4CBLA20 Multiped Robot

Self-Study Assignment
Group 42

SSA No.	Description
8	Finishing Final Report
SSA Owner	
Pranav Joshi	

Introduction

As per discussions in the previous meeting and indications from the Project Supporting Lecture, the final report needs to be edited and further finished. Meanwhile, in the building session, the hinges need to be tested on the metal tail prototype to see if it works.

Goal

- To test a tail that folds with the help of hinges
- To redraw the images in the Concept Designs chapter
- To write as much of the Final Design Chapter as possible
- To make the final design CAD render

Problems

Unfortunately the images in the second chapter couldn't be redrawn in time for submitting this SSA. However this will be worked on and finished before the meeting on Wedenesday 25th March.

Conclusion

- A tail that folds (with the help of hinges) works well, however it does pose a risk of getting stuck at the metal bar checkpoint sometimes (as per 19th March)
- The final design chapter was written as much as possible
- The CAD render was added to the final design chapter

Recommendations

- The Wiring, Electronics and Programming Section should be written by Arkadiy since he wants to work on the final report and this would be the best match, given how closely he worked with the electronics.
- Pictures of the actual robot (final design) should be part of the final report, it needs to be discussed where these pictures should be put.
- Links to testing videos, references to the studies that Floris used for research in his SSA for tails can be put into the References page

- The testing plan needs to be put into the final report

1 Elaboration

1.1 Building Report for 19th March

In the two hour building session, the main objective was to test the working of a hinged tail as a concept. To do this, the metal profile prototype had already been prepared, the only work remaining was to assemble the robot and test the hinged tail concept.

However, many side-obstacles were faced during this building session. Firstly, the power cord that connects the power brick to the arduino had a broken pin. This cord was quickly replaced.

Since the power cord was replaced, the servos went out of sync due to manufacturing defects. Hence with the help of Arkadiy, the servos were synced up again.

After the first few test with the hinged tail, the following conclusions were drawn:

- The tail worked as predicted in the stairs section of the racecourse, the robot was able to get up both stairs
- The screws attaching the hinge to the metal profiles seemed to get stuck on the lip of the first stair
- The screws attaching the hinge to the metal profiles also got stuck on the metal bar and prevent the robot from crossing the finish line

The robot getting stuck on the bar and on the lip of the stair (as shown in fig. 1), was initially blamed on two screws being bolted on the wrong way, ie; longer side down. This was quickly changed by reversing the direction of the screws that were wrongly oriented.

