Tactile Feedback for a Sailplane Pilot Giving Wing Air Conditions: Commercial Vest

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Background

Pilots have a variety of instruments in their aircraft which notify them of existing conditions. Such instruments include altitude, compass heading, and airspeed. These instruments typically rely on the pilot's senses of sight and hearing to perceive the information they provide, but what if there was another way to relay this information?

Unlike a bird flying through the air, able to sense the changes in the air around it (Brown & Fedde, 1993), a pilot remains inside a closed environment and relies on gauges to perceive these changes. Since an open air cockpit is generally not feasible, what we want is to present to the pilot a tactile representation of what is happening outside of the aircraft, to almost make the plane an extension of the pilot's body (see also Clark, 2003). Not only could this result in increased reaction time during potentially hazardous flying conditions, but it may also improve the pilot's quality of experience under normal conditions.

I propose to evaluate a commercial tactile feedback system which could be used to deliver tactile sensations to a pilot. Such a device will eventually be used to interface with sensors on the wings of an aircraft. In the present project, we will use sensor simulation software to provide us with a way to produce input to the tactile device. Two other UROP proposals are being co-submitted that aim to develop new tactile feedback systems. As the area of providing tactile feedback on airflow conditions is new, we aim to provide for our best opportunity for progress by this multi-project approach.

Research and Implementation

While many tactile feedback systems have been created for research purposes (e.g., see review: Hayward & MacLean, 2007), only a few have been produced commercially. Most of these devices are currently being used with gaming and simulation software (e.g., flight simulators). We are currently considering devices from a number of sources. The Intellivibe system (ivibe.com) is a tactile chair that is designed with six total feedback actuators for the back and legs. The LT-11 Laser tag vest (www.lasertron.us) is a tactile harness which provides feedback to the shoulders, chest and back. The TN Games FPS Gaming Vest (www.tngames.com) is an 8 actuator feedback device which is designed to be worn on the torso. A commercial device will be considered based on its ability to provide us with a relatively large number of actuators, and a programming interface which allows control over each actuator individually (e.g., via the C++ programming language). The TN Games device is particularly appealing because it meets both of these requirements.

The second part of this research will consist of the creation of software to enable visualization and access to simulated sensors. This software (to be developed in collaboration with Prasad Kulkarni) will allow us to graphically visualize the airflow conditions as monitored by a sensor array and will enable the sensor data to be used as input to a tactile feedback system. This software will be designed to interpret data from multiple sensor sources (e.g., real sensors or virtual sensors from a flight simulator).

These elements in conjunction will create a complete system which will be able to gather airflow readings and visualize how the air flows. It will provide a source of data which will be used by a tactile feedback device to deliver representative tactile sensations.

Evaluation and Report

Evaluating the ability of commercial tactile feedback systems to sufficiently represent wing air conditions to a pilot is important in deciding whether commercial devices will be appropriate for our needs. We will conduct user trials, testing the user's ability distinguish between variation in actuator activation, intensity, and pattern of activity. To what degree can a user perceive variation between multiple and single actuators? At what level can a user perceive variation in intensity? How resolute must a pattern of actuator activity be for a user to describe a tactile 'picture'? Our rating of a commercial device in relation to similar custom designs will be based on its ability to provide superior results in each of these three areas.

Project Budget and Schedule

This project is expected to begin on July 1st, 2008 and continue over the summer. During this time, a stipend of $1,400 would allow for funding up to 122 hours of research at an average of 10 hours per week. As part of the expenses required, a stipend of an additional $200 would be used for the acquisition of the TN Gaming tactile feedback vest that will be used in our research.

Time Line

Tactile Device Familiarization:	1 weeks
Tactile Device Testing:	3 weeks
GUI Design:	2 weeks
GUI Implementation:	2 weeks
Evaluation:	3 weeks
Summary and Report:	1 weeks
Total	**12 weeks**

Dr. Prince's Involvement

Dr. Prince will be coordinating and overseeing the research and development of our sensor simulation software and tactile feedback devices. This research will directly contribute to Dr. Prince's efforts to implement a complete wing air tactile feedback system for a sailplane. Dr. Prince will provide guidance and technical support throughout our research.

References

Brown, R. E., & Fedde, M. R. (1993). Airflow sensors in the avian wing. Journal of Experimental Biology, 179, 13–30.

Clark, A. (2003). Natural-Born Cyborgs: Minds, Technologies and the Future of Human Intelligence. NY: Oxford University Press.

Hayward & MacLean (2007). Do it yourself haptics, part I. IEEE Robotics and Automation Magazine, 14, 88-104.