Controlling The Designs
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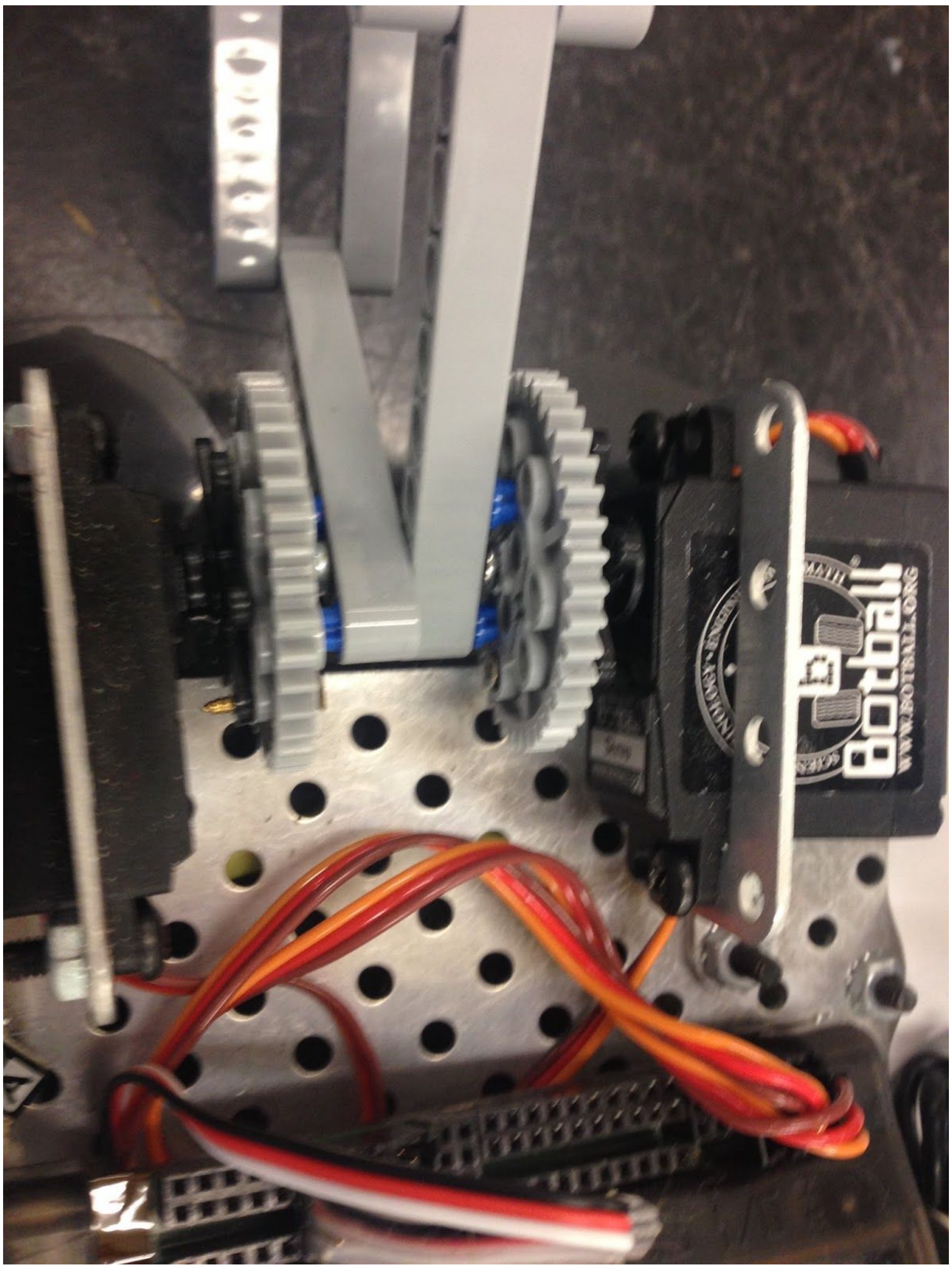
When coming up with a an appendage design, we had to think about the attributes needed to fulfil our strategy. We needed something that could grab while also being able to lift to a higher level all while staying within our projects hight restrictions. We had tried multiple designs focusing on getting 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. The arm our team decided on keeping on the final design of the robot was essentially an X-lift turned on its side. This 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.

