ExoActuator

Final Proposal

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DISCLAIMER

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EXECUTIVE SUMMARY

R8 KV110 motor brushless DC motor with the built-in hall sensor to overcome the effect of magnetic fluxes. The purpose of using this motor is to get the precise control of the rotor and the rotor can move smoothly and fast without posing any delays. The motor consists of a thin layer pad that reduces the heat dissipation as well. The torque produced by this motor lies in the range of 1.3 nm, but it can produce the peak torque of 4 Nm, that is quite high to move any kind of robot. This motor is used widely in robotics because of its easy operation with quick response and high precision. There are many reasons to use this motor which includes lightweight, minimum power consumption, high torque, small in size and it can control through the control quite easily. This motor comes with an MIT controller present in it and this can connect with the Arduino through the CAN-BUS. The PCB for the CAN-BUS with the Arduino can easily be designed, as the CAN-BUS needs to connect with the Arduino through a 4 pin connector and then uses the UART Band to communicate with the motor. The PCB for the Arduino to control the motor through the CAN but is a bit easy need only the CAN bus to connect with the input pins of the Arduino.

The motor can be used by the Arduino controller, as the motor contains a connector that can be used to connect with the Arduino and the Arduino will then connect with the computer. Where the commands can directly send from computer to the Arduino and Arduino will send those commands directly to the motor. Hence any changes can make in the control of motor like any stiffness value can use for the motor, damping ratio can change instantly, directions of the rotor can instantly select, the rotor can move with the steps and it moves to and fro etc. like everything can be done with this motor, it just needs to code the Arduino and set the speed, torque, stiffness, damping and other input values to operate the motor accordingly. These input values can upgrade instantly to change the motion of the motor. The update will affect the motor immediately and the motor will perform according to the new logic. The code in the Arduino can write with the Arduino syntax, and it just needs the logic to derive this motor as per the need. Another built-in function this motor contains is that it can detect the hurdle in the rotation and in case there is any hurdle present it will not keep pushing instead it will stop rotating or moving. Hence the motor can be used for collision detection as well.

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2 BACKGROUND

2.1 Introduction

Team Exoskeleton was asked to test control modes and design a motor controller for two types of actuators that may be used to retrofit a lower limb orthotic device, designed by the Biomechatronics lab at NAU. This orthotic device is used to research and/or validate rehabilitation techniques. The new actuators may provide more advanced control modes that could enable researchers to create more effective treatments. The team was asked to demonstrate effective control of a T-Motor AK80, the team was asked to do the same for a T-Motor R80 in addition to creating a motor controller PCB. These new motors offer a high torque to weight ratio and enable programmatic stiffness and damping. The researchers at the Biomechatronics lab plan to incorporate these new features into more advanced control schemes. These control schemes will be used to help persons with motor impairments walk more efficiently, thus enabling them to lead more active lives.

2.2 Project Description

Our team was tasked with the challenge of creating a testing bench to test the robot actuators. To test the actuators, the team must learn how to communicate with the actuator and its CAN bus protocol. The actuator has an integrated MIT Mini Cheetah controller and the team's goal is to make it move. After that is achieved then the team will make a controller for the mini actuators that the client has in his lab. These mini actuators do not have controllers built into them so the team will have to code a current controller into them themselves. If the team meets these requirements, then additional tasks will be added on as per client requests.

3 REQUIREMENTS

The client wants the team to build a testing bench for his lab that will help him in testing his actuators and motors with ease. The team will have to make the testing bench and make the actuators and motors move with code designed by the team.

3.1 Customer Requirements (CRs)

Required CRs to add to all projects unless given permission by the instructor to omit:

1. Build a test stand for th actuator that will be able to withstand peak operating conditions
2. Provide a method of measuring torque and speed of the motor
3. Make a circuit controller for the mini actuators that don't have circuit controllers built into them
4. Some additional requirements include: programming/validating various control modes, and (if time permits) retrofitting the exoskeleton
5. Within $3,000 Budget

(Requirements may be added over time if tasks are completed to the clients specifications)

