Air Flow Measuring Sensor Array for a Sailplane Wing: Software

Student: Sonja Foss; **Faculty Sponsor:** Christopher G. Prince

Background

The goal of this project is to implement an array of sensors that could be attached to the wings of a sailplane to measure the exterior wind forces. Knowledge of the air around the wing is important for a sailplane pilot for it is the air around the wing that keeps a sailplane in the air. If a pilot of a sailplane had more knowledge of these air conditions, we hypothesize that flight maneuvers could be more easily and safely carried out. Prasad Kulkarni (in progress) and Christopher Prince are studying the usefulness of airflow feedback to a pilot. Their Fly by Feel project (http://www.d.umn.edu/~cprince/PubRes/FbF/) involves feeding the airflow information obtained from the wing back to the pilot on their skin. The skin, a tactile sense, is relatively underutilized in aircraft cockpits. Research and development of tactile feedback sleeves to give a pilot tactile feedback of air flow information have been done by Matt Wronski (2008) and Jordan Parrott (2008) under the instruction of Christopher Prince. A sensory array technology for deployment on an aircraft wing that might suit our needs is commercially available (Caitlin, et al., 2002; Sensors, 2008). Our hope is to develop our own in-house sensory technology and when we have sufficient work completed, apply for a grant so we can compare our sensory array against this commercial available array.

The eventual goal is to join the tactile sleeves and the array of sensors so that a sailplane pilot could fly by feel, however this project will focus on implementing the array of sensors. To date, the Fly by Feel project is using only simulated sensors (e.g., from a flight simulator). This UROP project, in conjunction with the UROP proposal co-submitted by Usama Nasir, will involve the first concrete sensor array for the Fly by Feel project.

Contribution

Air Flow Measuring Sensor Array for a Sailplane Wing: Software
Student: Sonja Foss; **Faculty Sponsor:** Christopher G. Prince

Little research has been carried out with tactile feedback in the aviation context (e.g. see Spirkovska, 2005). To our knowledge the Fly by Feel project is the first to pursue the use of sensor arrays based on air flow information to feed back tactile sensation to the pilot. A feedback system might improve safety for the pilot because it may enable the pilot to more easily detect a stall condition. Stalls and spins are amongst the leading causes of fatal accidents in aviation.

Research and Implementation

The hardware side of this project involves an array of sensors to be connected by Usama Nasir, and I will be responsible for the software to interface with the sensors. The sensors to be used in this project are SCP-1000 which is an absolute air pressure sensor (VTI Technologies). Four of the SCP-1000 sensors will be used for the array. These SCP-1000 sensors use a Serial Peripheral Interface (SPI); I will be using the SPI to interface with the sensors. Along with the array of sensors there will be a flash memory device that will be used to store the data generated by the sensors. A microcontroller, most likely a Microchip 18F4550, will be used to connect to the sensors and the flash memory device. My part in this project will be to write code in the C language for the microcontroller to interface with the sensors and to store the sensor data in the flash memory device.

The final result of this UROP will be the sensors connected via a breadboard, software to read from the sensors and a way to download the data to a PC. Since the sensors will be connected by a breadboard, the system will not be durable enough for a flight test. After this UROP has been completed, a self contained version of the system could be made with the sensors and the microcontroller on a soldered circuit durable enough for a flight test. Even though the sensor array made in this UROP will not be used in a flight test, the data stored on the flash device can be used offline to drive the tactile sleeves. The software to enable offline use of the sensor data has already been completed by Prasad Kulkarni and Christopher Prince. The data generated by the sensors and stored on the flash memory will have to be analyzed on a computer. The type of flash memory to be used in this project has yet to be decided on but will either be a USB flash drive or flash memory on the microcontroller. If a USB flash drive is used, transferring the generated data onto a PC would easily done using the USB port on the PC. If flash memory on the microcontroller is used, then interfacing the flash memory device to a computer will be another software aspect of the project for me to implement.

Evaluation

To evaluate this project we will test how well the array of sensors, the microcontroller, the flash memory and the computer work together. There are several ways for the sensors to generate data in the early stages of testing, one of these ways is to put the sensors in a car and drive up and down the hills of Duluth. Another way to generate sensor data would be to put half of the sensors in a pressure controlled box and vary the air pressure around the other sensors in order to produce varying data amongst the sensors.

Timeline

Design of interface to sensors:	1 week
Code interface to sensors:	2 weeks
Design flash storage interface:	1 week
Code interface to flash storage:	2 weeks
Report:	2 weeks
Total:	8 weeks

REFERENCES

Catlin, L. W., Eccles, L. H., & GenKuong, F. (2002). Shared Development of Networked Smart Transducer Systems. Presented at Sensors Expo & Conference, Boston, September 24-25.

Kulkarni, Prasad. (in progress). Simulating Wing-Sensors on a Sailplane Airfoil To Evaluate Usefulness For Pilot Feedback. URL: http://www.d.umn.edu/~cprince/PubRes/FbF/proposals/Prasad.pdf

Parrott, Jordan. (2008). Tactile Feedback for a Sailplane Pilot Giving Wing Air Conditions: Vibration Motor Sleeves. URL: http://www.d.umn.edu/~cprince/PubRes/FbF/proposals/Jordan.pdf

Sensors (2008). Endevco and Boeing Sign License Agreement. June 26, 2008. Internet: http://www.sensorsmag.com/sensors/article/articleDetail.jsp?id=526198

Spirkovska, L. (2005). Summary of tactile user interfaces techniques and systems. NASA Technical Report, Ames Research Center, NASA/TM-2005-213451.

VTI Technologies. (2009) SCP1000 Series- Absolute Pressure Sensor. URL: http://www.vti.fi/en/products/pressure-sensors/pressure_sensors/

Wronski, Matt. (2008). Tactile Feedback for a Sailplane Pilot Giving Wing Air Conditions: Micro Fan Sleeves. URL: http://www.d.umn.edu/~cprince/PubRes/FbF/proposals/Matt.pdf