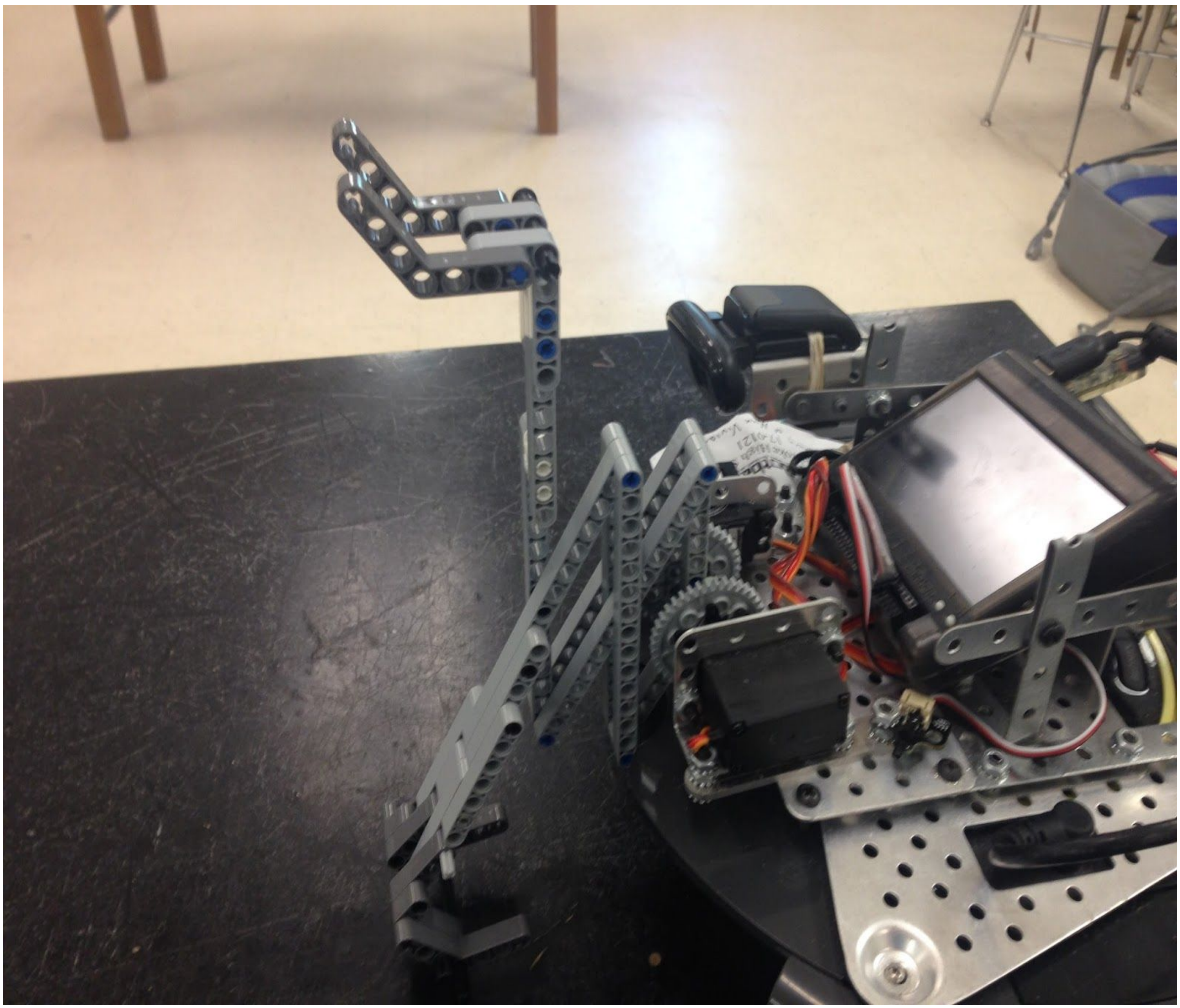
Part of our strategy was to be able to lift the seed bin and dump the seeds onto a higher platform while staying within the height requirement. So we used a simple X-lift design to help it fold into the height requirement while still being able to extend, grab, and lift to a platform taller than the 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. 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.