3.2 Engineering Requirements (ERs)

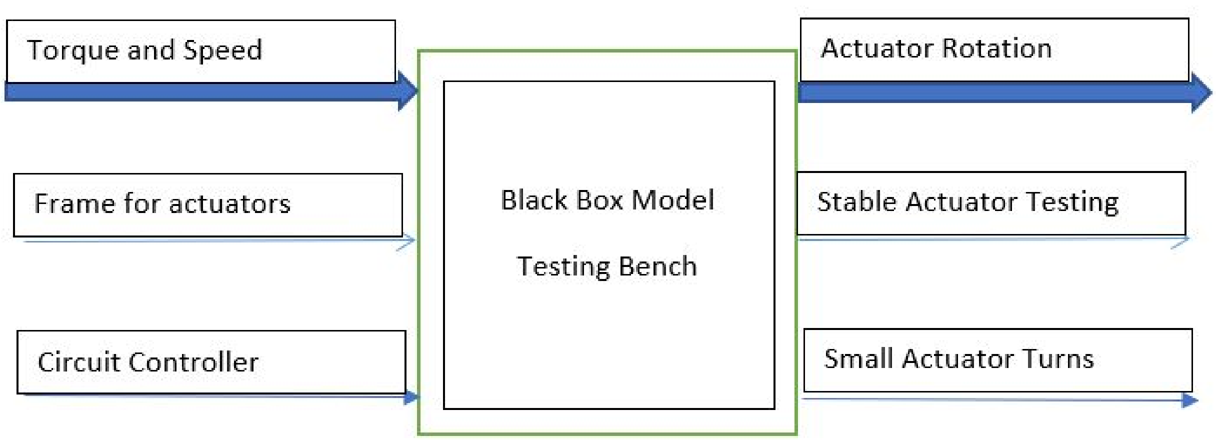
Engineering requirements:

1. Motor requires a maximum of 576 Watts
2. Controller should use CAN to provide current control to the actuator
3. Within $3,000

3.3 Functional Decomposition

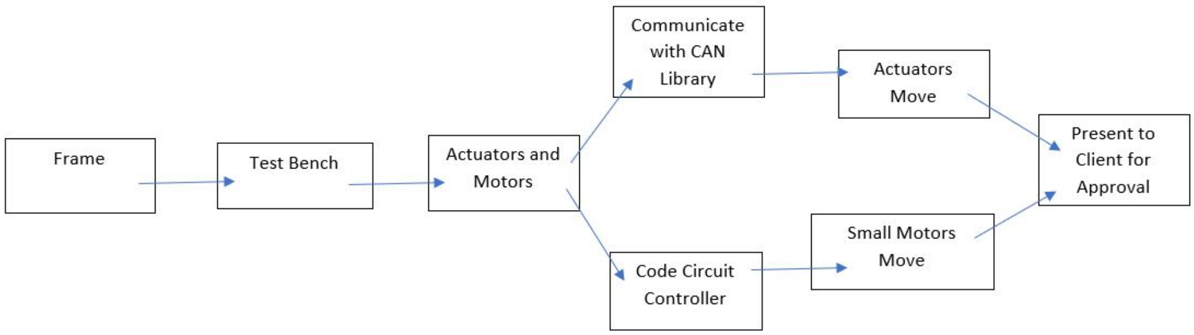
For the team, designing a test bench that will test multiple actuators is the first step, then the team is to make the actuators turn using the built in circuit controller in the motors that the team bought for the project. After those two criteria are done then the team will then move on to coding a circuit controller for the smaller motors that do not have a built in controller for the team to communicate with so the team will have to design their own. Once the team gets the motors moving and the client is happy with the results then the client will add more tasks to the team as time will dictate.

3.3.1 Black Box Model



Our inputs for this project are the following: a circuit controller for the smaller motors, a frame for the actuators to be tested on, and to measure the Torque and Speed of the motors. This will then produce the following outputs: the small actuator motors will move, the testing bench is stable and able to test multiple motors, and the final output will be getting the big motors to move. These inputs and outputs will be accomplished not in the following order but will be accomplished as soon as possible.

3.3.2 Functional Model/Work-Process Diagram/Hierarchical Task Analysis



The functional model shows the steps that the team will take to complete the set standards that the client has set for the project that he is sponsoring. The team will first get the frame, then build the test bench, afterwards the team will work on getting the actuators and small motors to move through either coding a circuit controller or communicating with the built in circuit controller via arduino. After these steps are completed then the team will go to the client and see if these components of the project are satisfactory to the clients criteria and if so then the client will add more tasks for the team.

Due to the motors being delayed progress on the project has slowed down but the team has the bench and has researched open source codes for the motors. When the motors arrive progress will go very quickly.

3. Testing Procedures (TPs)

Due to production issues regarding the motors, they did not arrive before the end of the semester. This caused the team issues in testing out the motors. Due to this the only testing that was able to be accomplished was through simulations on Solidworks. The three simulations that were done was to find the stress, displacement, and the strain of the 80/20 aluminum frame when the peak torque of 18 Nm per motor was applied.

