Design Detail Report

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DESIGN OF MR1

a) Overall dimensions (in mm) and estimated weight (in kg) :

(L x W x H) = (837 x 750 x 559)mm and 20.41 kg

b) Type of drive :

Overview of MR1 :

We used lightweight perforated iron bars to make the frame of the base and upper parts to make a flexible design which can be modified according to our needs. And we joined the iron rods using nuts and bolts to form the frame of the body. This was done to ensure that the base of MR1 robot has more weight so that much more stability could be achieved. The drive which we have implemented is the Omni-wheel drive. We used 4 omni-wheels of 10 cm diameter, each controlled with 24V motors. The advantage of these types of wheels is that it can go in any direction without the need to rotate it. We used 8mm shafts, clamps and couplers with motors.

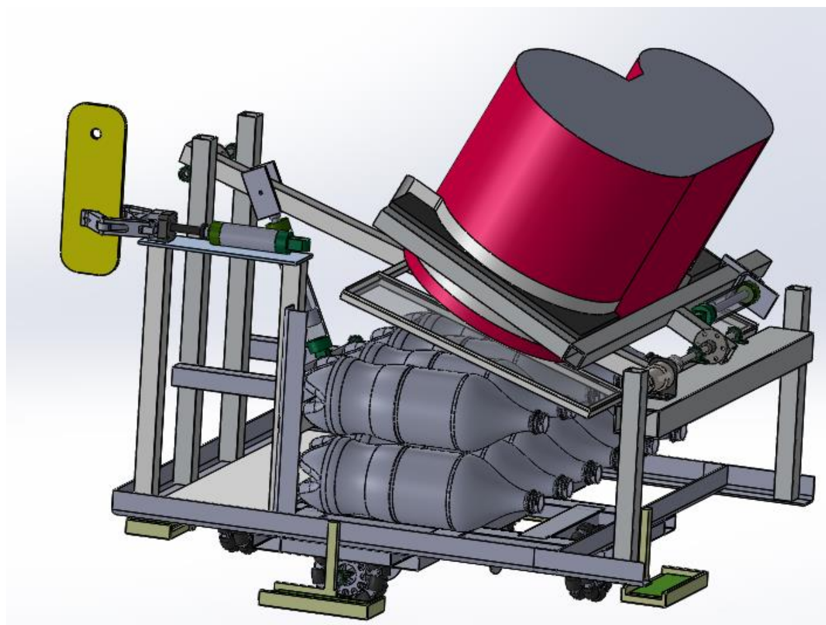
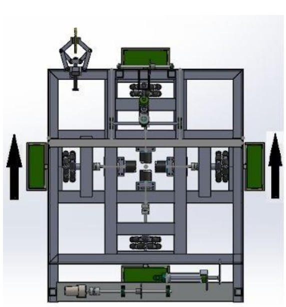


Figure 1: drive mechanism

Mechanisms of Omni wheel drive :

The Omni wheel has the property that it can roll in forward direction and slide left or right when forced to do so. So a four wheel omni drive can move forward when the side wheels move forward and can move sideways when the front and back wheels move sideways in the same direction. The drive can rotate clockwise when all the wheels move in forward direction and vice-versa.



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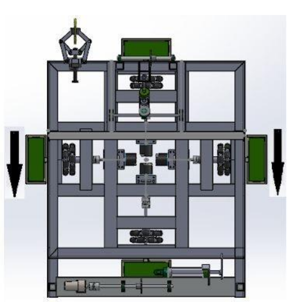

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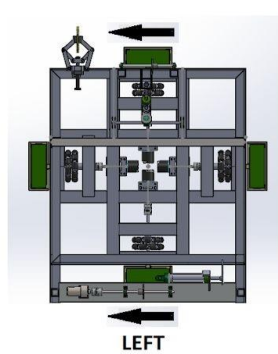

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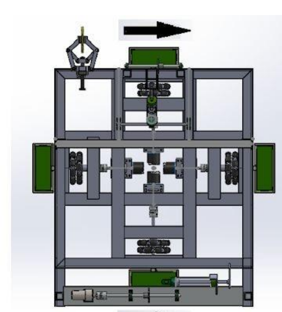

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c) Sensors and Actuators integrated :

Sensors :

LSA08 - We have used 4 LSA sensors in our MR1, one on each side. We are using it to recognize the path when the MR1 is crossing the forest region automatically.

