Designing for Wearable Health and Fitness? Think Inside the Box

Once upon a time, timekeeping was the sole function of a quaint device that people wore on their wrists, namely the watch. No, this is not the beginning of a fairy-tale from days of yore, rather a statement of where wrist-worn technology was just a brief decade ago. While still retaining a similar look and feel, the massive evolutionary leap that the humble wristwatch has taken in recent years means that timekeeping is almost forgotten amid the plethora of measurements now possible with the devices we wear on our wrists. Heart rate, calories burned, and steps taken are but some of the functions performed by contemporary wearable health and fitness monitors (Figure 1).

Figure 1. Wearable Health and Fitness Monitor

The evolutionary process continues apace as users continually demand newer and better hardware along with post-processing application software (apps) to help them understand the health and fitness implications of the measurements taken from their own bodies. In this design solution, we review the apparent dichotomy of hardware and software expertise required to develop wearable health and fitness monitors and their apps. We will examine a pioneering new device that seeks to traverse this divide, with the potential to significantly reduce the development time needed to introduce new products to this burgeoning market.

The Hardware Challenge

Bringing a wrist-worn wearable health and fitness product from a "blank-canvas" concept to a working reality can take months or even years, requiring expertise in several different areas. For example, heart-rate measurement is based on a technique called photoplethysmography (PPG). A PPG signal is obtained by illuminating skin using a light-emitting diode (usually green) and detecting changes in the intensity of the reflected light (Figure 3) using a photodiode that generates a current proportional to the amount of received light.

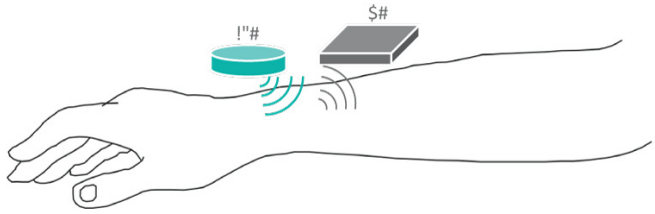

Figure 2. PPG Using LED and Photodiode

Variations in ambient lighting conditions and movement of the wearer can cause 'artifacts' (invalid readings that can negatively impact measurements). For this reason, device developers must have not only the expertise in optical sensor design (for PPG measurement) but a knowledge of complex motion-compensation algorithms that eliminate the effects of artifacts on the measurement process. Wearers also expect their device to operate for ever-increasing durations between recharges. Achieving this, for a variety of different use cases and functions, means developers also require a sophisticated level of power management knowledge. Finally, developing a comfortable, practical, and stylish wearable entails an understanding of mechanical design.

Clearly, there is a sophisticated skillset required to develop the hardware for a health and fitness wearable. While reference designs and evaluation kits provided by IC vendors can help

in understanding the underlying technology, the development time, costs, and risks associated with this type of product are overly prohibitive to companies that do not have these resources at their disposal.

Health and Fitness Apps

Separately, software developers seeking to create new and innovative apps for health and fitness wearables need fully functional hardware to provide them with the data for developing custom use cases. Due to the level of investment required, larger companies who have successfully developed and marketed a wearable health and fitness product are understandably reluctant to provide third parties with access to their hardware and/or raw data from their sensors. This creates the conundrum where hardware companies may fail to exploit the full software capabilities of their products, while the software companies who have this capacity, do not have access to the hardware and data they need to develop new applications.

Fully Functional Development Platform

App developers can overcome this problem using the MAX-HEALTH-BAND (Figure 3). Not merely a reference design or evaluation kit, it is a fully functional wrist-worn health and fitness monitor.

Figure 3. MAX-HEALTH-BAND

With the ability to monitor heart rate (HR), steps taken, and calories burned, the MAX-HEALTH-BAND measures inter-beat intervals (for heart-rate variability) and performs activity classification. This data is then stored and or/streamed, using a Bluetooth® connection to a smartphone running the Health Map app for Android® (Figure 4).

Figure 4. MAX- HEALTH-BAND Data Charting

Crucially, it streams raw PPG and accelerometer data, allowing developers to evaluate the device's optical sensors, based on the MAX86140 optical pulse oximeter and heart-rate sensor (Figure 5), as well as its proprietary motion-compensation algorithm. This provides for an unprecedented level of access to hardware and measured data for those creating custom applications or developing new algorithms with the raw data.

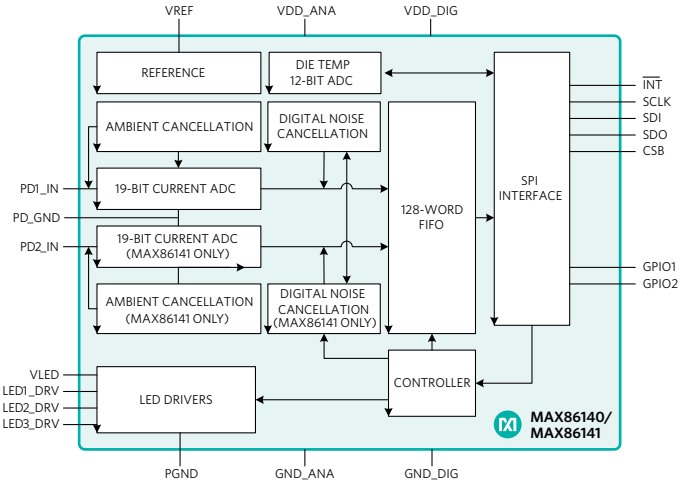

Figure 5. MAX86140 Pulse Oximeter and Heart-Rate Sensor

With the capacity to operate for up to seven days between recharges, made possible by the MAX20303 wearable power management IC, developers can evaluate the effect of their applications on the power consumption of the device.

