Tug Of War

Key concepts to focus on:

1. Torque
2. Power
3. Friction
4. Gear Ratios (A gear ratio is the ratio of the number of teeth on two gears that are turning together(ratio of the angular speed of the driving gear to the driven gear))
5. Weight
6. Engine Power

Attaching a ppt for a better understanding of each topic listed above(especially gear ratio):
nyu_battle_activity1_presentation_v2_tedl_dwc_EV3.pptx

Gears are used for two basic purposes: to increase/decrease rotation speed or to increase/decrease torque.
Smaller gear rotating bigger gear(gearing down) - Speed ↓ Torque ↑
Bigger gear rotating smaller gear(gearing up) - Speed ↑ Torque ↓

This website will give more details - Tug of War Battle Bots - Activity - TeachEngineering

Read this reddit page, it contains a lot of information - Tug of war robotics competition (advice and question)

Attaching a video to showcase how it's done - https://www.youtube.com/watch?v=sEymvuX15e4

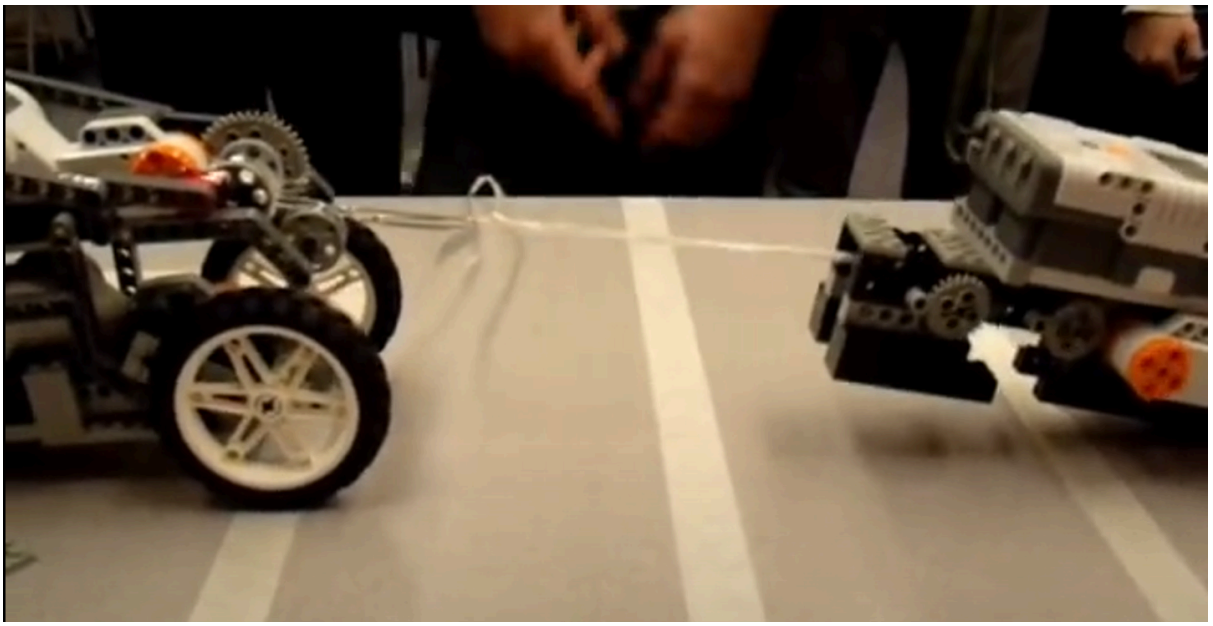
Attaching another video - https://www.youtube.com/watch?v=WM0y19gwkUg

In this video, a servo is used to power the bot and generating extra torque, and that ganna ka juice wala mechanism is used to pull it.