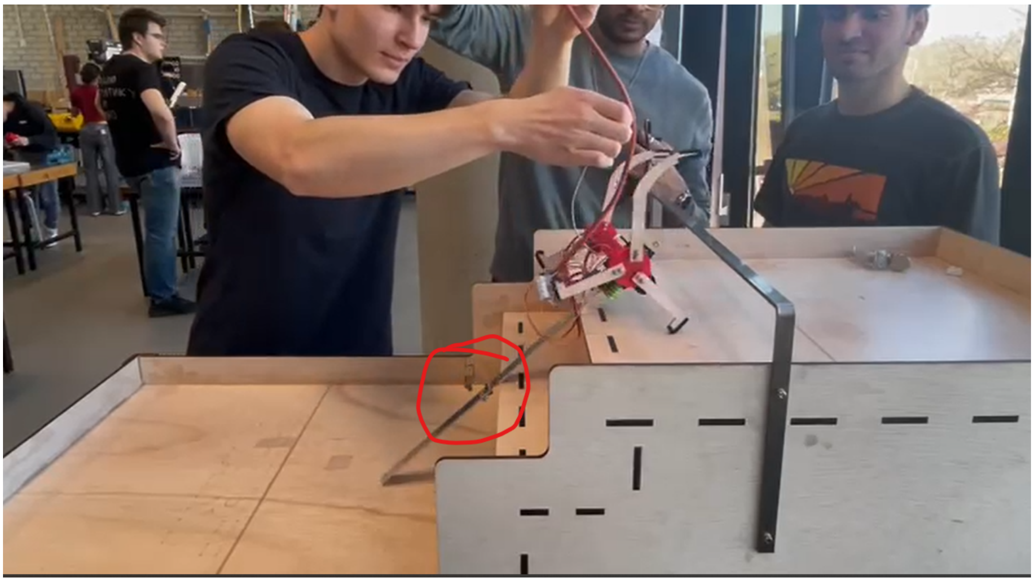


Figure 1: Hinge getting stuck at lip of stair

However, this **did not** resolve the issue completely. The robot was able to climb the stairs now, but it still got stuck at the metal bar due to the screws(as shown in fig. 2).

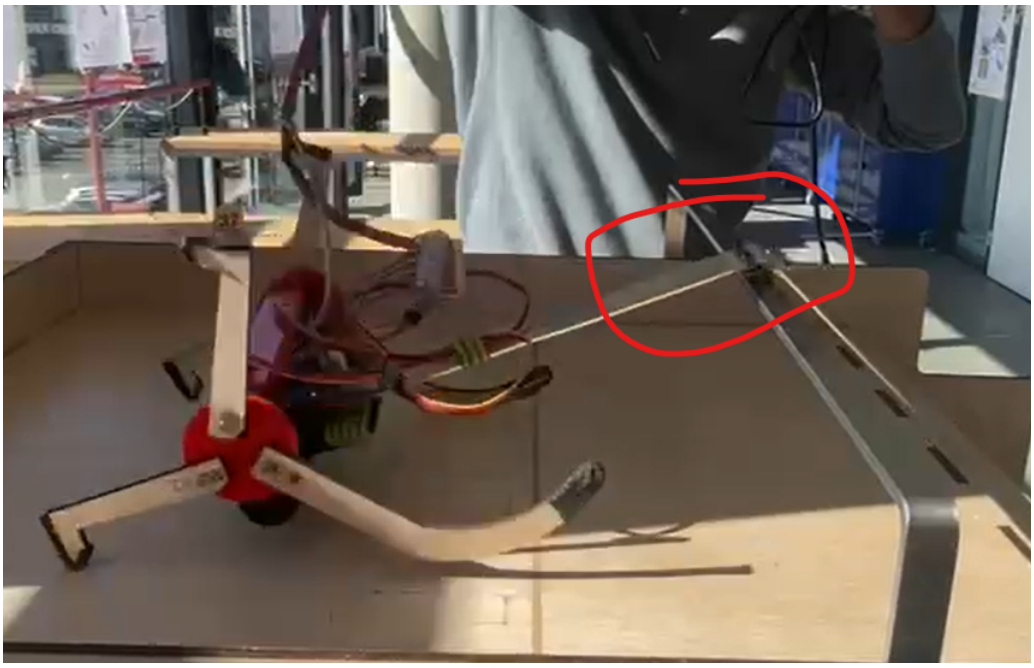


Figure 2: Hinge getting stuck at metal bar

To further ease the process of the hinge getting over the bar, the section of the hinge facing the bar was taped with electric tape to smoothen the contact surface and provide a gradual bump instead of the screws hitting directly onto the bar.

This helped initially, however it was not consistent. The robot was still unable to completely get past the metal bar. The building session was nearing its end, hence further prototyping could not be performed. However, with the current level of investigation, this problem is relatively easy to resolve and is being looked into by Anthimos.

1.2 Shortening Chapter 1 (RPCs)

A key take-away from the project supporting lecture was that the **first chapter can be shortened drastically** (hopefully down to half a page) to allow more space for the final design chapter.

The course coordinator clearly stated in the second project supporting lecture that they expect the final report to contain RPCs that are considered to be **unique to the group**.

