Wearable - Fitbit Flex 2

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Overview

Wearable devices organize “your life” through one or more sensors that observe data from your body and/or environment and process the data with potential feedback provided by yourself or an additional agent (it could be another person or computational agent). Although structured and fine-grain data is initially consumed by the wearable’s sensors, the particular data processing that occurs depends on the insights the wearable and its companion apps are generating at a given time. In the case of the Fitbit Flex 2, motion data from the sensors is organized in addition to event data that trigger notifications (such as phone calls, wake-up alarms, etc.). Once sensor data is available, the Fitbit app acts as a computational agent to organize the data in collaboration with other computational agents in the app itself and in Fitbit’s servers. This case study will focus primarily on the organizing system that starts with collecting a user’s motion data and then subsequently powering the user’s interactions with the Fitbit app.

What is being organized? The Flex organizes your life activities, including, but not limited to walking, exercise, sleep, and electronic notifications. Although an activity such as walking may require organizing information about distance walked, an activity like sleep may require organizing information in an entirely

different way. At its core, however, the information being organized is purely data recorded from Flex's device sensor, a 3-axis accelerometer, which precisely records movements of the user. The raw data itself is composed of data points that represent motion of the user over time and space. The data can be translated into information characterizing any activity the user performs while wearing their Flex and the data can also leverage other data sources to further enrich its understanding of the user's behavior. For example, the Flex uses its knowledge of the user's height and gender to more accurately calculate the distance traveled. In terms of electronic information, Flex also organizes information from user activities such as messaging, phone calls, wake-up alarms, etc. to create Flex notifications to direct the user's attention.

Why is it being organized? The personal nature of Flex's information containing a diary of its user's movements enables the device to create a picture of the user's activities. Since these calculations of user behavior are carried out in an automated fashion with minimal user input required, the activity information being organized has utility in any area where tracking daily activity may be useful. The information is organized so users have sufficient visibility into their activity for goal-setting purposes, for gamification purposes, for health or diet applications where the data is relevant, and for assorted activities that are made possible through the data generated by Flex. The main theme is that once data is collected, applications can be built on top of the data to benefit the user. In terms of built-in features in the Fitbit app, users can set sleep and step goals, users can challenge their friends, users can share their information with a healthcare provider for potential cost-savings, and more. In terms of notifications, Flex can also notify users via haptic feedback using its vibration sensor to draw user

attention in the event of phone calls and other events that the user has configured Flex for. The data serves as a basis to unlock opportunities for applications provided by Fitbit and for applications created by developers through Fitbit's API. It is also worth noting that although many of Flex's capabilities are health and wellness related, Fitbit's Terms of Service explicitly states that "The accuracy of the data collected and presented through the Fitbit Service is not intended to match that of medical devices or scientific measurement devices." Therefore, Fitbit does not have the goal of directly serving as a medical device.

How much is it being organized? As discussed, data is collected at sensor-level precision that is then translated to yield meaningful user behavior information. The amount of sensory data that is organized and reorganized depends on the Fitbit applications enabled at any given time. For example, sensor data is organized in a unique manner for tracking distances the user has walked versus how long the user has been in a sedentary position. In terms of storage granularity of saved data at a given time, Flex is capable of storing 7 days of minute by minute motion data as well as daily totals for the past 30 days. Another note is that Flex motion data for a given time period is not necessarily limited to being organized only a single time. Motion data can be reanalyzed and organized to yield more detailed insights with new future knowledge as well. The amount of organization operates independently in two distinct areas: organization for insight generation and organization for interaction. Organization for insight generation refers to organization of sensor-level data to synthesize information about a user's behaviors. Organization for interactions is a layer of organization that happens on top of the insight generation. This organization is an additional layer of processing that sifts through insights with the purpose of planning out

how to communicate the large amount of Flex data to users in a straightforward way. An example of this is the 5 LEDs and vibration motor that Flex relies on to communicate information to users directly through the Flex itself without the user looking at a Fitbit companion app on a phone, computer, etc. Fitbit must organize notification information, whether it is related to reaching a walking goal or an incoming phone call, to communicate through its limited interaction medium of vibrations and LED lights.

When is it being organized? Since Flex's data collection pertains exclusively to motion data from a user's body, Flex is constantly organizing the motion information of the user as long as it is charged and on the user's body. In regards to the motion data being organized and distilled into insights, the information is being organized at a few different times: on-sync (when motion data is synced to Flex's companion app), on user interaction (when a user requests specific information that needs to be computed from or travel down from Fitbit's servers), and on-demand (when Fitbit receives data such as a phone call on the user's iPhone that triggers an event response).

