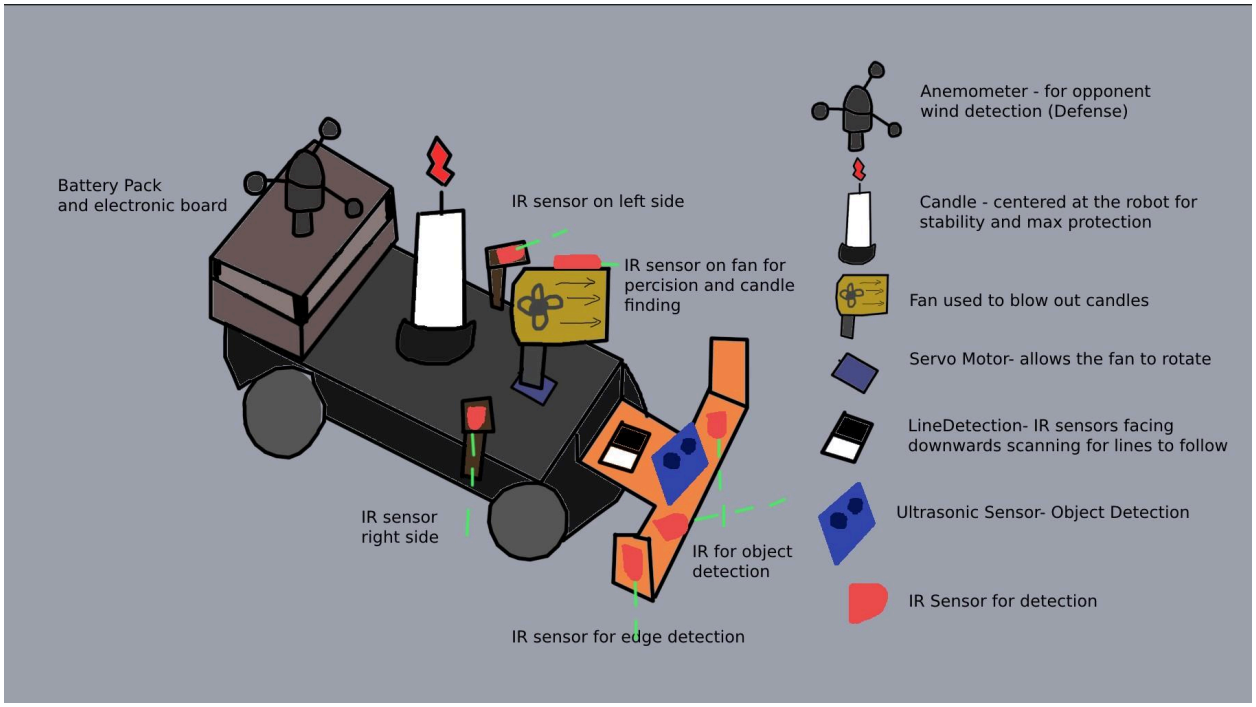
Autonomous Robot



Physical Design and Construction:

Our Autonomous Mobile Robot (AMR) uses an already available Elegoo base. This base is both sturdy and light enough to move easily around the field and comes with wheels that have great traction. Using a 3D printer extra parts are added on the outside of the robot to house the sensors and electronic components.

Both the battery and the board towards the robot's rear. This decision not only optimizes weight distribution but also ensures that the center of the robot remains undisturbed, allowing for the candle's optimal placement. Central positioning of the candle is important for ensuring a perfect balance, which is a crucial factor in maintaining agility during the contest.

It's important to emphasize the fragile nature of the candle's flame. Quick motions can cause sudden gusts of wind that can jeopardize the candle's flame . Given this delicate balance, our AMR's design incorporates a movement algorithm that stresses steadiness. It is decided that any sudden accelerations or decelerations can cause the candle to go out, therefore the robot is programmed for smooth transitions. Both the start and stop must be smooth very much like the take-off and landing of an airplane. This type of movement not only serves to protect the flame but also arms the AMR with a strategic advantage. This predictable and steady movement can become an asset when navigating the competition arena, allowing the AMR to seamlessly interact with opponents without risking its own flame.