Actuators :

1. Motors:

a) Johnson Motor - This motor is used in the Shagai picking part. The Shagai is picked up by a pneumatic gripper and the whole gripper and Shagai is rotated by johnson motor(10 rpm, torque =120kg-cm) so that the shagai is placed on the throwing slate.

b) DC Geared Motors- In the wheels of MR1 we have used 4 DC geared motors of 1200 rpm connected to Omni wheels for locomotion.

2. Pneumatic cylinder (stroke -100mm bore -25mm) - It is used in the catapult as well as the holding mechanism of the Shagai in the MR1 bot. It is also used in the gripper of MR1 bot pass the gerege to MR2.

Electrical Components

1. Cytron Motor Driver- It is used for controlling the direction of the motors and providing rated supply to them.
2. Relay- It has been used as switch to control the pneumatics different modes of operation.
3. PS2 remote and shield- This is used to control the MR1 manually as it is a semi-automatic bot. It is also used to change modes between manual and automatic modes of MR1. The whole throwing and picking mechanism is controlled through this PS2 remote.

d) Gerege holding and passing mechanism

We are using linear pneumatics actuator for gerege holding and same for passing gerege to MR2. We will be using clipper in MR1. The opening and closing of clipper will be controlled by linear pneumatics. In the normal state of pneumatics, the clippers will be closed. MR1 will reach near MR2 for passing gerege to it, MR2 will first grip the gerege with its tail meanwhile the linear pneumatics in MR1 will move in forward direction and clippers will open up, passing the gerege to MR2. In this way, gerege will be passed to MR2.

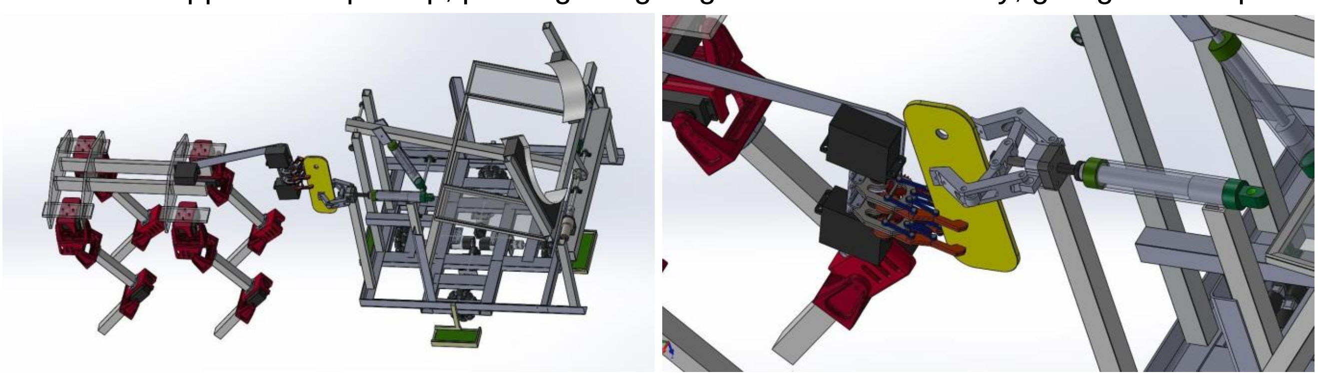


Figure 2: Gerege Passing

Shagai placing and throwing Mechanism :

Strategy:

- A Pneumatic piston is used to expand the holder which will lock onto the Shagai.
- Once the Shagai is set into place, the pneumatic piston compresses to lock the Shagai into position.
- A Johnson motor is used to rotate the holder and move it towards the platform specifically designed to hold Shagai fitted onto MR1

- The pneumatic piston expands again to release the Shagai onto the platform.
- We are using Catapult mechanism based on the pneumatic piston for throwing
- The MR1 will pick one Shagai at a time and will throw it from the Throwing Zone where the distance between it & Landing Zone is minimum.

