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Radiotherapy Ergonomic Patient Positioning System

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Radiotherapy Ergonomic Patient Positioning System

MNE 521 | **Team members:** Anthony Briscoe II, Joseph Oliva, Yvette Smith, Darius Stuvaints | **Faculty adviser:** Dr. Woon-Hong Yeo | **Student advisor:** Mark Ostyn | **Sponsor:** Department of Radiation Oncology at VCU | **Sponsor advisor:** Dr. Siyong Kim

Background

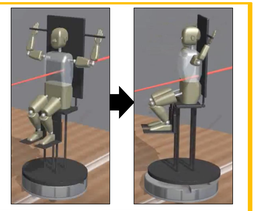
- In US, lung cancer accounts for 27% of cancer related deaths, and an estimated 307,660 new cases of breast cancer are diagnosed per year.
- Radiotherapy is a powerful tool used in modern cancer treatment.
- During radiation therapy, patients may move, leading to exposure of healthy tissue to radiation.
- We have designed a positioning device that allows for additional clearance between the machine and patient, therefore expanding the range of immobilization devices that may be used.

Project Overview

- Z positioning occurs so tumor is at the optimal height. Next, the gantry positions the tumor directly over the axis of rotation. Lastly, the rotary platform rotates the tumor to expose all sides to treatment.

Objective

- We design a novel, ergonomic positioning device that is comfortable and can gently guide the patient toward proper positioning during treatment.

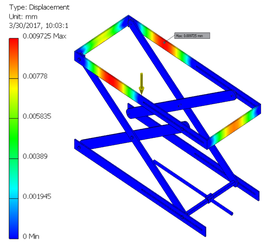


Design → Computer Modeling → Prototype Development → Functionality Testing

Computational Modeling

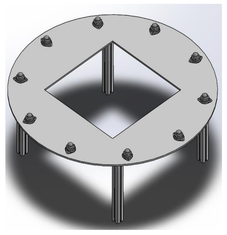
- Z Positioning : Movement in the vertical direction was attained by designing a scissor lift system powered by a stepper motor.
- Stainless steel 304 was the material chosen for the system. The mechanism would be subject to bending and buckling therefore a material of high strength such as steel had to be selected.

Isometric View of Z Positioner

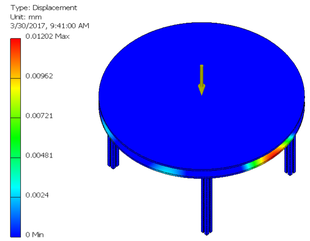


Deformation Analysis 889N Load

- Structural Support: The design of the structural system allowed for the gantry to be non-load bearing. While, also lessening the load on the rotating platform.
- Aluminum was used for the framing legs and for the plates. This was chosen after FEA tests showed that the system would not yield under the load of a patient.

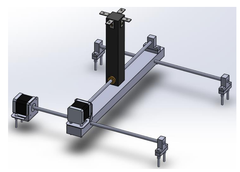


Isometric View of Structural Support



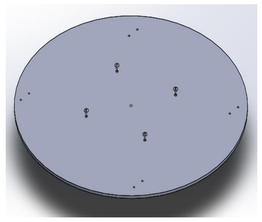
Deformation Analysis 978 N Load

- X-Y Positioning: Movement in the horizontal plane was achieved by constructing an orthogonal linear gantry system.

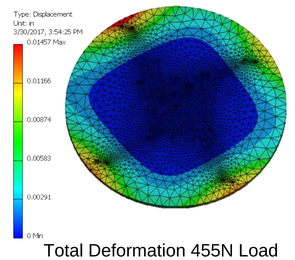


Isometric View of Linear Gantry System

- Yaw Positioning: Rotational movement in the horizontal plane was achieved by creating a rotary platform using a bipolar stepper motor and a lubricated round turntable.
- The material used is Aluminum 6061 it was chosen for its Yield Strength capacity. The mass point moment of inertia formula was used to determine the necessary torque to rotate the base one revolution per minute.



Isometric View of Rotating Platform

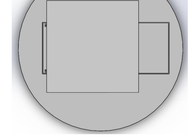


Total Deformation 455N Load

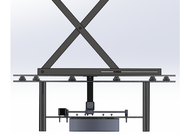
Control System

- Coding in python using Raspberry pi device was developed in order to control the stepper motors for movement in all three components
- A graphical user interface was generated in order for the user to have the capability to input the distance that the patient should move for the required treatment

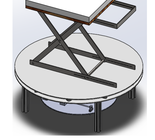
Full Assembly of System



Top View



Front View



Isometric View

Conclusion

- The design consists mainly of structural steel and aluminum along with the usage of four stepper motors
- The design has the ability to move 200 lbs and it moves ± 25 cm in all directions as well as rotates 360°
- The system designed will allow for increased flexibility in patient positioning during treatment along with assisting with proper dosage delivery during radiotherapy

Acknowledgments

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