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Virtual Design Review 4

Team 515 – Controllable CVT Device

Kemani Harris, Aaron Havener, Jacob Hernandez, Aliya Hutley, and Cade Watson

01/28/2025

Meet Team 515

Kemani Harris
Dynamics Engineer

Aaron Havener
Controls Engineer

Jacob Hernandez
Design Engineer

Aliya Hutley
System Engineer & POC

Cade Watson
Materials Engineer

Sponsor & Advisor

Florida Agriculture & Mechanical University and Florida State University

Dr. Carl Moore Jr.
Associate Professor

FAMU-FSU College of Engineering

Cade Watson

Objective

The objective of this project is to enhance the education of haptic robotics by creating a device using continuously variable transmissions (CVTs). The device is intended to utilize computer control and move through various positions to produce accurate output motion.

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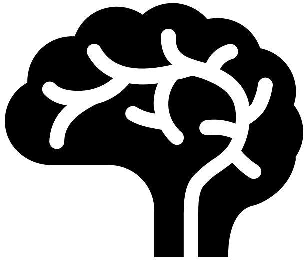
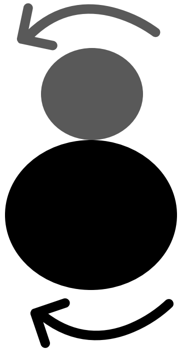
Cade Watson

Recap

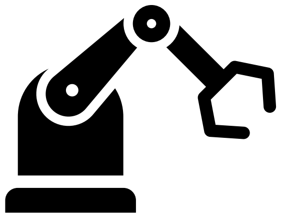
The primary goal of this project is to utilize CVT technology to present to STEM-curious students:



General autonomous robotic technology



The mechanical principle of CVT's



The use of CVT's in robotics

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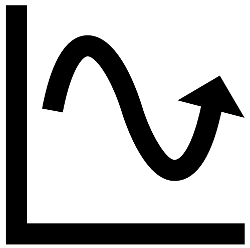
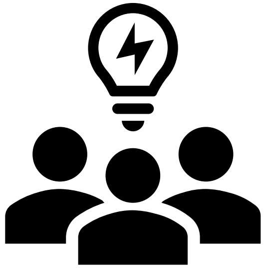
Recap

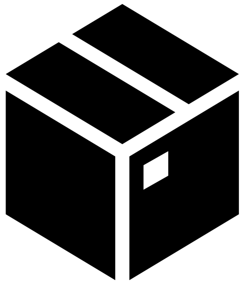
Other key design goals have been and still are:



Precise, autonomous two-dimensional movement



Customizable, well-displayed, and engaging output



Use in multiple locations

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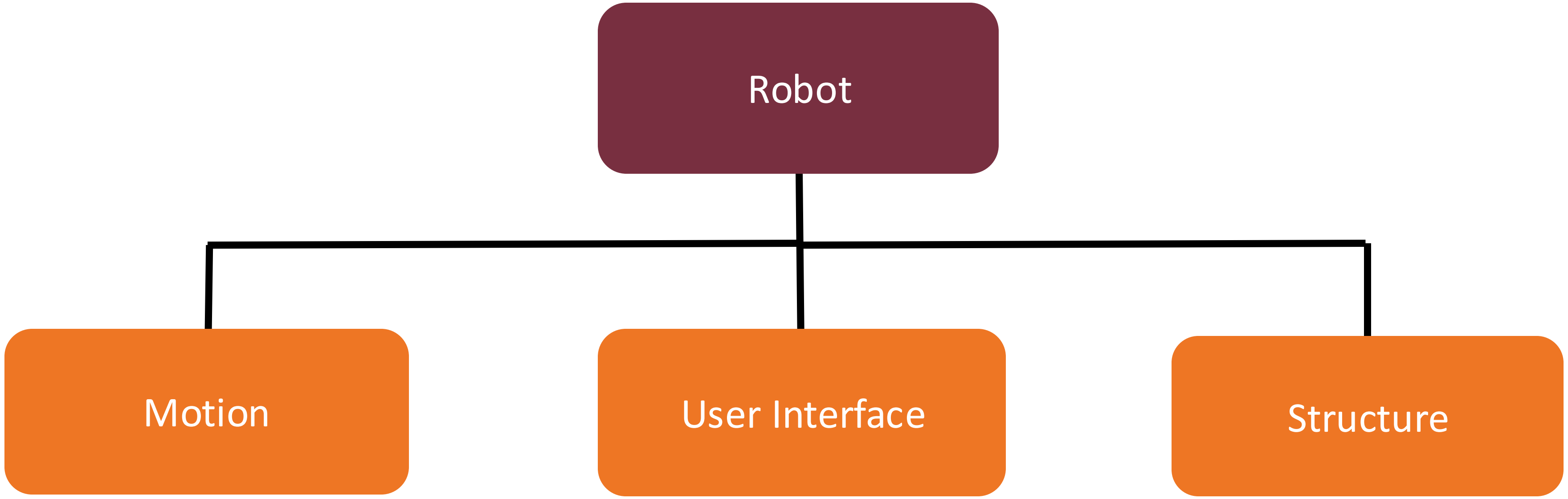
Recap

Three main systems are employed:



Proposed Concept

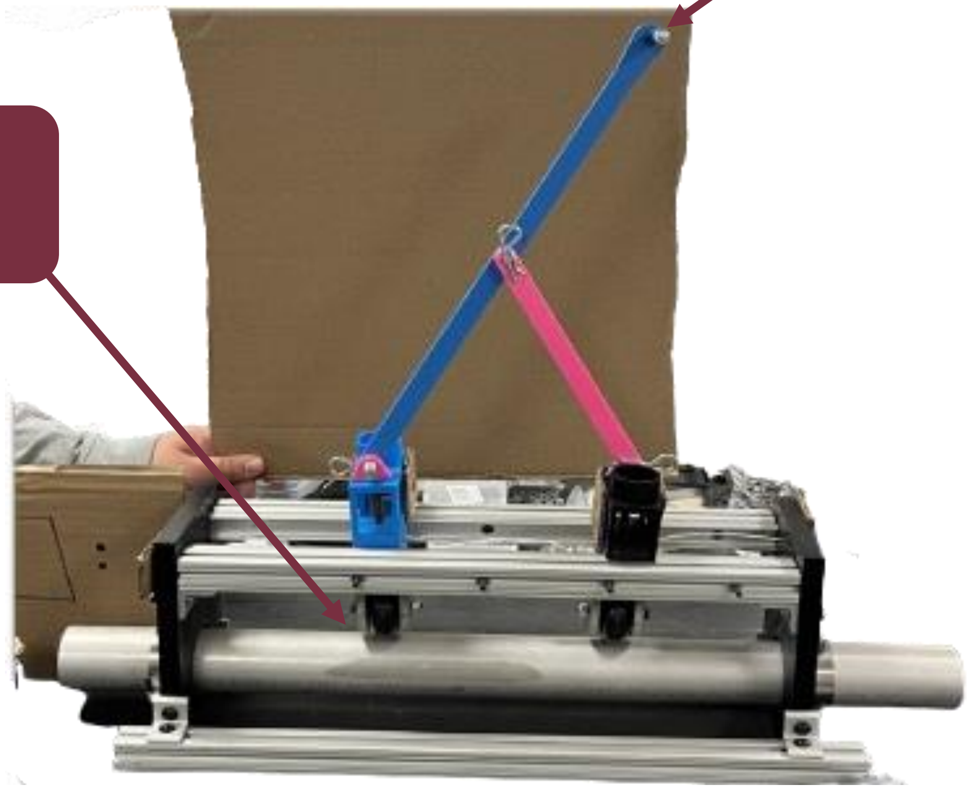
The selected concept from Fall Semester utilizes two-dimensional motion to create an interactive guessing game using light.

However

Sensing and control design was underdeveloped

Linkage design was neglected

Rolling material choice was left unverified



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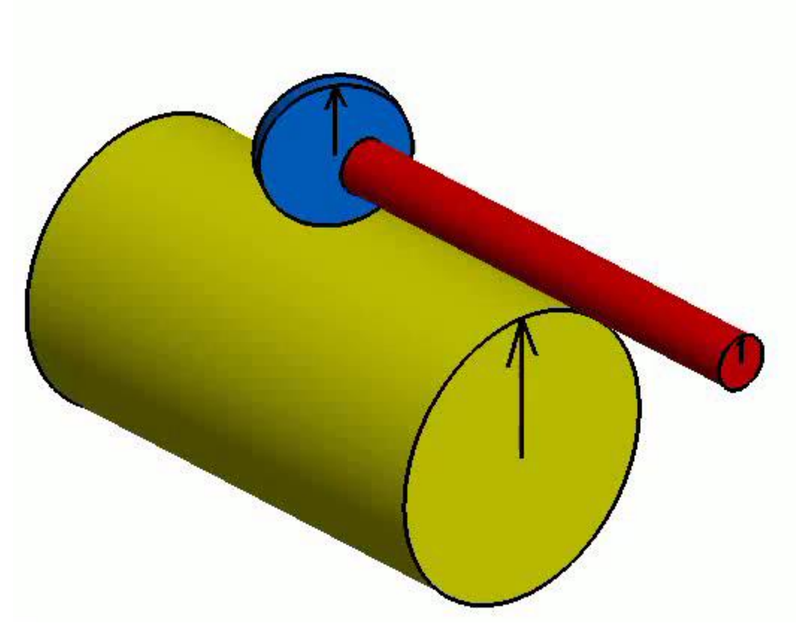
What Has Been Done? Motion System: Rolling Member Material Selection:

- Need for both rolling and slip drives material selection
- A design friction coefficient of 0.215 was previously calculated
- Material hardness is also a consideration



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What Has Been Done? Motion System: Rolling Member Material Selection

Cade Watson

- A Polyurethane wheel - PVC cylinder combination was originally proposed, but:
  - Determining a friction coefficient was difficult
  - Previous issues showed a harder material was needed
- Nylon and Aluminum showed to be great candidates for materials (μ near 0.3)
- A 2” diameter Nylon wheel (left) and 3” diameter Aluminum cylinder (right) has been selected