This can be done in two steps, first by removing non-unique bullet points from the RPC list and then presenting the list in the form of a table. Directly quoting the rubric, **"a complete, well-reasoned RPC"** is expected.

The RPC list was shortened by first removing non-unique bullet points as shown in fig. 3

1 | The Design Question and Concepting

The goal of this project is to design and build a robot that can successfully navigate a predetermined obstacle course. A comprehensive seven-phase design process was put into place to do this.

These seven phases were realized by first, describing RPCs (Requirements, Preferences and Constraints).

1.1 | Requirements, Preferences, Constraints

Requirements

- The robot must be able to climb the two steps and go over or under the horizontal bar.
- The robot must come to a halt and cross the finish line in its entirety.

Preferences

- The wiring should be neat and organized
- The robot:
  - Has a high reliability.
  - Can be manually controlled.

Constraints

- The robot fits in a glass box of 30 x 30 x 15 cm.
- The design uses the following (but not completely limited to) electronics:
  - 1x Arduino UNO
  - Servomotors (180, continuous)
  - Cables, connectors, power supply (5V, 7A)
- The robot must be powered using an external cable.

Figure 3: Step 1

Next, the RPC list was put into a table as shown below in fig. 4. This has brought the page length of this chapter to half a page which is perfect. More emphasis can be given to the final design chapter by using 1.5 pages instead of the previously allotted 1 page.

TU/e Final Report

1 | The Design Question and Goals

The goal of this project is to design and build a robot that can successfully navigate a predetermined obstacle course. A comprehensive seven-phase design process was put into place to do this.

These seven phases were realized by first, describing RPCs (Requirements, Preferences and Constraints).

Requirements	Preferences	Constraints
The robot must be able to climb the two steps and go over or under the horizontal bar.	The wiring should be neat and organized.	The robot fits in a glass box of 30 x 30 x 15 cm.
The robot must come to a halt and cross the finish line in its entirety.	The robot has - High reliability. - Can be manually controlled.	The design uses the following (but not completely limited to) electronics: - 1x Arduino UNO - Servomotors (180, continuous) - Cables, connectors, External power supply cable (5V, 7A)

Table 1.1: RPC List

1.1 | Design Goal

Keeping the above RPCs in mind, priority was given to the **reliability aspect** when selecting a concept design. The goal was to deliver a robot that can perform consistently and with a high predictability of motion. The robot should also have scope for adjustments, to improve speed and overall performance.

Figure 4: Final Draft of Chapter 1

1.3 Chapter 2: Final Design

Indications from the Project Supporting Lecture suggest that the final report should specifically highlight the unique parts of the final design. Another new development from the previous week is that there is a page allotment of 1.5 pages for this section now (since only half a page is being used for the RPC list). So the major changes that need to be made to this section are the following:

- The CAD render (when made) can take upto half a page
- The subsection "Housing of The Electronics and Servo" can be temporarily removed/archived
- The wiring, electronics and programming subsection requires the most space, since it is the most unique part of the final design.

When it comes to the wheels, the unique factor is the one leg that is much longer than the other two.

Elaborating on this is key, and it is done in the following manner (as shown in fig. 5)

3.1 | The Wheels

The wheels contain three legs each, two legs that are equally sized and one leg that is longer than the other two (**refer to CAD render here**). The asymmetry in leg sizes maximizes the use of the geometric constraints (as seen in table 1.1). It ensures that the second step of the robot falls directly onto the first stair of the racecourse. This abnormal shape is crafted uniquely for this given racecourse, hence providing the concept with improved originality (as preferred and seen in table 1.1).

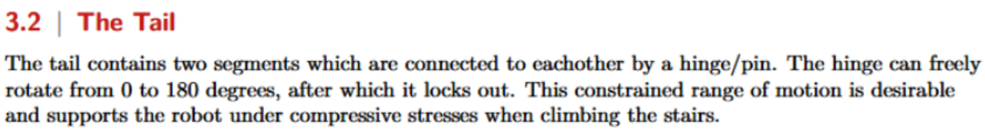
Figure 5: The Wheels Subsection

Note that the CAD render of the final design is yet to be made. it shall be done later in this SSA and elaborated on further. The table 1.1 that is referred to in fig. 5 is the RPC list table.

