Controlling The Designs
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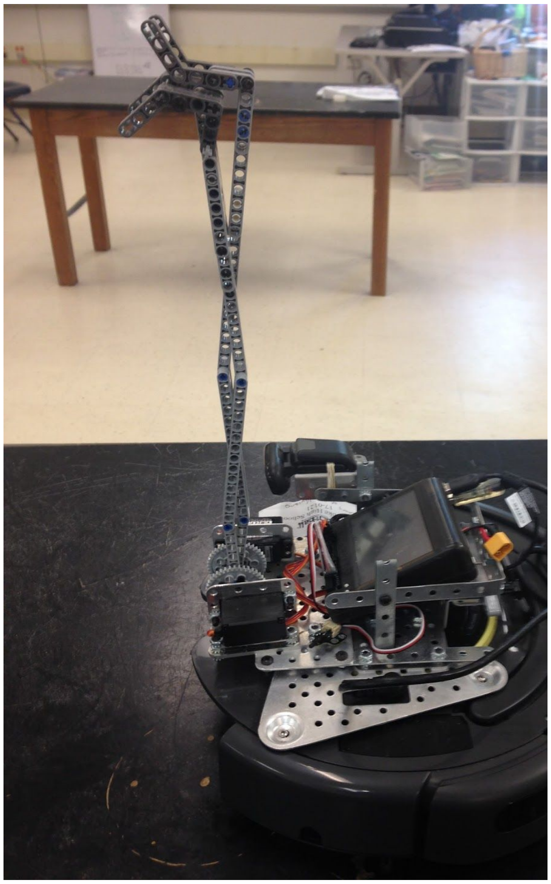
1. Developing a strategy

We started by brainstorming the strategy that we would use the get the most points. We reviewed the scoring options and rules to decide how we could easily get the most points within the allotted time.

Our team decided on parking one of the robots on the terrace since that is an easy 25 points. We noticed that there was a large bin at the end of the terrace, and decided to kill two birds with one stone by also scoring points by dropping poms into this bin on the terrace.

Unfortunately, this maneuver gets us a measly 40 points (5 points per pom in this bin) plus the 25 points for the bot on top of the terrace. This is where our large bot came in. By grabbing the seed bin and dumping its contents onto the terrace, we are able to increase our score. However, our strategy doesn't stop there. The small bot, which has already dumped the pink poms into the bin, is now able to grab the green poms and dump them into the bin as well. Ideally, this strategy can score us a maximum of about 145 points. However, this strategy is very risky, since the robots have no means of communication, and can sometimes fail if the small bot can't properly pick up the poms that are dumped by the large bot. Despite these contingencies, we decided to roll with this strategy. Once we decided on a plan to attack the situation, we started thinking about what would be best to execute this strategy.

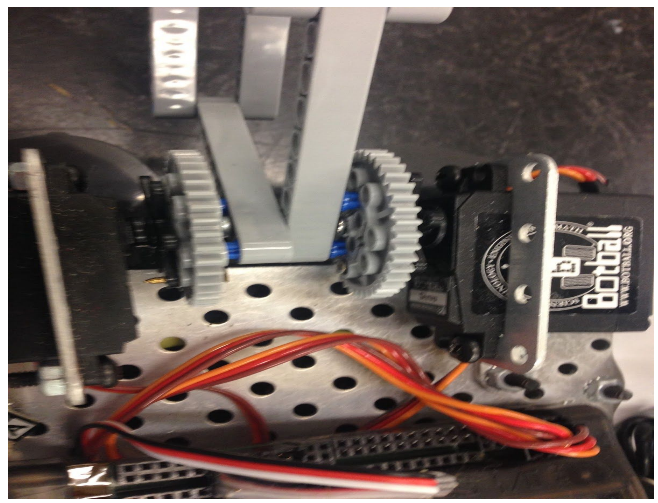


2. Deciding what our arm needs to do

When coming up with an appendage design, we had to think about the attributes needed to fulfill our strategy. We needed something that could grab while also being able to lift to a higher level, all while staying within our projects height restrictions. We had tried multiple designs focusing on getting the right amount of degrees of freedom but our process kept turning out wrong. We decided to use our chassis stability as a way to remove a necessary piece of the arm, so by removing a degree of freedom from the arm, we could make the base of the appendage easier to attach and build off of.