Measurement Options

The Health Map app allows users to choose which type of data they wish to store (Figure 6). The HR option stores the heart-rate measurement (either in continuous or sampled mode), which is post-processed using the device's own algorithm. For users who wish to develop their own algorithms, the RAW option captures the unprocessed optical sensor measurements. The app also provides the option to store both. The data can then be exported to a .csv file for later analysis.

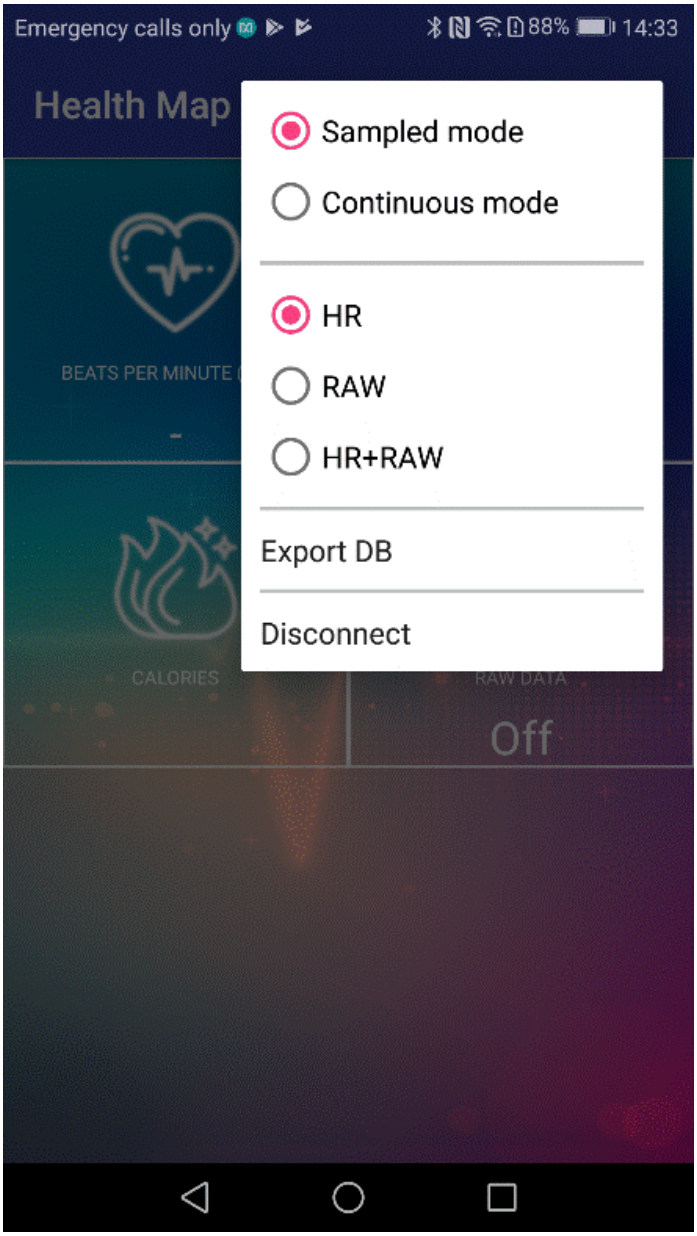

Figure 6. Health Map App Options

Health and fitness companies who want to bring their "own brand" of wrist-worn wearables to the market (but don't have the resources to develop one themselves) can do so quickly and with low risk through "white box" licensing of this device.

Conclusion

Developing a health and fitness wearable from scratch requires a sophisticated skillset and involves a high degree of risk. On the other hand, incumbent wearable solutions do not provide the level of access to sensors and data needed by software developers to create new health and fitness apps. The MAX-HEALTH-BAND overcomes both problems. It provides software developers with unparalleled levels of access to a fully functional hardware platform on which to develop their future health and fitness applications, and allows companies to customize and rebrand their wrist-worn wearables and quickly bring them to market.

Glossary

PPG: Photoplethysmography is the volumetric measurement of an organ

IC: Integrated circuit

LED: Light-emitting diode. A semiconductor device that emits light (usually visible or infrared) when forward-biased.

Artifact: Something observed in a scientific investigation or experiment that is not naturally present but occurs because of the preparative or investigative procedure

Photodiode: A photodiode is a semiconductor device that converts light into an electrical current

Learn more:

MAX86140 Best-in-Class Optical Pulse Oximeter and Heart-Rate Sensor for Wearable Health

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