Josh

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STEM Project-Challenge: **In class STEM Project/Competition - Individual Non Team Project(s)**
Team Number:
Team Name: **Josh**
Project Team Members: **Independent**

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IDENTIFY PROBLEM(S) **Entry #1 by Joshua H on Wed Feb 14 2024 4:46:12 PM**

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Main problems seen in testing:

1. Cable management is bad and confusing
2. The motor brackets (things that attach motors to other motors are too short. 2.3mm needs to be added (split along both sides to make it even)
3. Motor output is not attached to the bracket via screws. This needs to be done to avoid slipping
4. Screws are missing from various places, and some motors are not attached to their respective motor housing.
5. Legs tend to slip on hardwood floors and other similar textures. Maybe look into different types of rubber for foot bumpers.

BRAINSTORMING **Entry #2 by Joshua H on Tue Feb 27 2024 1:47:17 PM**

Add Comment

For the first major problem cable management, there are a couple of different ways to improve how it is currently working. First off, some general tidying of where the cables are located are beneficial. For example, making the wires go directly through the motor housing and brackets would clean up the legs significantly, and attaching the

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smaller boards directly to the body will keep things more sturdy. Another option is shortening the cables. This could be done by actually shortening them somehow, or using cable ties to bundle sections of cable together. Finally, a new piece that we now have can be attached directly to the main motherboard, and then the motor cables can be plugged directly into this. This would make cable management much easier, eliminating the need for some of the smaller boards, and this can be used in unison with some of the other methods mentioned above.

BRAINSTORMING **Entry #3 by Joshua H on Tue Feb 27 2024 1:51:52 PM**

Add Comment

To solve the second major problem, which was the problem of the motor brackets, there are a couple of ways to solve this. First off, the easiest way would be to simply extend the length of the motor brackets. This ideally is done by increasing the length of both sides equally, so all sections of the legs are centred. By doing this, I can still use the previously printed bracket endcaps, making for less redesigning to be done, and simple reattachement. Another way to do this is by printing the entire bracket in one piece, but this leads to more problems, like figuring out how to get the motor within the bracket in the first place.

BRAINSTORMING **Entry #4 by Joshua H on Tue Feb 27 2024 2:05:19 PM**

Add Comment

To solve the next few problems, those of the motor output not being securely attached to the motor themselves, and the problem of screws missing from various places are relatively easy to solve. All that needs to be done is finding/ordering the correct size of screws for these various areas. Then the legs can be more securely attached, and there is no longer any risk of the motors slipping.

IDENTIFY PROBLEM(S) **Entry #5 by Joshua H on Wed Mar 06 2024 12:38:25 PM**

Add Comment

After re-wiring using the shield for the Arduino Mega the only issue that seems to have arisen is some of the motors twitching occasionally. This seems to be a problem with either the code, or the port, as when a different motor is plugged into the same port, the same issue arises.

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SELECT SOLUTION(S) **Entry #6 by Joshua H on Wed Mar 06 2024 12:41:17 PM**

Add Comment

To solve the issue of motor twitching, I will look into the code and make sure that no motor ports are also bound to anything else, which could be a major issue which causes this. If this does not fix it, I will shuffle around the ports the motors are plugged into until they are no longer shaking/twitching.

PROTOTYPING/BUILD **Entry #7 by Joshua H on Fri Apr 12 2024 12:18:18 PM**

Add Comment

When rebuilding the legs on the robot, everything was fairly simple. I made sure to redistribute screws to where they would be used the best and made sure that all the motors were properly attached to their respective motor housing, as for some motors, this was not the case before. Everything in building went well, and the robot is looking good and functional like before

TESTING **Entry #8 by Joshua H on Fri Apr 12 2024 12:21:10 PM**

Add Comment

Upon testing the general walking capabilities of the robot upon completion of rebuilding, I found it to be much better than before. The robot looked a bit more stable, and you could tell that all the various loose motors from before was no longer an issue. It was also nice to not have to readjust the motors often, as was needed before. The only thing I noticed was that the connection between the top two motors on each leg wasn't super secure, and when the robot would do certain movements, it would essentially rip its own leg off. I fixed this for when it happened to one leg, but soon later it happened to another leg, so this one connection needs to be improved. Otherwise, nothing physical seems to be of issue right now.

ITERATION/REDESIGN **Entry #9 by Joshua H on Fri Apr 12 2024 12:22:37 PM**

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To fix the issue of the legs breaking, I will disassemble a portion of each leg to give me access to the broken joint in question. I will add a further 2 screws that have been proven to work to this connection, so that the connection will remain strong, and should be a non-issue in the future.

PROTOTYPING/BUILD **Entry #10 by Joshua H on Fri Apr 12 2024 12:25:59 PM**

Add Comment

When updating the legs in question on the robot, everything went well. I made sure to use screws that have been proven to work, and when attaching them they seemed much more secure. Additionally, one of the legs seemed a bit loose from where it is attached to the main body of the robot, but a small amount of hot glue on that joint seemed to solve the problem. For now, everything seems secure and there is no slipping, but further testing will be required.

