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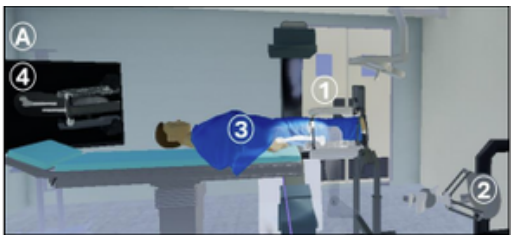
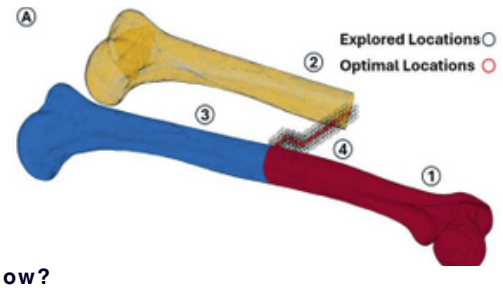
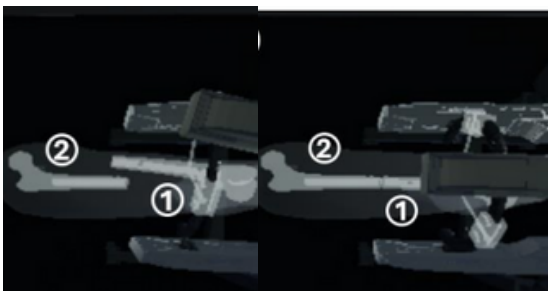
ROBOTIC PATH PLANNING & HAPTIC FEEDBACK FOR FRACTURE REDUCTION

Research Project | August 2023 - May 2024







What?

- Create & implement **novel path finding algorithm** for calculating optimal path for **femur fracture reduction surgery**
- Integrate the path with **haptic feedback** & **visual fixtures** for **robot assisted** surgery system

How?

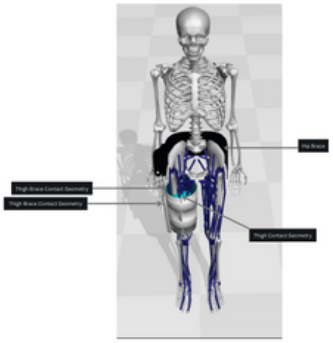
- Create novel algorithm based on A* search in **Matlab**
- Implement **Bezier curves** to generate smooth path
- Model **haptic feedback** force as **spring mass damper system**

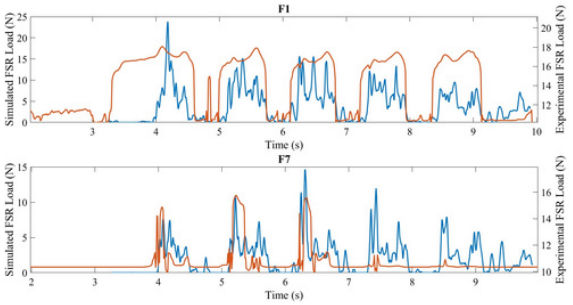
Results

- Successful realignment with maximal deviation of 3.0 mm translationally,
- and 1.5 deg rotationally

BIOMECHANICAL SIMULATION OF HUMAN-EXOSKELETON INTERACTION

Research Project | August 2024 - May 2025





What?

- Use **Opensim** for **biomechanical modeling** of interaction between human subject and lower limb **exoskeleton device**

How?

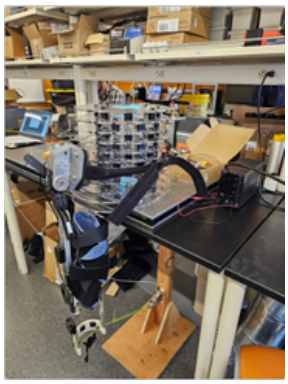
- Modelled device as simple geometry using **CAD (Solidworks)**
- Defined model joints and attached it to human model
- Modeled interaction force using springs at points of contact
- Appended motion from **IMUs** to model, used **arduino** for reading IMU data
- **Experimental verification**, using **FSRs**

Results

- **Plotted** force patterns for various motions such as walking, sideststepping, squatting, and stepping from FSRs
- Retrieved force patterns from **model motion** using Opensim
- Overlaped both plots for **data analysis**

EXOSKELETON DESIGN FOR GAIT STABILIZATION

Research Project | August 2024 - May 2025



What?

- Collaborated to create exoskeleton device.
- Led the team through **iterative risk analysis**, and change design to comply with **ISO, ASTM** and other relevant **standards**.
- Led the **design of test procedures** to ensure **user compatability** and **ergonomics**

How?

