2 DESIGN REQUIREMENTS

The objective of this project is to design an autonomous robot for the 2005 SoutheastCon (SECON) robotics competition. Rules and objectives of the competition necessitate a number of capabilities and limit possible design solutions. The following technical and practical constraints guarantee that the robot will qualify to compete and complete each game safely.

2.1 Technical Design Constraints

The technical design constraints listed in Table 1 relate to the performance of the robot. System performance issues such as the ability to capture targets, avoid collision, and detect signals are addressed.

Name	Description
Target Capture	The target capture system will gather five 0.3 ounce metallic balls that are ½" in diameter. It will lift the balls above the playing field and carry them back to the starting square.
Collision Avoidance	The robot will recognize the presence of an opponent 17.62 inches away and avoid collision if necessary.
Infrared Detection	The infrared detection system will detect the steady emission of a high output, infrared light emitting diode (LED) with a wavelength of 940 nm.
Power Supply	The power supply must provide at least five minutes of power.
Locomotion	The robot will travel a minimum distance of 462 inches (38.5 feet) at a minimum average speed of 1.54 inches per second.
Parking	The robot must return to the 6"x6" home square after collecting all five targets, and then align itself within the home square.

Table 1. Technical Design Constraints

2.1.1 Target Capture

The target capture system is crucial to success in the SECON robotics competition. Without an effective target capture system, the robot will not accumulate the points needed to win. This target capture system must retrieve five 0.3 ounce metallic balls from holes ¾" in diameter and ¾" deep while avoiding the collection of the opposition's targets. During the game, the target capture system may extend three inches beyond the 6" x 6" x 8" (L x W x H) size constraint of the robot, but this target capture system must return entirely within this size constraint at the start and end of each match.

2.1.2 Collision Avoidance

The goal of the collision avoidance system is to avoid an encounter with the opposing robot. The limiting factor in maneuvering around the oncoming opposition is the distance from which the position of the oncoming opposition can be detected. The system must be capable of detecting the opposing robot at a distance of 17.62 inches from the front of the robot to allow sufficient reaction time. Assuming the enemy is moving at a maximum speed of 12 inches per second, the robot will stop within an inch after detecting the opposition's presence. The robot will then have sufficient time to rotate 90 degrees in 0.785 seconds and move away from danger at 12 inches per second. In order to limit the distance that the opposing robot can travel towards our robot before detection, this system will poll the enemy's position every 0.1 seconds.

2.1.3 Infrared Detection

An infrared LED in the playing board with a peak wavelength of 940 nm informs the robot that the match has begun. This start signal has a radiant intensity of 7.368 mW with a half-view angle of 36 degrees. Therefore, the infrared detection system must recognize the steady output of the infrared LED described above and instruct the robot to begin motion.

2.1.4 Power Supply

The power supply's function is critical; it must supply steady electrical power to every component of the robot's systems. Devices such as sensors, chipsets, and motors depend on the presence of a steady power source to operate. The power supply must give these components and all other devices a minimum of five minutes of power each match.

2.1.5 Locomotion

The robot will follow a path similar to the one illustrated below in order to search half of the field for targets. Using a 9" wide magnet to sweep the field, six horizontal passes are required to fully sweep the target area, five vertical displacements are necessary to reposition the robot between passes, and the distances to and from the home square must each be traveled once. See Figure X below for an illustration. A typical run of this type will be 341.12 inches in length; since the maximum time allowed for a round is 5 minutes, the robot's minimum required speed 1.14 inches per second.