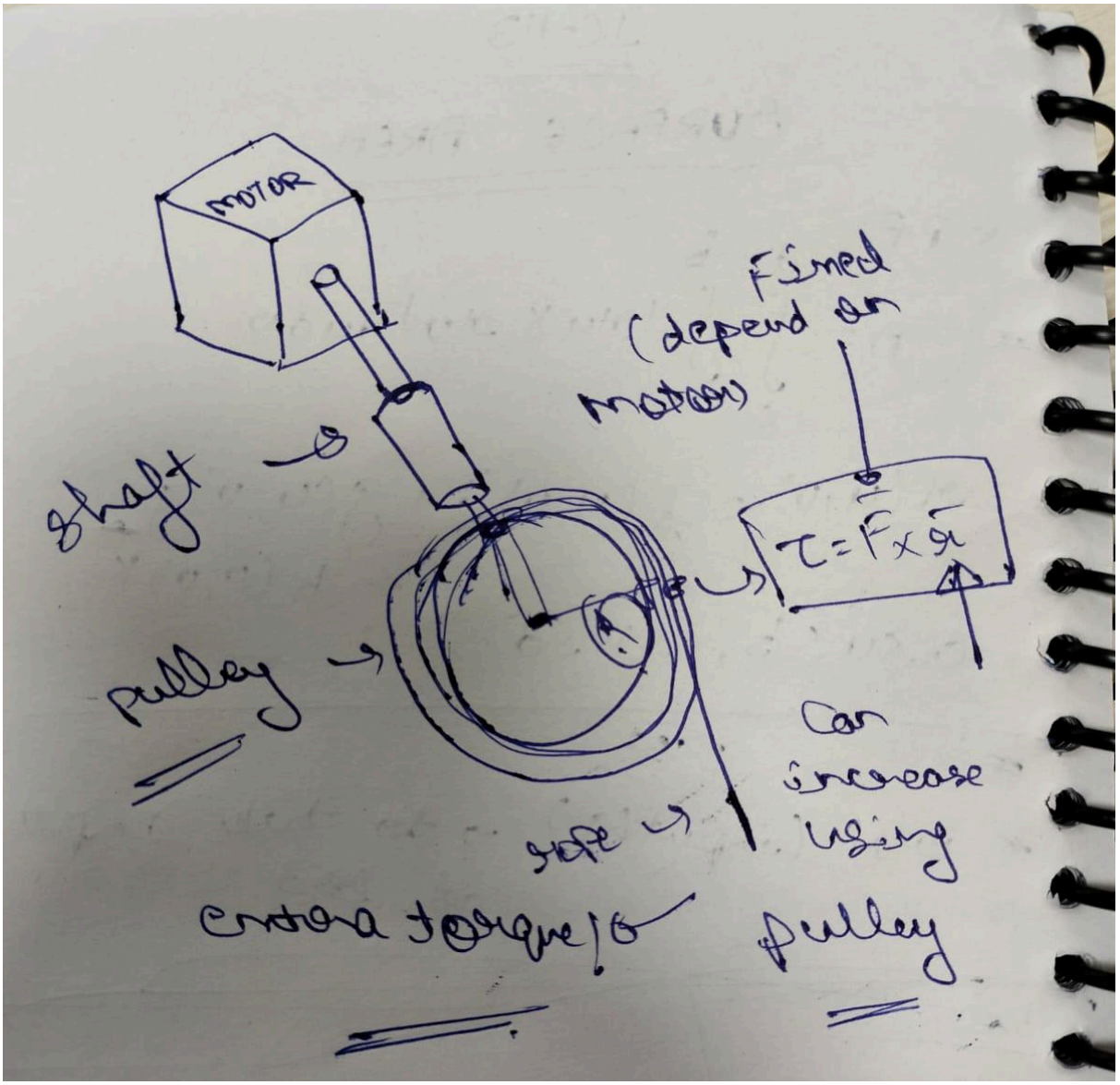
But as far as I have seen, we don’t have to collect the rope, we have to make a hook to tie the rope and then just pull. For extra torque, we will be using a servo as discussed.

So we should be moving our bot in backward direction along with the servo at its max rotation to ensure victory.

One important thing, see this image.



