and at a lower level. This is done so that after the first two seedlings are picked the bot can shift towards the other seedlings without any collision.

For lifting mechanism:
We are using a GT2 belt of width 6 m.
It will be wound around a Pulley of 20 teeth.

Pitch of belt = 2 mm

For 1 rotation of the stepper motor, Pulley will move 40 mm.

For 200 steps the motor pulley will move $= \frac{40}{200} = 0.2\, mm/step$

2. Paddy Rice and Empty Grain Picking and transferring it to the Storage zone(A-3):

Paddy Rice and Empty Grain Picking:
The 2 degrees of freedom gripper used to pick the paddy rice and empty grain consists of **7 links [6]** that are actuated by a servo motor. A helical gear attached to the servo drives two links that open and close the gripper. A 3-D printed mount assembled by **chrome rods [7]** is fed through an **aluminium shaft [8]**. This shaft mounted on extrusions through bearings is used to drive a chain-sprocket mechanism. Once the paddy rice or empty grain is grabbed, a planetary DC motor actuates the chain and sprocket and the gripper is lifted.

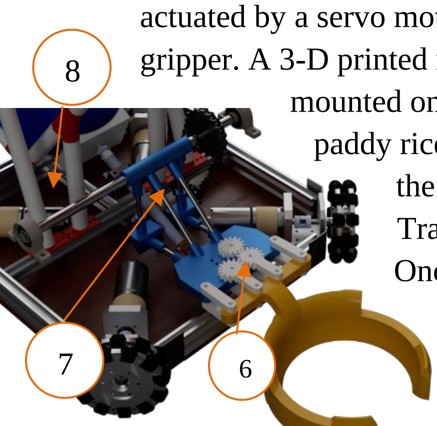


Figure 3

Transferring:
Once the gripper flips the ball, we use a **BLDC Belt Drive [9]** to shoot the ball and provide it with the necessary velocity to reach Area 3. To transfer the ball from the gripper to the BLDC which is mounted at the front of the bot, a **funnel and network of PVC pipes [10]** are used to guide it precisely. Once the ball reaches the end of the pipes, a pneumatic is used to push it through the flywheels.

To throw the ball from Area 2 to Area 3 our maximum range is 4m.

Using formula $R = \frac{u^2 sinsin\,2\theta}{g}$

R = 4m, ϴ = 25^0

We get, u = 7.153 m/s

This is the required launch velocity of the ball.

Converting m/s ⇒rad/s

r = 0.05 m (radius of flywheel)

V = ω r

ω = 143.06rad/s

To calculate rpm, $w = \frac{2\pi N}{60}$; N = 1366.122 rpm

Adjusting for single flywheel & motor performance

Rpm = 1366.12*2*2 = 5464.489 rpm

This is the ideal rpm of the flywheel.

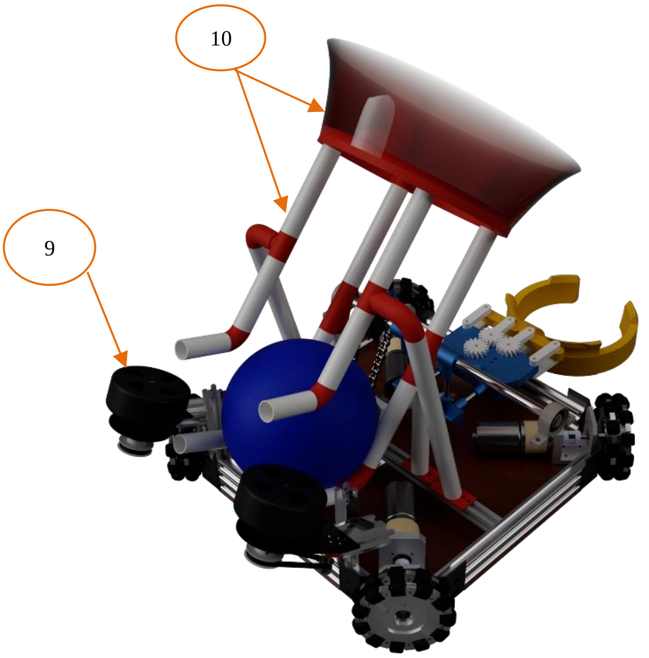


Figure 4

R2 Robot

1.Seedling Picking and Planting(A-2):

The seedling mechanism used for R-1 has been employed for R-2 as well where the grippers are mounted on extrusions and actuated by servos using a **gantry plate.**[11]

NOTE: According to our strategy, R-2 will not be picking and transferring Paddy Rice and Empty Grain to A-3. Instead, after planting seedlings it will directly enter A-3 and transfer the Paddy Rice into the silos.

2. Picking Paddy Rice (in A-3) and transferring in to silos:

For picking Paddy Rice, we have integrated a **lead screw mechanism** [12] to elevate the paddy rice to a height of 545 mm. To grab the Paddy Rice,
the gripper is designed with 2 links each attached to a pinion. A driver pinion is actuated by a servo motor. To overcome dimensional constraints, the gripper has been designed so that it retracts completely inside the 700mm x 700mm x 700mm frame before the game begins; during gameplay, it remains well within the constraints.

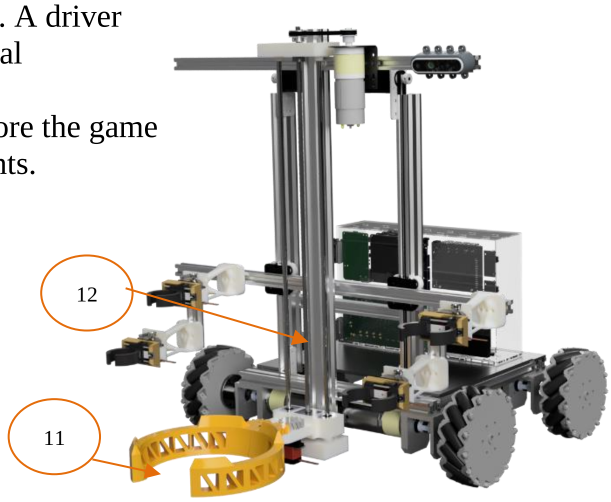
For the lead-screw,
Start = 4

Diameter = 8 mm

Pitch = 2

Lead = 8 mm

Nominal diameter dm = 8-2/2 = 7



tanα= $\frac{L}{\pi dm}$

α = 17.6^0 (thread angle)

Coefficient of friction = 0.2

Tanβ = μ

β = 11.3^0

$$\eta = \frac{\tan\alpha}{\tan(\alpha+\beta)} = \frac{\tan 17.6}{\tan(17.6 + 11.3)} = 57.46\%$$

Lead screw efficiency

Motor rpm = 300 rpm

300 revolution per minute

If the screw travels 8 mm per revolution.

It travels 545 mm in 13.625 seconds.