Experiment Safety Evaluation

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1 Flight Manifest

Primary Flyers: Isabel Bernal, Michael Heiman, Craig Morales, Bo Shi
Backup Flyers: None Team Journalist: The HERO team is planning to recruit Angela Swafford
Previous Experience: Angela Swafford covered MITs NORTHSTAR project in 1999. No team members have previous experience with the RGSFOP program

2 Experiment Description/ Background

The HERO team is investigating the effects on non-intrusive vibrotactile feedback on novice pilot perfomrance. This objective will be accomplished by integrating a vibrotactile feedback system and a laptop based flight simulator. Test subjects will be required to fly recovery maneuvers in simulated adverse weather conditions with and without the aid of the proposed system

3 Equipment Description

The HERO team equipment will consists of a laptop computer, flight simulator controls (joystic, throttle, and rudder pedals), a tactile feedback system, and haptic drivers. The most complicated pieces of equipment are the tactile feedback system and the haptic drivers. Students have narrowed down the format of the tactile feedback system to two finalists: vest based or imbedded in an aircraft seat. Pager motors controlled by a series of drivers connected to the laptop computer will serve as the pilot's tactile interface to the simulation.

4 Structural Design

The HERO team is currently in the process of deciding whether or not to implement the tactile feedback system in a vest or a seat configuration. Regardless of the outcome of this

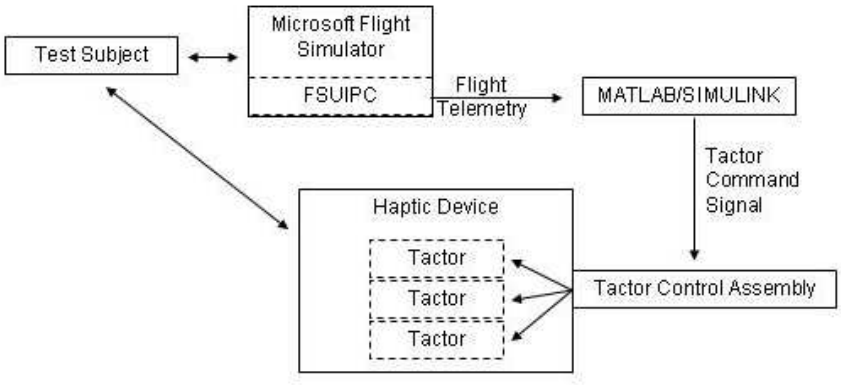

Figure 1: Equipment relationship diagram

decision, a test seat will be required. Rather than build a seat, students will attempt to obtain an off-the-shelf certified aircraft seat. The seat will most likely be bolted to the aircraft floor as indicated in TEDP documentation provided by JSC. The laptop, joystick, and rudder pedals will be securely mounted on the seat system in an as of yet undetermined fashion. Tactile system drivers will be in a self-contained box and will be securely mounted to the floor, must likely using cargo straps.

5 Electrical System

None of the electrical components of this experiment make use of large currents or voltages.

5.1 Electrical Components used in Ground and Flight Operations

- Laptop Computer
- Tactor Array consisting of approximately 12 Pager Motors
- Tactor Drivers and Power Supply

5.2 Hardware Requiring Electrical Power Sources

- Laptop Computer: 110V 1.5A A/C
- Pager Motors: $\approx$ 200mA each

6 Pressure/ Vacuum System

This experiment does not require the use of a pressure or vacuum system.

7 Laser System

This experiment does not require the use of a laser system.

8 Crew Assistance Requirements

There will be no special duties that will be requested of the KC-135 Flight Crew in assisting with the operaiton of the team's experiment on the ground or in-flight.

9 Institutional Review Board (IRB)

The proposed experiment requires IRB approval because it involves the use of human test subjects. The following documents are provided in the proposal:

- Layman's Summary
- Unsigned JSC Consent forms for each subject
- Hazard Analysis Information

In addition to the documents included in the proposal, the Massachusetts Institute of Technology IRB, the Council on the Use of Humans as Experimental Subjects (COUHES), requires the following documents to be submitted for approval:

- Application for Approval to use Humans as Experimental Subjects
- Authorization to Release Protected Health Information
- Consent to Participate in Non-Biomedical Research

10 Hazard Analysis

Hazard	Description	Cause(s)	Control(s)
Sharp Edges, Protuberaces	Subjects and Investigartors may come into contact with sharp edges, protrusions, and protuberances that can cause abrasions, cuts, lacerations, bruising, punctures, and penetrations.	exposed sharp edges, equipment not properly secured	Eliminate sharp edges with a durable blunting material, inspect for loose objects and missed sharp edges before flight
Pinch Points	Investigators' and subjects' extremities may become caught in pinch points, leading to crushing injuries.	Exposed and improperly designed joints and latches	Experimental equipment will be designed to minimize pinch points. If it is necessary to include a potential pinch point, it will be clearly labelled with a warning.
Inadequate Design/ Structural Failure	If the haptic system is incorporated into a deat or harness setup, inadequate design could result in structural failure. Test equipment would be lost, and test subject would be at risk of injury. In Addition, structural failure could result in components becoming free and interfering with neighboring projects.	Improper calculation of expected stresses and strains, lack of an adequate safety margin, use of materials weaker than required	Adequate safety margin incorporated into design, incorporation of proven off-the-shelf hardware as the main load bearing structures, preflight simulation of expected flight stresses to verify structural integrity.
Wire entanglement	Multiple sets of cables are required by the current experiment design to power and operate the tactile feedback system. Loose lengths of wire may become entangled with each other, test equipment, subjects, or investigators. Entanglement may create excess stress on the wires, which could cause fracture, thereby creating a potential shock hazard.	Wires not bundled, clamped, and secured properly, excesss wire length	cables will be bundled and secured, number of cable bundles will be minimized, length of cables will be carefully controlled, a clearly marked emergency kill switch will be used in the event of an entanglement
Electrical Shock	Subjects and investigators come into contact with a surface at a significantly different electrical potential than their own. The resulting voltage gap induces a potentially harmful current through his or her body.	exposed control and power wires, improperly grounded equipment, overloaded power supply, use of improper wire guage	all test equipment power run through appropriate fuses and/or circuit breakers with maximum current not to exceed 80% of system capacity (indicated in TEDP documentation), compliance with load tables in AOD 22896, proper grounding of test equipment, proper selection of wire guage