

The Physics of Robot Sumo

Physic of Sumo

Your robot will be more effective at pushing other robots off the table if you consider

- Mass
- Velocity
- Force
- Power

Mass

- Quantity of matter [kilograms]
- m =mass, v =velocity, p =(linear) momentum
$$p=m*v$$
- F =force, a =acceleration
$$F=m*a$$
 - With a larger the mass, more Force is required for same acceleration
 - Where to add mass? Consider the center of gravity (should be low and inside wheel base)

Velocity

- Velocity = Speed and Direction [meter/second]
- m =mass, v =velocity, p =(linear) momentum
$$p=m*v$$
- If we increase the velocity, we increase the momentum
 - The larger the momentum, the greater the impact force will be applied to the opponent
 - How do we increase the velocity of the robot?
Higher motor speed setting, larger wheels, gear-up

Force

- Pushing (Pulling) or Twisting
- Linear Force [Newton] or Torque [N-m]
- $T = \text{torque}$, $r = \text{wheel radius}$
- $\text{Force} = \text{Torque} / \text{radius}$
- How do we increase the Force applied by the wheels?
 - Increase the torque (lower gear ratio)
 - Decrease the radius (smaller wheels)

Power

- Power is Force * Distance / time [W=N*m/s]
- P=Power, F =Force, T=Torque, v=velocity,
 ω =angular velocity

$$P=F*v$$

$$P=T*\omega$$

- How do we increase the Force and/or velocity?
 - Increase the power (Motor power)
 - Make sure batteries are fully charged!

Build a better Robot (later)

- Sturdy construction
 - At least 2 attachment points for each part so robot stays together
 - Compact design
 - Triple pegs on multiple beams
- Wheel base
 - Wide base for slow turns
 - Narrow base for fast turns
 - Which is best for stability of robot?

Robot Design cont.

- Wheels
 - How many tires? 2 or more?
 - Tires- rubber or Omni? (for traction?)
 - Size – large or small?
 - Placement of wheels

Robot Design cont

- Sensors
 - Placement of light sensors (height above table? How far in front or to side of wheels?)
 - Placement of sonar sensor (low or high?)
 - Use additional sensor(s)?
 - Touch sensor(s) to detect if an opponent is pushing your robot?
 - Touch sensor(s) to detect if you are pushing an opponent or the bottle?

Strategy (for the future)

- Try to lift an opponent off the table?
- Try to hide from an opponent (cloaking)?
- Bounce off an opponent if attacked?
- Add a motor to power a mechanical device to attack your opponent (try to flip your opponent over)?
- Better search for opponent? Find again if opponent moves before you get to him.