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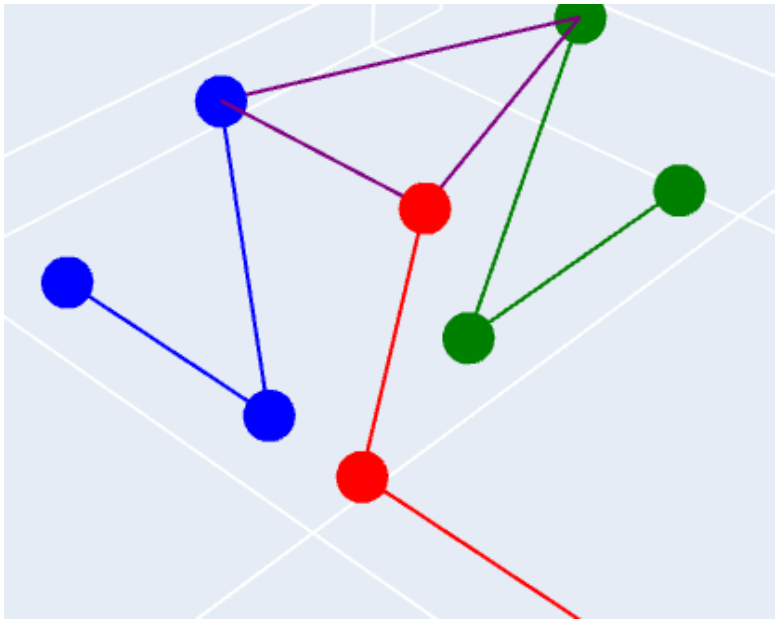

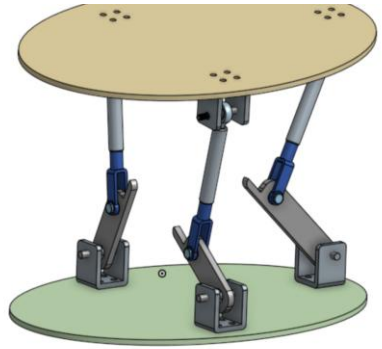

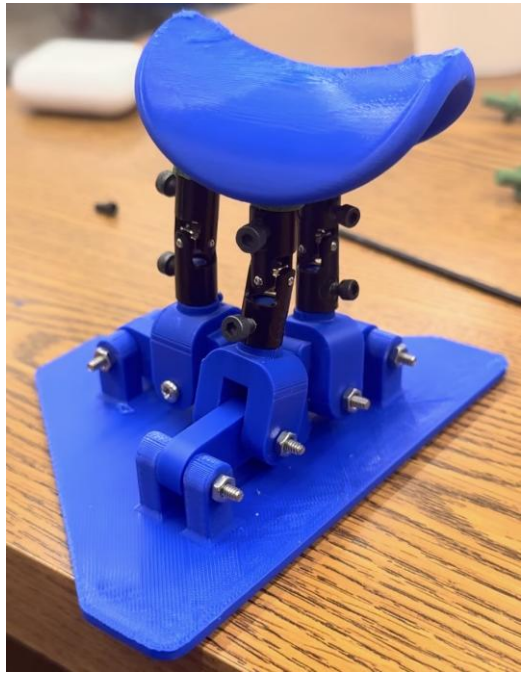

Mechatronics

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Hippotherapy simulators in physical rehabilitation: A systematic review

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ARTICLE INFO

Associate Editor: Dr. Oliver Sawodny

Keywords:
Hippotherapy simulator
Mechanical horse
Horse-riding simulator
Rehabilitation technology
Physical Therapy
Robot-Assisted Therapy