- Used **Solidworks**, and machines (**laser cutting, 3D Printing, Drill Press**) to **fabricate mechanical parts**
- **Benchtop and human testing** to ensure **part reliability**
- List possible hazards and score them based on severity and likelihood.
- Re-design hazardous parts for safety
- Used **published studies** and **predicate devices** to **design test procedures and ergonomics questionnaires**

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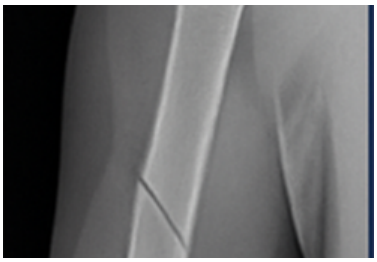
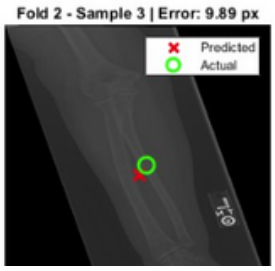
AI-BASED FRACTURE DETECTION

Course Project | August 2024 - May 2025





What?

- Use **AI** to determine point of fracture and optimal location for surgery

How?

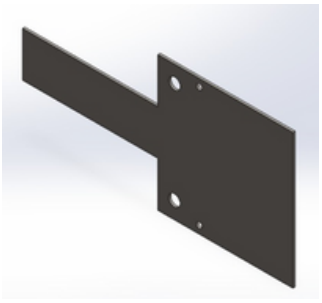
- Used **ResNet 50** model in **Matlab**
- Manually annotated fracture **dataset**
- **Trained AI model** using dataset
- Gave un-annotated data to model, to verify model effectiveness

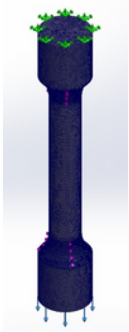
Results

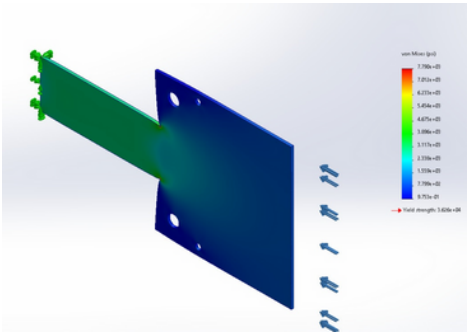
- AI predictions closely matched human prediction

FEA & MECHANICAL DESIGN

Technical Coursework | January 2025 - May 2025







What?

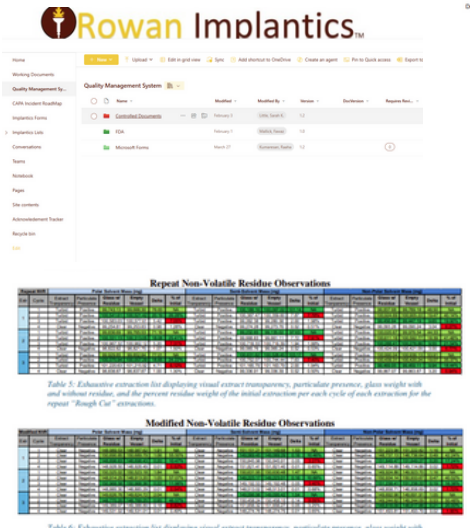
- Used **SolidWorks** to design mechanical components for various applications, and applied **FEA principles** to evaluate their performance.
- Developed **MATLAB** scripts to test parts under different **material properties** and **cost constraints**, guiding final **design decisions** based on stress and **deformation analysis**.

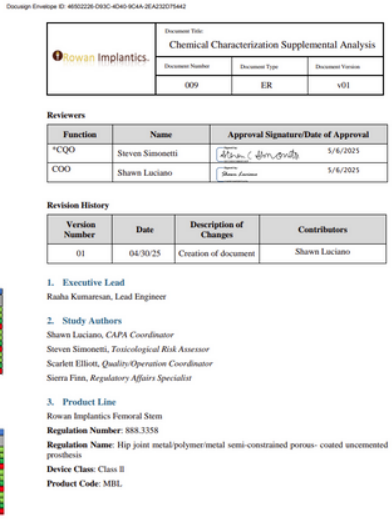
How?

- Matlab for **cost estimation** of parts depending properties such as density, volume, and number
- Soliworks for **design of parts**, **implementing meshes**, and **deformation, and stresses in different location of parts.**

MEDICAL DEVICE DEVELOPMENT (COURSEWORK)

Bootcamp | January 2025 - May 2025





What?

