Proton Therapy Device Manager

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Introduction

Proton therapy is a form of radiation treatment that allows physicians to precisely deliver a high does of radiation to target specific tumors. This precise form of radiation is due to custom machined brass apertures that fit into the nozzle of the Mevion S250 proton therapy system. The apertures are designed to direct the radiation to the affected area while blocking radiation from damaging healthy tissue.

.decimal, a Florida based radiation therapy company, is the manufacturer of these patient specific apertures. The brass aperture cutouts are two-dimensional cross-sectional areas of the patient's tumor and are designed according to the treatment plan designated by hospital personnel. The apertures are then transmitted to the .decimal manufacturing center for delivery back to the hospital.

Motivation

.decimal has determined the time it takes to complete the aperture loading and unloading procedure to be too lengthy and therefore undesirable for the patient's proton therapy experience. Optimizing both procedures will allow:

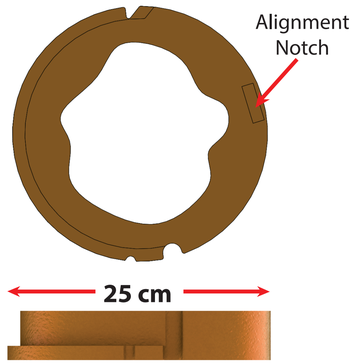
- More patients to be treated each year
- Improve therapy experience for patient
- .decimal will increase their yearly revenue
- Decrease patient treatment time
- Reduce physical effort of technician

Needs Statement

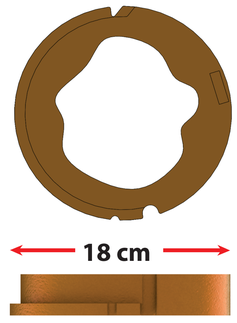
Develop an automated system that safely loads and unloads apertures into the nozzle of the Mevion S250 proton therapy system.

Apertures & Nozzle

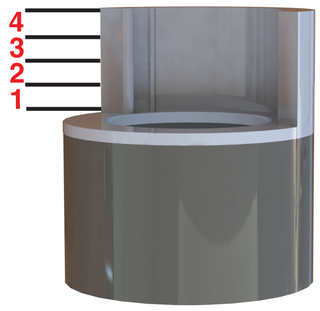
An aperture is a patient-specific radiation therapy product. The cut-out in the center of the aperture is determined by the geometry and location of the patient's tumor. The automated system must accomodate for a 25 cm and an 18 cm aperture. Up to four apertures will be loaded and stacked into the nozzle of the Mevion S250 proton therapy system.



16 kg Aperture



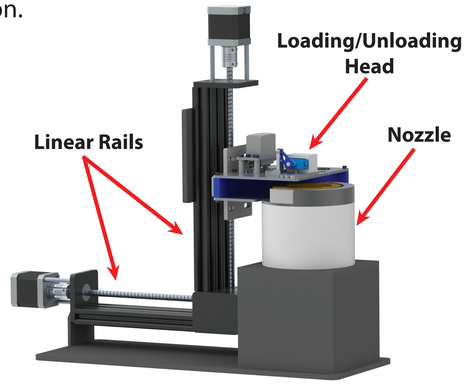
6 kg Aperture



Mevion S250 Nozzle

Design Concept

The automated system utilizes two subsystems to load and unload the apertures: the loading/unloading head and the linear rail system. The head will be guided by the linear rail system and will dock next to the nozzle and rotate the aperture into the correct position.



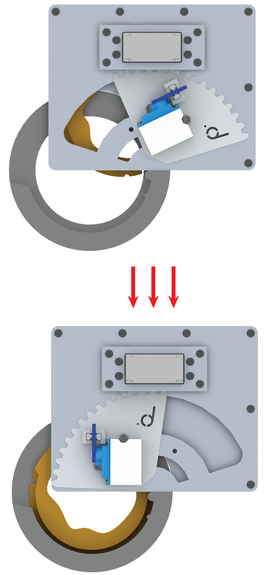
Loading Process

Step 1: Docking

The locking mechanism uses a micro servo to secure a lock into the alignment notch on the top surface of the brass aperture. The lock is a safty feature and helps guide the aperture through its range of motion. The linear rail system will dock the head next to the platform.

Step 2: Loading

A continuous rotation servo will rotate the aperture, about an instantaneous center of zero velocity, into the nozzle. The aperture is now in the correct position and the patient can continue therapy.



Project Scope

Provide proof of concept by designing and building a 1:4 scale model of the automated system to load an unload apertures into the nozzle of the Mevion S250 proton therapy system.

Proton Therapy Room

The traditional proton therapy process requires technicians to assist the patient throughout the proton therapy session. They will place the patient in the correct position, load the apertures, and guide the nozzle towards the targeted treatment area. The automated system will be designed to eliminate some of the patient interaction in order to speed up the proton therapy session.

Summary

An automation system has been developed by Senior Design Team 14 at Florida State University, in conjunction with .decimal, in order to improve the proton therapy treatment process. By optimizing the aperture loading and unloading procedure patients will have an improved proton therapy experience, more patients will be treated each year, the technician's effort will be reduced, and .decimal will increase their yearly revenue by manufacturing larger quantities of the patient-specific apertures.

The team provided proof of concept by fabricating a 1:4 scale prototype of the proposed device. Further research and development will be needed in order to implement a fully functional automated system.