ABSTRACT

Purpose: To evaluate the current evidence on Horse-Riding Simulators (HRS) as therapeutic alternatives to traditional hippotherapy and identify gaps in design and application.
Materials and Methods: A systematic review was conducted on studies involving HRS interventions. A total of 1754 English-language articles were screened, with 45 meeting the inclusion criteria for analysis.
Results: Forty-five studies were analyzed, mostly using commercial simulators and some custom-built devices. Intervention durations ranged from single sessions to 20 weeks across various populations. Randomized controlled trials represented 53.3 %, but overall evidence quality was low, with 37.8 % rated high risk of bias. Despite this, 93.3 % reported positive effects on balance, posture, and motor function, though comparisons with traditional hippotherapy remain inconclusive.
Conclusions: HRS present a promising therapeutic option where access to hippotherapy is limited, but current designs remain limited in their ability to fully simulate equine movement and sensory input. Future developments should focus on incorporating realistic and variable seat motion, multisensory feedback, and

Horse-Riding Simulator (Robotics and Rehabilitation Lab, Columbia University)

Aim

Design a therapeutic horse-riding simulator for physical rehabilitation, addressing clinical and technical gaps.

My Contributions

Designed the mechanical concept and preliminary CAD model

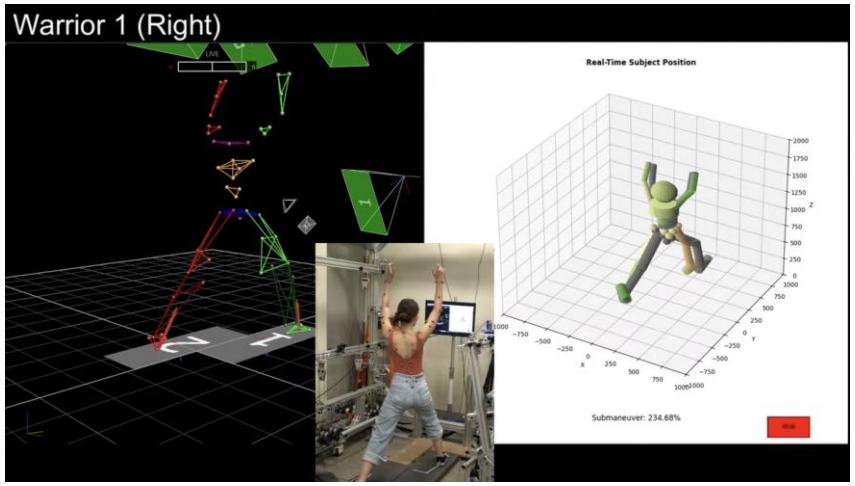
Performed Python-based kinematic and geometric analyses

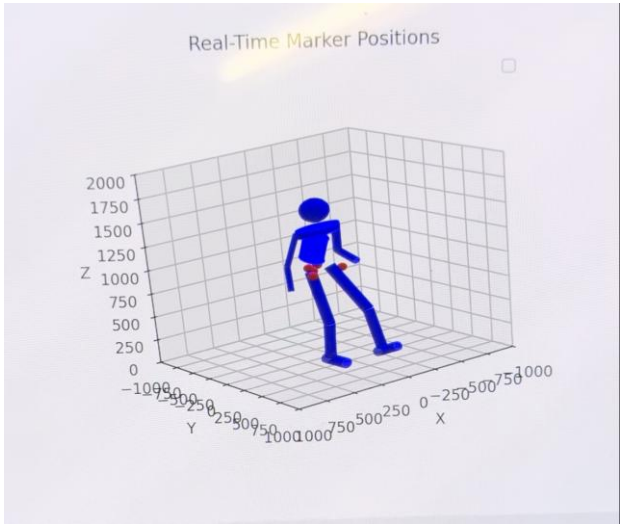
Built and tested early 3D-printed prototypes

Authored a peer-reviewed literature review identifying design gaps

Skills Gained

Kinematic analysis, CAD iteration, Python engineering computation, research synthesis, technical leadership





Yoga Rehabilitation Motion Analysis (Robotics and Rehabilitation Lab, Columbia University)

Aim
Develop a motion-analysis visualization tool to evaluate deviations between patient movement and target yoga poses.

