An Open Source Imaging/Therapy Platform for small animals

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Project Background

- Project started in January 2010
- Open-Source Initiative as part the WID/MIR collaboration
  - Design specifications will be freely available
  - Encourages collaboration amongst researchers
  - Decreases cost of obtaining new technology
  - Allows for more customized design

Previous Work

Spring 2010, BME 301:

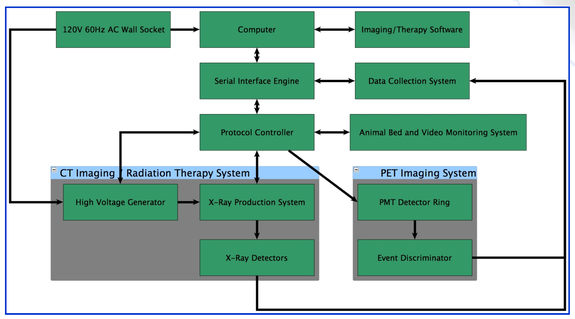
- Customer Requirements
- Preliminary Design Specifications
- First SolidWorks Model

Summer 2010, Tong Research Grant

- Preliminary OSMD Business Plan
- Customer Requirements
- SolidWorks Model, v2.0

Project Overview

- Integration of CT, PET, and Radiation Therapy (RT) in one device
- Small animal system
  - Used for research purposes
  - Act as a precursor for human system
- User-defined implementation
  - Online database of parts
  - Can choose any combination of systems
  - Clients can order components and DIY
  - Can alternatively order pre-built through the MIR

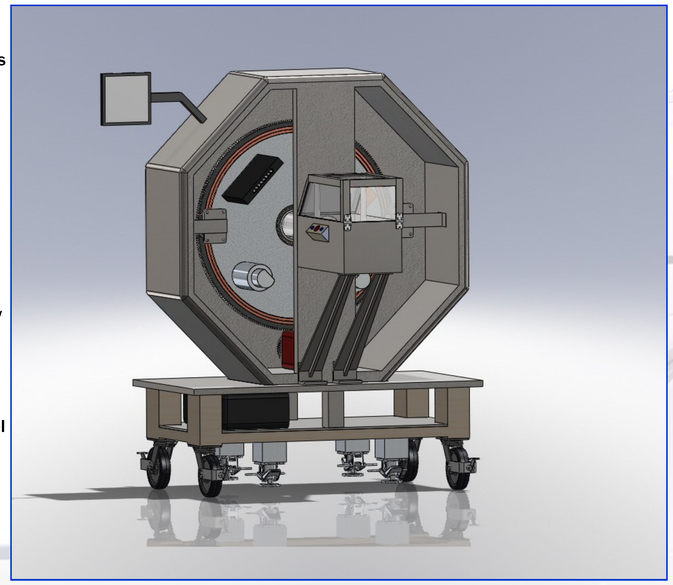


Abstract

The overall aim of this project is to develop an open source small animal imaging and therapy platform that integrates imaging (e.g., Computed Tomography (CT), Positron Emission Tomography (PET)) and therapy (e.g., radiotherapy (RT)) together. This system will be designed on a flexible platform, enabling researchers to build their own system according to the available resources and needs. The specific aim for the design project is to provide initial design of such an open source imaging/therapy platform and potentially start prototyping the system at the fast prototyping system at the Morgridge Institute for Research (MIR).

System Design

The System Design this semester focused primarily on completing the mechanical aspects of the device (e.g., gantry wheel). The SolidWorks Model from the summer was used as a starting point, but the device was extensively modified and further finished this semester. Additionally, a system overview was developed to show and clarify the dependencies of all the subsystems of the device.



Major Design Aspects

- CT and radiation systems located on the main gantry wheel
- Total weight of CT system estimated at 2250 lbs
- PET system is mounted on the opposite side of the gantry wheel
- Animal bed translates between both CT and PET regions
- 150 cm inner diameter for optimal imaging distances
- Support rods and animal bed constructed from A-36 Steel
- Cast aluminum steel enclosure
- Gantry motor capable of 10 rev/min
- Heavy casters and adjustable leveling mounts for travel and permanent placement
- Plenty of space for customizing parts selection
- Plastic cover for aesthetic optimization

Customer Requirements

Our customer is looking for an integrated system that can perform both small animal imaging and radiation therapy. The small animal can be size of a medium-sized rat or small rabbit or ferret. We assumed that the animal in question would be a mouse.

