April 2020

Contextual Haptics for Wearable Devices

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ABSTRACT

Haptic feedback is an important feature for wearable devices such as watches, fitness bands, etc. Current techniques to provide hardware feedback either cannot generate specially customized haptic feedback, or are limited to predefined haptic effects, and are limited by the battery and peak power draw available on a wearable device.

This document describes context-aware haptics that take into account the user state while using the wearable device. With permission from the user, the user state or activity, e.g., sitting, walking, running, etc. is detected by analyzing sensor readings from inertial measurement unit (IMU) sensor(s) that are included in the wearable device. Based on the user state, dynamic haptics are provided that adapt to the determined user state/ context.

KEYWORDS

- Wearable device
- Smartwatch
- Fitness band
- Contextual haptics
- Context-aware haptics
- Dynamic haptics
- Haptics library
- Haptics perceivability
- Haptic feedback

BACKGROUND

Haptic feedback is an important feature for wearable devices such as watches, fitness bands, etc. Haptic feedback is provided using hardware built in the wearable device. For example, eccentric rotating mass (ERM) based haptics or linear resonant actuator (LRA) based haptics can be used.

ERM-based haptics have hardware limitations such that these cannot generate specially customized haptic feedback. Further, the vibration amplitude and frequency are tied with each other. The use cases for ERM-based haptics are also restricted due to slow response. The haptic experience, e.g., a buzz, can be underwhelming for the user.

LRA-based haptics hardware is capable of generating advanced haptics. However, current wearable devices that use such haptics include pre-defined haptic effects and do not support dynamic updates of haptic effects. While LRA can provide a refined haptic experience, these are limited by the peak power draw supported by the battery of the device. Because of power limitation of the device, higher strength effects are usually generated with longer duration which results in less sharp feeling. Further, perceived strength of a haptic effect is also impacted by user context, e.g., sitting, walking, running, etc. It is difficult to find the right balance between sharpness and strength in all contexts.

DESCRIPTION

This document describes context-aware haptics that take into account the user state while using the wearable device. The user state or activity, e.g., sitting, walking, running, etc. is detected by analyzing sensor readings from inertial measurement unit (IMU) sensor(s) that are included in the wearable device. Based on the user state, dynamic haptics are provided that adapt to the determined user state/ context.