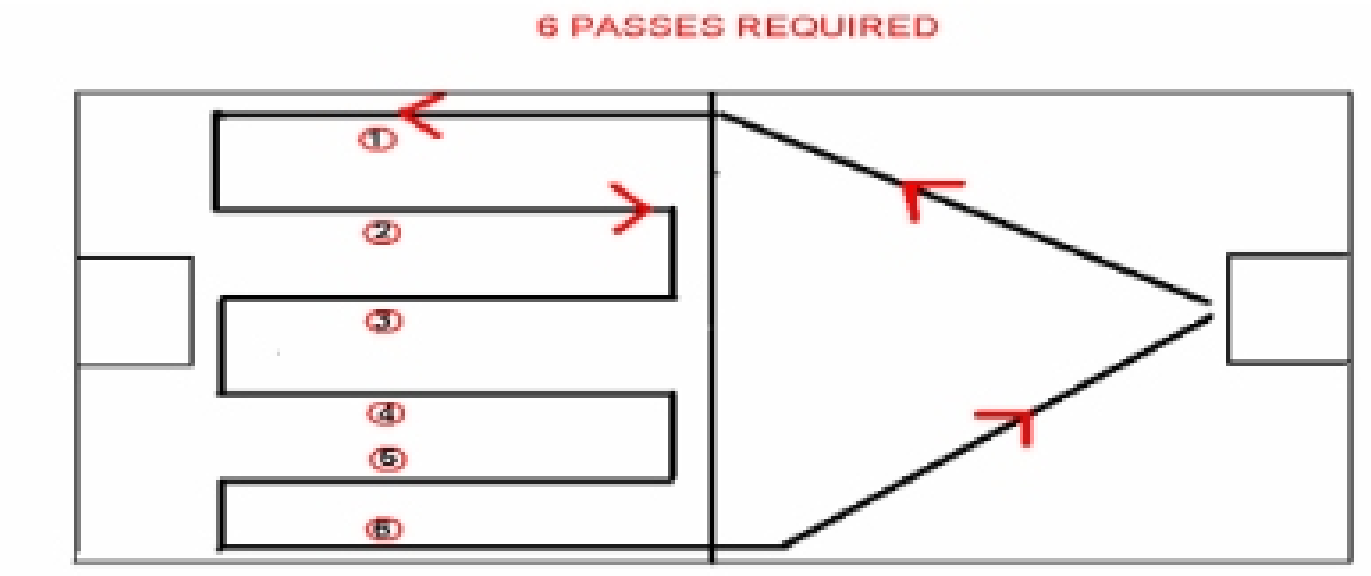

Figure 1. Simple Navigational Path

In order to follow this path precisely so that no targets are missed, two more constraints are necessary:

1. The robot will be able to carry out a rotation of any arbitrary angle with a zero turning-radius and within 5% of the requested angle.
2. The robot will be able to carry out a straight move of an arbitrary distance forward or backward within 5% of the requested distance.

The above-mentioned minimum speed and movement capabilities will ensure from the perspective of the locomotion system that the robot can complete the game successfully.

2.1.6 Parking

The final task the robot must complete is to return to the home square with all five targets. The robot must park completely centered on the home square with no part of the robot overhanging into the black area of the board outside the home square.

2.2 Practical Design Constraints

The design constraints listed below in Table 2 describe practical limitations that affect the design solution. These limitations address manufacturability, safety, ethics, sustainability, and environmental awareness.

Type	Name	Description
Manufacturability	Size	The robot will not exceed the dimensions of 6" x 6" x 8" (L x W x H).
	Weight	The robot will not weigh more than 20 pounds.
Health and Safety	Safety	The robot will abide by all safety regulations set by the governing body of the SECON competition.
Ethical	Playing Rules	All rules and regulations of the competition will be followed to ensure fairness for each competing team.
Environmental	Pollution	Batteries used to power the robot will be rechargeable and contain 0% cadmium – a heavy toxic metal that poses a threat to the environment.
Sustainability	Reliability	The robot shall reliably perform multiple times for all practice and competition rounds.

Table 2. Practical Design Constraints

2.2.1 Size and Weight

According to the rules of the competition, the physical dimensions of the robot cannot exceed 6" x 6" x 8" (L x W x H). The robot must fit into a 6" x 6" square at the beginning and end of each match. During a match, the robot body cannot change size; it must remain as one part and cannot separate into two separate functioning entities. Although the robot's body cannot change size, an attachment is allowed to extend up to three inches from the body during the competition. This attachment must be retracted when the robot returns to its starting square. Failure to abide by these rules will result in instant disqualification.

Another important factor is the weight of the robot, which affects the robot's speed and maneuverability. In comparison to light robots, a heavy robot requires larger motors and batteries with higher capacity. In turn, these larger motors and batteries will also add more weight to the robot. Though a heavy robot is slower than a lighter robot, it is less likely than a lighter robot to be deterred from its path if bumped by the opposition. An ideal weight, within the 20-pound limit, allows the robot to move quickly, evade opponents, and recover from collisions.

2.2.2 Safety

Since the robot will be operating in a public environment, it must not endanger the well being of its surroundings. The robot must not be a danger to any observers, the playing field, or its opponents. Flammable liquids, gases, and explosives are dangerous and will not be included in the design of the robot. Objects will not be projected from the robot in any manner. All parts will remain attached to the robot for the entire length of the competition.