Robofest Gujarat 3.0 Proposal

Type of Robot

- 2 Wheel Self Balancing Robot

Required Components

- **Structural Components:**

    1. Extruded channels 20mmx20mm
    2. Aluminum Sheet 3-4 mm
    3. L joints
    4. Nut bolts

- **Motion Components:**

    1. 300RPM Metal Gear Motors with embedded Encoders x 2
    2. Gears (Bevel Gear) x 2
    3. Rubber Wheels

- **Electronic Components:**

    1. Custom Designed PCB Board
    2. ATmega328P Microcontroller
    3. 16MHz Crystal Clock
    4. Motor Driver (Pololu) with High Current Supply
    5. Voltage Regulator
    6. Capacitors/Resistors/Wires
    7. LEDs
    8. Li-Polymer Battery
    9. Accelerometer

- **Accessories:**

    1. Screw Drivers
    2. Wrenches

Methodology of Making the Robot

A two-wheel self-balancing robot is an active area of research in Robotics. The challenge is to efficiently balance and move the robot in the desired trajectory despite being balanced on two wheels, thus forming a system of an inverted pendulum. We propose a well-planned design and test methodology for making such an efficient robot.

1. **Mathematical Formulation:**

    - **Deriving the dynamical equations of the system based on the theory of the inverted pendulum:** Using Newtonian mechanics, we derive the equation of motion and dynamics of the system.

    - **Form transfer functions for the angle tilt, theta, and position, x:** We will analyze the relationship between the theta and x and their dependence on other physical factors. Thus we will convert the system's dynamics to the state space system.

2. **Hardware Implementation:**

    - **Using a reliable sensor to get the state values with minimum errors:** We will find the best match of sensors to get accurate data. Develop robust state estimation algorithms to make the process error-free.

    - **Find a controller that can control these two conditions:** We will implement a control strategy using this state space system to achieve optimal system control. The most widely used controller for an inverted pendulum is the LQR. We will go with this but are not limited to it considering the varied field of the control system.

    - **Definition of the boundary conditions and extension of our system:** We will try to set the boundary limits of our Robot considering the capacity of the actuators and reliability of the sensors; using this, we will try to extend the applicability and feasibility of the robot as far as possible.

    - **Development of Custom PCB Board:** We will develop a custom PCB board for our main self-balancing robot, consisting of a microcontroller, motor driver, and other sensors, to optimize the electronics part of the robot.

Application of the Proposed Robot

There are numerous applications for self-balancing robots due to their comparatively small footprints and are thus efficient in congested areas. Some of the typical applications of these robots are

1. As **Delivery Robots**, self-balancing robots can be used to deliver items to households with some extension and addition of technology.

2. As **Assistive Robots**, self-balancing robots can be used as guides in museums, historical sites, and hospitals to assist humans.

3. As **Household Robots**, self-balancing robots can be used in households, for cleaning purposes, or assisting humans in their work.

Size of the robot for Proof of Concept (Small Version)

a. **Length in cm:-** ≅ 20cm
b. **Width in cm:-** ≅ 20cm
c. **Height in cm:-** ≅ 40cm

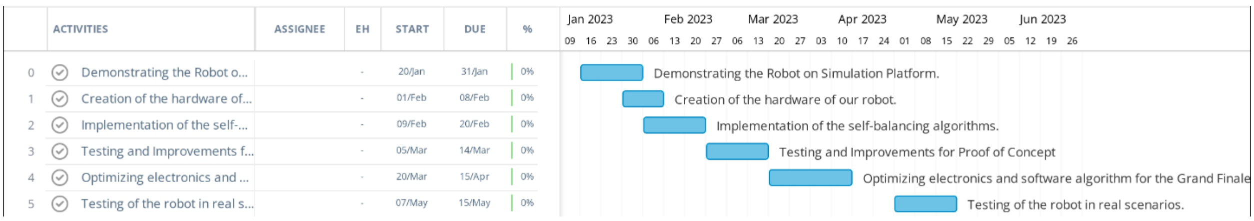
Size of the robot for Grand Finale (Actual Version)

a. **Length in cm:-** ≅ 20cm
b. **Width in cm:-** ≅ 20cm
c. **Height in cm:-** ≅ 40cm

