Wearable Patch Vital Sensors and their Business Opportunities

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- **Start up:** at November/2013
- **Aim:** return the achievements to our society from Maenaka Human-Sensing Fusion Project (supported by Japan Science and Technology Agency –JST-) and contribute to realize the healthy life for everybody, at anytime and anywhere

- **Vitalgram® Technology:**
  - Sensor device technology for vital sensing
  - Vital sensor with flexible and stretchable wiring
  - Vital sensor which adheres to skin
  - Low power consumption technology
  - RF wireless technology
  - Embedded software technology
  - iOS application development

- **Business field:** research and development support
  - Design, development, prototyping and consulting of healthcare monitoring devices
  - **Vitalgram® ECG** patch type multi vital sensor, **Vitalgram® multi EMG** sensor,
  - **Vitalgram® muti channel EEG** sensor
  - Customization and development: additional sensor, another wireless sensor system
  - Design, development, prototyping and consulting of healthcare management system
  - Design, development, prototyping and consulting of devices and systems for sensor network

- **Head office:** Kanagawa-ku, Yokohama
- **R&D center:** University of Hyogo, Shosha, Himeji
- **Contact:** info@AffordSENS.com
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Vitalgram® Technology

Wearable patch vital sensor
Bluetooth 4.0
Via Internet
Real time data on an iOS terminal
data analyses on a cloud server

Vitalgram® Data Analysis
Vitalgram® Rev.B

Main board:
- 3-axis accelerometer (for posture and activity)
- pressure sensor (for height)
- temperature sensor (for environment temperature)
- humidity sensor (for environment humidity or sweat)
- brightness sensor
- skin surface temperature sensor (backside)
- Bluetooth 4.0 module, Li-ion battery, USB port (*) possible to work separately

Sub board:
- 2 sets of head amp and variable gain amplifier for ECG and reserved

Stretchable wiring (thanks Nippon Mektron Ltd.):
- accordion Cu wiring formed on the polyimide film (compatible with FPC fabrication process)
- stretchable within 0 to 15% (max 60%),
- verified reliability under repeating stretch test (from 0 to 60%)

Disposable ECG Electrode:
- electrical and mechanical connection with adhesive PDMS film
Vitalgram® Application

1. Guardian
   A) For aged-people at a nursing home and infants at a kindergarten or a nursery school
   B) Nurse calling at a hospital
   C) Heatstroke prevention at a construction site etc.

2. Healthcare monitoring
   A) Daily physical condition management
   B) Stress degree check and fatigue degree check
   C) Disease prevention and health promotion through measurement of a long life rhythm

3. Remote home care and other application
   A) Home rehabilitation for heart failure patients
   B) Training management at Gym
   C) Correcting form of an athlete (ex. Pitching, catching and batting form of baseball players)
**Application for aged people:**

**Cooperation with nurse calling system**

**Targets:**
- hospital
- nursing home
- housing of the aged
- hospice
- sparsely populated area

**Feature:**
- Alternative nurse call button
- Existing Nurse call system using mobile terminals
  + Vital monitor with emergency call function

**Emergency call:**
- fall
- abnormal heart rate
- abnormal body temperature going up
- abnormal sweat

**Requirements:**
- highly reliable in particular
- Bluetooth radio connection
- wearability (for dementia patients)
Among the over 65 people, 16% are living alone and also 16% are receiving long-term care service(s).

<table>
<thead>
<tr>
<th>Type of residency</th>
<th>Help of long-term care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living with family/other</td>
<td>100%</td>
</tr>
<tr>
<td>Living alone</td>
<td>0%</td>
</tr>
</tbody>
</table>


Provided by K. Ueno et al. at Harvard BS
### Which market should we target?

