ABU ROBOCON 2025

DESIGN DETAILS DOCUMENTATION

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We identified our strategy to be the fastest robot on the field, to avoid any defensive or offensive moves by the other team.

In consideration of the points distribution and game layout, we came up with 2 key philosophies for our robot design -
Fast-Dunk-First - The dunking bot takes the charge, while the dribbling bot is the helper, both robots must be the fastest robots on the field.
Aggressive Defence - Both robots must have high traction to avoid getting pushed by the opponent.

To achieve this, our Robot 1, hereafter referred to as “Risky Batman” is the dunking robot made of 3 key mechanisms - Jumping & Landing, Drivebase, Ball Manipulation. Robot 2, hereafter referred to as “Reliable Robin” is the dribbling robot made of 3 key mechanisms - Shooter, Drivebase, Defence.

R2:- (Reliable Robin)

Overall dimensions(L*B*H):

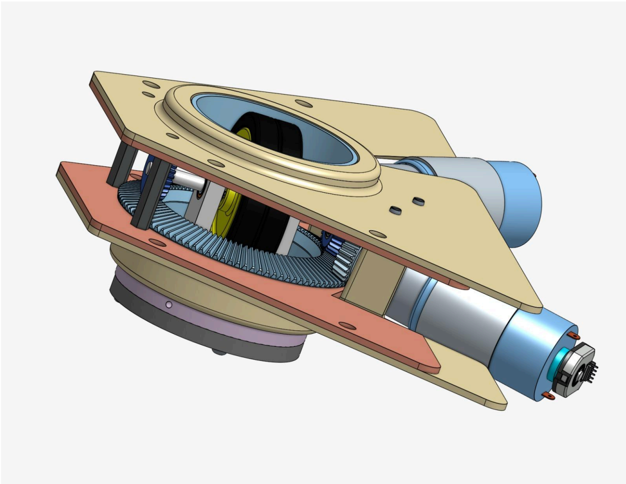
At start:- 797mm*797mm*1474mm
During the game:- 500mm*500mm*2124mm
Material used:- Mild Steel, Stainless Steel, ABS, PVC, Aluminium 6060 & Brass

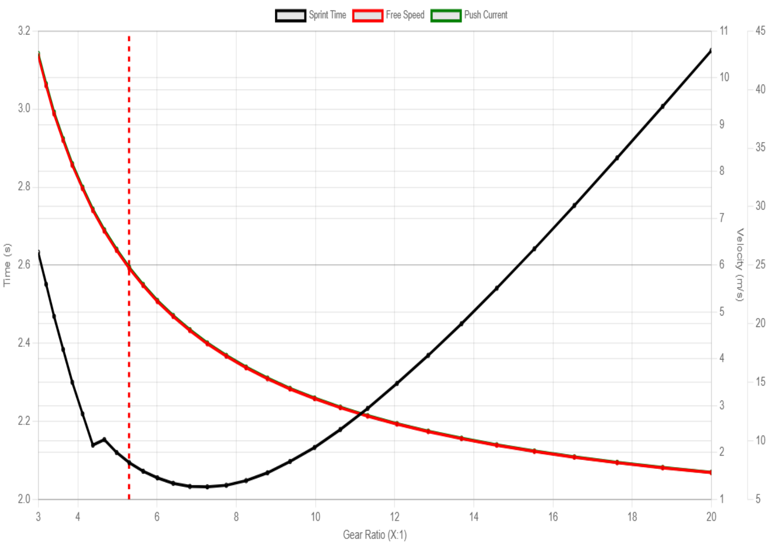
1.) Drivebase

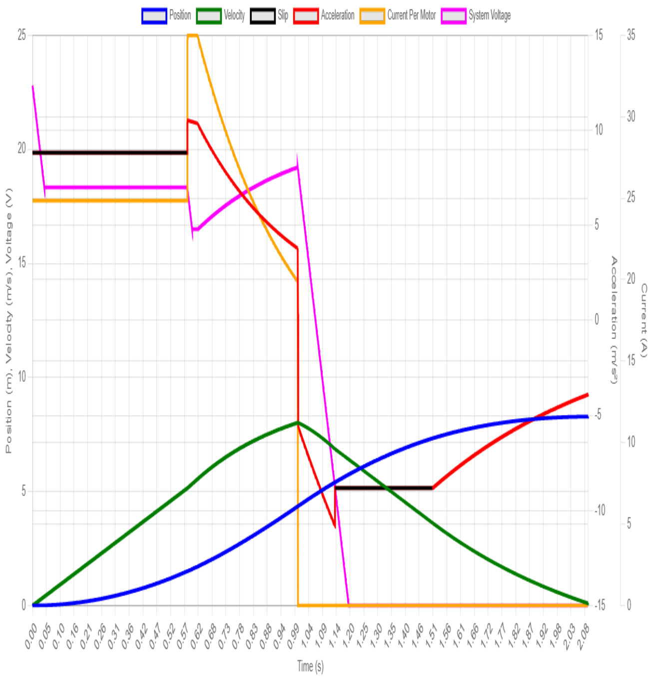
To achieve high acceleration and high traction holonomic motion, Robin uses 3 custom-made differential swerve drive modules. Each module uses 2 Dauchi 997 brushed DC motors, coupled to a 45mm planetary gearbox of 1:3.7 reduction ratio, to drive the 100mm wheel, with 1 AMT incremental rotary encoder on an input motor and the other on output azimuth angle.

