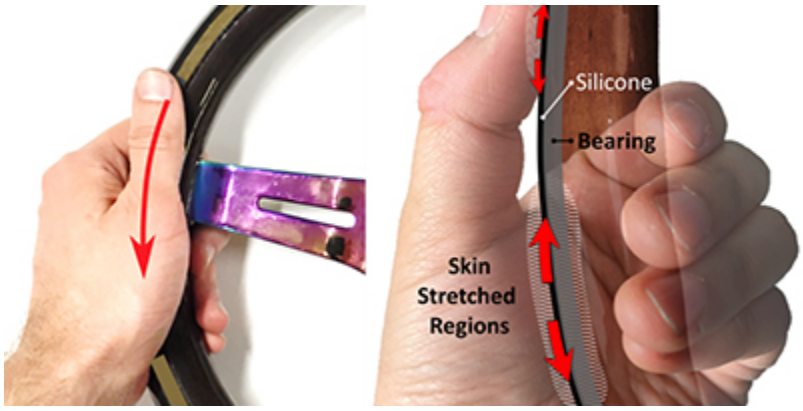
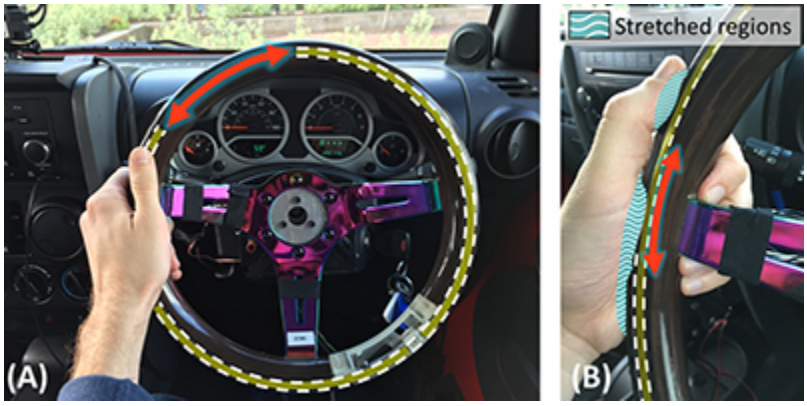
Docket #: S16-288

Steering Wheel Skin Stretch Haptic Feedback System

Engineers in Prof. Mark Cutkosky's laboratory have patented a compact, intuitive, haptic vehicle feedback system that communicates multi-dimensional information to drivers through the grip of the steering wheel. Current vehicle steering feedback systems rely on vibration (which only delivers discrete "on/off" information), sound and vision (which compete for a driver's attention with other auditory or visual tasks), and handwheel torque (which disrupts manual steering). Prof. Cutkosky's lab's alternative applies small shear forces to stretch the skin on the driver's hand, which communicates rich analog cues, including magnitude and direction information. The system provides a tactile signal regardless of the driver's hand position and does not affect the steering control. It is easy to program and control and is naturally reflexive for the driver, allowing instantaneous comprehension. This tool can be used for navigation, semi-autonomous vehicle intention notification, driver training, and safety applications to improve situational awareness.





Close-up view of the skin stretch produced by the steering wheel. Ring at front of the rim (highlighted yellow on left) can be gripped anywhere and can rotate 0.5 degrees, producing 2.5mm of skin stretch.

Stage of Development- Prototype
The inventors tested a prototype in a realistic on-road environment while driving a vehicle in suburban traffic. They demonstrated that drivers could easily perceive skin stretch cues and distinguish between a set of four stimuli of varying direction and displacement with reasonable accuracy even when competing against other sources of vibration as well as distractions inherent in driving. In a follow-up study, they found drivers could easily navigate an unknown course using only skin stretch cues, and these cues were better than auditory cues in the presence of a distracting task such as a phone call.

Applications

- **Human vehicle interface** - quickly and intuitively communicate information from the car to the driver with end-user applications such as:
  - safety - collision avoidance, lane keeping, blind spot detection, low traction warnings
  - navigation and trajectory planning
  - autonomous vehicles
  - driver training for cars, trucks and heavy equipment

Advantages

- **Rich haptic feedback:**

    - skin stretch provides analog signals having magnitude and direction, which communicates more information than discrete vibration event cues
    - fast, noticeable, intuitive, and naturally reflexive cues that humans are accustomed to with everyday object manipulation
    - tactile feedback that does not saturate the already heavily used visual and auditory channels
    - does not lead to desensitization
- **Compact, seamless integration into steering wheel** - surrounds whole steering wheel in continuous manner
    - provides effective feedback cues regardless of grip style
    - same size and shape as ordinary steering wheel
    - low power and fewer actuators than vibration cues
    - skin stretch does not interfere with steering dynamics (unlike handwheel torque which is coupled with the steering system)
- **Easy to program and control** - simple, low-power DC motor for actuation and optical encoders for sensing

Publications

- Ploch, C. J., Bae, J. H., & Cutkosky, M. R. (2021). *U.S. Patent No. 10,933,808*. Washington, DC: U.S. Patent and Trademark Office.
- Ploch, C. J., Bae, J. H., Ju, W., & Cutkosky, M. (2016, October). Haptic skin stretch on a steering wheel for displaying preview information in autonomous cars. In *2016 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* (pp. 60-65). IEEE.
- Ploch, C. J., Bae, J. H., Ploch, C. C., Ju, W., & Cutkosky, M. (2017, June). Comparing haptic and audio navigation cues on the road for distracted drivers with a skin stretch steering wheel. In *2017 IEEE World Haptics Conference (WHC)* (pp. 448-453). IEEE.

Innovators

- Mark Cutkosky
- Christopher Ploch

Licensing Contact

Luis Mejia

Senior Licensing Manager, Physical Sciences

Email