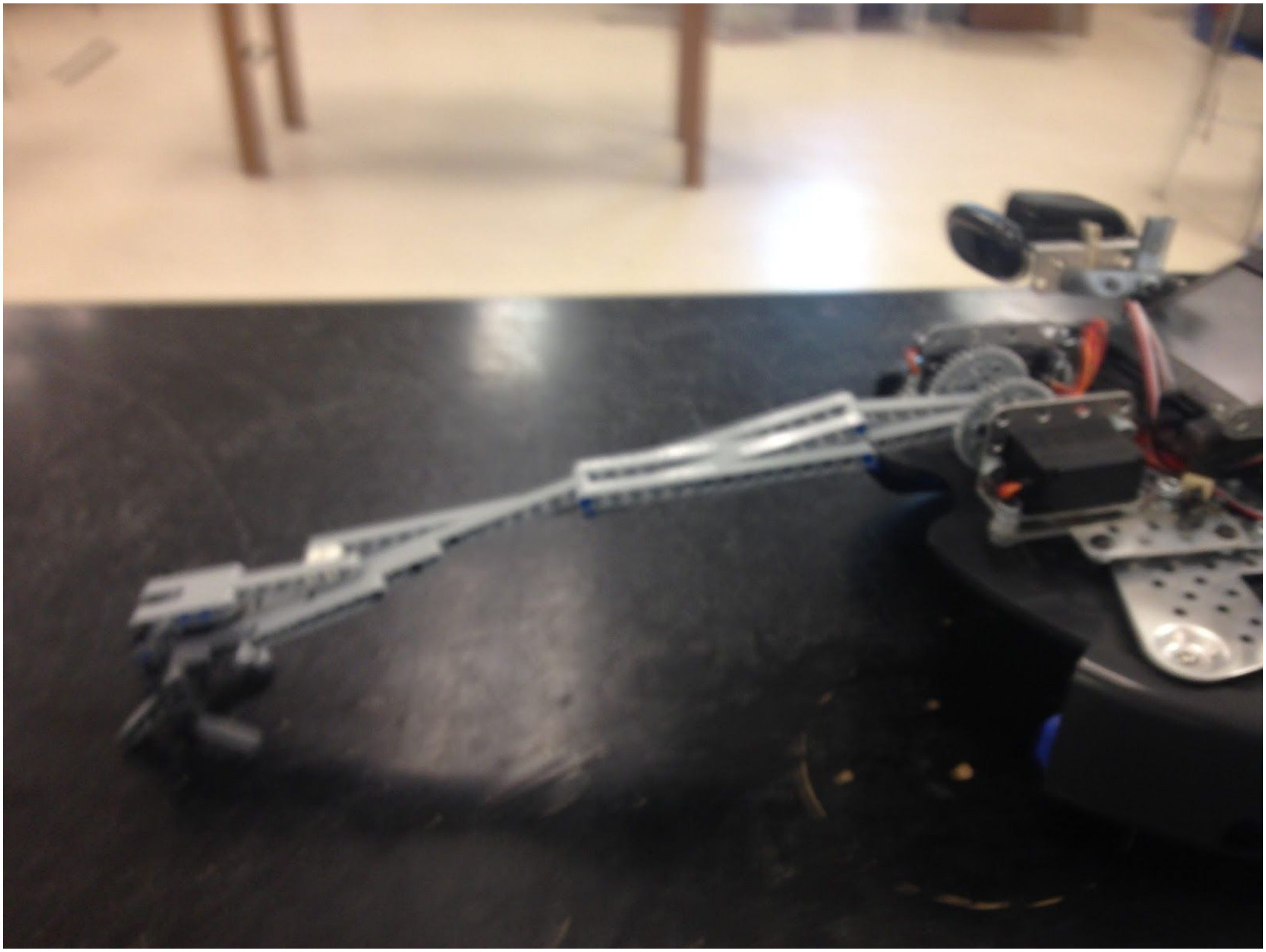
Our final design for our large robot ended up modeling a horizontal X-lift that is able to extend and contract, allowing for the grips on the end of the arm to close around objects. It was attached to a double servo mount so that both sides of the lift were connected to a servo, allowing for the maximum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

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. Another downside to this design choice was that



