Progress report 2023-08-11

RG Wells – 22961305

What I've been working on:

I have built a working prototype with LIMs based on Powrie's design. It uses that are geared to provide more stalling torque (specified 15 kg.cm, must validate) than Powrie's and the gearbox used is self-locking. I use sliders connected to the ADC inputs of an STM32 module to control the motors' power supplies through PWM. Each motor can be controlled independently.

The device was tested and could successfully climb up multiple consecutive steps, which goes beyond what Powrie reported. The reason for this success is likely the higher stalling torque and self-locking gearbox, which allows for easier control of each motor. However, the climbing motion is only successful if both LIMs flip at the same time, if one goes ahead then the other will not have enough torque to catch up. This is difficult to control manually, particularly during consecutive step climbing.

As discussed in our previous meeting, encoders could be used for a feedback controller but will be difficult to implement in the existing design and they appear to be prohibitively expensive. Simply increasing the torque may be enough to allow the LIMs to flip consistently with manual control. But even if not, the device can still be used to validate the model.

I have met with Prof Kristiaan Schreve to discuss video tracking. He also recommended OpenCV with aruco tags.

What I'm working on next:

Progress presentation: Preparing and practicing.

Improving prototype: Considering a higher gear ratio so that the motors have enough torque to lift a LIM even if it has fallen behind the other LIM. Also considering using a stronger brushless motor. I am also looking into current sensing for feedback control, which may give enough information to the controller to identify that one LIM is starting to move ahead of the other, allowing it to correct itself.

Model validation: I plan to start recording motion next week.

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.