When the top and bottom gear sets are driven in the same direction, the central gears stay put and the whole module rotates, changing the azimuth angle. When they are driven in opposite directions, the central gears also rotate, which in turn rotates the wheel, while the azimuth stays fixed. If the top and bottom gear sets are moved at different speeds, the two actions can be combined, thus each wheel receives the torque of 2 motors.

We improved previous designs on this concept by adding a homing pin and a rotary damper on the azimuth to control unwanted module rotation that's induced at high speeds. This setup gives us high precision wheel odometry, saves cost, as well as error correction for the backlash introduced throughout the gear train. Therefore Robin achieves a real world top speed of 5m/s and a time to goal of 2 sec.







This is the **Time v/s Velocity v/s Acceleration** graph of the swerve drive (**source:AMB calculator)**

This is the **Time v/s Gear ratio**

This is the **Time v/s Gear ratio v/s Velocity**

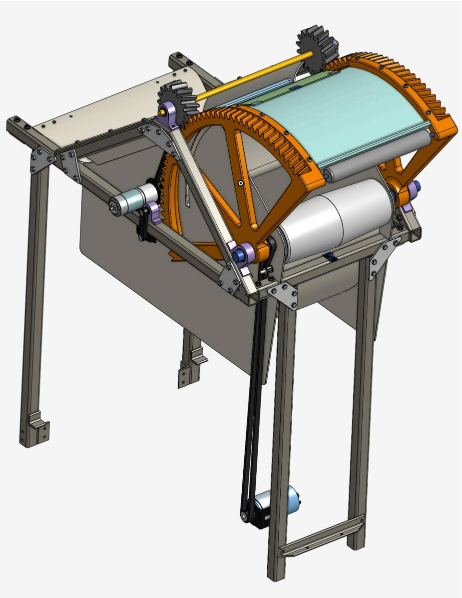
graph of the swerve drive (source: **AMB calculator)**

2.) Dribbling

For Robin to dribble while moving at relatively high speeds, we refrained from using any mechanism that requires precise manoeuvring. So, the dribbling action is achieved by integrating the shooter and the defence mechanism, both mechanically and in software.

While the robot is moving, the hood is made to point downward, then the ball is ejected at high velocity to achieve high rebound height. While the ball is in the air, Robin accelerates forward to catch it as it collides with the defence mechanism, then the ball is returned to the shooter. `

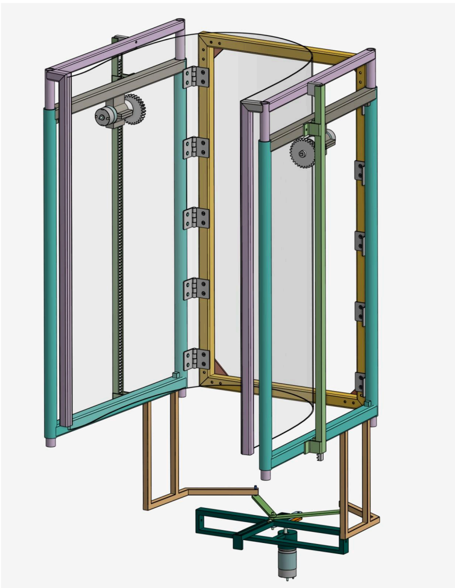
3.) Shooting and Passing



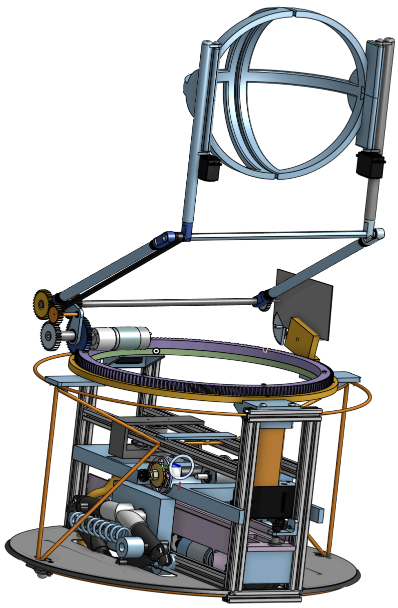
For shooting 2 and 3 pointers, and passing the ball to Batman, Robin uses a movable hood shooter and a flywheel. Using fused odometry data from the rotary encoders and the cameras, the hood is pointed at the correct angle and the flywheel is spun at required velocity. As the ball travels throughout the hood, a backspin is introduced, thus the combined action of drag force and magnus effect increases the probability of the ball going into the net.