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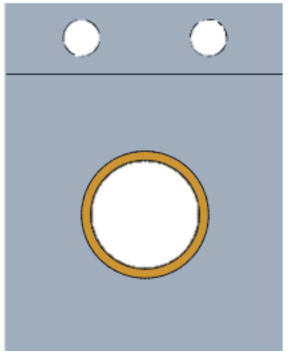
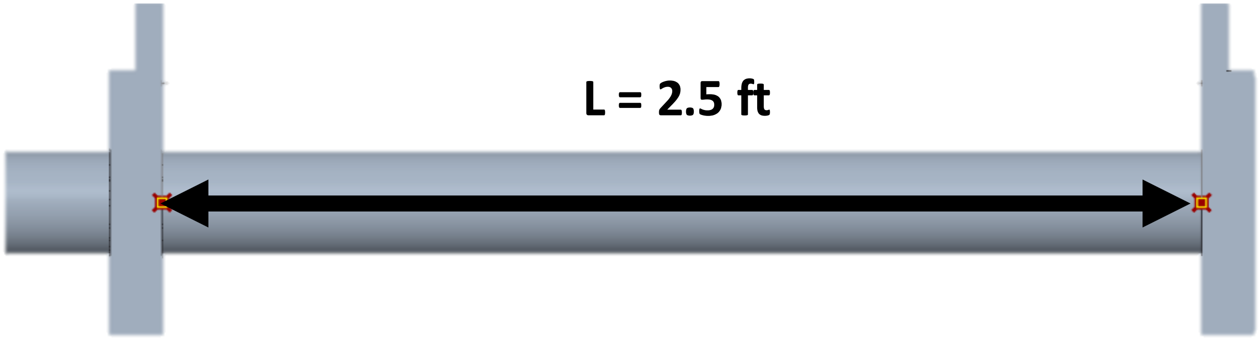
What Has Been Done? Motion and Structure Systems: Base Design

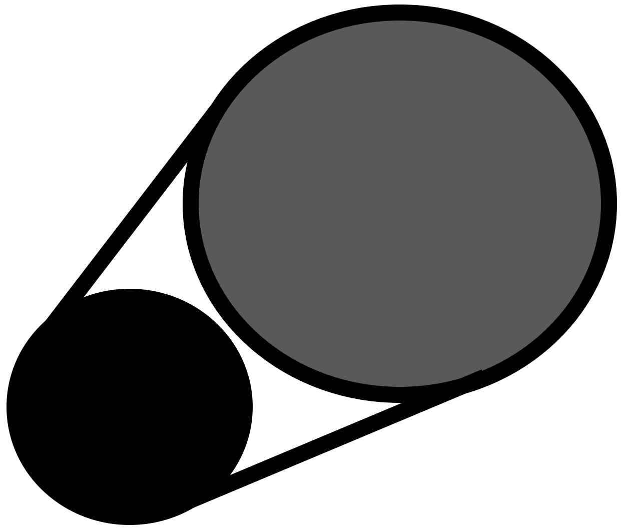
- To maximize output size while maintaining a reasonable footprint, a nominal cylinder length of 2.5 ft was chosen (shown by black arrow on right view)
- Plain bearings have been proposed to support rotation (shown by brass color on front view)



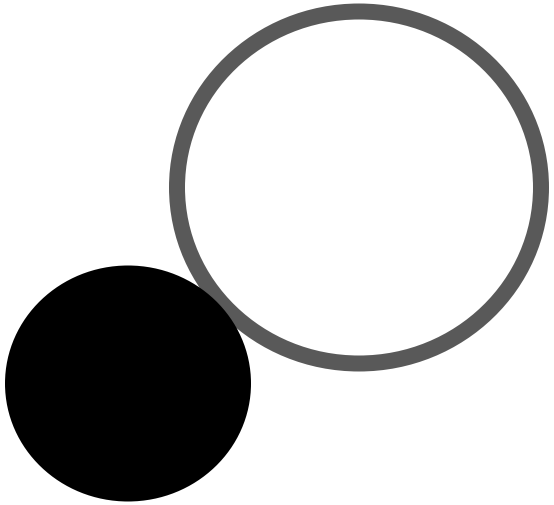


What Has Been Done? Motion System Cylinder Power Method

To transfer rotational mechanical power from a source to the cylinder, multiple options are currently being explored:



A belt drive mated to a pulley or some frictional sleeve on the cylinder (more consistent power transmission, but proving to be costly in both time and finances)



A frictional drive using some preloaded wheel attached directly to the cylinder (simpler, but slip is possible)

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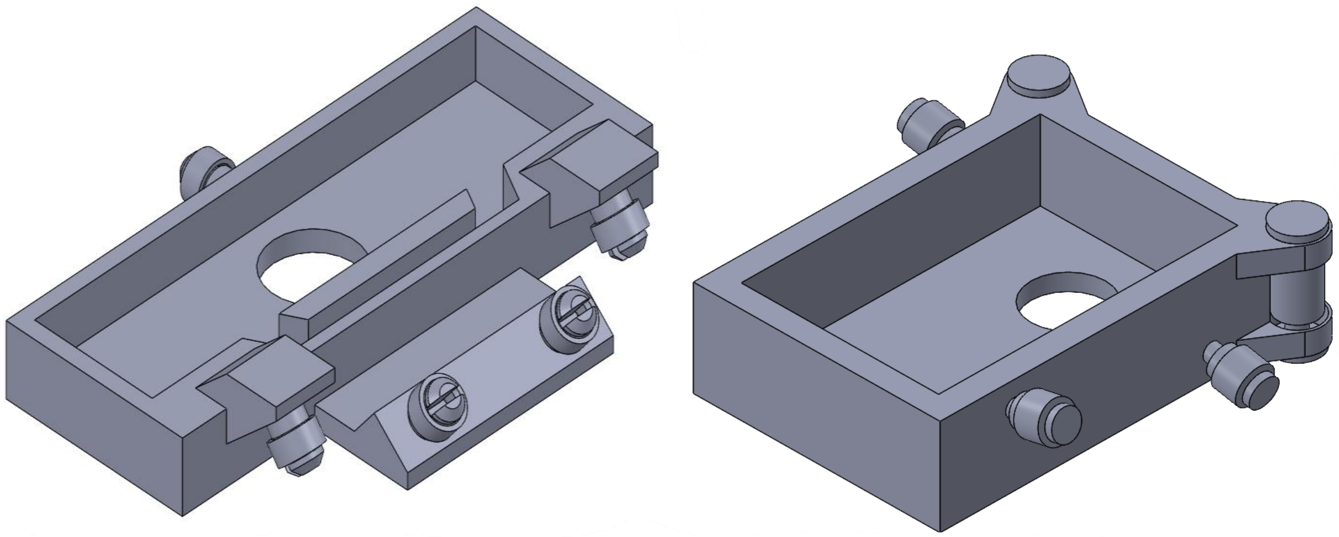
What Has Been Done? Motion and Structure Systems: Carriage Design