My Contributions

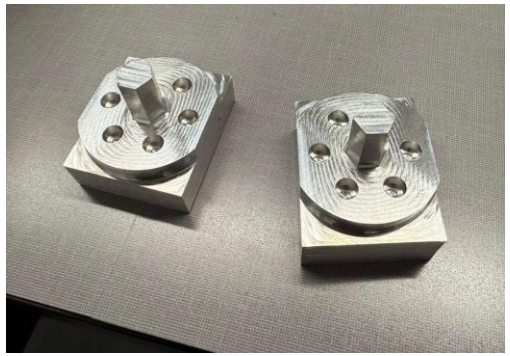
Extracted motion capture data from the Vicon Nexus database

Developed Python-based heatmap visualizations comparing subject and target motion

Implemented adjustable spatial and temporal resolution

Skills Gained
Motion capture analysis through Vicon Nexus, data visualization, Python for biomechanics, quantitative movement assessment

Humanoid Robot Project Lead (Columbia Robotics Club)



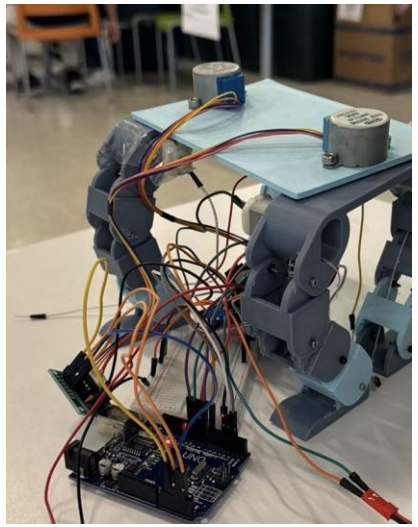
Aim
Establish the mechanical foundation for Columbia University's first humanoid robot through a quadruped platform.

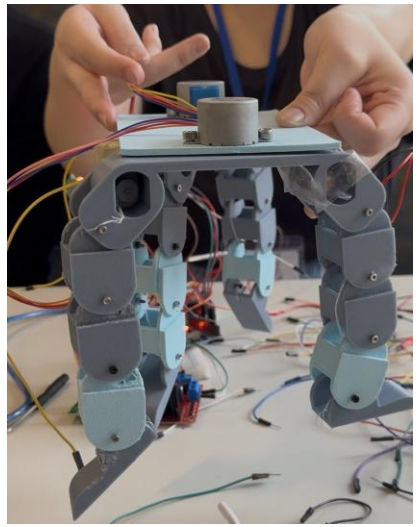
My Contributions

Led hardware design, CAD development, and parts procurement

Oversaw mechanical assembly and system integration planning

Skills Gained
Robotic hardware design, CAD for complex systems, CNC mill, design scalability, technical leadership





Biomimetic Climbing Robot (Hardware Hackathon)

Aim
Design a biomimetic climbing robot capable of adaptive gripping and autonomous movement for physiological monitoring.

