Development of Novel Human-Computer Interfaces for an Interactive Electronic Work Control System (IEWCS) for Glovebox Operations

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1. **Abstract**: Performing work in a glovebox requires significant administrative and technical documentation. Currently, for every two technicians working in a glovebox, there must be one additional technician that is simply reading off work instructions and recording the activities of the other technicians. Operators are distracted by the constant checking of their work, and all documentation is currently done manually making it labor intensive and difficult to integrate with other documentation. Working in gloveboxes also requires keeping track of the locations of radioactive materials in the gloveboxes in order to make sure technicians don't inadvertently perform an action that can lead to a technical criticality violation. In this work we would like to explore ways to exploit emerging technologies in sensing, computer vision, haptics, visualization, virtual reality, and modeling to try and develop a next generation Interactive Electronic Work Control System for glovebox operations. This system should ease the burden of documentation on operators, should integrate a sensing and modeling capability to help avoid technical criticality violations, and eventually could include biometrics to measure the fitness of human operators to perform their work.

2. Project Outline

a. **Goal** – The goal of this project is to develop a prototype system for enhancing the human capability to work in a glovebox. Students will use the Robot Operating System to integrate multiple sensors, write programs to analyze data from the sensors, utilize visualization software, develop planning software, prototype human-machine interfaces and make use of computer vision software. The team will work with their mentor to nail down a tight research goal that is important to the nuclear materials handling community.

b. **Motivation** – Work in gloveboxes requires a large amount of overhead in terms of people in order to ensure safety and security. Humans also become fatigued and can make errors in their work as their shift roles on possibly leading to a technical criticality violation.

3. Background Literature

- Robot Operating System tutorials: http://wiki.ros.org/ROS/Tutorials
- Python tutorial, http://www.learnpython.org/
- Nuclear Criticality Safety (wikipedia), http://en.wikipedia.org/wiki/Nuclear_criticality_safety

- Additional materials on the LANL criticality safety program will be provided upon arrival.

4. Week by Week Plan

(Plan subject to change based on results of the work)

Week	Task
1	Review background literature
2	Become familiar with ROS and integrating sensors with ROS.
3	Become familiar with human-machine interface software
4	Begin building prototype Glovebox state awareness system
5	Based on initial results start building glovebox planning visualization and capability prototype
6	Implement Glovebox modeling/planning software
7	Test and debug software
8	Execute second iteration of the system
9	Prepare report and presentation

5. Real world design issues as a project consideration

- Regulatory issues associated with such a system being included in LANL glovebox operations
- Human factors
- Reliability and safety

6. Equipment Available

- Microsoft Kinects
- Webcams
- Audio Speakers
- Stacklights
- Computers
- Budget available for additional sensors/HMI equipment
- Glovebox training facility
- Occulus Rift

7. Software

- Robot Operating System
- Python
- Pygame
- Numpy
- CMUSphinx