Electrical Controls:

- The microcontroller receives instruction for throwing Shagai from the remote.
- The microcontroller then feeds this signal to a relay which relays this +5/0 logic information to +12/0 logic level.
- The +12/0 logic information is finally fed to pneumatic actuator which expands when received high logic & compresses when received low logic.

<u>Shagai Pick and throw Mechanism:</u>

Design:

- **Pneumatic piston:** A Pneumatic piston with a stroke length of 10 cm is used and works at a pressure of 5 atm.
- **Johnson Geared motor:** A 10 RPM motor which has a gearbox diameter of

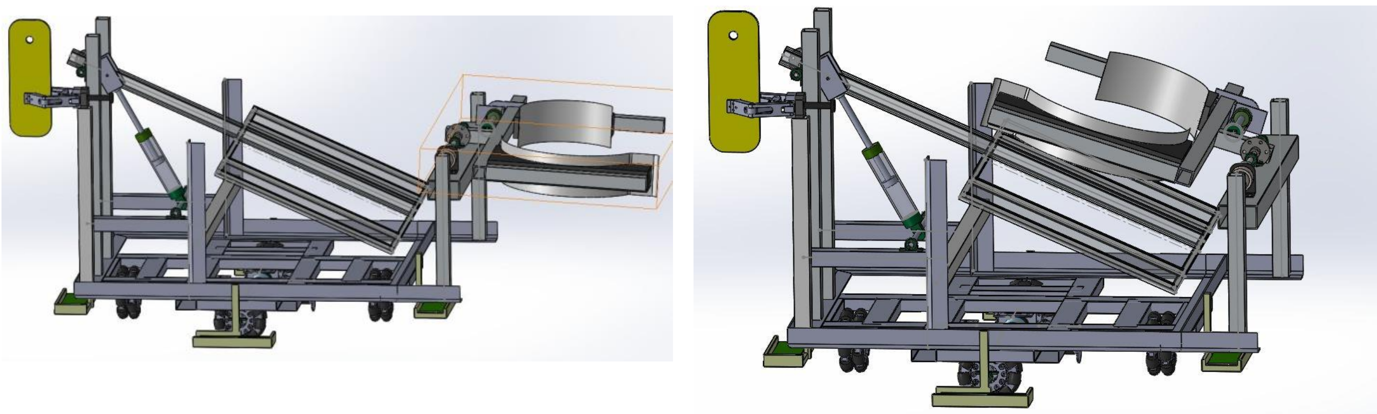


Figure 3 : Pick and throw mechanism

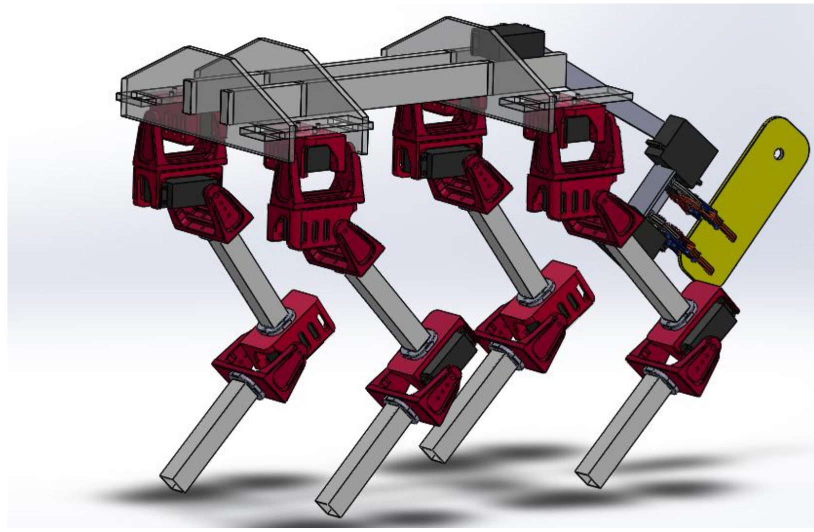
37mm and torque of 120 kg-cm is used to rotate the holder. A 12 V DC battery is used to power the motor. It can provide a maximum torque of 120 Kgfcm.