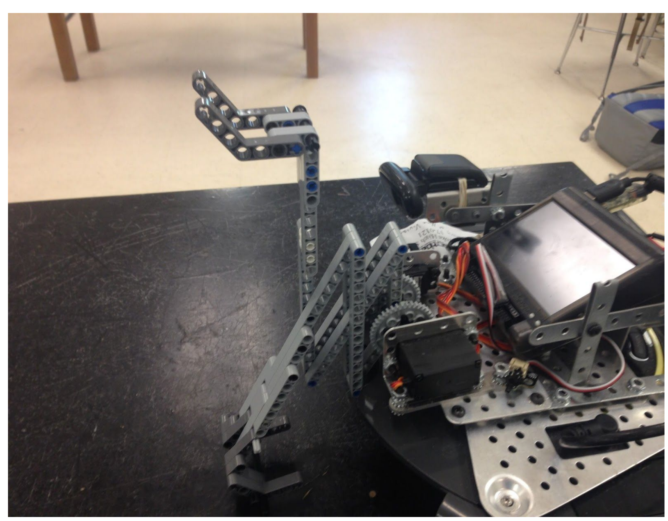
2.1 The arm

The arm our team decided on keeping on the final design of the robot was essentially an X-lift turned on its side. Part of our strategy was to be able to lift the seed bin and dump the seeds onto a higher platform while staying within the height requirement. So we used this simple X-lift design to help it fold into the height requirement while still being able to extend, grab, and lift to a platform taller than the height limitation on the robot. Another key factor we had to keep in mind was weight, and the X-lift design was made with light Lego parts and no metal, allowing it to do its job without being too heavy.



2.2 The servos

The idea with the servos was to have one motor that opens and closes the arm, and one that moves it up and down. One improvement we made on it was we put angled Lego pieces to push the bin into the "hand" of the arm if we were slightly off with positioning. This X-lift design allowed the robot to maneuver the arm in any direction, because the robot body is able to turn 360 degrees along the ground, while the arm itself would cover an area directly in front of it, up to an angle of 90 degrees in the air. One difficulty we had with this arm was controlling the height as well as the extension and retraction simultaneously. In order to adjust the angle at which the arm is at, a single servo would simply turn the arm to that desired angle, which unfortunately didn't allow for grabbing. Thus brought upon the decision to add a second servo.

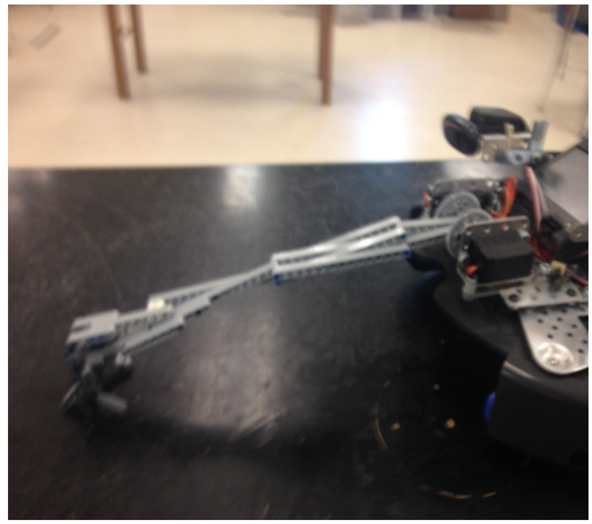


3. Final model

Our final design for our large robot ended up modeling a horizontal X-lift that is able to extend and contract, allowing for the grips on the end of the arm to close around objects. It was attached to a double servo mount so that both sides of the lift were connected to a servo, allowing for the maximum amount of angular movement.

Since the arm can move to be opened and closed while also moving up and down the position, each servo is set to.

3.1 Attributes



The arm is able to rotate and to extend to grab objects due to a combination of both servos rotating with specific objectives. One of the servos controls the angle at which the arm is positioned at, something we pondered in our original design, while the other servo controls the extension of the arm, which, in turn, grabs objects as the arm is extending outward. However, at certain positions, one servo would be maxed out over the other, which means that if you changed the positions over a certain cap the arm would change because the servo couldn’t move the other.

4. Programming

This caused for strange programming occurrences because we couldn’t just set the servos to a position and note where they were, we had to make a process for how to arm would react to several changes in his environment, meaning how the arm would change when one servo moves while the other is stationary. This design proved to be challenging but rewarding because the arm could do everything we needed as long as we could learn to control how the arm reacts in sequence to where we tell each to turn. The best way to set the sequence of movement of the arm was to find what combinations of servo positions worked to make the required action and then find out what the next position combo would be to get the next action.

4.1 Procedures

When working in the IDE we created procedures to set the arm to specific locations so that we could use the sequencing pattern to ensure that the arm would be able to run its complete course without capping out the other servo. We had trouble at first with its closing mechanics because the arm grips weren't completely latching down on the objects, but we knew that servos positions allowed it to fully close down applying the necessary force.

4.2 Implementing the proper commands

After we had the procedures down we had to make them work for our strategy. The plan was to have it work in tandem with another autonomous robot that was working on an upper platform. The robot’s job is the grab a bin and flips it onto a ledge where the other robot would collect the contents and put into another bin on the ledge. We ran a lot of tests in order to set the programs for these two robots to run properly with each other.

4.3 Results

Our final build was successful in its job of picking up the bin and during tests, it was successful at dropping the contents of the bin on the upper platform. At our Regional competition, the judges gave our team an award for the arm saying it demonstrated a high understanding of modern mechanics and "represented a machine that might be seen working on a bridge". We were all proud that all our hard work paid off because this proved to be the hardest challenge we had ever had to overcome.

5. Conclusion

We were able to control the design and the arm picked up the bin and song it just as we had planned, unfortunately during some of the double elimination rounds we had some complications with the movement of the bot and the arm wasn't able to hit its target every time, but we have since redesigned the movement patterns and plan on displaying its success at this years GCER autonomous robot competition.