HAPTIC FEEDBACK FOR COCKPIT TOUCHSCREENS

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What are Haptics?
Haptics are electronically created tactile sensations that are used most notably in smartphones to simulate button presses and deliver reminders.

Problem
Touchscreens are widely used in planes, but they don't have haptics and are difficult to use in turbulence.

Objective
To design a retrofit for Korry Electronic's touchscreen that can supply haptic feedback that is:
1. Distinguishable from Turbulence
2. Ruggedized against temperature, vibration and other environmental factors
3. Intuitive: Haptic buttons feel like real buttons
4. Satisfying to use, sleek form factor
5. Consistent haptic response
6. Efficient usage of weight, cost and power

Research
Guiding Question: Do pilots want haptics?

Interview
When we interviewed seasoned pilot Frank about the importance of haptics, he said, “Haptic feedback is highly valued.” And the largest challenge with using touchscreens?

Survey
We conducted a survey of pilots to gauge their reliance on tactile feedback (the feeling of pressing a button). While some pilots don't rely much on tactile feedback, most pilots do, indicating a need for haptics in cockpit touchscreens.
“Turbulence. When it's physically unstable, it's a challenge to get to the controls.”

Flight
On April 13th, our team flew with flight instructor Roger Weber in a Cessna to experience the challenges pilots face using a touchscreen in a plane. Team member Christian flew and observed significant vibration on the control panel even without any turbulence.

Integration Challenge
Where can we attach the haptics?

Idea 1: Inside Screen
Pros: • Great form factor
Cons: • Doesn’t solve turbulence problem • Limited space

Idea 2: Inside Thumb Rest
Pros: • Haptics attached closer to hand • Stabilizes during turbulence
Cons: • Unintuitive • Hard to design for all hand shapes

Idea 3: Inside Hand Grip
Pros: • Haptics attached to smaller mass • Stabilizes during turbulence • Wider form factor

Controlled Experiment
To maximize haptic performance we tested the effect of partially mechanically isolating the grips from the screen. We performed a controlled experiment and tested if a haptic pulse was distinguishable from vibrations generated by an operating clothes dryer. The grips were mechanically isolated using 2mm of damping foam. Result: While holding the mechanically isolated grip, haptic pulses were detected using 40% Less Power than with statically connected grips. This led us to the conclusion that mechanically isolating the grip will help pilots distinguish haptics.

Tech Decision
Linear Resonant Actuator (LRA)
Small magnet powered motor
Score: 7.2

Piezoelectric Actuator
Paper-thin vibrating sheet
Score: 5.6

Legend:
- Strength: 50%
- Form Factor: 20%
- Power Use: 10%
- Cost: 10%
- Weight: 10%

We compared two technologies for creating haptic feedback: Linear Resonant Actuators and Piezoelectric Actuators. To find the best option, attributes were assigned different values for each actuator and multiplied by weights to get a final score.

Final Design
Our final prototype design places an importance on haptics that operate under any conditions. Isolated grip design maximizes ability to distinguish haptics from vibrational noise. Hand grips give pilots a hold to stabilize when using the screen during turbulence. LRAs used are ruggedized against extreme temperature.

This research provides a starting point for the expansion of Korry's product development. This is an opportunity to add unique value to their touchscreens and become pioneers in cockpit haptics.