HAPTIC FEEDBACK FOR COCKPIT TOUCHSCREENS

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What are Haptics? 1

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

Problem 2

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

Objective 3

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 enviromental factors
3. **Intuitive**: Haptic buttons feel like real buttons
4. **Satisfying** to use, sleek form factor
5. **Consistent** haptic response
6. **Efficent** usage of weight, cost and power

Research 4

Guiding Question: Do pilots want haptics?

Interview 4.1

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?

"**Turbulence**. When it's physically unstable, it's a challenge to get to the controls."

Survey 4.2

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.

"I rely on tactile feedback to make sure the right button is pressed:

- Strongly Agree
- Strongly Disagree

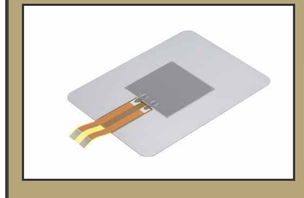
Flight 4.3

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.

Tech Decision 5

Linear Resonant Actuator (LRA):
Small magnet powered motor

Score: 7.2



Piezoelectric Actuator:
Paper-thin vibrating sheet

Score: 5.6

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.

Legend:

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

We chose the Linear Resonant Actuators because they had significantly more vibrational strength. We valued strength over every other attribute because our test flight demonstrated there was strong vibration in the cockpit.

Integration Challenge 6

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

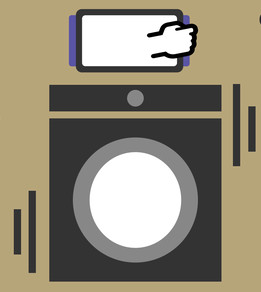
Cons:
- Wider form factor

Side profile of different grip prototypes. Created chronologically from left to right.

We decided integrating the haptics into a pair of side grips was the best option. This allows a pilot to stabilize their hand, while using their thumb on the touchscreen. Prototypes were 3D printed and went through several iterations to find the most ergonomic shape.

Controlled Experiment 7

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 dampening foam.

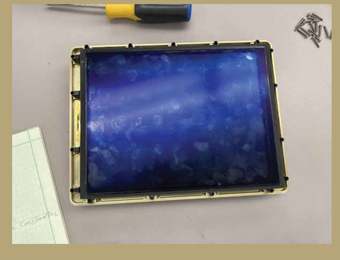


Result:
While holding the mechanically isolated grip, haptic pulses were detected using

40%
Less Power

than with statically connected grips. This led us to the conclusion that mechanically isolating the grip will help pilots distinguish haptics.

Final Design 8



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