OPEN SOURCE MEDICAL DEVICE PROJECT: ANIMAL BED CONTROLLER

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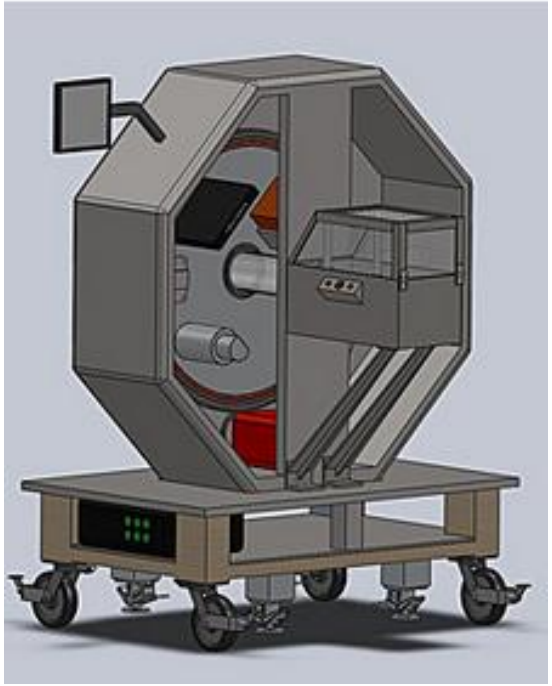
Background

- Part of Open Source Medical Device Project:
  micro CT/PET/RT system
  - medical research on small animals
- Our project: Small animal positioning system
- Existing systems in commercially available imaging systems (Siemens Inveon at WIMR; SARRP at John Hopkins)
  - Problems:
    - Cost
    - Size
    - Degrees of freedom

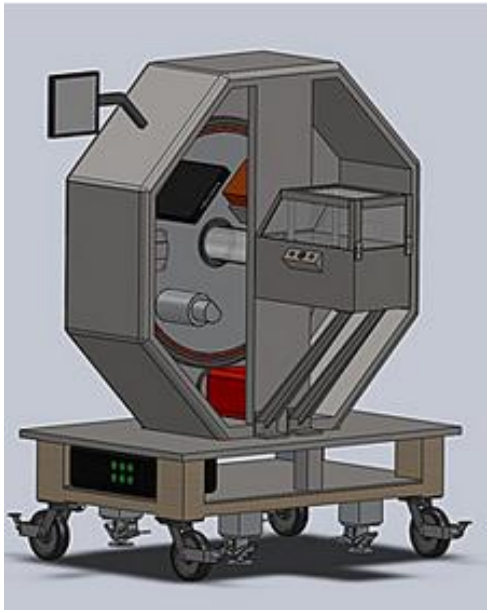


<http://discovery.wisc.edu/home/discovery/events/open-source-medical-devices-conference/open-source-medical-devices-conference-home.cmsx>

Motivation

- Medical Imaging Devices are expensive
  - Can be upwards of a million dollars
- Open-source device for everyone
  - Put design and specifications on web

http://www.feilab.org/Research/PreClinical_microPETCT.htm



Problem Statement

- Want cheaper and more accessible approach to micro CT/PET/RT system
- Design beyond scope of individuals' knowledge and resources
- More degrees of freedom needed
- Open to public
- Variety of background knowledge

Client Requirements

- End of system must fit into 12 cm wide hole
- Five Degrees of Freedom
  - All three axial movements
  - Rotation about the x and y-axis (pitch and yaw)
- Precision
  - .1 mm (100 microns) in axial movement
    - Up to 1 cm in x and y directions and 75 cm in z-axis
  - .1° in rotation movement
    - Up to 5 degrees on both sides

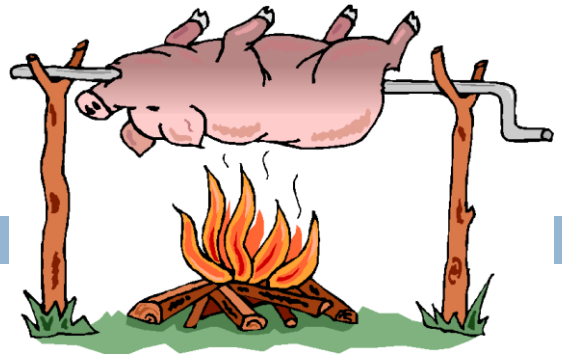
Design for X, Y & Z Motion

- 3 Linear Actuators connected together
- Electro-mechanical
  - Repeatable
  - Positive feedback
  - DC or stepping motors
  - Cheap
  - Variable Sizes