<table>
<thead>
<tr>
<th>#</th>
<th>Description</th>
<th>Long-term care insurance</th>
<th># of customers (000)</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Certified home care services</td>
<td>applicable</td>
<td>3,284</td>
<td>65.3</td>
</tr>
<tr>
<td>2</td>
<td>Long-term care insurance facilities</td>
<td>applicable</td>
<td>861</td>
<td>17.1</td>
</tr>
<tr>
<td>3</td>
<td>Nursing home</td>
<td>not applicable</td>
<td>359</td>
<td>7.1</td>
</tr>
<tr>
<td>4</td>
<td>Elderly service apartment</td>
<td>not applicable</td>
<td>133</td>
<td>2.6</td>
</tr>
<tr>
<td>5</td>
<td>Group home/ Care home</td>
<td>not applicable</td>
<td>81</td>
<td>1.6</td>
</tr>
<tr>
<td>6</td>
<td>Other</td>
<td>mostly applicable</td>
<td>310</td>
<td>6.2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>5,030</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Potential target

Source: Ministry of Health, Labour and Welfare, 全国有料老人ホーム協会

Provided by K. Ueno et al. at Harvard BS
1. Sleep quality evaluation
   Evaluate sleep quality by measuring REM and non-REM sleep

2. Stress check
   Stress measurement by autonomic nerve activation degree (evaluation from the balance of the strain of sympathetic nerve and the parasympathetic nerve)
   HRV analysis (heart rate beat fluctuation analysis method)

3. Epilepsy attack foresight by HRV analysis

4. Predicting heart failure and detecting arrhythmia
1. Various vital signs such as ECG (heart rate), body temperature, blood pressure, SPO2 etc. in a human-body should be measured at the suitable place.

2. Many small patch sensors can be attached on the suitable spots at the same time although lack of life style compatibility.

3. The collected data by patch sensors are quite reliable without the influence of movements.

4. Therefore we can wear them without feeling uncomfortable and with living a daily life.

Why patch sensors?

Source: MMRI
(classify 130 wearable products)
Wearable devices need to meet basic criteria for adaptation and sustained use

| Clear Value Proposition | • Is the value proposition unique and clear?  
|                        | • Can the customer understand the value to select the product? |
| Design / Aesthetics    | • Wearable products are visible, hence must appeal visually.  
|                        | • Is the accompanying mobile app well designed? |
| Fit / Comfort          | • Does the product provide sizes to fit a wide range of users?  
|                        | • Must be comfortable to wear at all times. |
| Quality / Reliability  | • Is the product robust enough to endure wear and tear? |
| User Experience        | • Is it intuitive, seamless, meaningful, and easy to use?  
|                        | • Is the setup experience frictionless?  
|                        | • Can the data be accessed by other apps? |
| Lifestyle Compatibility| • How much lifestyle change does the device require? |

Source: Endeavour Partners
### How should we differentiate from other devices?

<table>
<thead>
<tr>
<th></th>
<th>Smartwatches</th>
<th>Activity trackers</th>
<th>Patch sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clear Value Proposition</strong></td>
<td>• Many applications for mass users</td>
<td>• Focused value on activity tracking</td>
<td>• Focused value on health monitoring</td>
</tr>
<tr>
<td><strong>Design / Aesthetics</strong></td>
<td>• Option for color variation</td>
<td>• Limited design and color</td>
<td>• Not so cool</td>
</tr>
<tr>
<td></td>
<td>• Interchangeable bands</td>
<td>• Function less as a fashion item</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Function as a fashion item</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fit / Comfort</strong></td>
<td>• Adjustable bands</td>
<td>• Some trackers can be adjusted</td>
<td>• Suitable for night use</td>
</tr>
<tr>
<td></td>
<td>• Not suitable for night use</td>
<td>• Suitable for night use</td>
<td></td>
</tr>
<tr>
<td><strong>Quality / Reliability</strong></td>
<td>• No significant recall</td>
<td></td>
<td>• Disposable ECG electrode patches are approved for medical use</td>
</tr>
<tr>
<td><strong>User Experience</strong></td>
<td>• Interface, applications, and connectivity with smartphones enables a richer experience</td>
<td>• Depends mostly on the mobile app for user experience</td>
<td>• Depends mostly on the mobile app for user experience</td>
</tr>
<tr>
<td><strong>Lifestyle Compatibility</strong></td>
<td>• For watch users, smartwatches fit into the users lifestyle</td>
<td>• Need to “take care” of the tracker with charging, syncing, etc.</td>
<td>• We have no experience to wear patches except band-aids.</td>
</tr>
</tbody>
</table>