Figure 4 : Shagai picking and throwing mechanism

Design of MR2

a. Overall dimensions and estimated weight : Lx B x H = (890 x 565 x 385) mm and 8 kg.

b. Drive mechanism (4-legged mechanism)



MR2 is a 4 legged quadruped with 3 degree of freedom per leg. As such, it can move each leg independently in all 3 directions. To make the bot move, it has to move each leg in a specific sequence. This is called a gait. For MR2 we are going to use the trot gait because it is relatively simple and fast compared to statically stable gaits like a creep and crawl. In trot gait, one diagonally opposite set of legs move backward (pushing the body forward) while the other set of legs lift up and swing forward. This is demonstrated in the picture below:

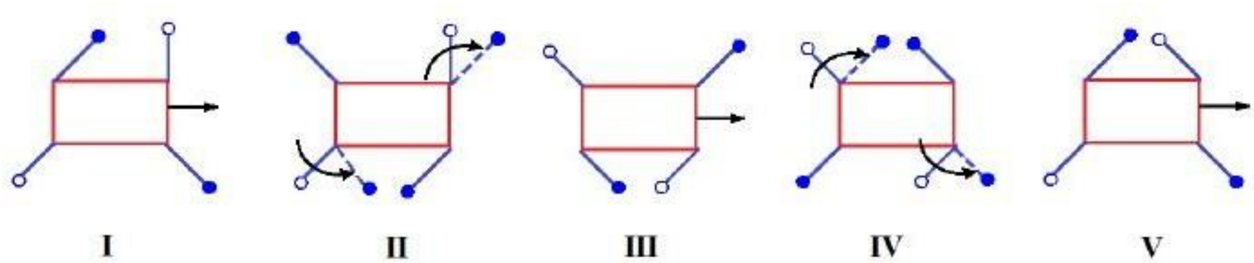


Figure 5: drive mechanism

To move each leg to its desired position, we are using inverse kinematics to determine the servo angles for each joint. These equations are simple and their solutions can be calculated analytically. There are 4 legs and 3 DoF per leg, so a total of 12 IK equations have to be solved at every instant.

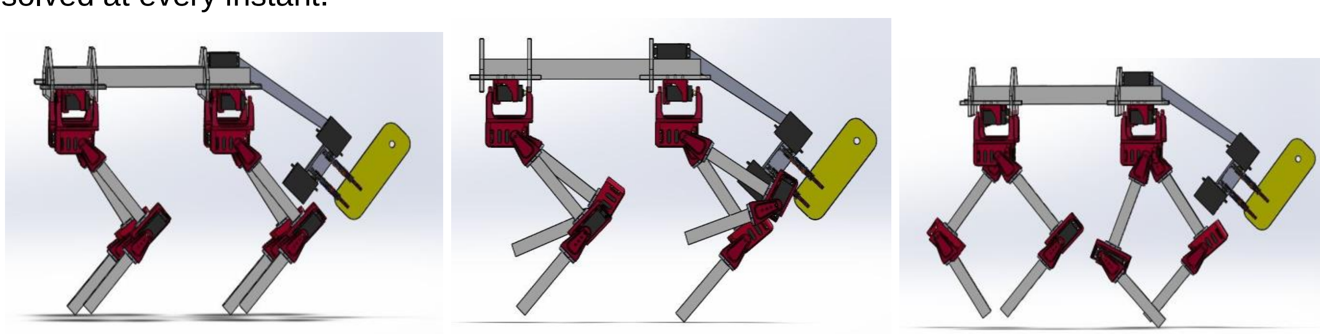


Figure 6 : Walking mechanism with Gerege

Crossing sand dune and rope :

