Conceptual Design Phase 1

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I. Introduction

A. Problem Definition

The Southeast Conference (SECON) is held annually by IEEE in different places around the southeast United States. In 2024 the conference will be held in Atlanta Georgia on the week of March 20. A part of the conference, there are several competitions that students from many different universities are allowed to compete in. One of these competitions is the Student Hardware competition where students build autonomous robots to complete specified tasks that change from year to year. This year the competition is themed around a rocket launch where humanity's fate is determined by the successful launch of the rocket to resupply an orbital defense network. The robot must autonomously navigate a U shaped course within a 3 minute time limit. There are several tasks contained with in the course, including climbing a hill, crossing a crater, and moving rocket parts to the launch pad.

There are several constraints placed on the robot by the competition rules. The first and most important constraint is that the robot must operate autonomously, meaning it can have no operation commands sent externally from the robot. To meet this constraint the robot will be capable of making decisions based on the course conditions. The second constraint is that the robot must fit within a one cubic foot area at the start of each competition run, and it may not weigh more than 25 pounds, however after the start of each run the robot may expand to any size that fits within the course bounds. The team has also specified that the robot will stay as one whole unit throughout the run, and not split into multiple parts. Finally the robot will not cause any harm to the course or harm to any bystanders [1].

II. Background

A. Conceptual Design

The design process began by identifying key competition rules and point gaining tasks. The scoring schema played heavily into the first design phase of this project. This was broken down into how achievable certain points were, and whether or not it was feasible to aim for those point categories. This lead to a design that ignores the small objects and aims for course completion over anything else. The team has elected to ignore the specific placement of the boxes and instead has opted to just put them in the larger, less specific drop off area. The team has also decided to ignore the thruster assembly section as the movement of the thruster pieces would be extremely difficult to keep upright as per the rules, and no feasible design was discovered that would allow for the proper transportation of thruster components across the crater. Instead of focusing on these areas, the team will focus on areas of the robot's construction that are integral to being as competitive as possible, such as the drive train and the micro-controller.

The robot design is split up into seven main sections. These sections are the chassis and drive train to support the robot. The power supply will deliver power to all the robot's functions. The main controller will be the brain of the robot. The team spirit display will show team spirit at the designated times. The button presser will be the system to stop the timer. The box sweeping mechanism will collect and deposit the large boxes into the overall drop zone. Finally the start recognition system will start the robot on each course run. These systems will be outlined later in this design phase paper.

III. Ethics and Standard Considerations

A. Ethical Considerations

The team commits to transparency during this project. This is to the members of the team, the instructor/advisor, and the customer. This robot must be designed with the intention to do no harm to any person/persons and/or physical property. The robot will not infringe upon the intellectual property of others through its design or programming. This team will commit to ethical practices and interactions internally and externally. This includes reporting progress honestly, not infringing upon the ideas of others without permission to use those ideas, and the team will not infringe on copyright or trademark laws.

B. Standard Consideration

The standards of this project fall under the jurisdiction of the CPSC, the Consumer Product Safety Commission, a United States government commission. The team commits to following the standards. The robot will be accessible to the students participating in the project, the customer, the instructor/advisor and potentially others after the completion of the project. This level of accessibility requires that the robot meet the electrical and mechanical standards. The Electrical safety standards are as follows: live electrical components shall be enclosed. Motors, transformers, and similar components must be secured. The robot must be GFCI, Ground Fault Circuit Interrupter, protected, The mechanical safety standards are as follows: no pressure over 5 psi, moving components with capability to harm must be enclosed, and parts which have the potential to become projectiles must be secured [2]. The robot must also adhere to standard ISO 10218 which covers the safety practices for the construction of non-industrial robots. This states that all powered moving parts shall be covered by stationary or mobile guards. It also states that no part of the robot shall move faster than 1 inch per second excepting the drive systems, which are limited to 1 foot per second. The robot must also have an emergency shutoff that leaves all mobile components in the deenergized position. This standard also states that a robot must not have any single fallible piece that leads to the failure of a safety function, requiring backups for all safety functions [3].