4.) Defence

For the defence aspect we incorporated 2 dimensional adjustments, that is height and the width adjustments. For the height increasing, we used rack and pinion mechanism, which takes 6 seconds to reach the full height. For the width adjustments, we used a slider crank mechanism. We used 2 wind like structures which are getting adjusted with the help of slider. Its a reciprocating mechanism and are able to get precise adjustments. Maximum width increasing length is 1180mm. We are using a film to help in the stopping of the ball.



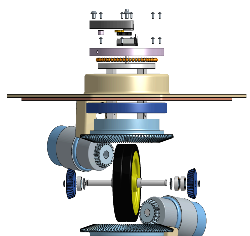
R1:- (Risky Batman)



Overall dimensions(L*B*H):

At start:- 500mm*500mm*600mm
During the game:- 500mm*500mm*1000mm
Material used:- Mild Steel, Stainless Steel, ABS, PVC, Carbon fibre, Brass & Aluminium 6060

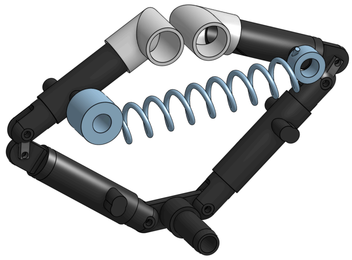
1.) Drivebase



Batman uses a simple 2 wheel differential drive, with 2 passive small castor wheels for support, suspended on a lead screw to make it recede into the robot while landing. In consideration of rules 6.5.1, 6.6.1 and 9.2, we're also using a mixed airflow fan and vortex seals, made from liquid silicone poured into a 3d printed mold, to suck the air out from underneath the robot. This increases the wheel traction, reducing wheel odometry error, and makes Batman highly difficult to move while catching the ball and jumping, 2 scenarios where the opponent robots will try to displace it.

2.) Jumping And Landing

We use 2 sets of 4-bar prismatic links (aka legs), connected together with pulley and Dauchi motor with 368.7 gear-ratio. Each leg is connected The fan reverses direction to release the vacuum from underneath Batman, while the prismatic legs are actuated from their locked position by the Dauchi 997 brushed DC motors, coupled to a 45mm planetary gearbox of 1:515.6 reduction ratio.



$m = 12kg, \theta_{ini} = 120°, \theta_{end} = 30°, \theta_{to} = 40°, SF = 1.5, d = 2L_{link} = 0.20m, T_{motor,peak} = 1.4$

$E_{req} = SF \times mgh = 1.5 \times 12kg \times 9.81m/s^2 \times 2m = 353.16 = E_{PE,linear} + E_{PE,rot}$

$E_{req} = F_{max}d[cos(\theta_{end}/2) - cos(\theta_{ini}/2)]^2 \div 2cos(\theta_{end}/2)[cos(\theta_{end}/2) - cos(\theta_{end}/2/2)] + 0.25F_{max}d[(\theta_{ini} - \theta_{end})cos(\theta_{end}/2)$

$where,\ \theta_{ES} = 2arccos((cos(\theta_{ini}/2))^{1/3}) = 1.29rad \Rightarrow F_{max} = 1903.9N$

$k_{ind} = F_{max}/[4d \times tan(\theta_{ES}/2)(cos(\theta_{ES}) - cos(\theta_{ini}/2))] = 2128 \div 4\times0.20\times0.75\times0.30 = 1.18\times104N/m.$

$k_r = 0.5(\theta_{ini} - \theta to)F_{max}d \times cos(\theta_{to}/2) = kr,total = 0.5\times1.3962128\times0.20\times0.94 = 35.9Nm/rad$

$T_{gearbox} \approx F_{max}(2d) + k_{r,total}(\theta_{ini} - \theta_{to}) \approx 413N \le G \times T_{motor,peak} \Rightarrow G \ge 413N/1.4N = 295 \Rightarrow G = 368.7$

3.) Dunking Mechanism

We added a dunking mechanism which acts as the catching mechanism as well, attached on top of the 16 inch chassis turntable bearing which rotates 360 degrees The end effector uses spring for counter balancing and getting less torque from the motor. One motor is used and 2 degree of freedom is obtained.