PROTOTYPING/BUILD **Entry #11 by Joshua H on Fri Apr 12 2024 12:29:44 PM**

Add Comment

After the rebuilding of the legs was completed, The next thing to do is cable management. Using the new Arduino shield, I will connect all the motors to this directly, and bundle all of the wires together in sections. I will also bundle together the 3 cables from each leg and run them through the motor housing directly, which will significantly reduce the "messiness" of the motor wires. After all the motors are attached, I will bundle up excess cable, and tuck underneath the main body of the robot, where the battery is. With some of the other cables, such as the whole battery and ps2 receiver configuration, I attached these as I saw fit, and zip tied extra cables. Overall, everything is now secured in place, and the robot is looking much better as a whole. This will be beneficial for testing, as cables getting stuck is no longer an issue, and for future modifications to the robot, as cables are no longer as confusing.

PROTOTYPING/BUILD **Entry #12 by Joshua H on Thu Apr 18 2024 5:13:59 PM**

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After the robot has been rebuilt, and cable management was completed, It is time for the next major step in the robot - Improving walking mechanisms. There are many different ways to do this. Some of the ways I will work on this is:

- Increasing traction on the legs
- Increasing the Speed the robot walks
- Increasing height legs move vertically when walking
- Increasing efficiency of walking movement

TESTING **Entry #13 by Joshua H on Thu Apr 18 2024 5:16:28 PM**

Add Comment

When working on the various changes made to walking mechanisms, there were a few things that I noticed. When changing the speed of the robot, "Done by editing the code if(gait_speed == 0) duration = 1080; else duration = 2160;", where a lower duration = faster speed, there was a point of diminishing returns. At around ~500 speed, the legs would start slipping a ton, and started to slow down, along with looking much less in control. This could be improved by increasing the traction on the feet of the robot.

TESTING **Entry #14 by Joshua H on Thu Apr 18 2024 5:19:43 PM**

Add Comment

When changing the height the legs moved vertically, I noticed that the robot seemed very unstable. The central body was moving around, and gradually being lowered as the legs could not support it properly. Several of the legs also ripped apart under the stress of this, so changing the height the legs step is not a good decision without other changes being made to the robot. It is worth noting that this should not be the case, as when three legs are walking, the other three are supporting the robot, and should do this without needing the walking legs. The robot needing the support of the walking legs could be a sign of a flawed walking code to begin with, and fixing this issue might fix things substantially.

TESTING **Entry #15 by Joshua H on Thu Apr 18 2024 5:24:10 PM**

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When changing the traction of the legs on the floor, this was the most detrimental change I have made to the robot. While the traction was

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increased, this also worked against me. As mentioned before, the body of the robot was somewhat supported by the legs that were actively moving, rather than the ones that should be supporting it. This made the robot try to walk in two separate directions essentially, destroying some of the 3D-printed parts beyond repair, and just generally being the worst walking change made so far. If the walking code is changed so that the robot is not supported by the moving legs, This increased traction could work very well, and could allow for very fast walking speeds, but this is a major undertaking and might not work out in the future. Overall, I will work towards doing this, and building some stronger 3d-printed parts.

TESTING **Entry #16 by Joshua H on Thu Apr 18 2024 5:26:10 PM**

Add Comment

For changing height of walking, the following codes need to be changed:
step_height_multiplier = 1.0; (1.0 should be increased a small amount) (line 243)
step_height_multiplier = 1.0; (1.0 should be increased same as before) (line 415)

TESTING **Entry #17 by Joshua H on Tue Apr 23 2024 6:10:24 PM**

Add Comment

Upon testing the robot, some more things have been realized. The robot walks well on default and at slightly higher speeds (800-1000) speeds when the height is set to 2.0. However, after some time, the robot starts to lose elevation as the motors are too weak. Eventually, the lifted legs start to drag on the ground, making it unable to walk after 30+ seconds. With some more testing, the tetrapod gait seems to work almost better. It functioned on ~700 speed, and 3-2.5 height. With some messing around, the legs did start breaking once more, and all legs need to eventually be replaced, and cable management needs to be redone. WIth the reinforced legs, it may be worth doing more testing with the tetrapod gait, as this seems to be more stable then the original tripod gait.

IMPLEMENT SOLUTION(S) **Entry #18 by Joshua H on Mon May 27 2024 4:20:19 PM**

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Over the time I spent working on this robot, I made many changes and improvements, and there are still some to be done. First off, I redesigned and reprinted the motor brackets several times to ensure they were the right size, and strong enough to support the legs without breaking. While these brackets are now much better than before, they still break occasionally, (specifically leg #2), and considering they are being printed with 4 walls and 30% infill, perhaps they could do with a major overhaul to the design of them. They tend to break along the layer lines as well. Furthermore, lego rubber wheels were added on to the legs of the robot to much improve the grip of the robot on various surfaces. This change came with many troubleshooting changes in the code, such as increasing the height of the step, increasing speed, and making the robot walk more on its "toes. furthermore, some troubleshooting was done in the code in various places, such as changing the rotation of a specific motor and changing ports. Finally, a Arduino mega "shield" was put on top of the board to make it easier to attach motors, and various cable management and cleaning was done to present a more clear and concise robot.