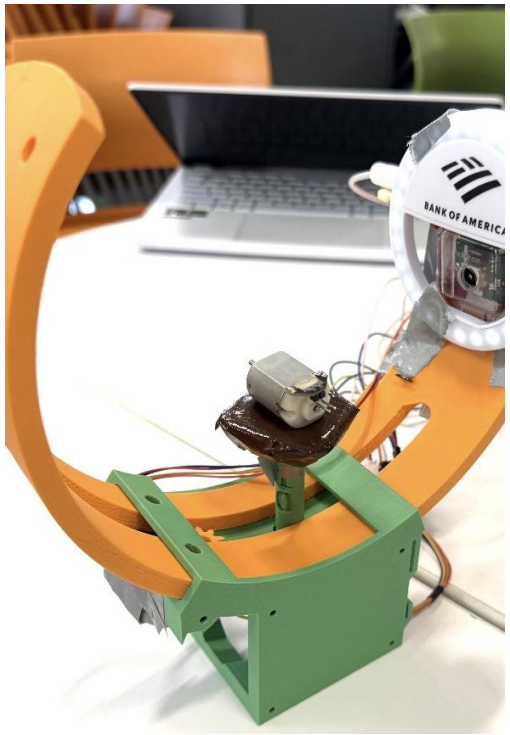
My Contributions

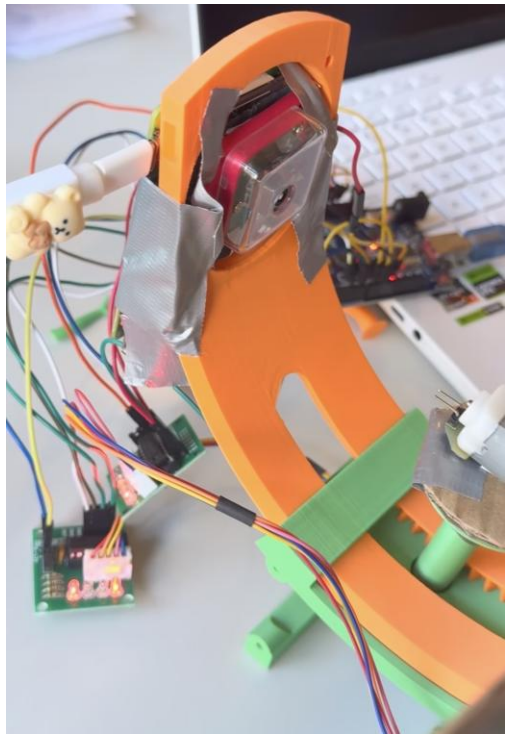
Designed a multi-segmented, single-actuator limb system

Led complete mechanical design and hardware assembly

Skills Gained
Biomimetic design, underactuated mechanisms, rapid prototyping, end-to-end hardware development

AI-Based 3D Scanner Prototype (Hardware Hackathon)





Aim

Create a low-cost 3D scanning system that generates printable 3D models of real objects

My Contributions

Developed a functional 3D scanner using NVIDIA NeRF

Led hardware design and control integration with Raspberry Pi and Arduino

Skills Gained
Mechatronic integration, embedded systems, AI-assisted 3D reconstruction, prototyping and debugging

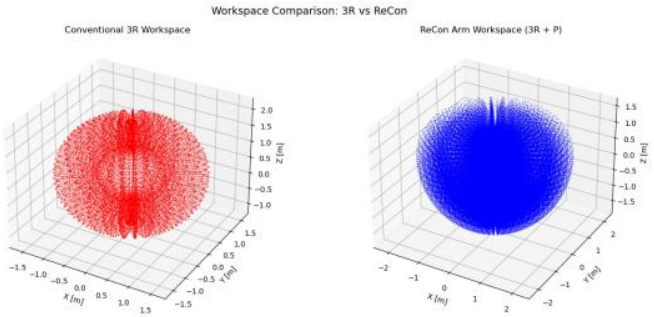


Fig. 4: Workspace comparison between a 3R arm and the ReConArm.

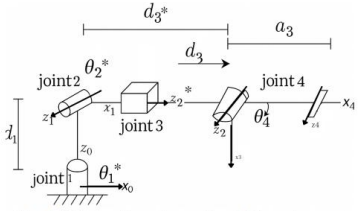


Fig. 1: Joint configuration and variable assignment.

Fig. 2: CAD model of RRPR mechanism.

Theoretical Design of Optimized Welding Arm (Introduction to Robotics Project)

Aim

Optimize welding arm reach and reduce singularities with minimal modifications

My Contributions

Developed the CAD, forward kinematics, and conceptualization of the model

Contributed to the writing of an IEEE formatted paper on the design and inverse kinematics development

Skills Gained

Forward kinematics modeling, system-level conceptualization of mechanical devices, design documentation