To detect the sand dune and rope, we are planning to use 2 ultrasonic sensors on the front and back of the robot respectively. These are going to face downwards and measure the distance to the ground. When the sand dune approaches, the front ultrasonic sensor will detect a reduction in height. This indicates the sand dune. Now the bot will execute a pre-defined sequence of leg movements to climb up the sand dune. It will follow a similar set of instructions to climb down and go over the rope.

c. Actuators and sensors Integrated:

a) Laser Sensor and Receiver- It is used to detect the condition that the gerege is completely inside the gripper of MR2 and after which the gripper will close and the automatic bot will start moving.

b) To move joints we are using 12 CYS-S0650, 55 kg-cm servos. These servos can supply the required torque to lift the weight of the bot. For the Gerege gripper, we are using a 20 kg-cm servo.

c) For navigation, we are using a camera, Raspberry Pi, and image recognition to detect the position of the line. The bot moves accordingly to keep the line in the center. In case a turn is detected, the bot rotates to keep the line in the center.

d. Gerege holding and raising mechanism

We have used a servo motor based mechanism on MR2 to raise the gerege. The lifting of the gerege is facilitated by the rotational motion of the servo motor. For gripping the gerege in MR2, we have used servo based grippers(equipped with a laser(or any bright light source) and LDR to detect the presence of gerege), in which the rotation of clamp is governed by a servo motor.

When the gerege is passed from MR1 to MR2 in Gobi Urtuu, the tail of MR2 remains below its body and it holds it in that position till it reaches the final point which is the mountain Urtuu. Once the bot reaches the top of the mountain, the tail along with the gerege is raised by an angle of about 15 degrees and the game ends. For the movement of the tails, a servo motor is used and the gerege is gripped tightly by the motor's clamps. This mechanism also provides rotation in the gerege.

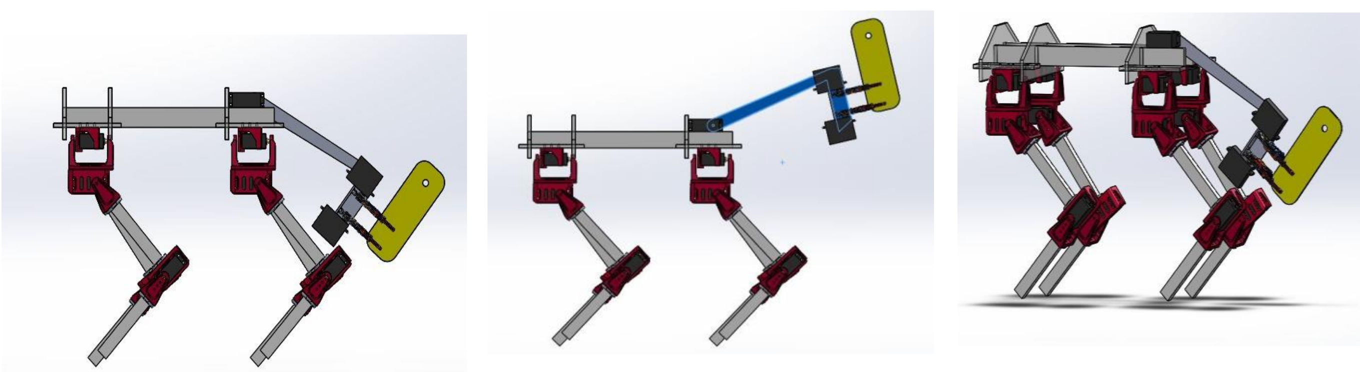


Figure 7: Gerege holding and raising mechanism