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ABSTRACT

In order to measure cervical disk health reliably, a prototype has been built to facilitate natural neck extension and flexion during a lateral fluoroscopic examination. The prototype includes a linear actuator, frame, headboard and control system to achieve the desired neck motion safely while being controlled from a remote location. There is no current device on the market that meets these needs.

MOTIVATION

Currently, technicians must manually move the patient's neck during fluoroscopy; this process is time-consuming, error-prone, and also exposes hospital staff to unnecessary X-ray radiation. The goal this semester was to design a portable, motorized device that promotes natural neck movement safely during fluoroscopy examinations. These examinations will assist in diagnosing abnormal cervical vertebrae movement.

BACKGROUND INFORMATION



Flexion of the neck www.rad.washington.edu



Extension of the neck www.rad.washington.edu

Cervical Spine

- From base of skull to between shoulders
- First seven vertebrae, including atlas and axis
- Protects spinal cord from injury
- Supports and facilitates head movement

Extension & Flexion

- Rotating neck forward and backward
- No lateral rotation
- Extension brings the head toward back
- Flexion bring the head forward toward chest

Degenerative Disc Disease (DDD)

- Often found in older adults
- Progressive disc water loss and compression
- Decreased flexibility in affected area
- Advanced stages can impair nerve function and mobility

Fluoroscopic Imaging

- Dynamic, real time, X-ray imaging
- Imaging is a diagnostic tool for assessing anatomical injuries and conditions
- Distinguishes between tissues by density and composition
- Spinal vertebrae imaging useful for diagnosing DDD
- Patient exposure to radiation kept low by technique of using short rapid bursts during procedure
- High mass attenuation materials, like metals, block image



Siemens Fluoroscopy Machine http://www.medical.siemens.com/siemens/en_US/rg_marcom_FBAs/files/presskits/ACC05/AXIOM1A.jpg

DESIGN SPECIFICATIONS

Performance

- 45° of extension and flexion from a horizontal position
- Steady rate of rotation (approximately 1°/sec)
- Allow rotation to occur about a natural anatomic center
- Pose no risk to staff, patients, or other equipment
- No lateral obstruction of neck during imaging