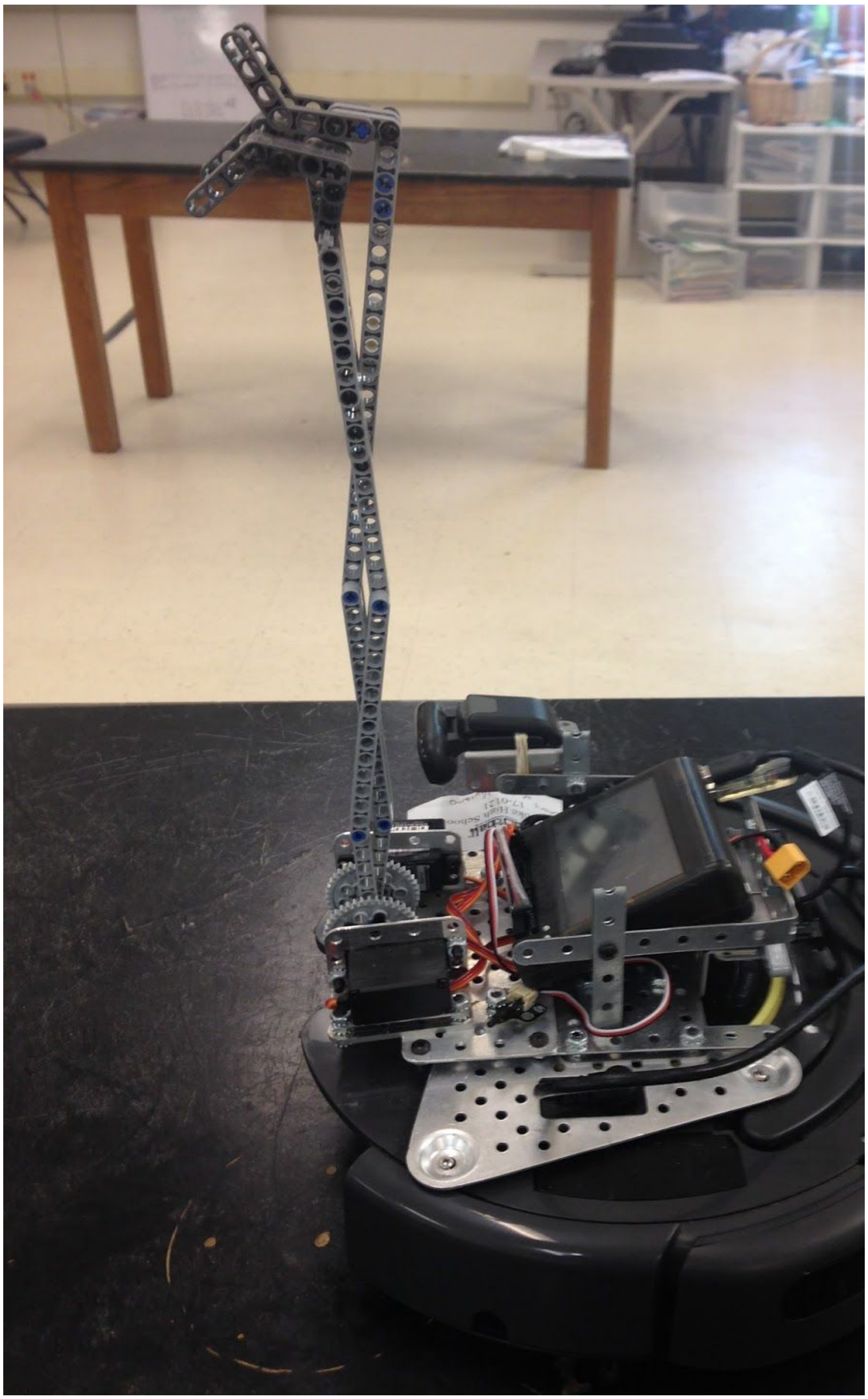
This caused for strange programming occurrences because we couldn't just set the servos to a position and note where they were, we had to make a process for how to arm would react to several changes in his environment, meaning how the arm would change when one servo moves while the other is stationary. 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 for 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.





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 fulling latching down on the objects, but we knew that servos positions allowed it to full close down applying.

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 flip 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.



Our final build was successful in it’s 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 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.