In the last SSA, a subsection for the housing of the electronics and servo was made. For now, this subsection has been **archived** (by commenting it out) since it **does not** contain a huge amount of unique work. The housing is quite straightforward and easy to understand by a full CAD render of the design.

It is more important to dive deeper into the Tail subsection and the Wiring,Electronics and Programming subsection. These segments differentiate the design and require further exploration.

The tail subsection was fabricated as follows. It was not elaborated in detail with respect to argumentation behind using a hinge, since this elaboration will be done in detail in the modeling section of the report.


3.2 | The Tail

The tail contains two segments which are connected to eachother by a hinge/pin. The hinge can freely rotate from 0 to 180 degrees, after which it locks out. This constrained range of motion is desirable and supports the robot under compressive stresses when climbing the stairs.

Figure 6: The Tail subsection

1.3.1 Redrawing the Conceptual Designs in Chapter 2

Firstly the jumping robot was redrawn, this was done as shown in fig. 7

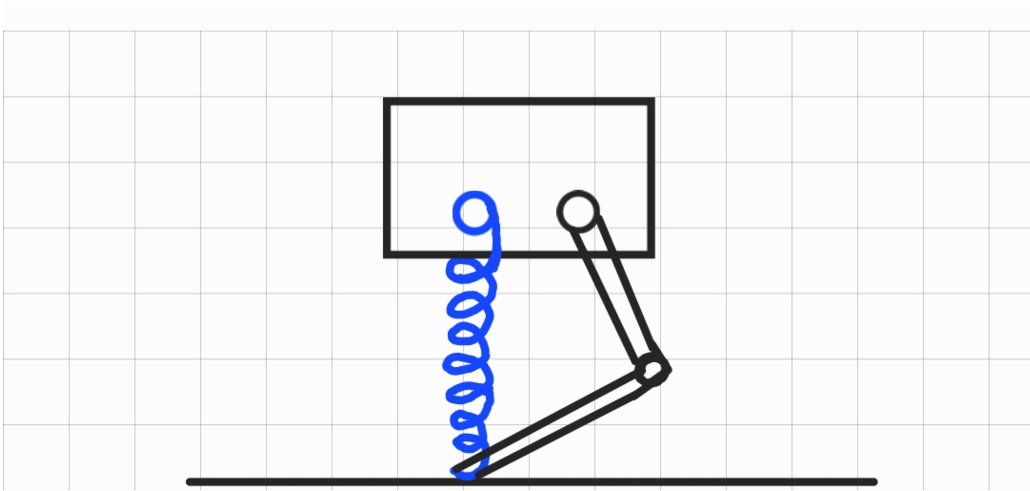


Figure 7: Jumping Robot

This was followed by redrawing the grapple hook design as shown below in fig. 8:

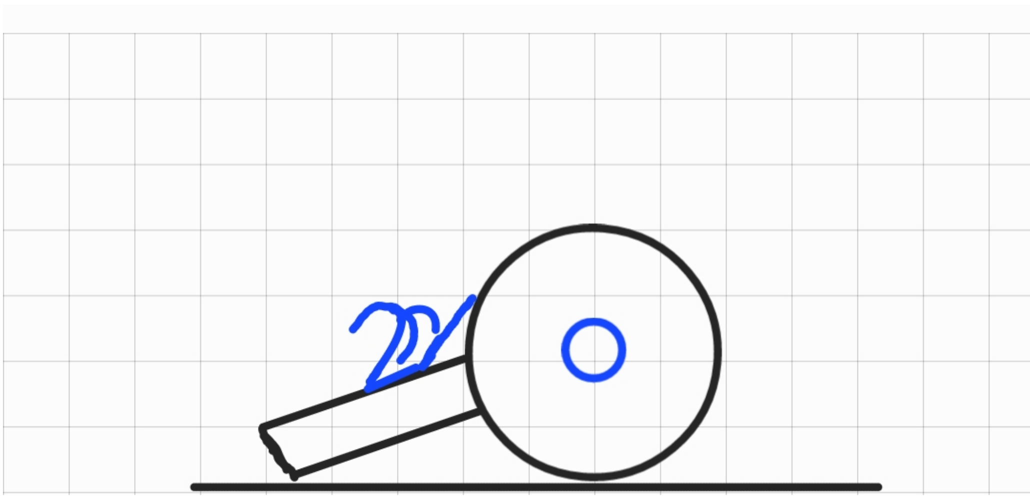


Figure 8: Grapple Hook Robot

The grapple hook robot drawing was a bit difficult to replicate, perhaps it needs to be redrawn if it is not clear enough.

1.4 CAD Render

For this section, firstly the new arduino housing (base frame) was imported as shown in fig. 9