3.1 Testing Procedure: Stress, Strain and Displacement of CAD model

This test was done in Solidworks due to the motor production issues as mentioned above. The main objective of this test was to ensure that the torque provided from the motors would not be too much stress, strain, and displacement for the frame to handle.

3.2 Testing Procedure: Objective

The objective of this test was to see how much stress, strain and how much the 80/20 aluminum extrusions will flex under the torque of each motor. Each motor outputs a peak torque of 18 Nm which was used for that value to simulate the worst case scenario.

3.3 Testing Procedure: Materials Required

The only materials needed for this test are a computer powerful enough to run the tests.

3.4 Testing Procedure: Schedule

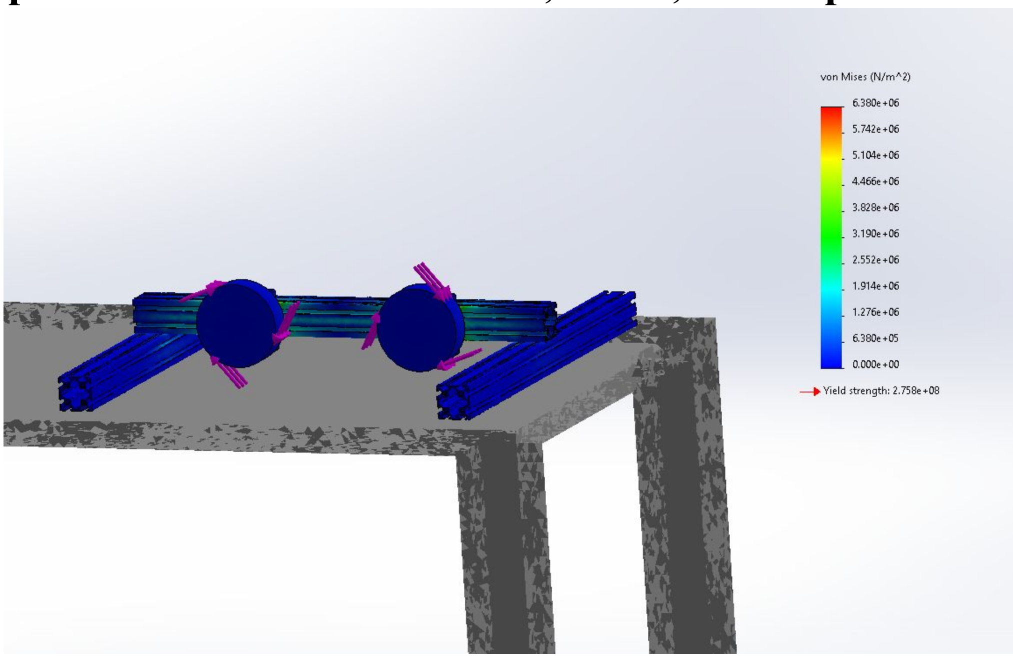
At the time of writing this report this test was already completed. The results show that there are no major issues with the material used to assemble the frame. Images of the results are in the appendix

4. Conclusion:

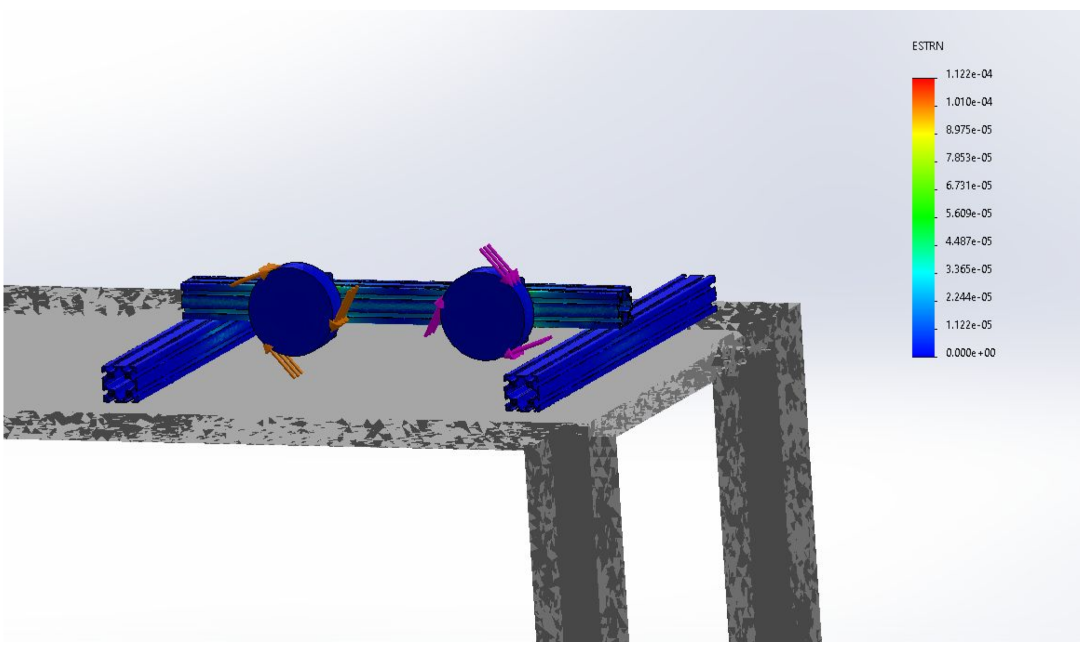
At the time of writing this report, the team is waiting for the motors to arrive and move the bench to the lab. Once the motors arrive the team will start looking into what open source codes that the motors are compatible with and then start working on putting the bench together and compiling the code for the motors to spin. Then the team will start working on the Circuit Control code for the smaller motors. The team will need to discuss with the client on whether the budget will need to be increased due to the changes in the project. The team will start to move more effectively once all the materials have been bought and acquired in the lab for assembly and coding.