Jacob Hernandez

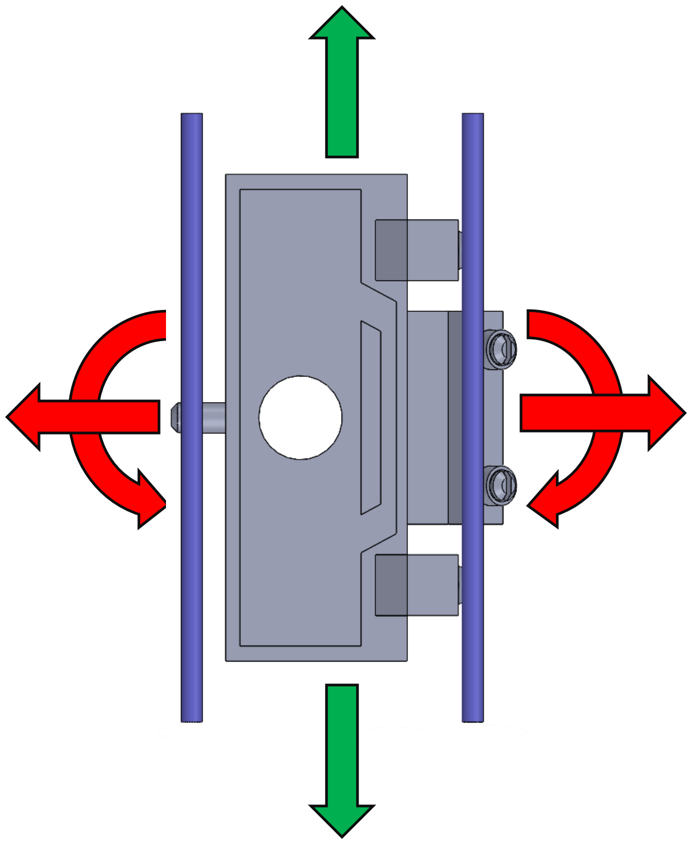


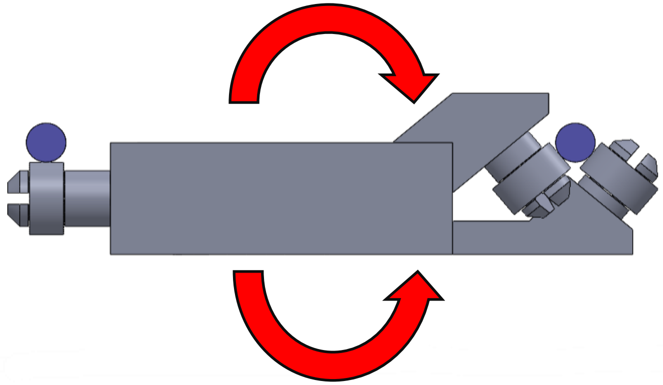
Goals:

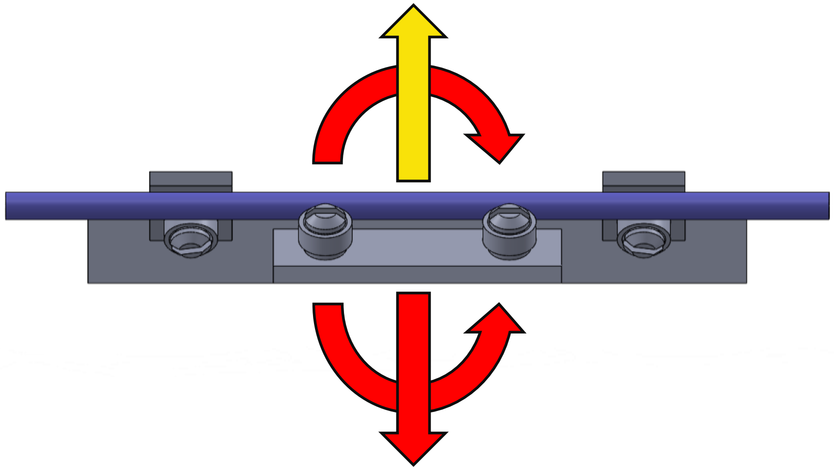
- Achieve 1 DOF
- Accommodate for different types of component arrangements
- Ensure smooth movement