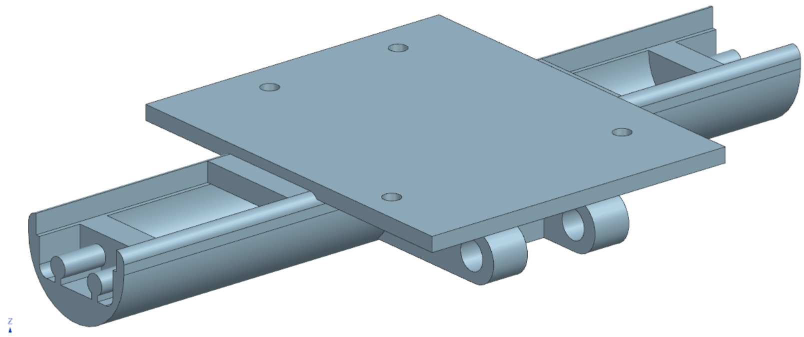


Figure 9: Base Plate

This was followed by assembling the servomotors and the legs as shown in fig. 10

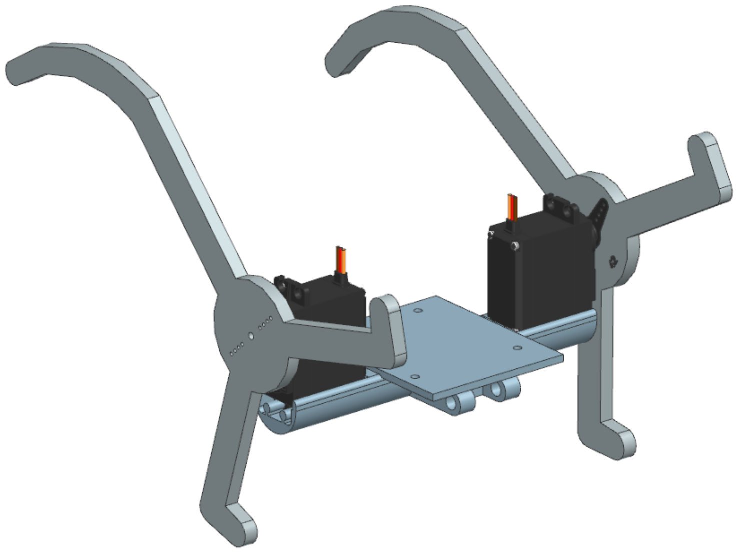


Figure 10: Servo motor and legs assembly

Following, the top plate was added as shown below in fig. 11

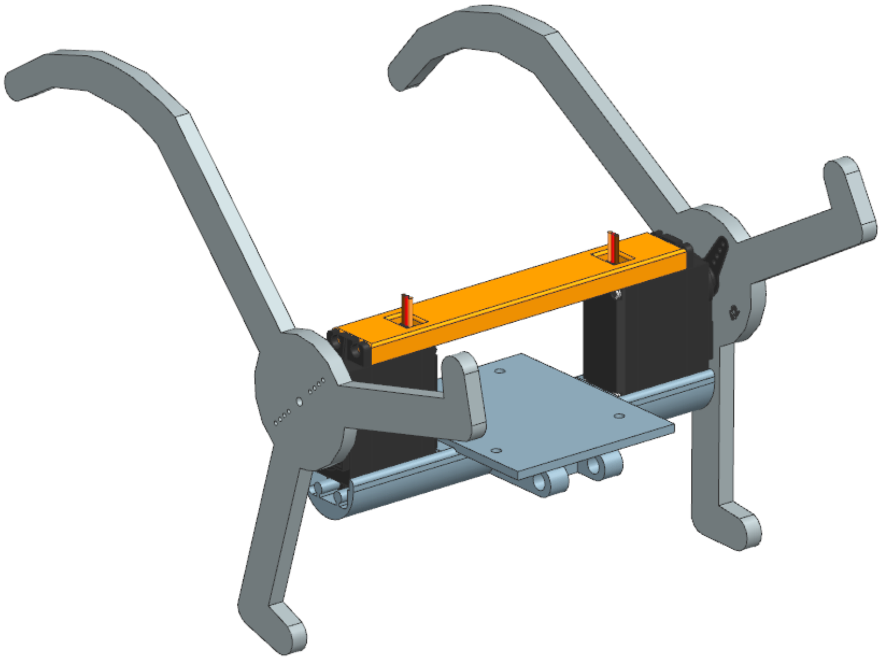


Figure 11: Top Plate

The tail was assembled in parts and constrained accordingly.The hinge was added underneath the joint. These changes are displayed below in fig. 12

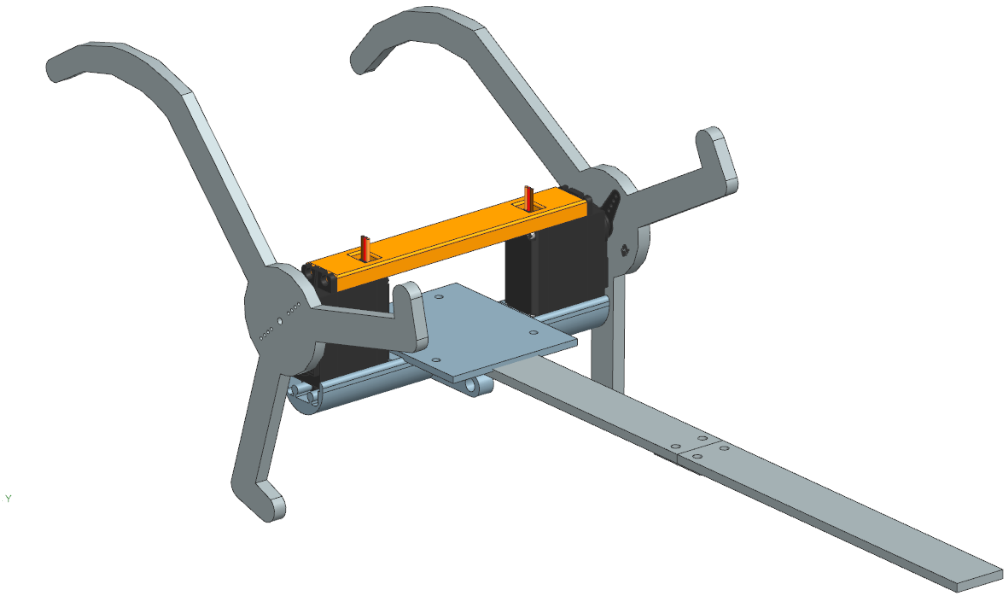


Figure 12: Tail assembly

Next, a unique color was added to each component to provide an element of visual differentiation. This is shown in fig. 13