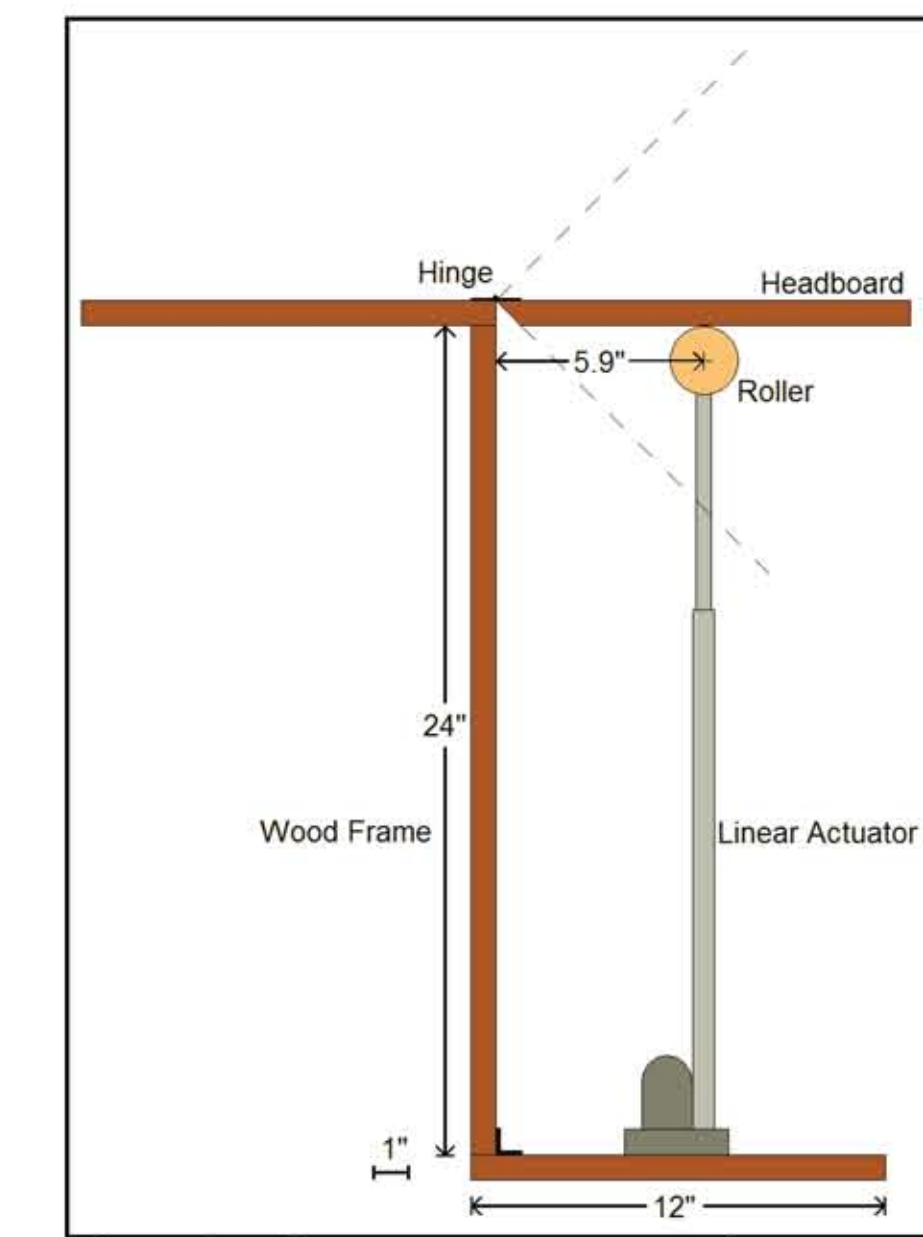
Control System

- Remote control operable from another room
- Protected from damage due to humidity, fluid spills, etc
- Provide feedback to staff on angle of extension or flexion

General

- Easily installed and removed from imaging table
- Padded to ensure patient comfort and safety
- Made of radio-translucent materials like plastics, not metal
- Durable enough to withstand daily use for several years
- Appealing and professional appearance
- Prototype within budget of \$200-250

FINAL DESIGN & PROTOTYPE