IV. Overall Design

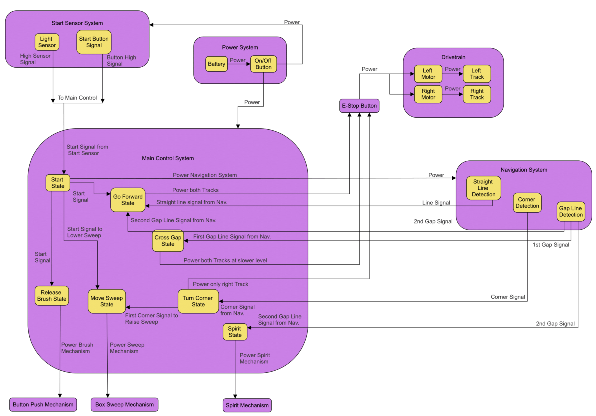

Fig. 1. Full Block Diagram

V. Chassis and Drive Train

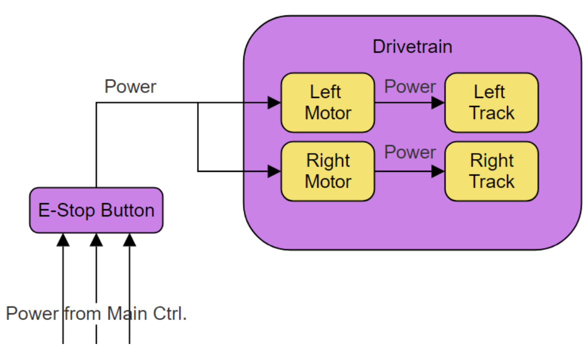

Fig. 2. Drivetrain Block Diagram

VI. Power Supply

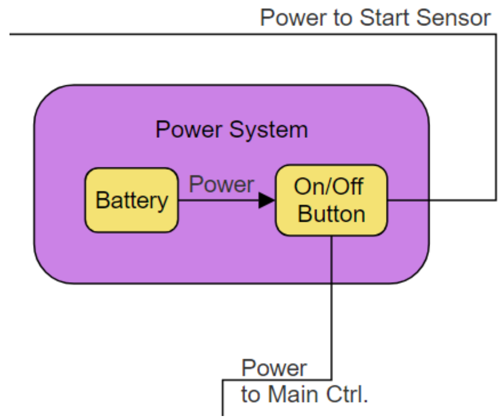

Fig. 3. Power Block Diagram

VII. Main Controller

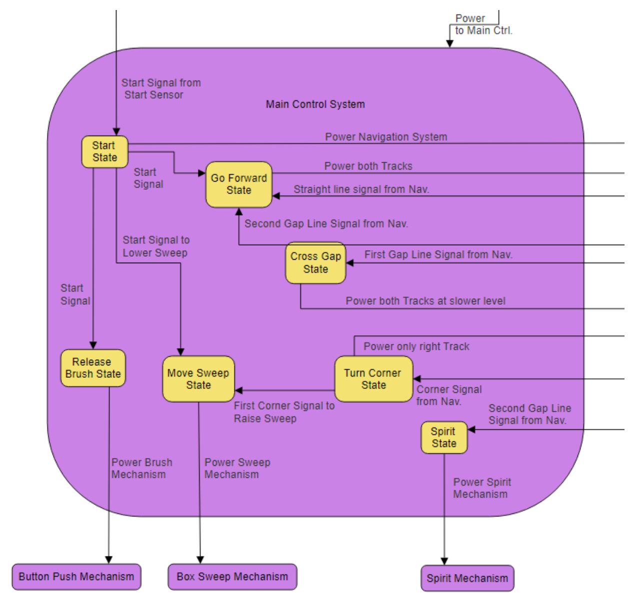

Fig. 4. Main Control Block Diagram

A. *Team Spirit*

B. *Button Presser*

C. *Box Sweeper*

VIII. Start Recognition

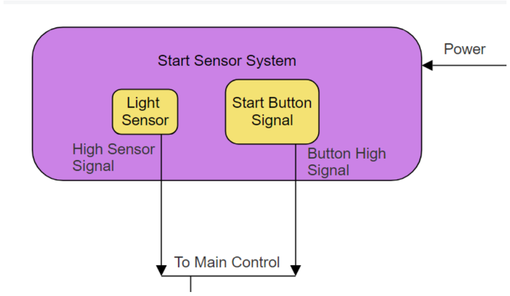

Fig. 5. Start Sensor Block Diagram

IX. Analysis

For our drive train we will be using dc motors. In order to validate the operation of our motors we can take the specs and parameters of our selected motor and model the motors in LTSpice. Then once modeled we can give a range of different values for the load and the input voltage that will show the response of the motor to different input conditions. We will also use stepper motors as our actuators for some of our control system such as for our sweeper arm the will collect some boxes. In order to simulate this we can do so by creating an equivalent analog circuit in LT Spice or Matlab and testing different duty cycles on the stepper motor because it requires different pulse width modulations to change the direction and angle of the arm attached to the stepper motor. For the arm/sweeper that is attached to the stepper motor we can determine the length by analysing the SECON obstacle documentation and basing our arm/sweeper length from the center of the course where our robot will be placed, to the right side of the wall. Our power system for the whole robot can be modeled in LT spice by modeling our systems and sub systems as a load and doing a transient analysis of how much power our system draws over a certain period of time at maximum capacity. Modeling our system at maximum capacity or full load gives us an idea of what type of amp hour and voltage our battery needs to be to support the full system.