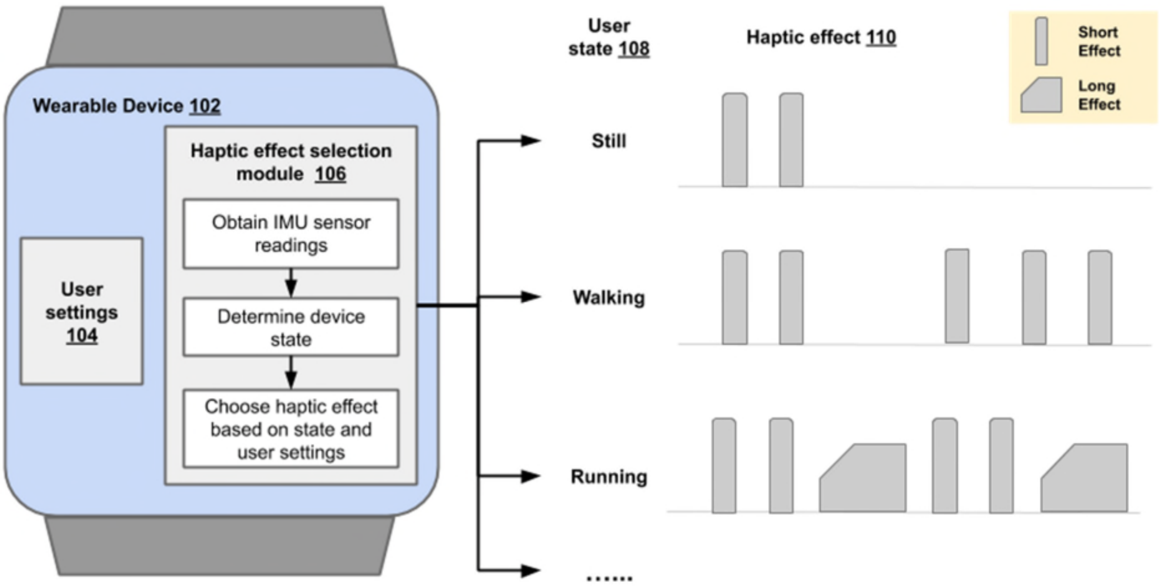

Fig. 1: Provision of haptic feedback based on user state

Fig. 1 illustrates the provision of haptic feedback based on user state, per techniques of this disclosure. A user that wears a wearable device (102) can engage in various activities such as walking, running, sitting still, etc. while wearing the device. Permission is obtained from the user to perform activity recognition using data from sensors in the wearable device. The user can provide such permission and other settings via user settings (104) that are stored on the wearable device.

Sensors from which data is obtained can include inertial measurement unit (IMU). A haptic effect selection module (106) obtains IMU sensor readings (and other sensor readings, as permitted by the user) and determines the device state. Based on the determined state and the user settings, a suitable haptic effect is chosen.

For example, as seen in Fig. 1, when the user state (108) is "still" a haptic effect (110) that includes two sharp, sequential pulses (short effect) is employed. For other activities such as walking, running, etc. corresponding waveforms (e.g., for running, a mix of short and long effects, as seen in Fig. 1) are employed. The haptic effects are chosen such that these are perceivable by the user while engaged in the activity. For example, the haptic effects can be switched to a library that corresponds to the recognized activity. This ensures that the user does not perceive a change in the hardware performance as a result of changes in their activity. Further, based on the detected activity, corresponding fitness experiences can be triggered automatically. For example, once running is detected, logging of relevant running data is automatically started (with user permission) and a run-tracking experience (app) is launched and displayed on the screen.

The described techniques provide haptics that make interactions with wearable devices feel useful and delightful. Further, by providing appropriate haptics based on the detected activity, the techniques ensure that the user does not miss an incoming message that happens when the haptics feel is weak.

Unlike traditional solutions where perceivability of haptic effects is manipulated by changing the drive voltage to the actuator, the described techniques do not use drive voltage as a proxy for perceivability of actuations. Instead, to increase the feel-ability of effects, alternate libraries of effects are used, without an increase in the maximum supplied voltage. The effects are designed to be semantically similar while triggering greater stimulation of sensory receptors on the body.

The described techniques are suitable for all small form factor devices, such as wearables, that have inherent limitations in the size and performance of their batteries, which place limits on the amount of power that can be provided to an actuator at a given time. Further, in devices that have actuators which cannot be driven at higher voltages or which have lower peak accelerations, the described techniques can enable designers and engineers to improve perceived haptic performance by automatically substituting standard effects for highly perceivable effects in situations where haptic performance is likely to be most challenged, e.g., the user going for a run.

Further to the descriptions above, a user may be provided with controls allowing the user to make an election as to both if and when systems, programs or features described herein may enable obtaining user information (e.g., detection of user activity, a user's preferences), and if the user is sent content or communications from a server. In addition, certain data may be treated in one or more ways before it is stored or used, so that personally identifiable information is removed. For example, a user's identity may be treated so that no personally identifiable information can be determined for the user, or a user's geographic location may be generalized where location information is obtained (such as to a city, ZIP code, or state level), so that a particular location of a user cannot be determined. Thus, the user may have control over what information is obtained about the user, how that information is used, and what information is provided to the user.

CONCLUSION

This document describes context-aware haptics that take into account the user state while using the wearable device. With permission from the user, the user state or activity, e.g., sitting, walking, running, etc. is detected by analyzing sensor readings from inertial measurement unit (IMU) sensor(s) that are included in the wearable device. Based on the user state, dynamic haptics are provided that adapt to the determined user state/ context.

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