MEMS & Sensors for Wearable Electronics

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Outline

• Wearable electronics market overview
• MEMS & Sensors in wearable
  – MEMS
  – Beyond MEMS for wearables
  – Interactions with handset
  – The power issue
Market for wearables by application

The World Market for Wearable Technology - by Application

Source: IHS

Wearable market by device

World Market for Wearable Technologies - by Product

Source: IHS

Sport, Fitness & Activity Monitors Market

- 1.8 billion people managing chronic condition in 2013. 2.2 billion in 2019
- Global health expenditure already $6.8 trillion
- Wearable push into healthcare as means of motivating and tracking patient’s activity
- Opportunity to meet long-term demand from health providers, payers and payers in curbing health expenditure amongst post-acute and ambulatory population
Sport and Fitness mobile apps

**Total Sports & Fitness Mobile Application Downloads**

- Heart Rate Apps
- Multi-sport & Activity Tracking Apps
- Running Apps

**Top 10 Fitness Apps as of April 1, 2014**

- Runtastic
- RunKeeper
- MapMyFitness
- Fitbit
- JEFIT
- Daily Workout Apps
- Adidas
- Feel Free Apps
- Nike+
- Endomondo
- Azumio

Notes: total top 10 apps: 146 million downloads

Source: IHS © 2014 IHS  Sport, Fitness & Activity Monitors - April 2014
Top suppliers of Sport, Fitness & Activity Monitors

Market Share for Sports/Fitness/Activity Monitors - Units

Source: IHS  © 2014 IHS  Sport, Fitness & Activity Monitors - April 2014
Apple & Google position themselves

**Apple**

- Healthbook app in iOS8 later in 2014
  - Pre-installed in iPhone.
  - Storing fitness metrics such as distance travelled and calories burned. Able to track also blood pressure, HR, hydration and glucose level
  - Apple in close touch with FDA
- Hired top executives from Masimo + sensor staff from Digital Health, Vital Connect, AccuVein, C8 Medisensor and Senseonics
- Forming iWatch team
- M7 sensor hub in iPhone 5s allowing continuous activity monitoring

**Google**

- Android KitKat OS in smartphones
  - Making sensor hub mandatory to support activity monitoring with handset
- Android Wear OS
  - Demonstrated features: maps, navigation, Google now content, search, messaging, smartphone notification, health and fitness
  - “Google correctly understands that consumer demand will be in part driven by app accessibility, and that content and services are required to deliver on the promise of a smart device” (Shane Walker, IHS)
- Monetization strategy of Google?
  - Google to become trusted cloud store for personal data collected from wearables that could be shared with health providers?
MEMS & SENSORS IN WEARABLES
MEMS market by wearable product

MEMS Market for Wearables - by product

- Head-up Displays
- Smart Clothing
- Cycling Computers
- Outdoor Pursuits Computers
- Fitness & Heart Rate Monitors
- Pedometers
- Activity monitors
- Smart glasses
- Smart watches

Millions of US$

Source: IHS

© 2014 IHS Consumer and Mobile MEMS market tracker, Feb 2014
MEMS market by component

MEMS Market for Wearables - by MEMS component

Source: IHS

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MEMS suppliers for wearables

MEMS market shares for wearables

- Hokuriku
- MEMSIC
- Hitachi Metal
- VTI
- Domintech
- Analog Devices
- Wolfson
- Freescale
- AKM
- Bosch
- Qualcomm
- Others
- Knowles
- Kionix
- InvenSense
- MEAS
- STMicroelectronics

Source: IHS
© 2014 IHS  Consumer and Mobile MEMS market tracker, Feb 2014

Source Nike
Teardown of Nike+ Fuelband
Source IHS
3-axis accelerometer
STMicroelectronics
Motion sensors bet on wearables as historical CE segments saturate
Motion sensors: from 3 to 9 axis?

• Discrete accelerometer used today in most wearables for activity monitoring
• Sensor suppliers push use of 9-axis combo (accelerometer + gyroscope + magnetometer)
• „Always-on“ Advanced activity monitoring: recognizing automatically whether one is walking, biking, running, swimming...

Source: InvenSense

Wearable development platform
Beyond MEMS for wearable

Activity/motion:
- accelerometer,
- gyroscope,
- magnetometer,
- pressure

Wellness and medical parameters:
- pulse oximetry,
- optical heart rate sensor,
- chest belt,
- ECG sensor,
- skin conductivity,
- temperature sensor,
- bio sensors
- humidity

MEMS energy scavengers

Next generation wearables

Environment:
- pressure,
- humidity,
- gas,
- UV sensor,
- temperature

User Interface:
- MEMS microphones,
- MEMS reflective displays,
- capacitive sensors,
- optical sensors
- ambient Light Sensor
- proximity sensors

Legend
- MEMS
- Non MEMS technology
- Either MEMS or non-MEMS

Source: IHS, Sensors for wearable electronics 2014, July 2014
How will sensors in handsets and multiple wearables interact?

Away from smartphone into wearable
- Environment sensors: humidity, UV...
- Health sensors: pulse oximetry?

Needed in both:
- Motion sensors
- Light sensors
- Microphones

Correcting each other: motion sensors for activity monitoring, navigation...

Source Samsung

Source Valencell
Some sensors still consume too much power for „always-on“ monitoring

Teardown of Google Glass XE-C, (source IHS Teardown, preliminary results, May 2014), showing discrete accelerometer in addition to accelerometer already included in combo. Discrete accelerometer probably for ultra-low power use.
How to power multiple “always-on” sensors?

- Energy harvester?
- Sensor hubs?
- Better sensor fusion?
Conclusion

• Wearable device market to reach $30 billion in 2018 up from $8.8 billion in 2012
• Apple, Google, Intel... heavily investing
• Health monitoring is key driver. 2.2 billion people managing a chronic condition in 2019
• Wearable seen as next big thing for sensors in consumer after handsets and tablets
• Sensors for wearables still in their infancy.
  – New sensor needed
  – Better interaction with handset
  – Power consumption issue