Sketch of Prototype, to scale

Actuator

- 165 lb load capacity with a 12" stroke length
- Base of actuator bolted to a metal flange, in turn bolted to wood frame base
- Roller wheels attached to top of actuator to allow smooth movement and support of headboard
- Connected to control circuit, which allows bidirectional (up and down) movement

Frame

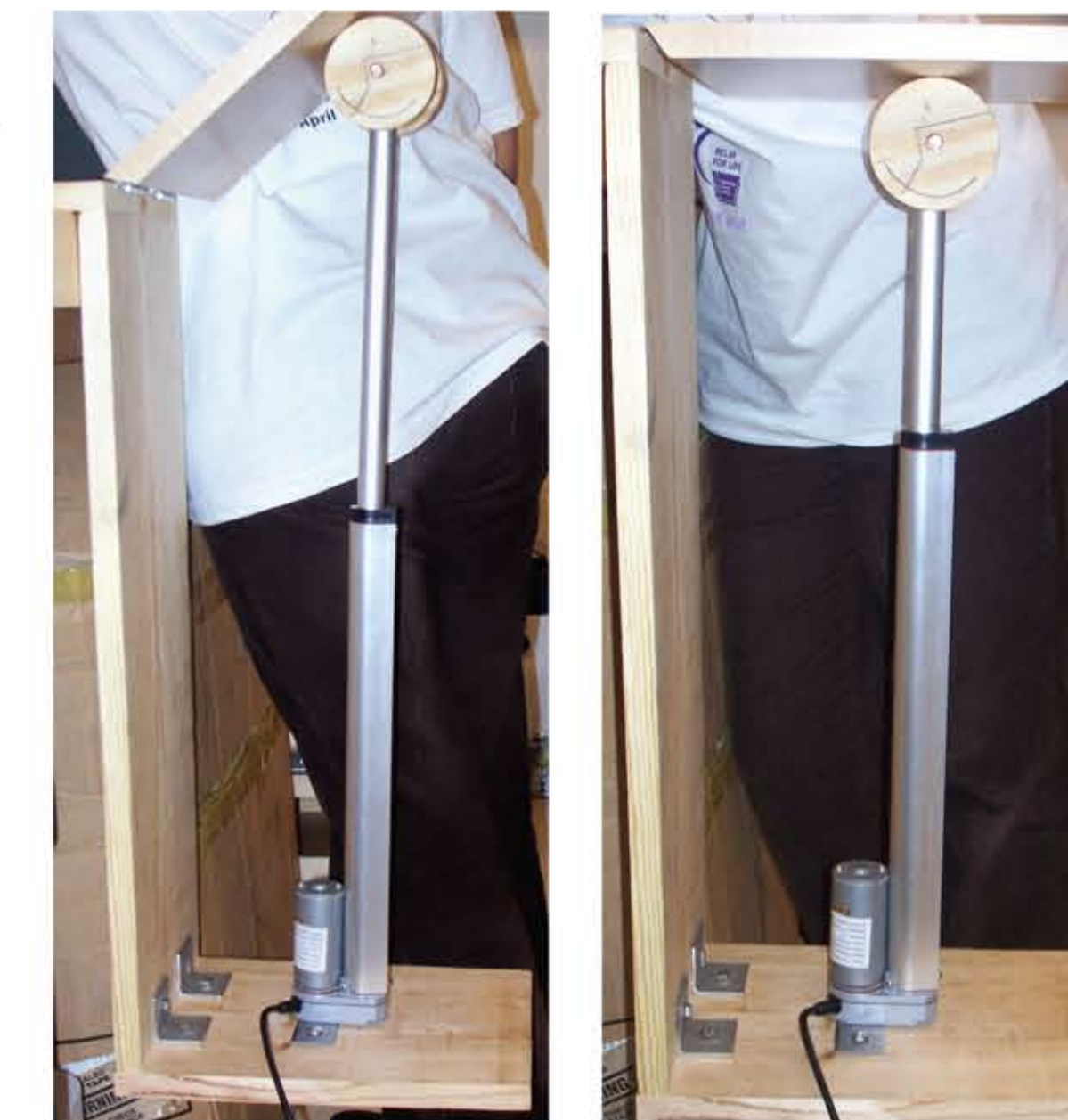
- Made out of 3/4" thick wood
- Three pieces are attached by screws and metal supports, forming a Z configuration
- Attached to the headboard, linear actuator, and examination table