How or by whom is it being organized? Flex data is organized by computational agents created by Fitbit and Fitbit's service partners. All the data produced or collected by Flex and Fitbit has an imposed structure on it. This results in the ability of computational agents created by Fitbit and other developers to organize the information in a scalable and efficient manner. The constrained structure of the data also grants the ability to seamlessly update these computational agents at any given time.

Where is it being organized? The data is being organized on the Flex device itself, in Fitbit's companion app, and in servers managed by Fitbit and its partners. The form factor of the Flex allows for its use across the body in a variety of clothing accessories. The data only encounters minor organization on the device itself due to its limited computational power and storage space, but after syncing to the Fitbit companion app via Bluetooth Low Energy technology, organization can then take place on a much greater scale. Organization occurs in Fitbit's companion app, but since the app also has connectivity to servers via the Internet, unrestrained organization of significant scale and speed is readily available to the app.

Sources:

1. https://help.fitbit.com/articles/en_US/Help_article/1135

2. https://www.fitbit.com/flex2

3. https://www.fitbit.com/shop/flex2#specs

4. https://www.fitbit.com/legal/terms-of-service

5. https://www.fitbit.com/eu/legal/privacy-policy

Wearables Faceted Classification

Overview

This faceted classification applies to wearables. What constitutes a wearable? In the context of this classification, a wearable is anything worn on one's body that achieves at least one of the following

1) Collects data about the wearer's body, the environment around the wearer, or the wearer's interactions with their environment

2) Alters information received across one or more of the wearer's body's senses (sight, hearing, taste, smell, and touch)

As an example, our category of wearables could include a jacket because jackets alter the wearer's skins' receipt of cold air, rain, and other weather conditions.

A note regarding wearables that require multiple components to be used simultaneously on one's body: Some wearables may utilize multiple components placed in separate areas of the body. A component external to the sensors, for example, could be a central computing device that does the calculations and communicates data with the Internet. In the case where multiple objects are used in tandem, this classification system is to be applied to each object independently. This also applies to wearable devices that computationally interact together in a distributed manner across multiple individuals (e.g. A wearable worn by basketball players to help teams as a whole perform more efficiently).

Properties

Format: *[Property name]: [Property description]*

Values: [Example property values]

Note: The property values are intended to serve as a starting point, but are not exhaustive by any means. Some properties may not have any examples provided.

Permanently Worn:
Description: Is the wearable intended for permanent or long-term (over 3 months) installation on the wearer's body?
Values: True, False

Wearable Lifestyle:
Description: Characterizes the nature of a wearable's use in one's lifestyle
Values: Constant, Routine, Activity-based, Other

Goal:
Description: Intended goal-category of the wearable
Values: Rehabilitation, Mobility, Measurement / Diagnosis, Monitoring of Vitals, Performance Enhancement, Environment Awareness (Safety), Rescue, Fertility Tracking, Lucid Dreaming, Mental Well-being, Direction Guidance, Compliance, Other

Feedback Cycle Type:
Description: The method by which the wearer experiences feedback to make progress toward achieving their desired goal state of using the wearable
Values: Alerting through Wearable, Alerting (through Companion App), Live Activity Guidance (through Companion App), Post-activity Insights in Companion App, Physical Feedback via Wearable Actuation, Environment Actuation, Other

Activity:
Description: Activity name for which the wearable is utilized

Values: Athletic Training, Amateur Fitness, Sleep, Surveillance, Construction, Military Training, Physical Therapy, Sporting Match, Navigation, Musical Performance, Mental Well-being, Communication, Other

Body Location:
Description: Areas of the body where the wearable can be located
Values: Ankle, Arm, Back, Chest, Ear, Feet, Fingers, Hand, Head, Legs, Mouth, Neck, Pelvis, Shoulders, Thighs, Torso, Waist, Wrist

Body Layer:
Description: The layer of the body in which the wearable is intended to be worn
Values: Internal, External, Both

Body Location Flexibility:
Description: Flexibility of the wearable's location on the wearer's body to achieve the intended use
Values: One body area, Multiple body areas

Form Factor:
Description: The form factor that secures the wearable to the wearer's body
Values: Inside body, Undergarment, Clothing (outerwear), Band, Headset, Footwear, Helmet, Adhesive, Exosuit, Other

Companion Device Interface:
Description: The form of the available companion interface that facilitates intended use of the wearable
Values: Web, Mobile, Television, API Access (Data Platform), No-separate Interface, Other

Companion Interface Required:
Description: Is a separate interface outside of the wearable required to achieve the primary goal of the wearable?