In this image, one bot has a bigger height while the other has a smaller one, so when the rope is tied and the bots started pulling, the rope got tight and the smaller one got lifted which reduced its power to pull and it difficult to win, so we can’t make our bot smaller in height.
Also we can apply pulley system along with servo to increase torque.



There is another video showcasing two bots with kind of wheels and justifying which one is advantageous over the other -

TUG-O-WAR || DS ROBOTICS VS. RTU BOT || RTU KOTA || THA…

Also, see that an extra weight is added on the second bot(which is winning) for better friction hence resulting in better grip.

Some points to increase chances of victory -

- We will add a wheel lock system to maximize traction in case of slipping.
- Will make our bot heavy by either adding sandbags or adding weights that are used to measure the weight of objects.
- Can add a servo and will ensure to control its force
- Pulley System
- Will have to test the force using the spring balance

Some more about gear ratios -

The gear ratio is the ratio between the number of teeth on two gears that are meshed together or the ratio of the rotational speeds of the input and output shafts in a gearbox. It plays a crucial role in determining the torque and speed of your bot.

- **High Gear Ratio (e.g., 4:1, 5:1)**: This means the input gear (attached to the motor) has fewer teeth than the output gear. This setup increases torque but reduces speed, which is ideal for a tug of war bot since more torque helps in pulling with greater force.
- **Low Gear Ratio (e.g., 1:2, 1:3)**: This setup increases speed but reduces torque, making it less ideal for a tug of war scenario where pulling power is more critical than speed.

Suggested Gear Ratio for Your Bot

Given the dimensions of your bot (25 cm by 15 cm) and the focus on maximizing pulling power, a **gear ratio of around 4:1** or **5:1** would be ideal. This will give you higher torque, allowing your bot to pull with more force, which is essential in a tug of war competition.

Components for a 4:1 or 5:1 Gear Ratio

1. Motor:

- **Type**: Brushed or brushless DC motor.
- **Power**: Choose a motor with high torque output. A motor rated between 100-200 RPM at high torque would be suitable.

- **Voltage**: Typically, 6V to 12V motors are common for small bots.

2. Gears:

- **Input Gear (Pinion Gear)**: A small gear attached to the motor shaft.
    - **Teeth Count**: Around 12 teeth.
- **Output Gear (Driven Gear)**: A larger gear that drives the wheels.
    - **Teeth Count**: Around 48 teeth for a 4:1 ratio or 60 teeth for a 5:1 ratio.

3. Gearbox:

- **Type**: Spur gearbox is simple and efficient for small bots.
- **Material**: Metal gears (like steel or brass) are preferred for durability, though nylon can be used for lighter weight.
- **Size**: Ensure the gearbox fits within the bot's dimensions, ideally mounted centrally to maintain balance.

4. Wheels/Tracks:

- **Diameter**: Choose wheels with a diameter that complements the gear ratio, usually around 6-8 cm for your bot size, ensuring that they provide sufficient traction without compromising torque.

Gear Ratio Calculation Example

For a 4:1 gear ratio:

- **Input Gear**: 12 teeth
- **Output Gear**: 48 teeth

Gear Ratio = (Output Gear Teeth) / (Input Gear Teeth) = 48 / 12 = 4:1

This means the motor turns 4 times for every 1 turn of the output gear, multiplying the torque by four while reducing the speed.

Benefits of the 4:1 or 5:1 Ratio

- **Increased Torque**: More pulling power, which is crucial for winning a tug of war.
- **Controlled Speed**: The bot moves at a controlled speed, reducing the risk of slipping and ensuring steady pulling.

Practical Considerations

- **Space**: Ensure that the gear setup fits within the bot's dimensions.
- **Heat Management**: High torque can lead to more heat generation in the motor and gears. Consider adding heat sinks or cooling fans if necessary.
- **Testing**: Always test the gear setup under load conditions similar to the competition to ensure the bot performs as expected.

Using a well-chosen gear ratio like 4:1 or 5:1 will enhance your bot's ability to apply force steadily and strongly, which is critical for a tug-of-war competition.