Navigational Expertise with Reflective Sensors:

To navigate its environment it will utilize the designated paths on the ground. By using reflective sensors attached to its underbelly, it will be able to know whether or not the robot is on course.

These sensors operate on a simple yet effective principle, they can differentiate between reflective surfaces and non-reflective ones. In a scenario where there are no black surfaces under the sensor, the sensor receives a signal and knows that the ground beneath is not on path.

Should the AMR encounter a black line, indicating a change in its environment, it adjusts its direction to align with this new pathway. Continuous feedback from the sensors is processed in real-time, allowing the robot to adjust its direction as needed. This is done by an algorithm communicating with the motors responsible for movement. The small adjustments are key to following the line precisely as large movements could knock the robot off track.

In situations where the AMR goes off path , it will use an algorithm to find it again. It first rotates 90 degrees to the left. If unsuccessful, a 90-degree turn to the right is executed, this is because the robot will never be too far from a line and at a certain point have to detect something. In the case that no line is detected by doing a 180 scan a forward movement will be done and another scan will perform.

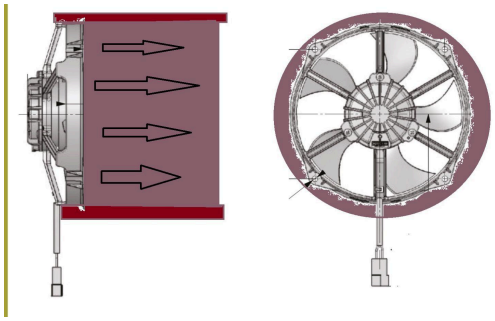
Advanced Fire Detection and Extinguishing Mechanism:

The most important aspect of the AMR for this challenge is the fire detection system. This system relies heavily on IR sensors, calibrated to pick up the distinct heat signatures emitted by candles. While the other idea was to incorporate light detection sensors, because of their heightened sensitivity even with adjustments, concerns about them misinterpreting other light sources made me favor the IR sensors.

These IR sensors, strategically placed around the AMR, feed continuous data to the onboard algorithm, allowing it to determine both the direction and approximate distance of a detected candle. An IR sensor on each side of the robot along with ones in the from and one on the fan with the robot will allow for more data which would result in a more precise robot.

The fan, the primary tool for extinguishing fires, is mounted on a versatile rotating base. As the robot approaches a detected fire source, continuous updates from the IR sensors allow the servo motor to fine-tune the fan's position. By moving left and right with the fan the robot does not need to rotate, ensuring both speed of blowing out a candle and steadiness of the actual robot.

To boost the fan's effectiveness, a custom encircling tube will be placed on the fan. This part could be 3d printed or even be a paper rolled up. This design ensures that the fan's airflow remains focused. Unlike a normal fan which equally distributes gusts of wind the tube will allow for higher precision. This is very much like a barrel on a weapon.



Defensive Strategy with Anemometer:

This strategy could be implemented given the right sensor. Anticipating threats from other competitors, the inclusion of an anemometer in the AMR's design could be useful. The issue is acquiring one is either expensive or too large for the robot. 3D printing one could be done but many testing needs to be performed. Assuming it does work, the sensor could detect the direction and speed of wind coming from other robots.

By determining the rotation of the sensor it could be estimated which side the opponent robot is on. In addition by calculating the speed of the rotation, the algorithm could detect the distance from the competition robot. In response to a threat of other enemies blowing out the candle , the AMR could trigger evasive maneuvers, such as zig-zag patterns, potentially outmaneuvering competitors.

 *Image of an actual anemometer.*

Object Detection with Ultrasonic and IR Sensors:

An efficient navigation system should not only follow paths but also recognize and avoid obstacles. The AMR achieves this through an ultrasonic sensor located at its front. Emitting sound waves, which reflect off obstacles, the time taken for their return provides a measure of the object's proximity, assisting in collision prevention.

To add on to this, two IR sensors are diagonally placed, monitoring the AMR's left and right. Their orientation ensures peripheral detection, allowing the robot to detect any objects on its sides. This will cause the AMR to adjust its course accordingly. Together, these systems provide a comprehensive awareness of the environment, enabling the AMR to navigate efficiently amidst competitors, walls and potential fires.