Mechanical

Overview

The final mechanical design follows the demand given by the control team. It is compact, small, cheap in budget, and has a decent amount of redundancy. The robot is designed with 2 layers and 6 surfaces for mounting. The dimension is 130mm x 90mm x 200mm. The cost of manufacturing of the chassis is £0.00 with all the given parts, laboratory scraps, and screws and nuts.

[insert robot picture / rendering picture here]

The structure of the robot consists of two major layers and one minor mounting sides. The bottom layer is used as the mounting plate for the two motors with original mounting plate and wheels, the battery, and the structural support for the upper layer. The upper layer is used as the mounting plate for the FPGA, esp32, camera, and the accelerometer/gyroscope. There are two pillars connecting the upper and lower plate. This pillar is also acted as the mounting space for the motor control board using zip ties.

Manufacturing constraints.

The robot is manufactured using laser cutter, using scrapped 3mm clear acrylic. There are several considerations for this decision apart from the basic requirements of having all components mounted on one robot.

[insert plate pictures here]

The first consideration is the budget. The preliminary consideration pointed out that the cost for extra external sensors, motors, etc. will be high. Thus, the cost of chassis manufacturing needed to be reduced to a minimum. The lab provided several means to cut cost. 1) The fixing pieces are free. 2) The additive manufacturing (3D printers) and materials are free. 3) The acrylic scraps can be free if it was bought before. Due to the second consideration, it was decided to use laser-cut acrylic as the major structure. One challenge was the size of the scraps. The pieces were thoroughly cut and there was barely any space on it. Design choices were made that the plates would be small enough to be cut from the scrap acrylics. Thus, the 70mmx90mm size was determined.

The second consideration is the fast iteration time. Due to an increased number of usages of the 3D printers in the lab, it was impossible to have the base chassis iterated in a daily basis. Moreover, due to the nature of additive manufacturing, it was impossible to get pieces printed quickly as well. However, the laser cutter was rarely used and available almost all the time and it would only take it minutes to produce a piece. Ideally, the iteration speed can be increased to a ridiculous pace where pieces can be produced every 5 minutes. This provided a huge advantage to try the new designs with control team and finalize the mechanical design.

[insert fusion model histories here]

The third consideration is the dimension. The robot is required to be able to fit in and manoeuvre through the maze, which limited the projection area of the robot to 300mm x 300mm. Another limitation is provided by the control team that the rover had to be small to 150mm maximum in length. Moreover, in order to utilize the scrap, the plate length was further set to 90mm maximum which resulted in a length of 130mm maximum. The height limitation was determined by the camera viewability. A series of experiments were conducted to compare the camera height to the viewability of the camera as in figure [experiment figure number].

[some pictures of that experiment] [in description, mention appendix of camera height experiment]

The fourth consideration is redundancy. Though the chassis was iterated many times, reusing the parts was still desirable due to budget concerns (limited scraps). Every iteration provided more than enough mounting surfaces for future use and expansion. The upper board from the second iteration was designed to be interchangeable with the lower board in case there were any necessity to mount more components on the lower board.

The final consideration is stability. A stable testing environment is required by the control team. The components need to be fixed to one place and have minimum wobbling. Thus, the robust fastening measures are considered. The plates were designed to maintain multiple fixturing positions to hold stability.

Iteration History

The mechanical design has two major iterations with minor iterations throughout. The first iteration involves taking account for a leaping goal with reusability, redundancy, and extendibility. The second iteration is an overhaul based on the first iteration and follows the additional constraint and the demand from control team.

The first major iteration was a long chassis board design. The ultimate goal for this chassis was to have two parallel mecanum wheels sets. Mecanum wheels are able to provide a diagonal direction vector. With four of the mecanum wheels, it is possible to have an omni-directional movement. The idea was to put two of mecanum wheels parallel to each other as one wheel. One wheel will be driven by two motors to control the different speed for each mecanum components of the wheel. It would provide a lot of control challenges. However, it reduced the complexity for the future algorithm.

[picture of mecanum wheels and vectors]

The second major iteration was a short chassis board design which was the final design. After the control team was experiencing difficulties of the basic balancing. The mecanum wheel plan was abandoned. It was required by the control team that the chassis as to be small as well. Thus, this version of the chassis design was introduced and finalized after several minor iterations.