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Electromechanical Robotic Platform for Patient Motion Management in Radiotherapy

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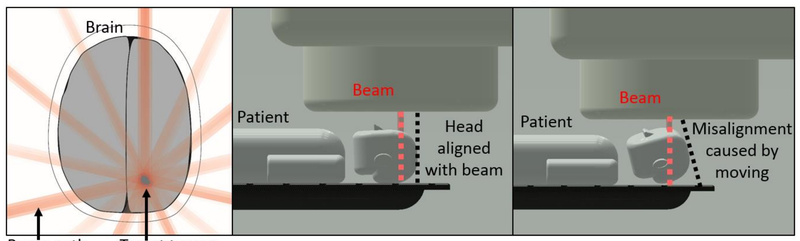
MECHANICAL AND NUCLEAR

Electromechanical Robotic Platform for Patient Motion Management in Radiotherapy

CAPSTONE DESIGN EXPO 2016

Background

- Each year 60,000 people are diagnosed with head and neck cancer.
- During radiotherapy, patients do not remain still due to nervousness, breathing, and swallowing.
- Currently, head movements are slightly restrained with the use of a molded, cast-like mask, but it can't manage patient motion.

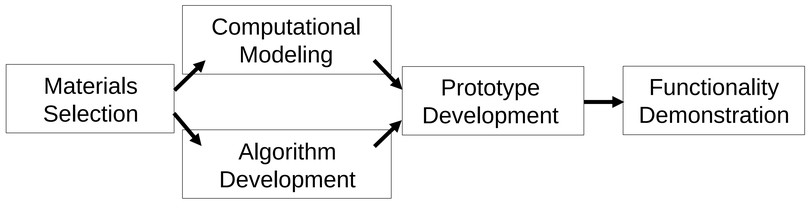


Beam misalignment due to the patient motion.

Objectives

- We aim to design an electromechanical robotic platform based on radio-compatible materials that can avoid interfering with radiation treatment and imaging.
- We aim to develop a prototype device for compensation of the position and orientation of a patient in radiotherapy.

Project Overview

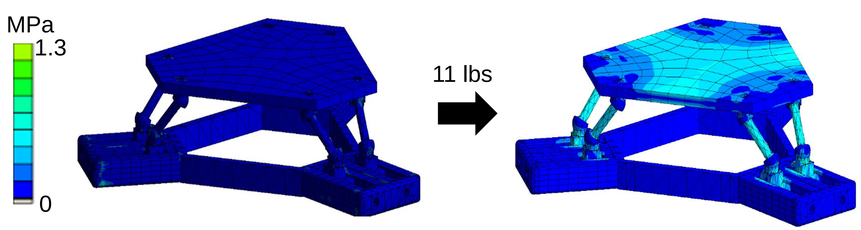


Design & Prototyping

- **Materials:**

  Multiple materials were examined in the process for radio compatibility resulting with materials such as ABS Plastic, Polyamide 66, and Carbon Fiber.

- **Computational Modeling (deformation):**

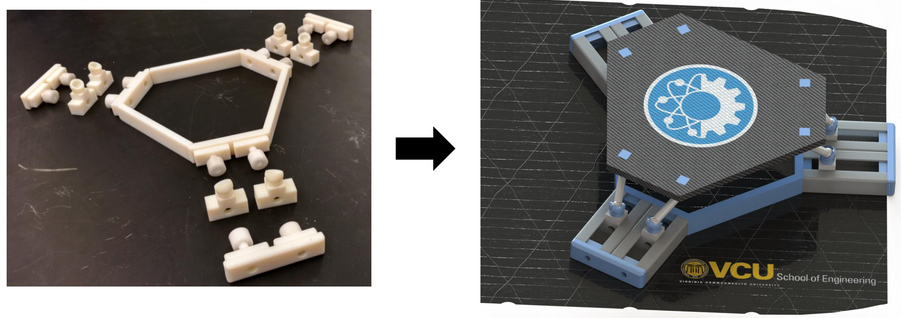


Under an average weight of 11 lbs, the platform shows very little deformation.

- **Algorithm Development:**

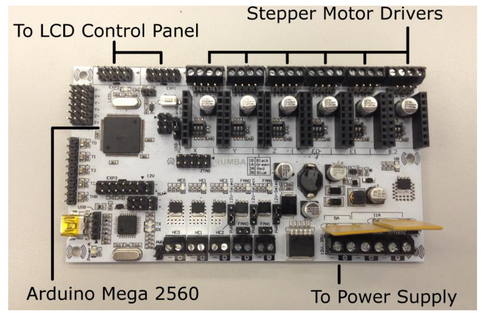
  - Six Degrees of Freedom
  - Use Euler Rotation Matrices
  - Use 3D Point-Line Distance
  - Verification of the new positions
  - Step Motors to new positions
  - Update current Position

- **Prototype Development:**



- Stepper motors drive six power screw assemblies.
- The screws drive six corresponding sliders along a channel.
- The sliders position the lower sockets based on calculations from the algorithm.

Device Operation



Conclusions

- We fabricated a prototype device using radio-compatible materials that are capable of continuous motion within the area of operation.
- The prototype device was able to provide motion in the six degrees of freedom with a 0.1 mm and 0.1° of accuracy.

Future Plans

- We will integrate the prototype device with a treatment couch available at the clinic.
- A graphic-user interface will develop for easy and precise control of the device while monitoring patient motions.
- During the treatment, the device will receive feedback from an existing patient monitoring system.
- The device will compensate for patient fidgeting and breathing.

Acknowledgements

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