Simulated the **FDA approval process** for a **hip implant** as part of a mock medical device company.

How?

- Rotated through roles including **COO, Engineering Lead, and Audit Coordinator** to oversee regulatory, technical, and quality operations
- Trained team members on **SOPs** and interpreted **ISO standards** for compliance
- Conducted **mechanical, chemical, and toxicological risk assessments** following ISO guidelines
- Responded to mock FDA communications and prepared documentation for device approval

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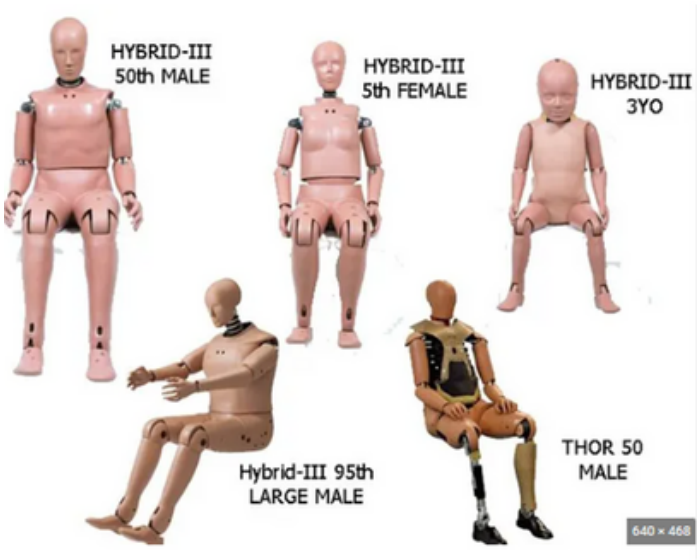
BIOMECHANICS - RELEVANT COURSEWORK

Technical Coursework | January 2025 - May 2025



What?

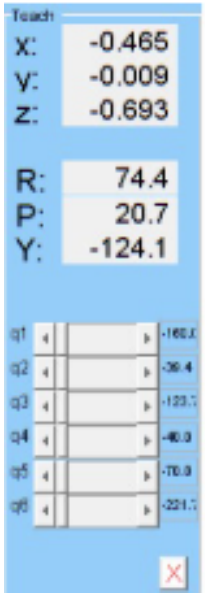
Learned to apply mechanical engineering principles to **human movement, injury analysis, and safety systems**. Studied **human gait**, **posture**, and **crash biomechanics**, including the **Head Injury Criterion (HIC)**—a metric used to assess head injury risk in impacts.

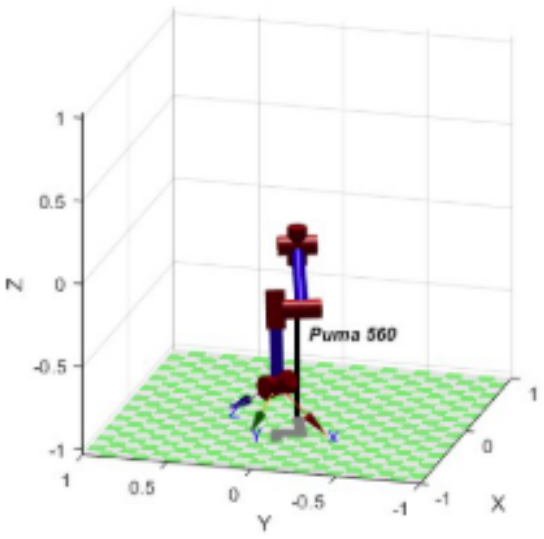
How?

- Used **anthropometric data** to calculate joint forces, torques, and loading
- **Analyzed gait abnormalities** and corrective strategies
- Reviewed **crash testing methods** and injury thresholds based on HIC scores

INTRODUCTION TO ROBOTICS - RELEVANT COURSEWORK

Technical Coursework | August 2024 - December 2024





What?

- Gained foundational understanding of **robotic systems**, **including inverse and forward kinematics**, **Denavit-Hartenberg (D-H) conventions**, **robot pose estimation, and workspace analysis.**
- Explored the effects of joint configurations and singularities on **end-effector** behavior.
- Also covered basic concepts in **computer vision** and **image processing**.

How ?

- Used the **Peter Corke Robotics Toolbox** in MATLAB to model robotic manipulators and simulate motion
- Programmed and visualized forward and inverse kinematics across various **joint configurations**.
- Generated **workspace plots** and **animated robot motion** to evaluate pose behavior under different kinematic conditions
- Analyzed the effects of singularities on **robot manipulability** and **task-space accuracy**