Appendices

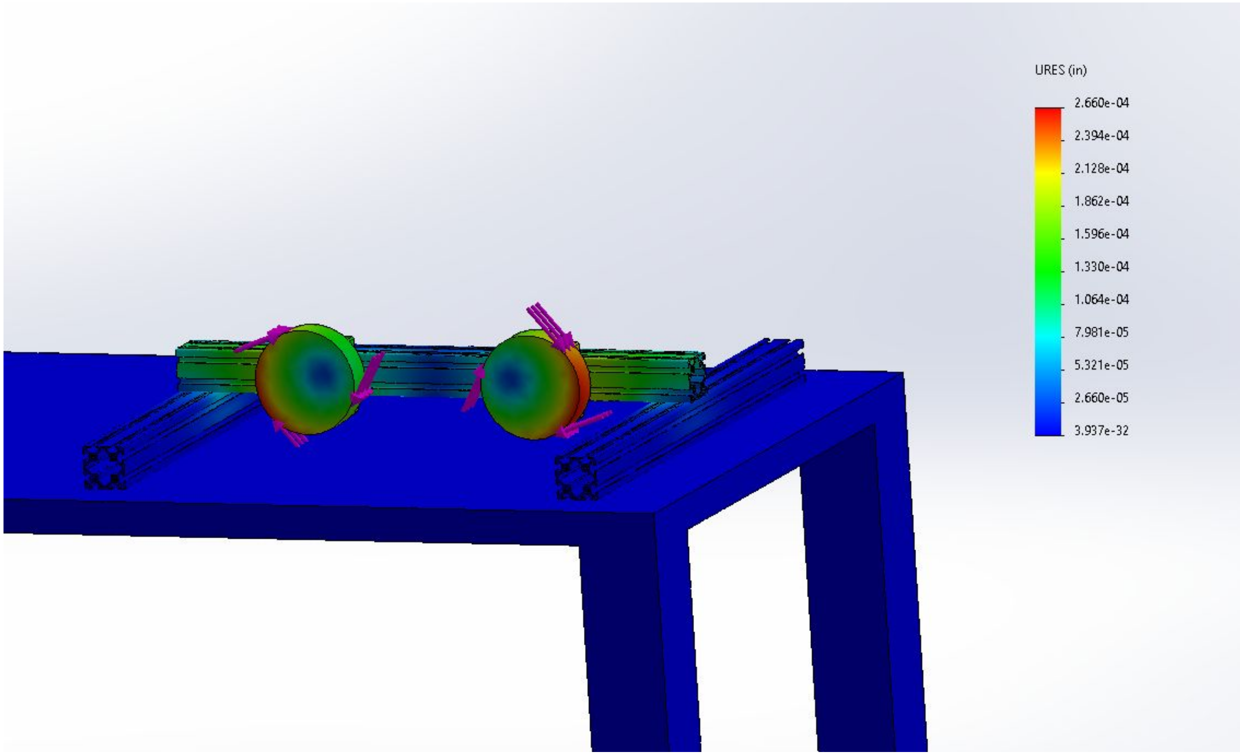
3.4 Appendix A: Results from stress, strain, and displacement tests



Stress Results



Strain Results



Displacement Results