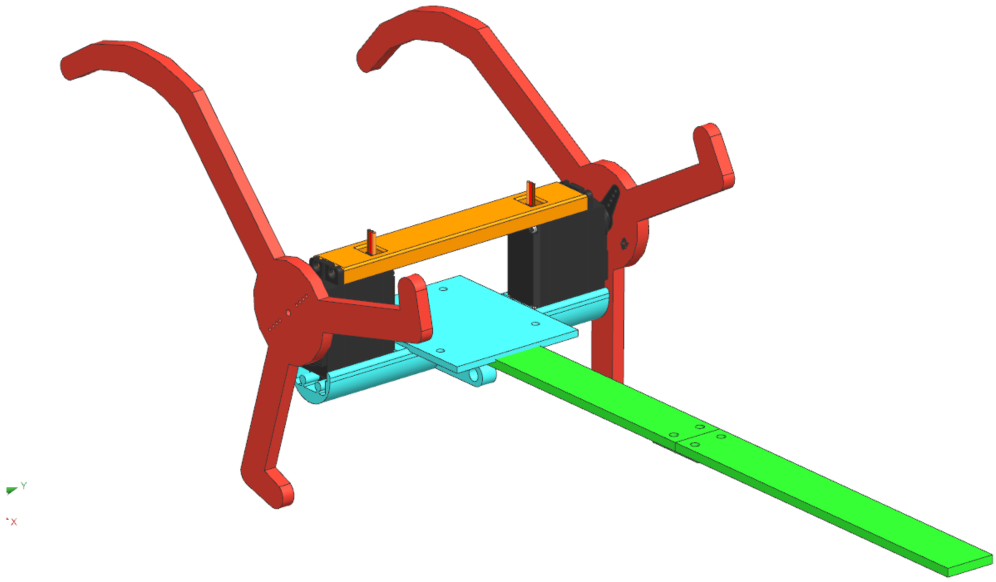


Figure 13: Colored Render

Finally, each part needs to be labelled and numbered as shown in fig. 14. This was done using online platform canva [1]

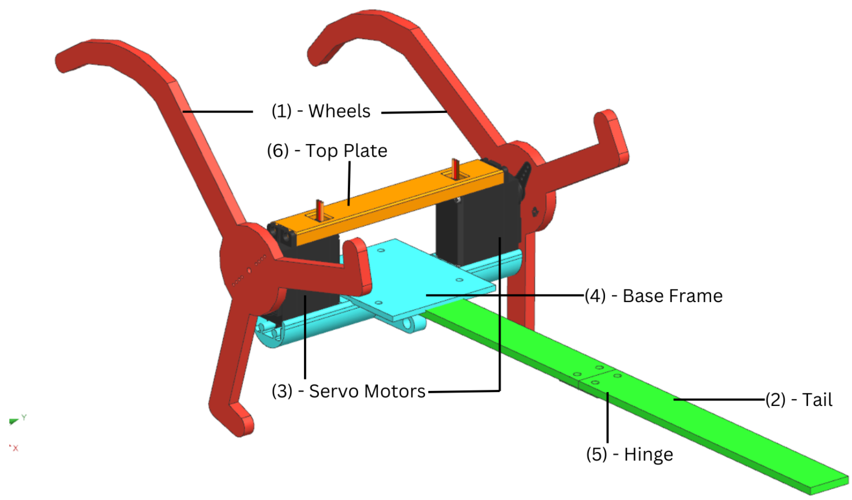


Figure 14: Labelled CAD Render

This render was added to the final report.

Overleaf Link to this SSA

`https://www.overleaf.com/read/vbbwhynfkhmt#08ac9d`

References

[1] *Canva*. URL: `https://www.canva.com/`. (accessed: 25.03.2024).