What Has Been done?
Motion and Structure Systems:
Prototype Carriage 1

Jacob
Hernandez







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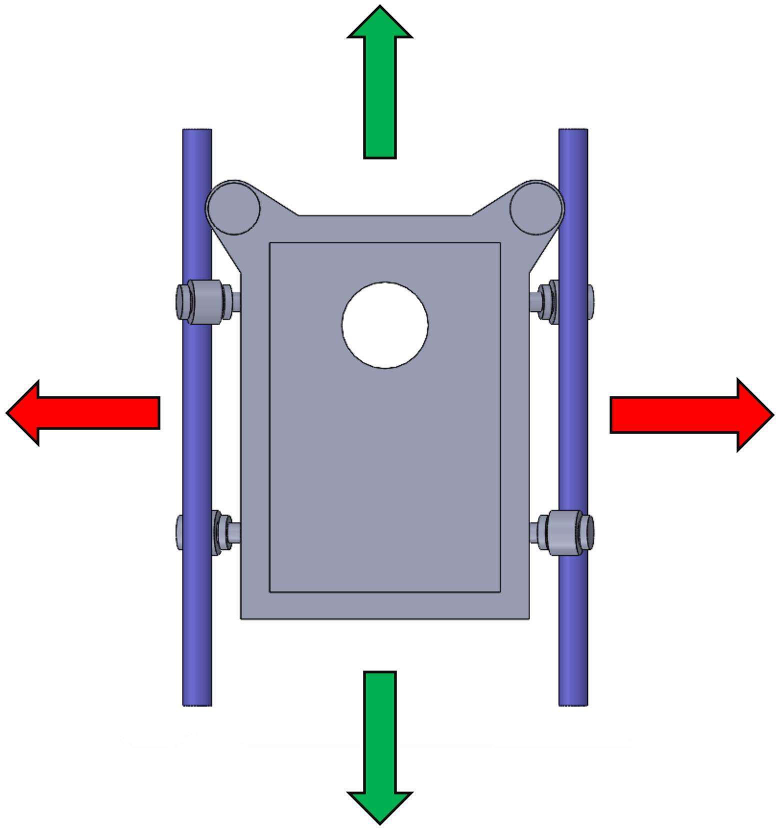
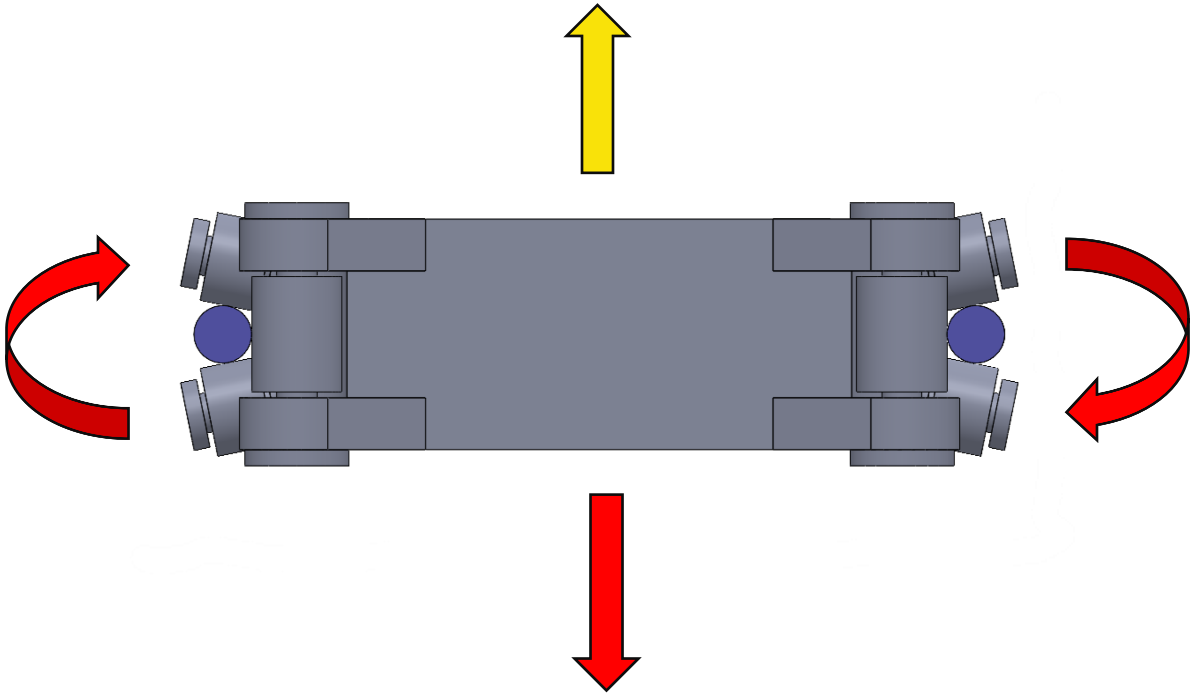
What Has Been done?
Motion and Structure Systems: Prototype Carriage 2