Headboard & Hinge

- Connected to wood frame by metal hinges
- Tapered end allows +/-45 degrees of rotation from horizontal position

Roller Guide

- 1/4" rod threaded through hole in shaft, metal spacers and end pieces
- 2" diameter wheels free to roll as headboard rises and falls, providing support



Device in Two Positions, side views



Frame Base Components, side view



Roller Guide, front view



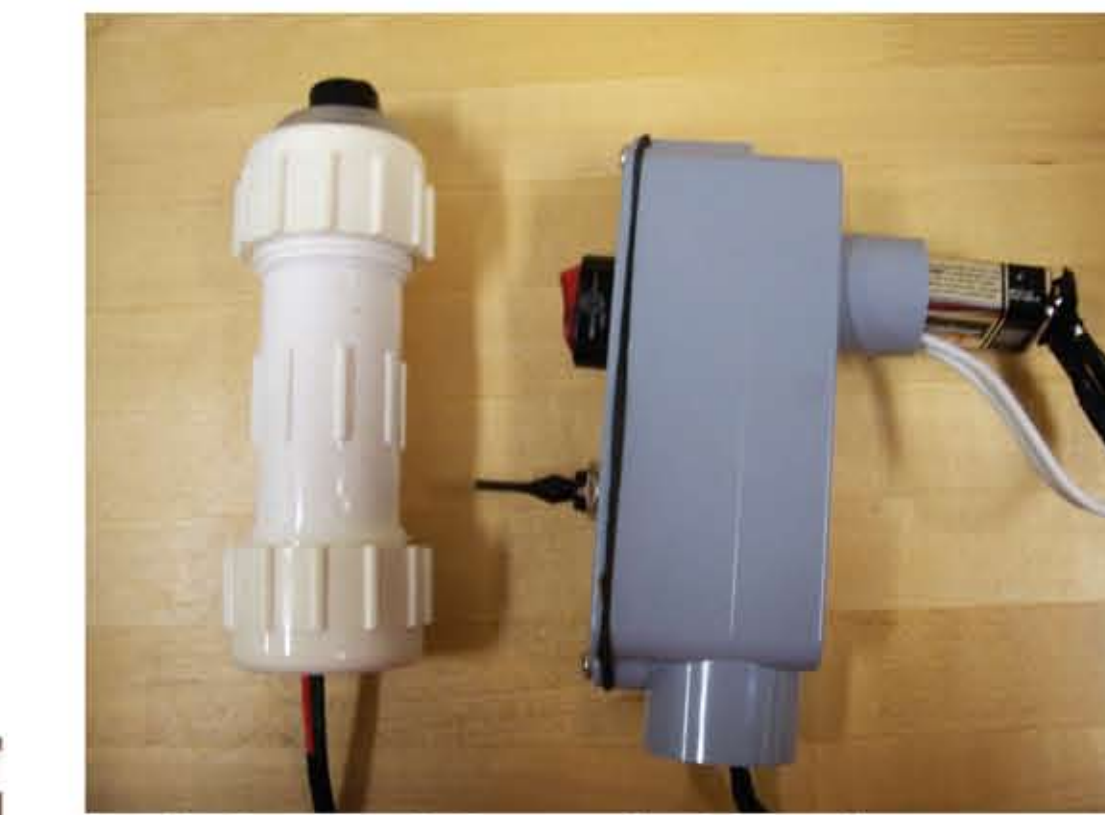
Hinge, top view



Hinges, side view

Power Switch

- SPST rocker switch, ON and OFF positions
- Rated to handle up to 12 V DC and 30 A
- Large red button easy to use
- Provide or cut power when needed



Panic Button & Doctor's Controls

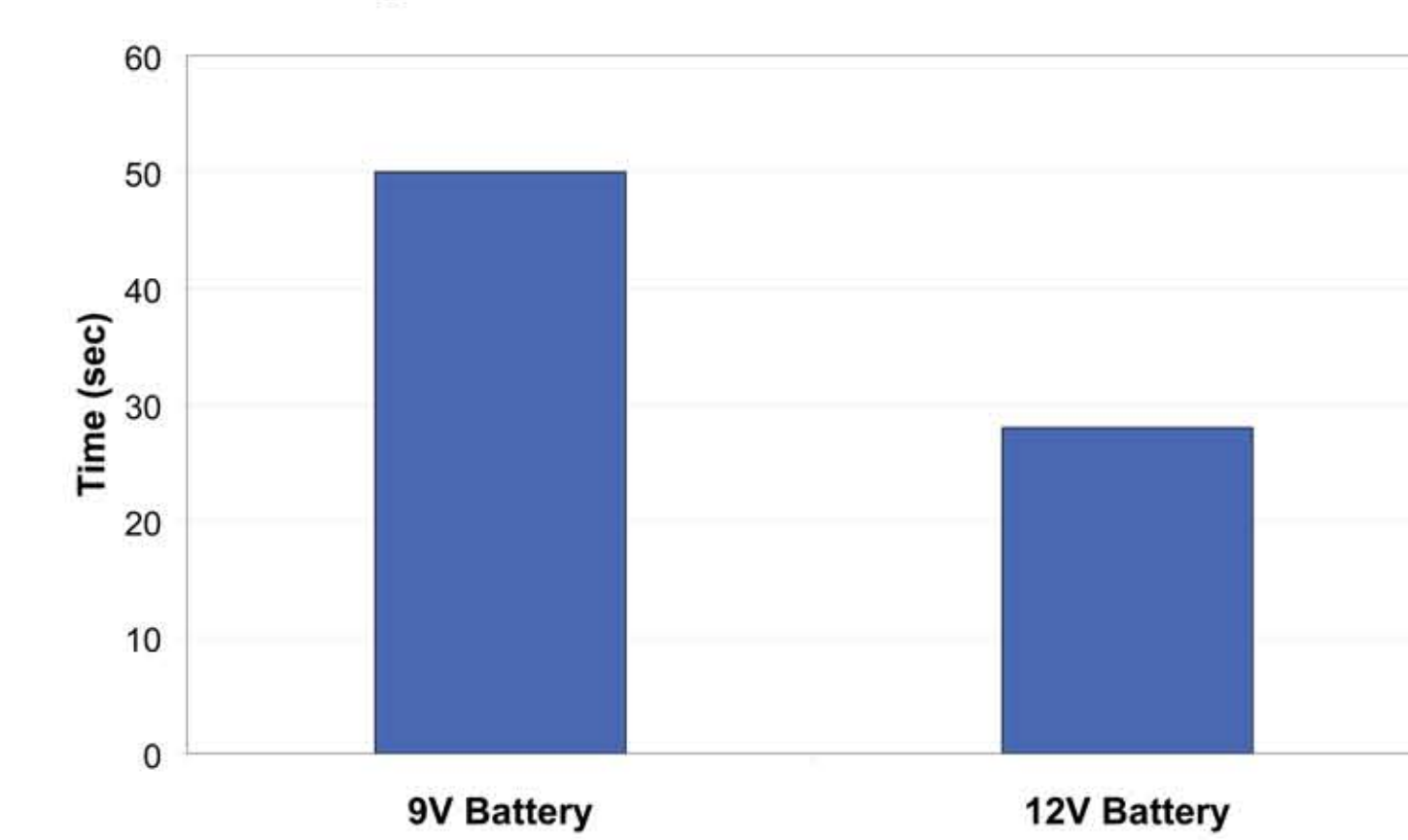
Patient's Panic Button

- SPST rocker switch, ON / OFF
- Can handle up to 12 V DC and 30 A
- Large red surface easy to use and understand
- Incorporated into handheld control stick
- Patient can immediately stop rotation if he or she experiences pain or discomfort