NOTE: *The size of our self-balancing robot will remain the same for the proof of concept and the grand finale. We will focus on our robot's electronics(such as the development of a custom PCB Board) and software parts (such as implementing better control algorithms) to optimize it. Hence, we complete the mechanical part at the time of proof of concept.*

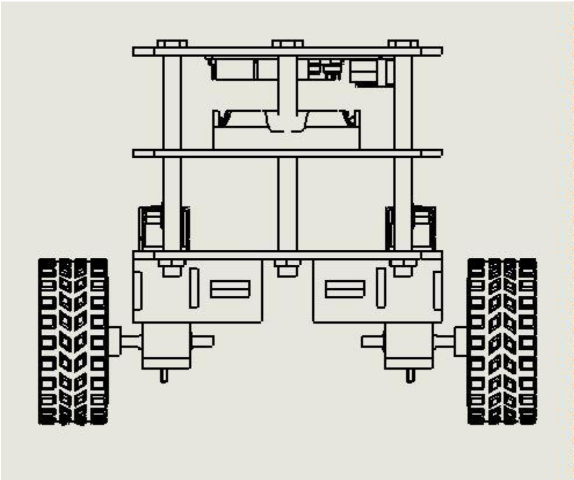
Timeline for robot making with Milestones

S. No.	Duration	Objective	Description
1.	*20 - 31 January*	Demonstrating the Robot on Simulation Platform.	Before going to the hardware, testing the model in simulation is necessary to filter any mistakes. We will also test our proposed controllers and algorithms, and after fine-tuning them, we will implement them on the hardware.
2.	*1 - 8 February*	Creation of the hardware of our robot.	We will start creating the prototype for our robot. This stage mainly focuses on developing the hardware of the robot. During this stage, we will try to eliminate the errors related to hardware.
3.	*9 - 20 February*	Implementation of the self-balancing algorithms.	We will focus on implementing the self-balancing control algorithms on the actual robot.
4.	*5 - 14 March*	Testing and Improvements for Proof of Concept	We will focus on testing and debugging our complete hardware and software stack for the robot.
5.	*20 March - 15 April*	Optimizing electronics and software algorithms for the Grand Finale	In this phase, we will develop a custom PCB and extend our algorithms so that our robot can carry weight.
6.	*7 - 15 May*	Testing of the robot in real scenarios.	In the last phase, we will rigorously test the complete robot stack to its limits and look for possible issues.

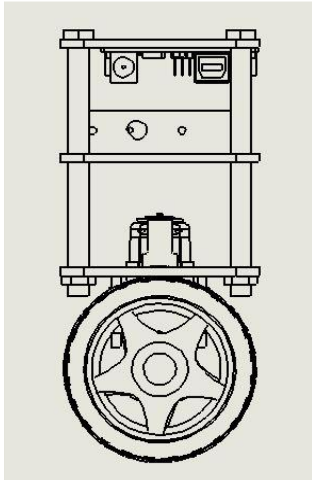


Robot Assembly Design (CAD Drawing Link)

