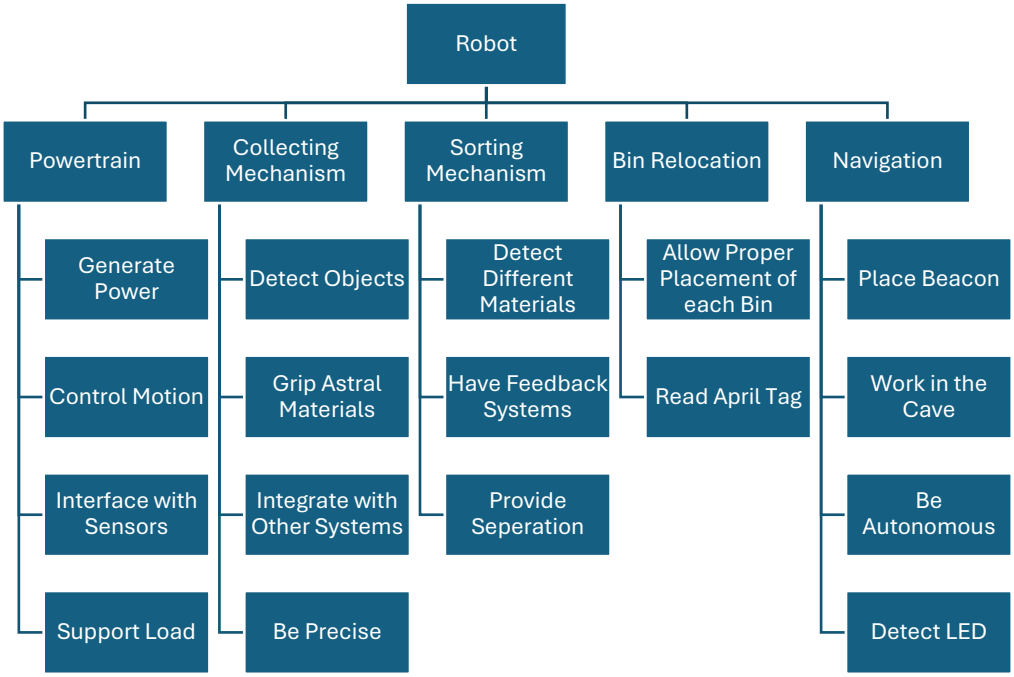
Functional Decomposition



1.3.1 Explanation of Results

The functional decomposition was acquired based on requirements defined by the game manual and knowledge of robotics. The game manual explains all the ways to acquire points. These consist of sorting and placing the astral materials into the correct bins, the robot travelling into the cave area of the game field, relocating the bins into the correct locations, and placing the team beacon into the designated location. From these the team determined the robot will need to grab, sort, and sense autonomously. Outside the game manual, it is given that the robot must be able to move, have a power supply, and support a load.

The 5 main functions of the robot include the powertrain, collecting mechanism, sorting mechanism, bin relocation and navigation. The powertrain is responsible for the physical motion of the robot and is closely related to the bin relocation and navigation. The collecting and sorting

mechanisms are closely related as they both deal with the handling of the materials. Navigation is also closely related to the collecting mechanism and the bin relocation as the robot must navigate the arena based on the position of the materials and navigate to move the bins.

The functional decomposition presented above demonstrates the primary functions and subsystems and the corresponding subsystems necessary, with the main branches of the robot including the powertrain, collecting mechanism, sorting mechanism, bin relocation, and navigation systems. The functional decomposition was assembled after team discussion, both with and without the team's computer and electrical engineers; the necessary functions were decided after interpretation of the game manual and the event in which the robot will compete, as this decides what is necessary for the robot to execute.

1.3.2 Connection to Systems

1. Power Train
    a. The power train will require something to draw power from such as a battery. Without power the robot will not be able to operate.
    b. For the robot to turn and move back and forth, the power train will need a way to control its motion. It is also important for the robot to not go too slow due to the 3-minute time limit, but fast erratic movements are also undesirable.
    c. The sensors will need power to operate; therefore, an interface between the sensors and the power train is needed.
    d. Since the robot will need to pick up the astral materials, it is necessary for the power train to be able to support a load both for grabbing and storing astral materials.

2. Collecting Mechanism
    a. Astral materials in the robot's path will need to be detected to activate the collecting mechanism.
    b. Once materials are detected, the collecting mechanism will need a way to reach and grab ahold of the astral materials.
    c. Several systems will be working together to collect the astral materials. The collecting mechanism will need to integrate with other systems such as the power train since it will need power and the ability to support a load.
    d. Precision of the collecting mechanism is important so that the robot does not miss the astral materials. Placing the team's beacon will also require precision.
3. Sorting Mechanism
4. Bin Relocation
    a. The robot will need to place bins in the correct location.
    b. The robot will need to read April tags to know where to place the bins.
5. Navigation
    a. The way to acquire the most points in the competition is to place the team beacon. To do this, the robot will need to locate where to place the beacon.
    b. Part of the game field will have a covered, dark area with infrared noise inside. Astral materials will be inside this area and points are given for the robot travelling in there. The robot will need a way to navigate its way through the cave despite being intercepted with infrared noise.

c. The robot will need to be fully autonomous. There are no controllers allowed, so the robot will need to operate on its own for the entire three minutes of the competition.
d. To indicate the start of the competition, an LED on a wall on the game field will illuminate. Therefore, the robot will need to detect this LED to know when to begin operation.

1.3.3 Smart Integration

Many subsystems incorporate elements from other functions. The Control Motion subsystem relates directly to the detection of objects and the bin placement subsystems, as motion control is needed to move bins correctly, and object detection directly affects how the robot will move. The Support Load subsystem relates to the Collecting Mechanism function and its corresponding subsystems. The weight of the collected materials must be supported by the drive train for the success of the project. The Sensor Interface subsystem is closely related to Object Detection, LED detection and the reading of April tags, as these rely on sensors on the robot. Each of these relate to the Control Motion subsystem. Additionally, combining the Collecting mechanism and Bin Relocation functions creates an excellent opportunity to innovate and use one element of the robot for multiple functions.

1.3.4 Action and Outcome

The robot will navigate the arena autonomously. Materials will be collected, supported and deposited by the robot. A team beacon will be placed. The outcome of these actions is points earned via the Scoring Summary (Table 3.6) in the game manual.

1.3.5 Functional Resolution

Team 507’s robot will have several integrated subsystems including navigation to traverse the game field with an effective propulsion system, identify and harvest the randomly scattered astral materials, uptake and then physically relocating the bin full of material. This will earn points for the team in the Southeast Competition, setting the robot on the path to winning.