Ergonomics

- The device should be user friendly and easy to use
- Anesthesia should be easily administrable to the patient
- The system should be easy to clean

System Requirements

- The system should be as cost-effective as possible
- The design should incorporate shielding so the user is not at risk

System Requirements (cont).

- The system should be usable multiple times a day without lag time
- The design should be able to include better components if desired

CT Requirements

- The resolution should be 100 microns or better

PET Requirements

- The resolution should be 2 mm or better

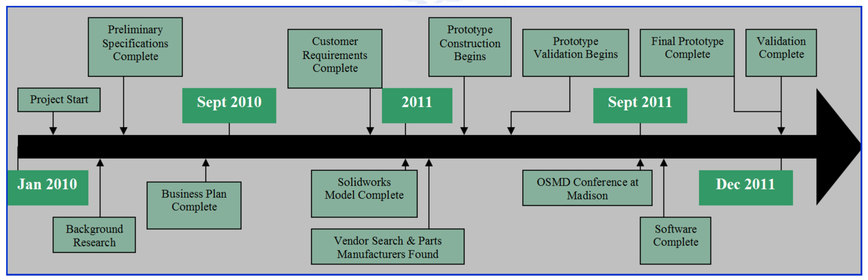
RT Requirements

- The system should have intensity modulation & treatment planning

Other Requirements

- The system should incorporate the capability to check vital signs
- The system should have a positioning system for the animal bed

Project Plan



Vendors & Parts

Another major focus of this semester was the search for parts and vendors. Since we would like the final system to be easily constructable, off-the-shelf products for components such as the X-ray tube are far more effective and useful than having each component be a custom assembly.

Several vendors were contacted this semester. A partial list of the components we need, their prices, and other information is given in the following table.

Purpose	Vendor	Cost	Quantity	Total Cost
Vendor Parts				
Gantry Motor	Baldor	$350.00	1	$350
Heavy Casters	McMaster-Carr	$137.00	4	$548
Gantry Wheel	Kaydon	$490.00	1	$490
Animal Bed	Dragon Plate	$179.50	1	$179.50
260kV, 7.7mA Power Supply	Spellman	$4,995.00	1	$4,995
CT Xray Source <150kv	North Star Imaging	$50,000.00	1	$50,000
RT Xray Source 250kv	North Star Imaging	$75,000.00	1	$75,000
RT Tube Cooling System		$10,000.00	1	$10,000
250kV High Voltage Cable	Okonite	$100.00	2	$200
XRS-FOP Scintillator	Hamamatsu	$2,000.00	2	$4,000
High Speed CCD Sensor	Aptina Imaging	$1,000.63	15	$15,009.45
Multi-Channel Analyzer	Ortec	$1,000.00	1	$1,000
Microcontroller	Atmega	$18.70	10	$187
PMT*	Hamamatsu	$2,500.00	32	$80,000
PMT*	Electron Tubes	$300.00	32	$9,600
Laser Alignment Module	Instapark	$4.88	10	$48.80
MLC Collimator Motors	HiTech	$15.99	64	$1,023.36
Track Actuator for Animal Bed	Firgelli Automations	$169.99	1	$169.99
Track Actuator for X-Ray/CCD magnification	Firgelli Automations	$209.99	4	$839.96
Custom Parts				
Octagonal housing	McMaster-Carr	$252.51	1	$252.51
Animal Bay	McMaster-Carr	$550.00	1	$550
Animal retainment	McMaster-Carr	$48.44	1	$48.44
support table	McMaster-Carr	$300.00	1	$300
Gantry	McMaster-Carr	$108.36	1	$108.36
Support gantry wheel	McMaster-Carr	$112.50	1	$112.50
Wheel stabilizers	McMaster-Carr	$18.38	1	$18.38
PET enclosure	McMaster-Carr	$150.00	1	$150
Gantry motor	McMaster-Carr	$88.54	1	$88.54
Computer/Viewing Station		$3,000.00	1	$3,000
MLC Collimator Leaves				
Xray detector housing				
Lead shielding				
TOTAL				**$258,395.41**

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