COMP208-Scaling

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Objectives

Build a load bearing robot that should be able to climb two flights of stairs while carrying at least 2kg of weight such as a shopping basket. This load should be able to be placed at the bottom and easily taken off at the top:

- Climb two flights of stairs
- Turn a variable amount of degrees
- Carry at least 2kg

Research and Prototyping

At the start of the project we researched and prototyped two main ideas for how to achieve the goal. One using linear actuators and one using tank tracks.

The tank worked by having two tank tracks that gripped onto the stair using 3D printed L shaped tank track segments and a front tank track that came at a 90 degree angle and lowered itself to match the stairs' angle and aid in climbing.

The main complexity in this was in designing the tank track segments which clipped together to form any variable size tank track and creating a gearing system with a high enough torque to climb. I went through a number of iterations to create the tank track segments to find the best grip and also went through many different gearing mechanisms to get the correct torque.

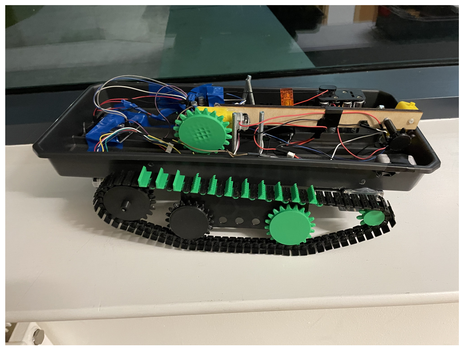

Figure 1:Tank Stair Climber

Linear Actuator Scaler

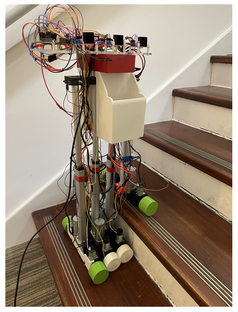

Figure 2:Linear Actuator

Design

Using a cybernetic approach applying a closed loop system utilising, sensing (laser sensors, light sensors and whisker sensors, controlling (finite state machine) and actuating (linear actuators and encoded motors). Due to the linear actuators being vertically tall this means the centre of gravity is higher causing stability issues so extra care has to be taken in designing the components to help stabilise it. There were a few iterations of the load carrying basket, at the start I used the idea of having handles to carry any sized object however hanging bags could cause sway and increase the stability issues so I designed a fixed basket that would hold items rather than bags. Furthermore the weight should be evenly distributed on either side so that there is no tilt to one side. The main material that is in use is PLA as it is cheap and biodegradable meaning that it is not as harmful to the environment as other plastics and it can be used in 3D printing to create custom components. Also being used is some scrap acrylic that was laser cut to mount the electronics, doing this means excess material is not being used reducing the impact on the environment.

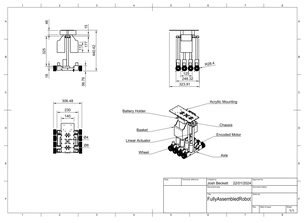

Figure 3:Measurements of stair climber

Programming

I took the lead in programming, the main challenge to overcome coding wise was ascending the stairs. The way I achieved this was by defining a state CLIMB.

```
procedure CLIMB
    raise first actuator up
    move forward
    stop above stair
    while first actuator not on floor do
        lower first actuator
    end while
    stop first actuator
    raise middle actuators up
    move forward
    stop above stair
    while middle actuators not on floor do
        lower second actuator
        lower third actuator
    end while
    stop second actuator
    stop third actuator
    all actuators up
    move forward
    stop above stairs()
end procedure
```

State Machine

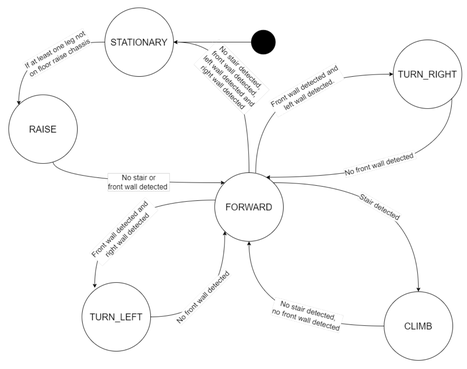

Figure 4:State Machine Diagram

Electronics

The following electronics were required:

- Linear Actuators x4
- JGY Encoded Motors x8
- Arduino Mega 2560
- L298n Motor Drivers x5
- 12V Lipo Rechargeable Battery
- VL53L0X
- IR Infrared Obstacle Avoidance Sensor Module

The diagram below shows how the electronics was constructed:

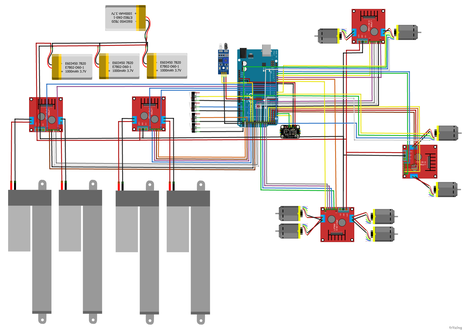

Figure 5:Component Diagram

Analysis of Final Product

After rigorous testing on the assigned stairs I have found that there are a few issues to make it work more effectively:

- Wheels with tires for extra grip.
- Whisker sensors that have a gentle slope to not get caught.
- More robust laser sensors that can take more readings without overheating.

References

[1] X. Lu, "stairs climbing robot," 2016. Last accessed October 15 2023.

[2] J. Bruton, "How this robot climbs up stairs," 2023. Last accessed October 21 2023.

[3] M. Watkins, "Introduction to cybernetics," 2023.