Jacob Hernandez





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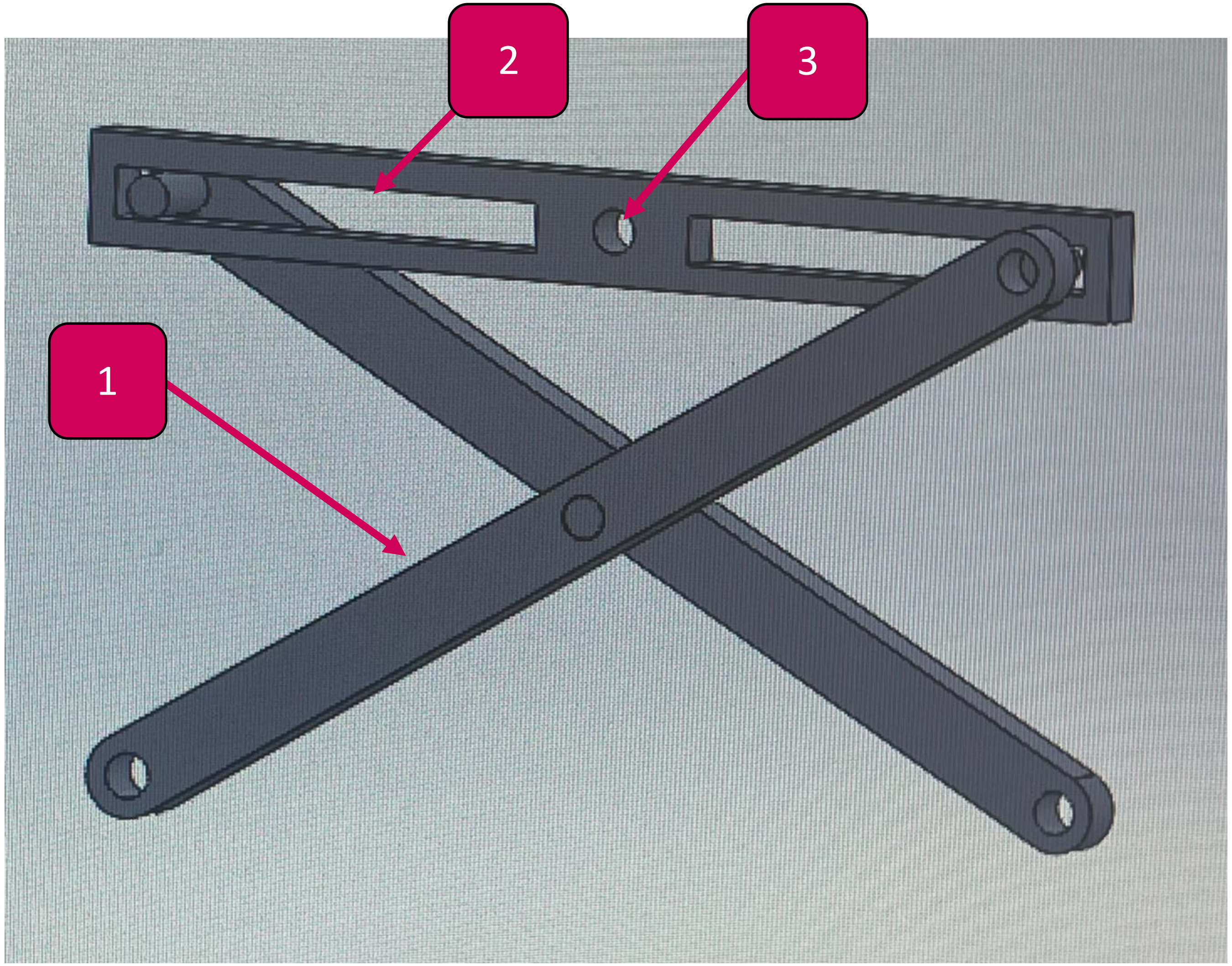
Hernandez

What has been done? Linkage Design

1) Equal Link Length

2) Slider Linkage

3) Middle Coupler Point



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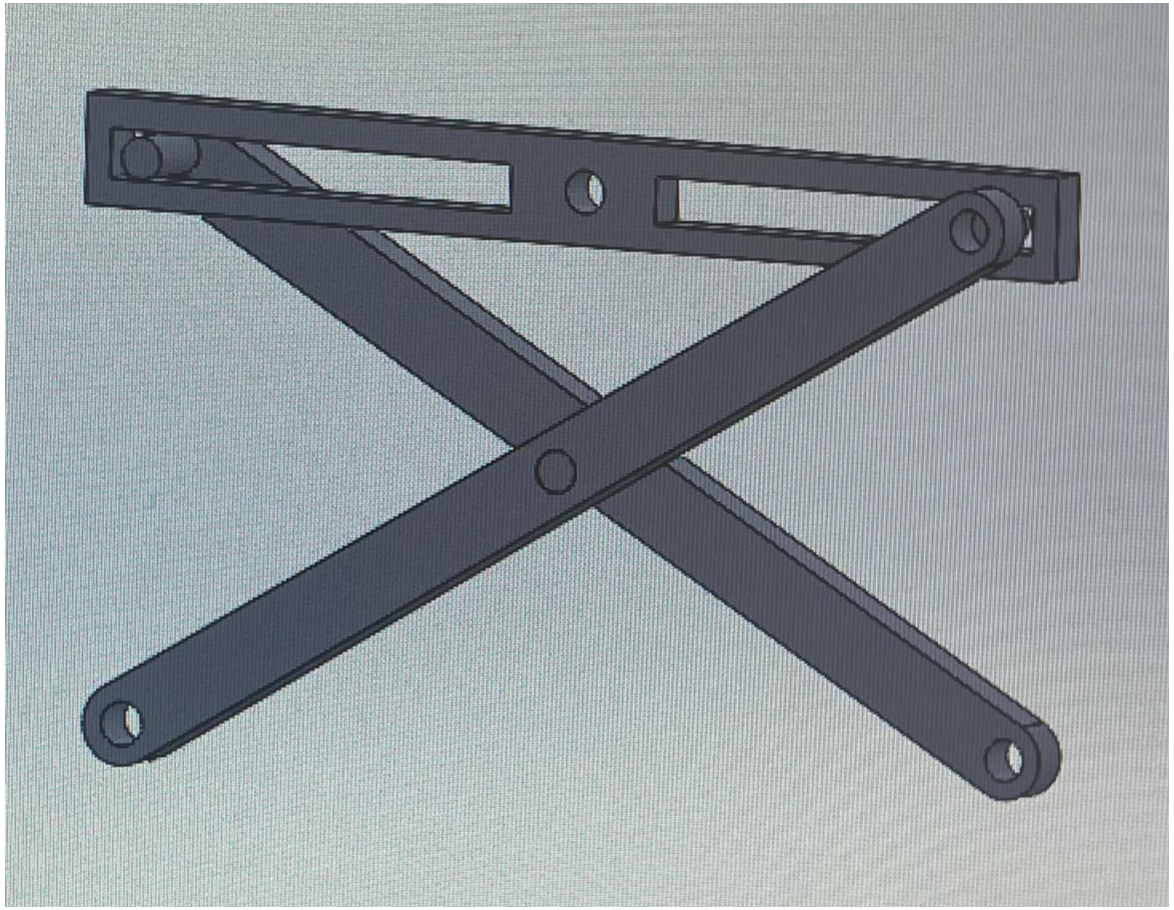
Future works
Linkage Design

