Tasbi:Multisensory Squeeze and Vibrotactile Wrist Haptics for Augmented and Virtual Reality

【Summary】:

In this work, we present Tasbi, a multisensory haptic wristband capable of delivering squeeze and vibrotactile feedback. The device features a novel mechanism for generating evenly distributed and purely normal squeeze forces around the wrist. Our approach ensures that Tasbi’s six radially spaced vibrotactors maintain position and exhibit consistent skin coupling. In addition to experimental device character-ization, we present early explorations into Tasbi’s utility as a sensory substitution device for hand interactions, employing squeeze, vibration, and pseudo-haptic effects to render a highly believable virtual button.

Fig. 1. Tasbi is a multisensory haptic wristband capable of delivering squeeze and vibrotactile feedback for a variety of uses in AR/VR.

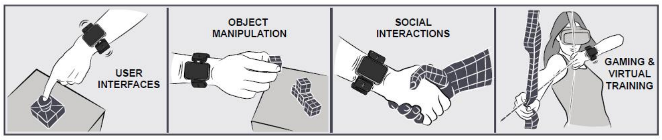


Fig. 2. Tasbi enables a variety of interactions with the virtual world. Vibrotactile feedback may substitute for fingertip contact with virtual buttons or other types of user interfaces, while squeeze may convey the weight or stiffness associated with manipulating virtual objects. Squeeze and vibration can further add to telepresence and remote social interactions such as hand shaking or holding, and can also provide immersive feedback for gaming and training.

【Two feedbacks included in the device】:

Vibrotactile Feedback

Squeeze Feedback

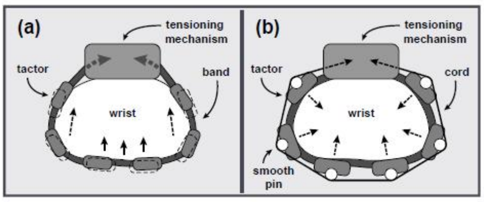


Fig. 3. **(a)** Typical constricting-band approaches to squeeze produce non-uniform and tangential forces which would cause embedded tactors to shift. **(b)** Our decoupled approach aims to produce pure, uniform normal forces.

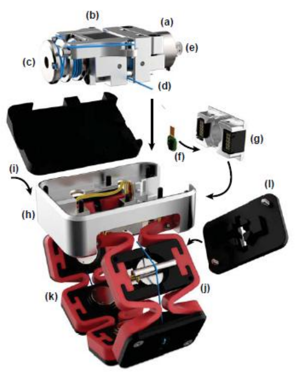


Fig. 4. Exploded view of Tasbi (color added for clarity). The squeeze mechanism consists of a 12 mm DC motor **(a)** and a 13 mm Harmonic Drive gearbox **(b)** which drives a two-sided spool **(c)** to create tension in a UHMWP cord **(d)**. Control feedback is provided through an optical encoder consisting of a reflective code wheel **(e)** and optoelectronic sensor **(f)**. The sensor is epoxied into the rear housing panel **(g)** which also contains two 10-pin connectors for all electronics. The drive assembly **(a-e)** drops into the main housing **(h)** and is secured in place with a housing lid **(i)**. Each vibrotactor unit **(j)** contains a 10 mm LRA vibrotactor and a smooth stainless steel pin to convert cord tension into normal force. Vibrotactor units are clipped into elastic sidings **(k)** and secured with lids **(l)**.

【Tasbi】:

The overall dimensions of the watch are approximately 50 × 50 × 15 mm and the total weight is less than 200 grams.

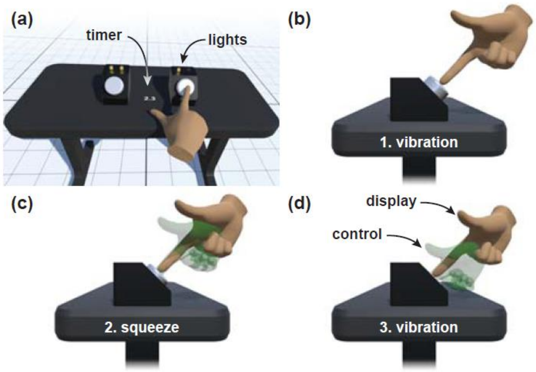
A. Squeeze Mechanism

B. Vibrotactile Band

C. Feedback and Control

【SQUEEZE CHARACTERIZATION】: Testing the squeeze of equipment.

【MULTISENSORY VR INTERACTIONS】: Test the device in an AR / VR environment.



【Conclusion】:

To conclude, we have presented Tasbi, a haptic wristband featuring multisensory squeeze and vibration for AR/VR interactions. The device produces evenly distributed forces up to 15 N and 10 Hz radially around the wrist. Importantly, our design eliminates tangential shear forces which would have otherwise presented problems for band embedded vibro-tactors. Finally, we presented a proof of concept application in which squeeze, vibration, and a psuedo-haptic effect were utilized to create a highly believable finger-button interaction.

【Important Reference】:

C. Pacchierotti et al., "Wearable haptic systems for the fingertip and the hand: Taxonomy, review, and perspectives," IEEE Trans. Haptics, vol. 10, no. 4, pp. 580–600, Oct 2017.

J. Perret and E. Vander Poorten, "Touching virtual reality: a review of haptic gloves," in ACTUATOR Conf., June 2018, pp. 1–5.

F. Chinello et al., "The HapBand: A cutaneous device for remote tactile interaction," in Haptics: Neuroscience, Devices, Modeling, and Applications, M. Auvray and C. Duriez, Eds. Berlin, Heidelberg: Springer, 2014, pp. 284–291.

T. K. Moriyama et al., "Development of a wearable haptic device that presents haptics sensation of the finger pad to the forearm," in IEEE Haptics Symp., March 2018, pp. 180–185.

B. Stephens-Fripp et al., "Applying mechanical pressure and skin stretch simultaneously for sensory feedback in prosthetic hands," in IEEE Intl. Conf. Biomed. Robot. and Biomech., 2018, pp. 230–235.