

Device for tracking head motion in an MRI simulator

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Darren Klaty , Jeff Groskopf, Sara Schmitz, Spencer Strand

Problem Statement

The goal of this project is to design and build a system to track a subject's head motion in an MRI simulator and link this to a video display. When the subject moves his/her head, a displayed video (movie) is turned off; when the subject stops moving his/her head, the video resumes. Our goal is to use this device to train children to keep their head still when undergoing an MRI scan. Ideally, this device and software should be user-friendly. The system should be capable of detecting at least 0.2mm and 0.2 degree head motion at 30 Hz or better. The subject will be lying in a simulated MRI scanner, so access to the subject is somewhat spatially limited.

Client Requirements

- Have the ability to detect movement in 6 degrees of freedom
- Fit into the MRI simulator, approximately 4 cm size restrictions
- If the project does eventually end up being used in an actual MRI scanner non-ferrous materials must be used
- Accuracy of detection as small as 0.1 mm or a tenth of a degree of rotation
- Feedback to the patient so they can tell when they are moving and need to stay still

Design Requirements

1. Physical and Operational Characteristics

- a. Performance Requirements: Device should be capable of withstanding repeated use without breaking, It needs to fit with the patient inside the MRI scanning simulator.
- b. Safety: The device will be used on human subjects so precautions must be taken to ensure nobody is harmed from using the device. Also it must not

interfere with other medical equipment or devices that are to be used in conjunction with it.

- c. Accuracy and Reliability: A high level of accuracy is required from the design as very slight movements on the part of the subject can greatly alter the image the MRI is producing. Movement detection should be as precise as 0.1 mm or one tenth of a degree of head rotation.
- d. Life in Service: The device should be able to withstand repetitive use and last for an extended period of time while still operating correctly. It should last for thousands of uses if necessary.
- e. Shelf Life: The shelf life of the system should be an indefinite amount of time. All components should maintain working order with minimal component replacement.
- f. Operating Environment: The device will be placed on the exterior of the patient's body. It will be used indoors in a stable environment. There should be very little human contact to cut down on possible breakage of the device or its components.
- g. Ergonomics: The device should experience very little human contact; only minimal forces should be applied for slight adjustments for positioning.
- h. Size: The device needs to be able to fit inside the MRI simulator along with the human test subject. Only the sensor that must be attached or removed from the subject must be mobile but will remain within close proximity to the simulator.
- i. Weight: The total device should not exceed 20 kg. The sensor or the part of the design that is placed on the human subject should be less than 2 kg.
- j. Materials: The materials used in the design that come into human contact must be hypoallergenic.
- k. Aesthetics, Appearance, and Finish: Functionality is more important than

appearance in this project. If the device works correctly the appearance of the device should be made as professional as possible.

2. Production Characteristics

- a. Quantity: Only one device is needed at this time.
- b. Target Product Cost: Target cost is approximately \$500. This is flexible based on necessary components.

3. Miscellaneous

- a. Standards and Specifications: Device must comply with OSHA regulations.
- b. Customer: Client prefers that current MRI simulator set up remain unaltered, however nonessential components can be altered if necessary.
- c. Patient-related concerns: The sensor must be easily sterilized and should be comfortable during extended use of the system. All materials used must be hypoallergenic.
- d. Competition: There currently exists a head tracking device (MoTrak) used in MRI simulators made by Psychology Software Tools, Inc.