Finalize Dimensioning

Physical Protype

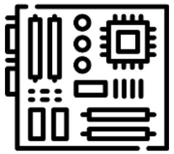
Integration



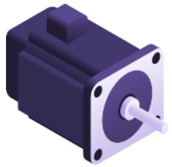
Future Works

Recommended Component Selection

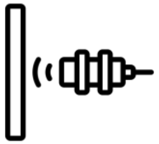
Key Difference	Arduino Mega 2560	ESP32 – S3
Processor	8-bit, single-core	32-bit Dual-core
Clock Speed	16 MHz	240 MHz
Memory	8 KB SRAM, 256 KB Flash	512 KB SRAM, 16 MB Flash
Wireless Connectivity	None	Wi-Fi, Bluetooth
PWM Resolution	8-bit	16-bit
PWM Pins	15 pins	5 up to 32 pins
Power Supply	7-12V	3.3V
Price Range	$48. 40	$22



Microcontroller: (Arduino Mega 2560 vs. ESP32-S3)



Servo Motor: (DYNAMIXEL AX Series vs. MG996R)



Sensor: (Linear Potentiometer vs. Ultrasonic Sensor)

Component	DYNAMIXEL AX-18A	MG996R	DYNAMIXEL AX-12A
Torque (Nm)	1.8 (12V)	1.08 (6V)	1.5 (12V)
Speed (sec/60)	0.19	0. 17	0.119
Cost ($)	$ 109.90	$ 11.20	$ 49.90

Jacob Hernandez

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Future Works – What To Expect Next Time?

Motion System:

- CVT power method selected
- Motor and control hardware selected
- Major carriage and linkage design update completed
- Major progress on control algorithm achieved and testing started

User Interface System:

- Hardware selected
- Progress on codebase achieved

Structure System:

- Base design updated to fit carriage design and hardware

Future Works – What To Expect Next Time?

Jacob Hernandez

PROJECT: T515 Controllable CVT

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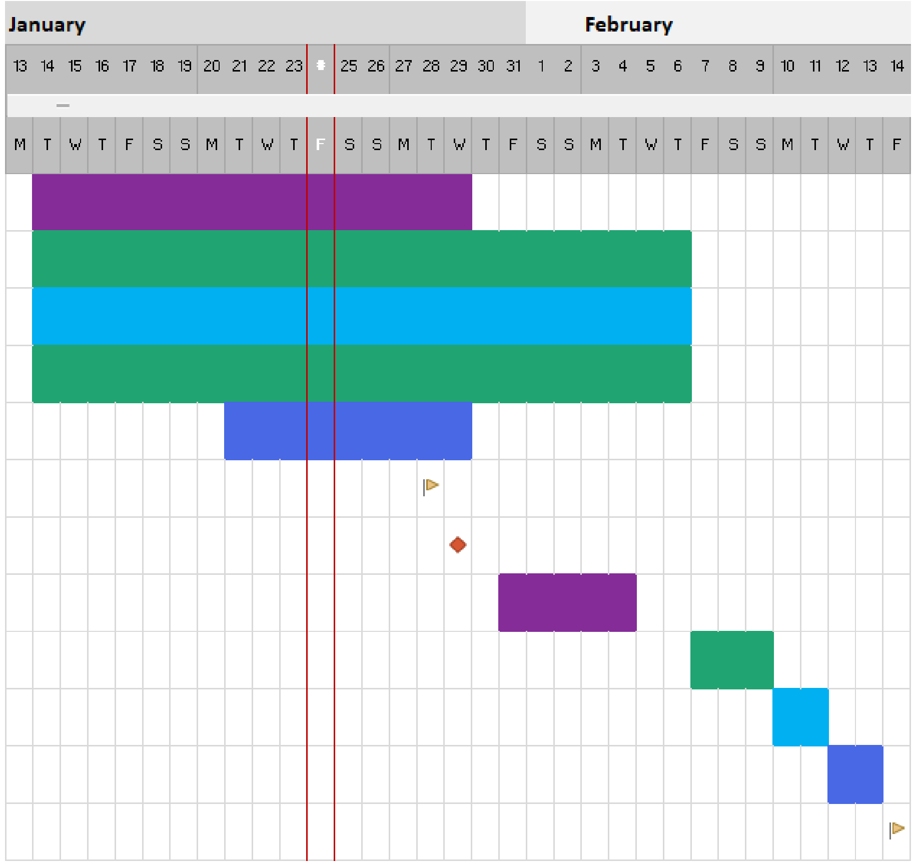
Kemani Harris, Aaron Havener, Jacob Hernandez, Aliya Hutley, Cade Watson