T-LST-series: http://www.zaber.com/products

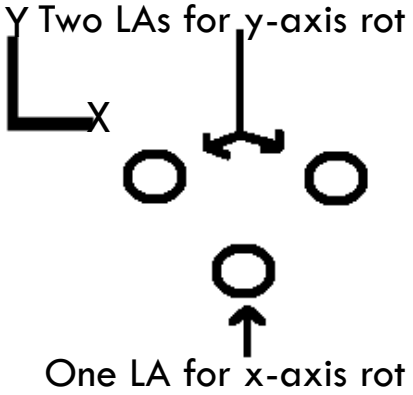
www.directindustry.com

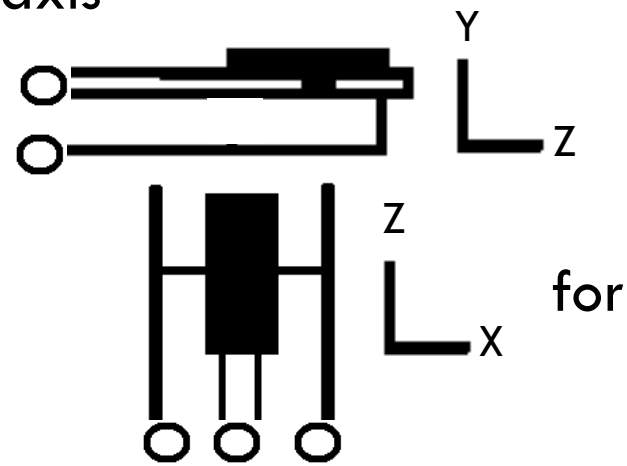
Design 1: The Spit



http://www.njmcl.org/2011/06/gooney-bird-detachment-pig-roast/pig-on-a-spit/

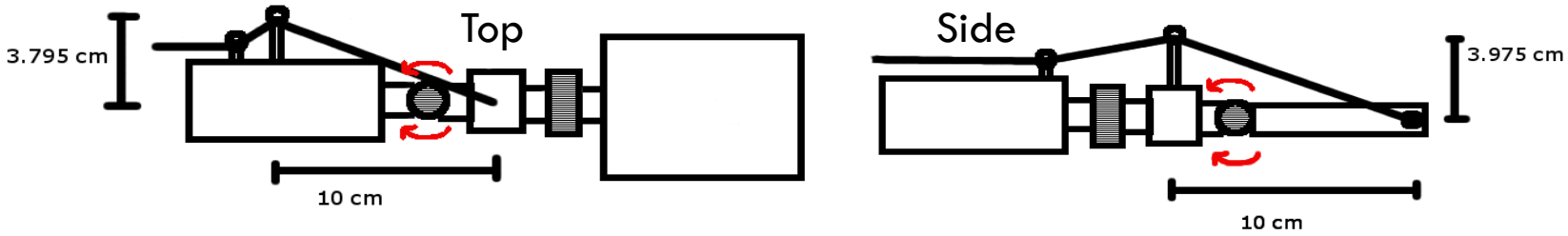
- The Design
  - Three linear actuators (LAs)
    - Two accounting for rotation about y-axis
      - Differing distances in each actuator will determine the yaw angle
    - Third accounting for rotation about x-axis
      - Decreasing distance will pull front down and tilt forward, determining the pitch angle
- Positives
  - Allows for extra precision in the z-axis
  - Will be a sturdy system
    - Very small amount of deflection
- Negatives
  - Requires three linear actuators for two DOF





Design 2: Springs and Strings

- Bed rotates around bearings
- Opposing forces hold bed in place:
  - Helical torsion spring
  - String attached to linear actuator



- Position of linear actuator determines angle
- Advantages:
  - little weight added at end of arm
  - little image attenuation
- Disadvantages:
  - non-constant changes in angle (0.0944° to 0.1° above with 0.006 cm step for linear actuator)

Design 3: Stepper Motor Model

- Hybrid (HB) stepper motor
- Control pitch and yaw
- Sufficient torque
- Easy to control
  - Open-loop system
  - Impulse proportion to angle
- Precise
  - 0.9-3.6 degrees per step (100-400 steps/revolution)
  - Each step further divisible
- Long lifetime

Figure. A stepper motor and wire for motor driver <http://www.sherline.com/67127pg.htm>

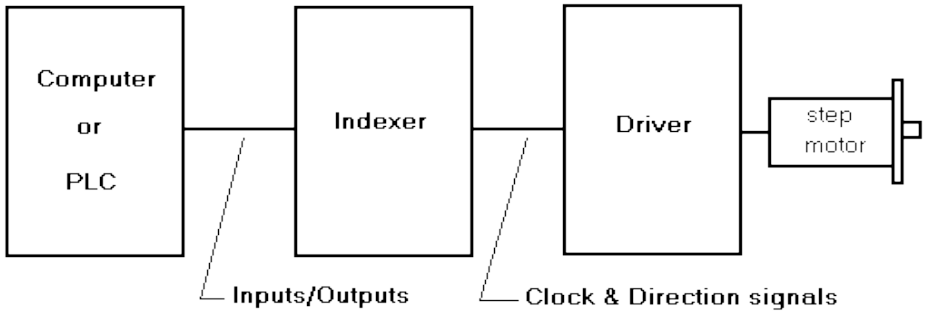


Figure. Typical stepper motor system. <http://www.anaheimautomation.com/intro.htm>

Design Matrix

	The Spit	Springs & Strings	Stepper Motors	Weight
Accuracy/Precision	20	19	22	25
Cost	15	20	20	25
Repeatability	18	12	18	20
Lifetime	17	15	17	20
Feasibility	5	6	9	10
Total	75	72	86	100

Final Design: Actuator and Stepper Motors

- Three Actuators for X, Y, Z- axis translation
  - Combined with slides or hinges
- Two Stepper motors for pitch and yaw rotation
  - Combined with a bracket and a base
- Ideally feasible and reusable
- Reasonable cost

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Figure - An ideal future model. Followed by animal platform, rotational motor device, and translational actuators. <www.**trossenrobotics.com**>

Future Work

- Purchase linear actuators & stepper motors
- Set up system
- Program motion controller
- Attach animal bed to motion control system
- Test system
- Refine design

Questions

References

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