*Partially provided by K.Ueno et al. at Harvard BS*
Strategic options for healthcare and monitoring devices for healthy persons

Key trends in wearable device industry

• Competition in wearable device industry is getting harsh as many new entrants come to the market

• Although wearable devices are getting prevalent, there are adoption issues
  – Customers stop using the device if it doesn’t fulfill the basic criteria

• With integrated functions and better fit to consumer needs, smartwatches will take over other wearable devices’ market shares

Strategic options for healthcare wearable devices

1. Different value
   Provide superior healthcare functions which other wearable devices cannot provide

2. Focused value
   Focus on specific value and provide cheaper products with better business model

3. Different target
   Target people who don’t own/use other types of wearable devices

Provided by K. Ueno et al. at Harvard BS
For examples: Market opportunities for healthcare and monitoring devices

<table>
<thead>
<tr>
<th></th>
<th>Market opportunities</th>
<th>Target size (in Japan)</th>
<th>Alignment with strategic options</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Safety monitoring at nursing home</td>
<td>820,000</td>
<td><img src="" alt=" " /> ✓ <img src="" alt=" " /> ✓</td>
</tr>
<tr>
<td>b</td>
<td>Blood pressure monitoring for hypertension patients</td>
<td>9,000,000</td>
<td><img src="" alt=" " /> ✓ <img src="" alt=" " /> ✓ <img src="" alt=" " /> ✓</td>
</tr>
<tr>
<td>c</td>
<td>Glucose level monitoring for diabetes patients</td>
<td>2,700,000</td>
<td><img src="" alt=" " /> ✓ <img src="" alt=" " /> ✓</td>
</tr>
<tr>
<td>d</td>
<td>Electrocardiogram monitoring for arrhythmic patients</td>
<td>1,000,000</td>
<td><img src="" alt=" " /> ✓ <img src="" alt=" " /> ✓</td>
</tr>
<tr>
<td>e</td>
<td>Emergency report for heart attack</td>
<td>---</td>
<td><img src="" alt=" " /> ✓ <img src="" alt=" " /> ✓ <img src="" alt=" " /> ✓</td>
</tr>
<tr>
<td>f</td>
<td>Calorie monitoring for dieters</td>
<td>23,000,000</td>
<td><img src="" alt=" " /> ✓ <img src="" alt=" " /> ✓</td>
</tr>
<tr>
<td>g</td>
<td>Health and location monitoring for children</td>
<td>2,000,000</td>
<td><img src="" alt=" " /> ✓</td>
</tr>
<tr>
<td>h</td>
<td>Pregnancy support for women</td>
<td>500,000</td>
<td><img src="" alt=" " /> ✓</td>
</tr>
<tr>
<td>i</td>
<td>Health and location monitoring for pets</td>
<td>20,000,000+ (dogs and cats)</td>
<td><img src="" alt=" " /> ✓</td>
</tr>
</tbody>
</table>

Provided by K. Ueno et al. at Harvard BS
Vitalgram ® road map

2014
- Fall warning (at Nursing home, Elderly service apartment)

2015
- Vital check (at Certified home care services, • • •)
- Heatstroke prevention (at construction site, • •)

2016
- Remote rehabilitation control system for cardiac insufficiency patient
- Electroencephalograph (EEG)
- Health monitoring for pets

2017
- Development of Sweat sensor
- Heatstroke prevision algorithm
- Vitalgram with Blood pressure and SPO2 sensor

2018
- flexible and stretchable patch sensor
- wireless charging system
- disposable patch sensor (downsizing and low cost)
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