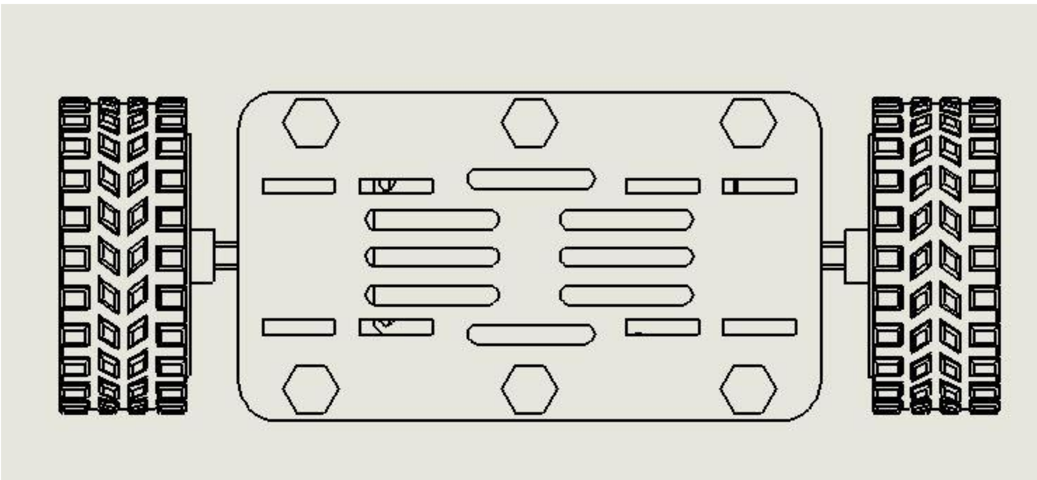
1. **Front View:**



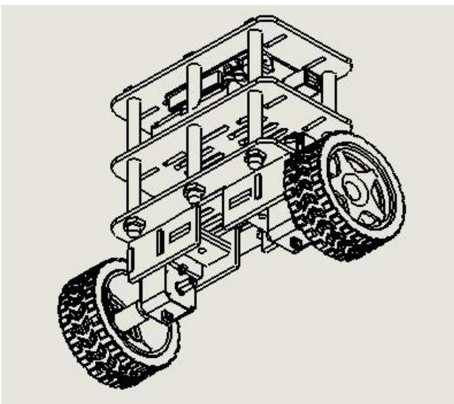
2. **Side View:**

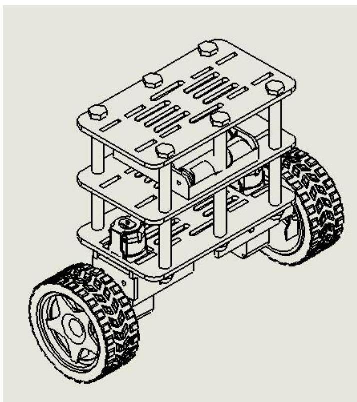


3. **Top View:**



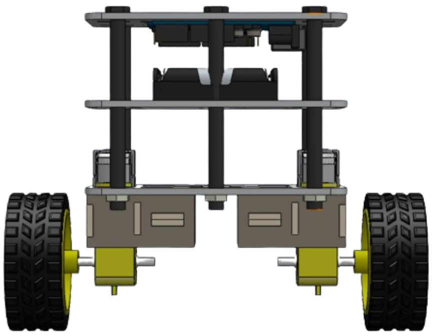
4. **Third Angle Views:**



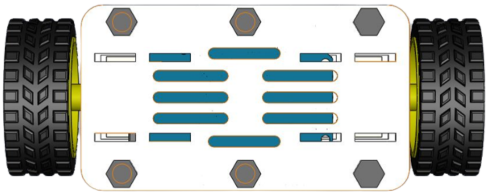


Proposed Robot 3D Model ([Solid Works Design Link])

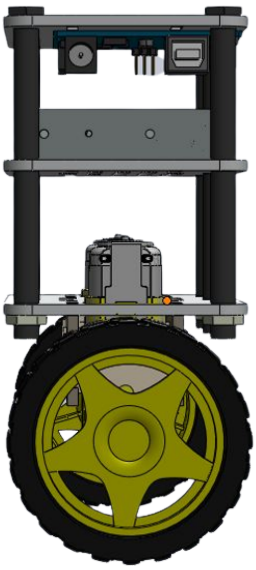
1. **Front View**



2. **Top View**



3. **Side View**



4. **Side Angle View**