Background Research-Nano Sumo-Team D
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Initial Design Considerations:(As stated in the combat guidelines)

The autonomous nano robot must abide by the following physical design requirements:

- Mass <= 25g
- Width <= 2.5cm
- Height <= 2.5cm
- Length <= 2.5cm
- $Width_{ring}$ <= 19cm

The control system must be completely autonomous with the exception of a delayed start initiated by the user.

- Delay must be no less than five seconds.
- Robot combat is restricted to push/flee maneuvers. This implies that external weapons are not allowed, and strategies aimed towards disabling the autonomous interface will result in disqualification.
- The contact point or front scoop between robots must be designed such that collision does not result in shearing or body lacerations.

Future Design Considerations:

- Minimizing Costs(component trade-offs)
- Autonomous Navigation
    - Positioning
    - Obstacle Detection
    - Navigation
    - Control
- Power Output
- Weight Reduction
- Combat offensive/defensive strategies
- Innovative advantage(creative solutions/counter moves)

Current State of Progress:

Motors:

Dc motors will be responsible for steering and driving the robot. A sumo bot with greater agility and thrusting power will translate to a better design and ultimately a greater likelihood of winning. Dc motors that we will concentrate on for driving the robot include brushed, geared, and ungeared types. Brushed motors are the most common type used for such applications due to their durability, torque output, and programmability. Internally geared motors include a gearbox that help to reduce weight and overall size. Their output speed is reduced significantly, but as a result have an increased output torque that makes them especially desirable for compact designs. Ungeared motors come in a larger variety of input requirements making design less restricted, but often require larger, more cumbersome, drive trains to step down the speed and step up the torque. The most recent and relevant technological improvement has increased dc motors efficiency by implementing neodymium stators. By replacing ceramic magnets with rare earth neodymium magnets the current is used more efficiently and translates to higher speed/torque ratios for an overall lower unit weight. In summary we plan to further research motors, esspecially the following attributes.

- Brushed DC motor
- Internally geared
- Preferably a motor constructed with neodymium stators

A tentative range of requirements are listed below:

Requirements	**Lower**	**Upper**
Voltage (v)	4	12
Current (mA)	30	
Stall Current (mA)	1500	9000
Torque (output)		
Speed (rpm)	150	600
Overall Length		
Unit Weight (g)	3	10

Controllers:

The controllers discussed in the following section apply to both radio-controlled and autonomous robots. As the brain and human sensory organs play a vital role in human transportation, robotic controllers and their additional sensors play an identical role in robotic mobility. In the autonomous case, the controller inputs data from external sensors, decides the course of action, and provides an output signal to create a desired result. For radio-controlled cases the process is simplified, the input source is an onboard receiver which is paired with a user controlled transmitter dictating the desired course of action. Many small-scale autonomous projects through universities and private firms implement similar controllers due to their diversity and programmability. Newly developing technologies for robotic control include the following subcategories.

- **Microcontrollers** are single-board computer systems that allow varying input methods(Analog, Serial, R/C) and provide an integrated development environment(IDE) in which the chosen software controls or alters the output signals for a desired result. The following are examples of microcontrollers that we intend to utilize for our project.
    - Arduino brand controllers have rapidly become the most used between 15 to 60 input/output pins
    - Raspberry Pi is similar to arduino in that
    - Wifi microcontrollers utilize security enabled ad hoc or infrastructure wireless connections to pair robot with operator. They provide the same control features as arduinos, however, they have the added feature of open source coding or

- **Electronic Speed Controllers (ESC)** are buffers that take input commands and provide PWM signals that allow precise control of drive motors or servos. While many microcontrollers have output pins that emit PWM signals, eliminating the need for an ESC, an ESC may still be necessary due to an input voltage higher than what the microcontroller is capable of. After reviewing similar projects some considerations for choosing the right speed controller should be addressed:
    - **Number of control channels**: Each channel is dedicated to one output load (i.e. motor)
    - **Battery eliminating circuit (BEC)**: A BEC draws power from the input power supply and eliminates the need for separate power source to supply the ESC.
    - **Input Method (R/C, Serial)**: The radio control input relies on signals from the receiver, opposed to the serial input, which would receive signals via the microcontroller.
    - **Reversibility**: Some ESC's are not able to switch polarity and, therefore, cannot run motors in both CW and CCW directions.

    - **Continuous current draw**:
    - Input voltage:
    - Size constraint:

- **Robotic sensors** provide quantitative data of its environment and provide the necessary inputs for a controller to dictate the proper command. The autonomous robot will need to perceive how it is oriented to its surroundings, the boundaries of those surroundings, and its proximity to the opponent. The most recent and relevant sensors for an autonomous sumo robot are discussed in detail below.
    - Li-Dar
    - Ultrasonic Range Finder
    - Proximity/Touch

Ultrasonic transducers, also referred to as ultrasonic range finders, operate on the principles of sound waves similar to sonar and even human sight. High frequency sound waves are internally produced via a transducer. These waves radiate out until obstructed by a solid body, at which point, the emitted waves are echoed back towards the transducer completing one cycle. The time of one cycle is tracked by the rangefinder and used to closely approximate the distance between the source and the other body. Rangefinding techniques are useful for autonomous navigation, due to their processing speed and ability to track in many directions at varying distances.

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Transmitters/Receivers:

- Radio control allows the user to control input signals that are sent through the transmitter to the receiver onboard the robot. The signals from the receiver dictate how the ESC delivers power to the drive motors. Each receiver has a finite number of channels which dictates where the power needs to be delivered. If the user commands the robot to go forward on the transmitter then the receiver will pick up that signal, relay it to the ESC and provide power to both motors. For turning, the receiver will send a signal to the ESC to power one motor but not the other, this will translate to turning left or right depending on the command
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Power Supply:

- **Lithium**
- **Hj**
- **bj**

Power Transmission:

- **Tires:** Tires are responsible for directly translating input electrical power into output mechanical power.
- **Bearings:**

- **Drive Mechanics:** Drive mechanics are responsible for transmitting the input power into output power.

Materials: