Project FF(Four-legged Friend)

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Introduction

Boston Dynamic team's Spot robot had been a pioneer in modern kinematic robots as well as a generator of interest in the field. However, Spot is a $75,000 piece of engineering that a typical college student simply cannot get their hands on to learn and experiment with. This is the main reason behind the creation of FF. I wanted to build a scaled, inexpensive and easily assembled working prototype of a quadrupedal robot that could be used as a learning tool for fellow students and children who are interested in robotics.

Design Process/Prototype

When the project was in its infancy, I already knew that I wanted to implement the 8 spare servos I collected from previous projects as 8 separate joints for the robot. The first 4 servos would be on the body as the main driver of the thighs while the other 4 would operate the knee joints. Initially I wanted to build the body parts on SolidWorks and 3D print them, but since I do not currently have access to a 3D printer, I opted for cardboards as a medium.

First I measured the servos then incorporated the shape into the parts. Since the servos were rectangular, I realized I could insert it into a rectangular cut out as well as gluing the mechanical arm to the cardboard to create motion when the servo rotates. The cardboards were cut to allow the part to fold in half, reinforcing the limbs and weight of the circuit by doubling its thickness.

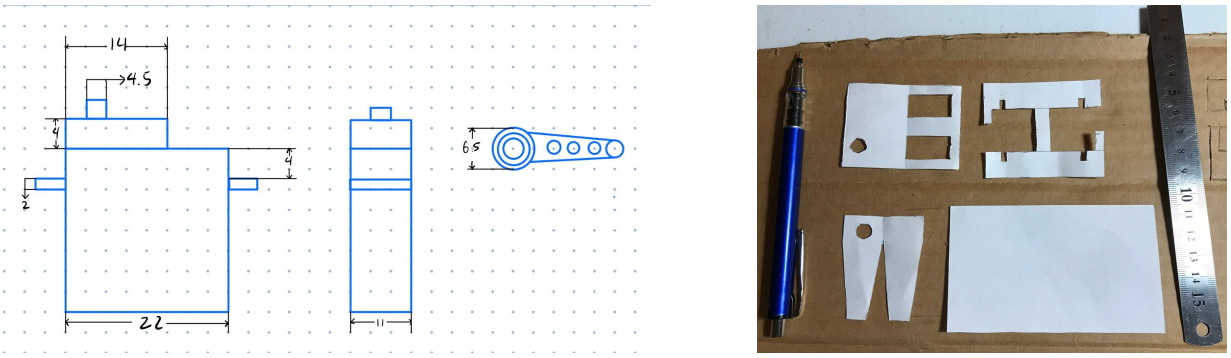


Figure 1: Dimensions of a typical micro servo and paper templates to cut parts from cardboard.

With the parts cut out and assembled, I tested the range of motion of each servo and adjusted them according to the degree of rotation of the joints. I also attached an ultrasonic to the body, which acts as eyes, enabling FF to walk or sit depending on if an object is detected in front of it.

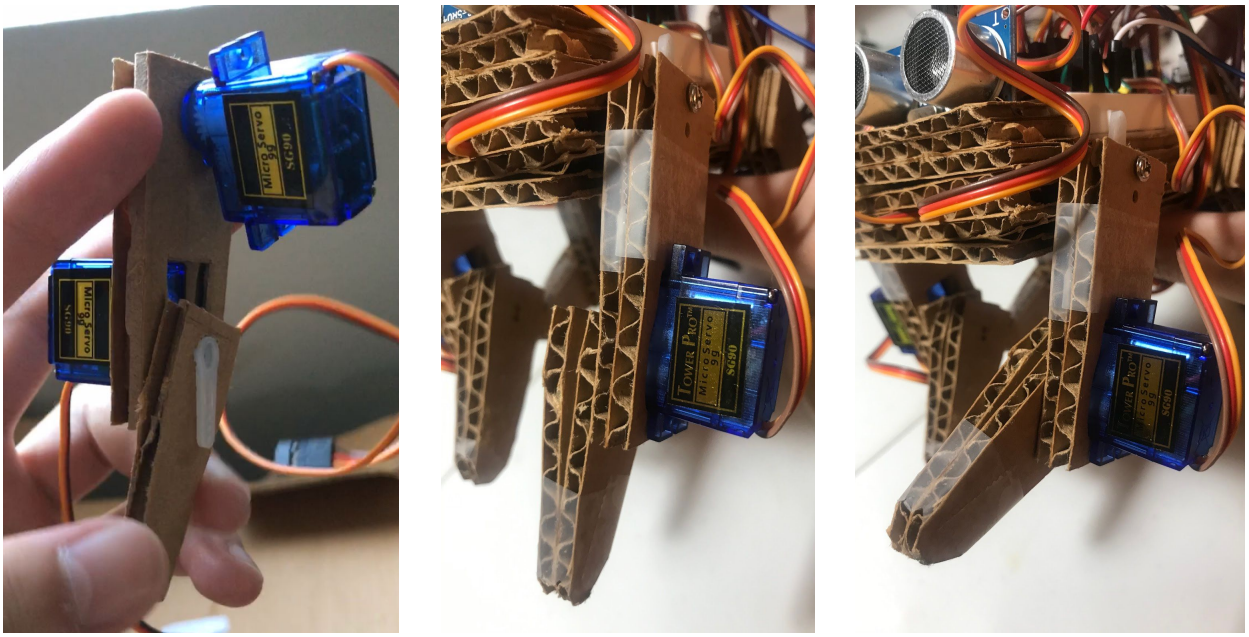


Figure 2: Leg joint servo attachment and leg movement

Next, I wired the circuit onto a breadboard and placed it on top of the robot's body and connected the Adafruit Metroboard. To program the robot's walking animation, I analyzed videos of animal strides and repeatedly changed the code of each servo to somewhat match the movement observed.

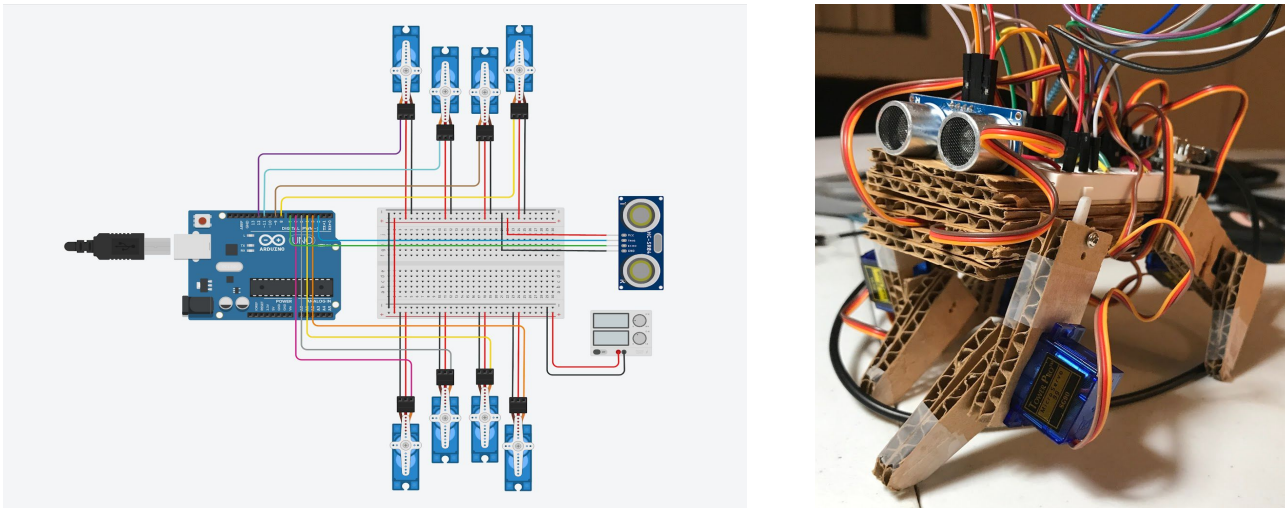
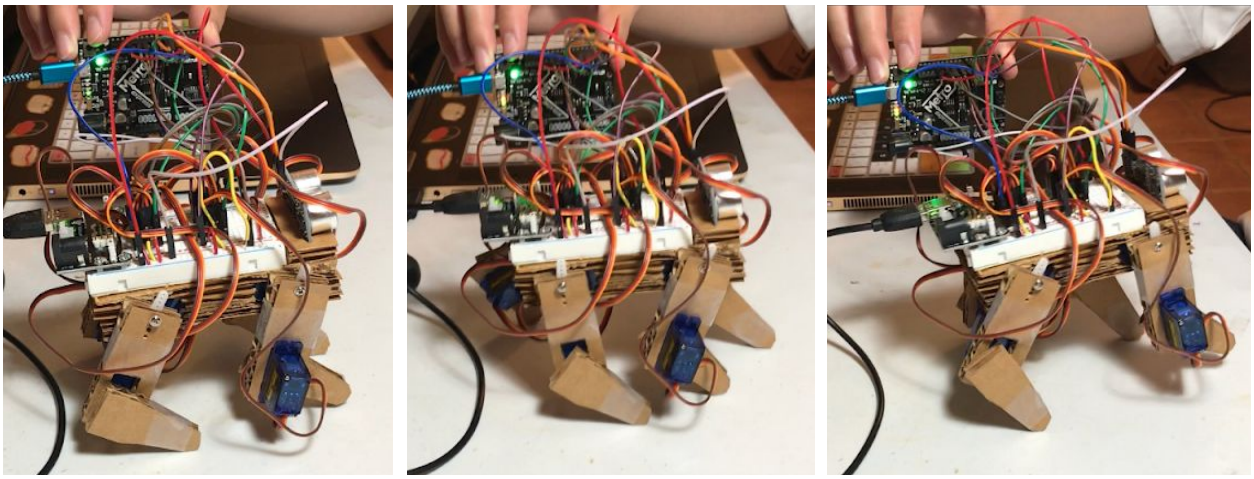


Figure 3: Circuit wiring and assembled product

Problems and Solutions

There were a few problems that I encountered while working on the robot. Firstly, since it was my first time working with cardboard, I had to revise my entire design several times before coming up with optimal parts. I decided to make the cut for the fold perpendicular to the cardboard grains so that it is both sturdy enough to be functional as a joint and malleable enough to be folded in half. Moreover, powering 8 servos drains a regular 9V battery more quickly than I had anticipated. I continuously readjusted the servos to replicate the gait of a 4 legged animal but the battery was fully drained in about 30 minutes. As the battery was draining, the servos became more and more unresponsive and jittered as not enough power was supplied. When this first occured, I thought that I had burned the servo motors and spent a lot of time debugging before figuring out what the problem was. Luckily I had a power bank that can supply the correct 5V and 2A required to sufficiently power all the motors at the same time.

Figure 4: Walking animation



Conclusion

I achieved my vision of creating a functional walking quadrupedal robot that is both inexpensive and easy to build. Although compared to Spot, FF can only walk and detect objects in its immediate front, the project is modular enough that more modules could be supplemented to add more functionalities. In the future, I hope to be able to fine-tune the walking motion to create a more realistic gait. Additionally, I want to create and print 3D parts so that the robot is more rigid and stable when walking. Furthermore, Machine Learning could be implemented where FF can learn to copy the gait of a certain animal. Finally, an app could be deployed to control our four-legged friend via bluetooth.

References

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