Project start date: 1/6/2025

Scrolling increment: 7

Legend: On track | Low risk | Med risk | High risk | Unassigned

Milestone description	Category	Assigned to	Progress	Start	Days
Select Materials for Wheels/Cylinder	High Risk	Cade Watson	75%	1/14/2025	16
CAD Design	On Track	Jacob Hernandez	50%	1/14/2025	24
Model and Simulate	Low Risk	Aaron Havener	10%	1/14/2025	24
Linkage Design	On Track	Kemani Harris	50%	1/14/2025	24
Motor, Microcontroller, and Sensor Selection	Med Risk	Aliya Hutley	50%	1/21/2025	9
Design Review 4	Milestone	All	75%	1/28/2025	1
Send Order Request	Goal	All	60%	1/29/2025	1
Establish Test Plan	High Risk	Aaron and Aliya	0%	1/31/2025	5
Rough Prototype Assembly and Systems Integration	On Track	All	0%	2/7/2025	3
Prototype Testing	Low Risk	All	0%	2/10/2025	2
Establish Control Method	Med Risk	Aaron and Aliya	0%	2/12/2025	2
Design Review 5	Milestone	All	45%	2/14/2025	1



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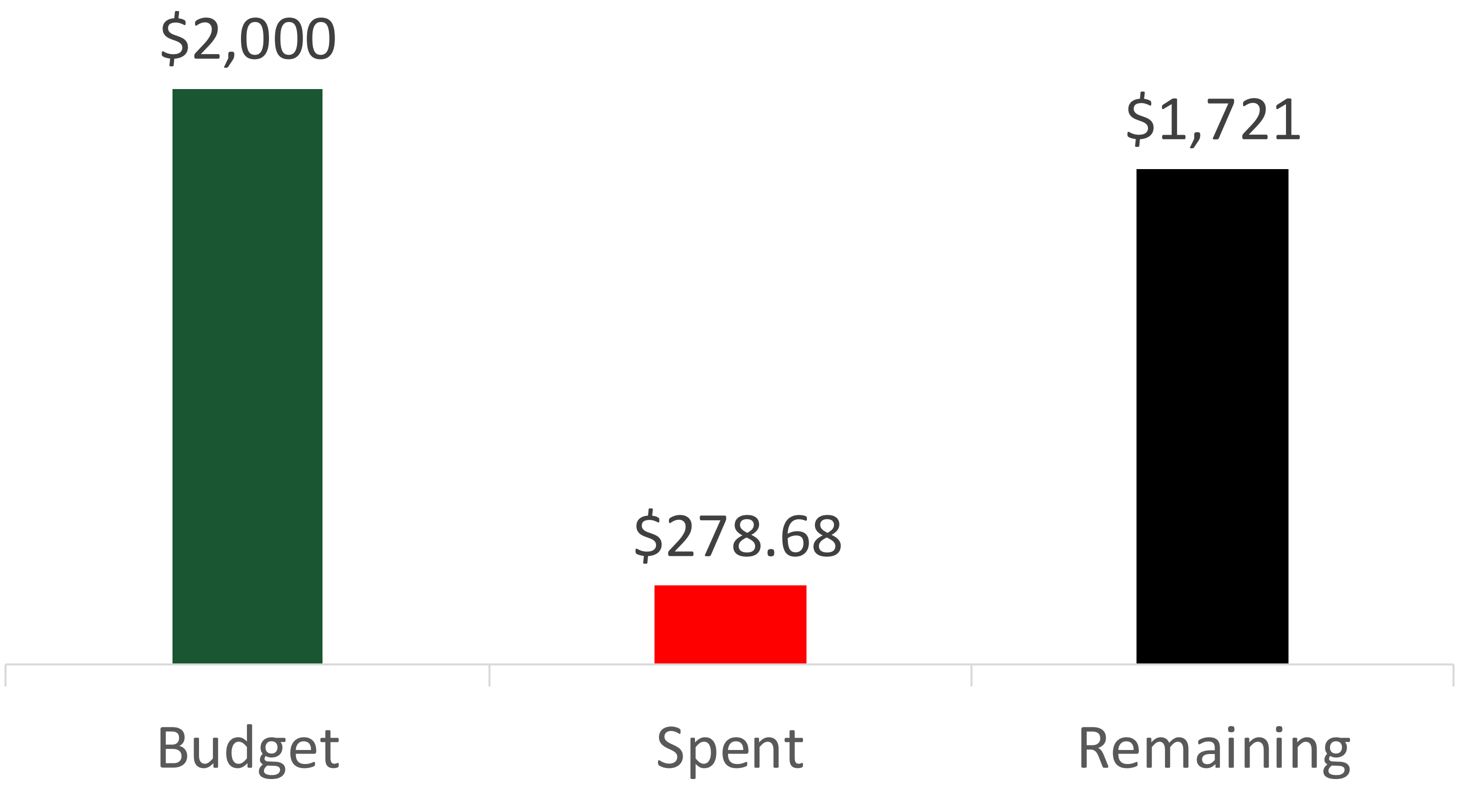
Jacob
Hernandez

Thank You



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Back Up Slides

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Future Works – What To Expect Next Time?

Kinematics → Modeling & Simulation → Testing & Integration

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