X. Appendix

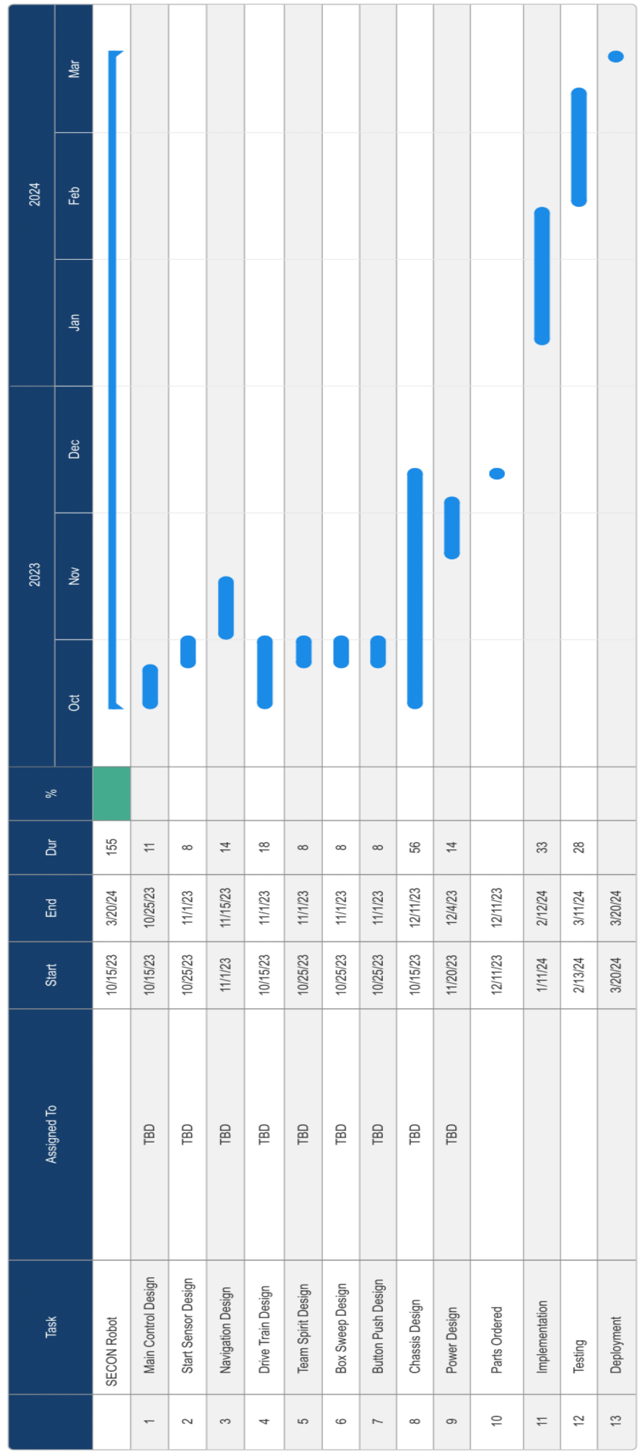

Fig. 6. Design Timeline

REFERENCES

[1] R. Voicu, "Ieee southeastcon 2024 student harware competition rules," accessed 9-6-2023. [Online]. Available: https://ieeesoutheastcon.org/wp-content/uploads/sites/497/SEC24-HW-Competition_V5.6-1.pdf

[2] CPSC, "The dangers of electric toys," accessed 10-3-2023. [Online]. Available: https://www.bing.com/ck/a?!&&p=06377dcc098b2afeJmltdHM9MTY5NjI5MTIwMCZpZ3VpZD0wNDU5NzNiNi1iNDI3LTZhMGQtMDRlNC02MWQ3YjUwYjZiM2ImaW5zaWQ9NTE5Nw&ptn=3&hsh=3&fclid=045973b6-b427-6a0d-04e4-61d7b50b6b3b&psq=cpsc+sfatey+alert+the+dangers+of+electric+toys&u=a1aHR0cHM6Ly93d3cuY3BzYy5nb3YvczNmcy1wdWJsaWMvMjg3LnBkZg&ntb=1

[3] ISO, "Iso 10218," accessed 10-3-2023. [Online]. Available: https://cdn.standards.iteh.ai/samples/51330/c008a0a974584a5098400991b63eaae9/ISO-10218-1-2011.pdf