Progress report 2023-08-18

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What I've been working on:

I have familiarised myself with OpenCV's ArUco module. It allows for pose estimation of markers, which would essentially allow me to output the state of the robot by placing markers on key locations. To calculate these positions from an image, the camera must first be calibrated. After calibrating my smartphone camera, I found that it was still not very accurate, I could identify points a metre away within 1cm precision, but that wasn't really enough.

While trying to find ways to improve the calibration, I started questioning what level of precision do I need and why? This led to the further question of how I would even use this data. Upon reflection I realised that tracking the exact position of components in the device throughout its movement doesn't really help me. The device will follow a fixed path within two dimensions, the only thing that could cause its path to vary is if it slips. To validate when and how the wheels or frame slip, I can just take a video of the device and note when it does, and confirm that the same happens in my model/simulation. There are of course other aspects I want to validate, but these don't appear to need position data either. When trying to describe the motion of the device, most of the time the answers are Boolean; either it does or it doesn't climb, either it does or it doesn't slip, etc.

This led me to consider what questions am I trying to answer with my model, which I started listing:

1. How does the device move, when does it slip etc?
2. How much torque will the motor need to climb stairs?
3. What coefficient of friction is needed on the wheels in order to climb stairs?
4. How can the design parameters (tail length, gear ratio, etc.) be changed to improve the ability to climb?
5. What are the differences and limitations when climbing consecutive steps?
6. When it climbs unevenly (one LIM moves ahead of the other), how much more torque does the trailing motor need to catch up?

I would like to reach out to Justin Pead; as he is the main stakeholder, he may have additional questions hew wants to be answered in this project.

If my model answers these questions and my physical device confirms the answers, I would consider the objectives of the project complete.

What I’m working on next:

Improving prototype: Will replace motor gearboxes with higher gear ratios for more torque.

Improve models: In order to validate the models, I need to confirm the parameters of my physical device. This means measuring masses so that the inertias in the model are accurate, and measuring the stalling torque of the motors at different voltages. I also want to update the models to be able to provide answers to questions 5 and 6, which I had not considered until I tested the physical device.

Model validation: I need to perform experiments to answer each of the listed questions, and compare this with the answers provided by the models.

Unchanged:

Next iteration: While building and testing the device I have been considering potential improvements for a future version. If time allows, I would like to build a second device after I have validated the model using the first device. The design of this device would consider lessons learned from the model, and multiple concepts could be quickly tested in simulation. The ideas I’m currently pondering include using bearings, herringbone gears, brushless dc motors, and possibly even connecting the two LIMs together with a bolt so they move rigidly together, eliminating the possibility that one moves ahead of the other.