Values: True, False

Sensors:

Description: Sensors included in the wearable

Values: Accelerometer, Gyroscope, Altimeter, Ambient Light, Barometer, Blood Pressure, Heart Rate, CO2, CO, Oximeter, Humidity, ECG, EEG, EKG, EMG, Galvanometer, Glucometer, GPS, Magnetometer, Microphone, Pedometer, Camera, Pressure, Temperature, Ultraviolet Light, Visible Light, Compass, Other

Intended Feedback Recipient:

Description: Who is the wearable's data designed for? Who needs to view the data in order to deliver the insights intended by the wearable?

Values: The Wearer, Medical Professional, Lawyer, Law Enforcement, Parent, Coach, Rescue Personnel, Other

Feedback Sensory Richness:

Description: The expressiveness of the communication utilized by wearable to relay information to the wearer through the wearer's senses

Values: Single Sense, Multi-Sensory

Feedback Guidance:

Description: The senses utilized by wearable to relay information to the wearer

Values: Sight, Hearing, Taste, Smell, Touch

Feedback Insight Granularity (measured in time):

Description: The time scale for the intended feedback recipient (computational agent or otherwise) to make a decision or give advice based on the feedback data

Values: Milliseconds, Seconds, Minutes, Hours, Days

Method of Power:

Description: Energy source for the wearable

Values: Rechargeable Battery, Disposable Battery, Wireless Charging, Other, No Power Required

Power Lifespan:

Description: Length of the lifespan under normal usage amounts when using the wearable goal for its main intended goal

Values: Hours, Days, Months, Years, Indefinite

Storage Capacity:

Description: Time interval of supported storage capacity if constantly using the wearable to achieve its main intended goal without data offloading

Values: Second, Minute, Hour, Day, Month, Year, Indefinite

Storage Purpose:

Description: The purpose of the main storage medium available to the wearable device

Values: Permanent Storage Space, Buffer Space (for backup), Buffer Space (for computation), Store Configuration (user preferences and settings), Other

Data Offloading:

Description: The method by which data collected by wearable can be shared with external devices

Values: Manual Wireless Syncing, Automatic Wireless Syncing, Manual Wired Transfer, Other

Communication Protocol:

Description: The communication protocols that the wearable is capable of transmitting (sending or receiving) data in

Values: Bluetooth, WiFi, Pre-Cellular, Cellular, Zigbee, Z-Wave, 6LoWPAN, Thread, NFC, RFID, SigFox, LoRa, Ingenu, Weightless-N, Weightless-P, Weightless-W, ANT, ANT+, MiWi, Other

Communication Protocol Ownership:

Description: The communication protocol's ownership. Is it proprietary or open sourced?

Values: Open, Proprietary, Other

Default User Data Privacy:

Description: By default, what parties does the privacy policy for the wearable's data allow in terms of access to your data (your anonymized data or otherwise)

Values: Public, Third-party, Third-party (anonymized data), Manufacturer, Manufacturer (anonymized data), Other

User Data Ownership:

Description: Does the wearer have complete decision-making ability when it comes to use of their data by other people or parties?

Values: True, False

Data Access Method:

Description: What methods are available for accessing the data generated by the wearable?

Values: API, Physical Storage File Transfer, App File Export, Other

Data Access Cost:

Description: The cost for users to access data collected about them that has been made available by the wearable?

Values: Purchase, Free

Distributed Wearable:

Description: Does the wearable make use of data from or collaborate with other wearables?

Values: True, False

Sources

For Sections: Insights for Methods of Power, Body Location, Sensors

1) https://vandrico.com/wearables/directory

For Sections: Communication Protocol

1) https://www.link-labs.com/blog/complete-list-iot-network-protocols

2) https://www.rs-online.com/designspark/eleven-internet-of-things-iot-protocols-you-need-to-know-about

For Sections: Default User Data Privacy, User Data Ownership

1) https://www.loeb.com/publications-articles-20170712-gamechangingwearabledevicesthatcollectathletedataraisedataownershipissues

2) https://us.kantar.com/business/health/2016/mhealth-data-ownership-and-accuracy/