Momentary DPDT Toggle Switch

- Rated for up to 12 V DC and 20 A
- Provides bidirectional control of current through linear actuator
- Toggle itself is easy to use
- Intuitive up and down controls

Full Range of Motion Times for 9V and 12V Batteries



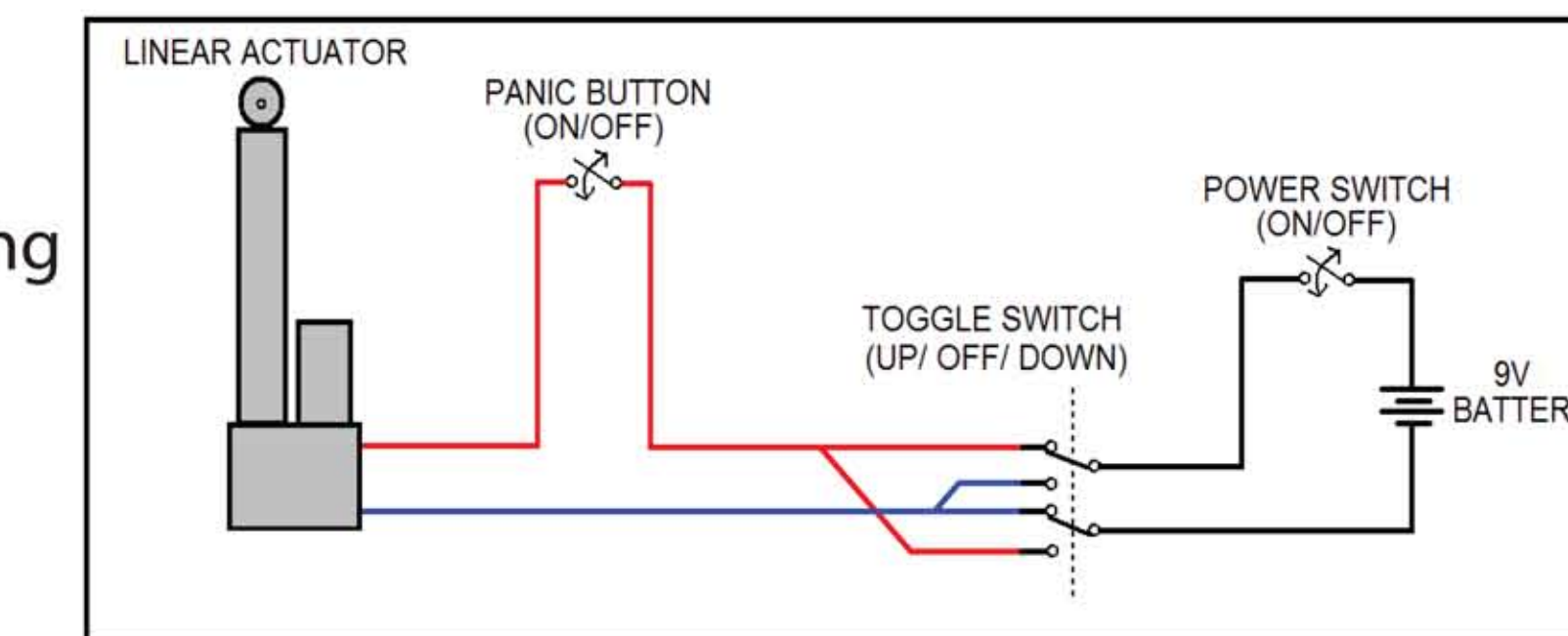
Toggle Switch & Rocker Switch <http://www.radioshack.com>

Linear Actuator

- Average 1.0 A current draw
- Rated to safely handle 12 V DC
- Shaft runs up or down depending on direction of current

Battery

- 9 V standard
- Wired to power switch and toggle switch
- Open circuit means no power loss when actuator not moving



Schematic of circuitry wiring and components

FUTURE WORK

- Pursue alternative materials options for frame and hinge construction to maximize stress tolerance and maintain high image quality
- Incorporate head stabilizer and pad into design for steadiness and comfort of patient
- Interface with computerized system that controls movement and provides digital angle feedback to the hospital staff during the examination
- Adapt design to incorporate an AC to DC converter or rechargeable power source
- Test prototype with various load sizes in preparation for human testing

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