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ASIA EDITION

Anytime-Anywhere' is the latest trend in personal health monitoring

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DIGITAL HEALTH - CEO INSIGHTS

Mr Zarola is focused on defining the business strategies for the sub-segments of medical instrumentation and patient monitoring. His career at ADI has included a number of technical and marketing roles in both the sales and product line organizations.

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Healthcare has historically been provided in clinics and hospitals globally. With rising costs of healthcare, aging population, the desire to stay healthy even while indulging on an unhealthy lifestyle and most importantly, the availability of affordable but capable technologies have started the trend in personal health monitoring, Anytime and Anywhere, where and how we measure vital signs, has now become boundary-less. Investments made in the medical electronics have yielded remarkable advances in diagnostics and health monitoring. The general assumption by most has been that healthcare will continue to advance and be readily available to the developed world and will expand globally to regions that have been receiving minimal support. But with the spiraling costs of healthcare, the vision of 'healthcare for all' is still a long way off.

A solution to reducing healthcare costs is to take advantage of the latest technologies and innovations that will enable patients to reduce hospital/doctor/clinic visits unless necessary, and as well as help them leave hospital more quickly, yet safely. By continuing treatment and monitoring health in an environment where costs are lower, such as at home, the cost for providing healthcare is reduced. Patients have the added benefit of recuperating in a comfortable setting. In developing nations like India, this has the enormous advantage of making healthcare affordable, which is the need for the hour. To maintain patient safety and reduce recurring in-hospital stays, or even avoiding a trip to the clinic/hospital unless necessary, high performance but affordable vital sign monitoring (VSM) devices designed to support the patient environment are essential. The out-of-hospital VSM market is growing exponentially and has the potential to outgrow many other market sectors.

So far, home health and wellness monitoring has been limited to simple thermometers, set of bathroom scales and in some household, the blood pressure or glucose monitors. Heart Rate Monitors (HRM) for sports and fitness, defined primarily by the chest strap or hand held electrodes on treadmills in the gym, are used as remote health monitoring devices.

Driving forces of the personal health monitoring trend are:
â€¢ Communications infrastructure that offers global access to healthcare resources
â€¢ Advancements in technologies that make remote health monitoring feasible and compliant to our lifestyles
â€¢ Growth in the support infrastructure that provides real-time motivation to maintain a healthy lifestyle
â€¢ Realization that preemptive health monitoring can reduce the length and occurrence of in-hospital stays

Vital signs are currently being monitored across market sectors with a common set of requirements, but environmental constraints and how the information is interpreted and used has significant impact on the efficacy of any monitoring device. Analog Devices is the technology leader bringing innovative responses to address these constraints. Following are a few of the market subsets and goals, constraints, and proposed technologies that will enable the desired personal health monitoring capabilities.

At home
Devices must be non-intrusive and fit seamlessly with our lifestyle- a requirement that resonates across all market sectors. Devices must be small, and since most will likely be body worn, they will need to be battery operated (either disposable or rechargeable). The user does not want to be fiddling with batteries or chargers frequently, so the devices must support ultra-low power consumption to provide uninterrupted, long term use.

Home health monitoring falls into three categories: disease management, health and wellness and safety. Disease management includes glucose measurement, cardiac monitoring, pulse oximetry, continuous blood pressure, and respiration monitoring. It is expected that these devices will be prescribed following a clinical consultation. The device will require a certain level of regulatory approval (like FDA), and the compliance requirements will be as high as for those devices intended for hospital environment. In addition, the devices will need to be small, portable, ultra-low power, and wirelessly connected. Products like Analog Devices' ADAS1000-3, a single chip 3-lead ECG analog front end (AFE) provide diagnostic-quality signals to ensure regulatory compliance and support the home health prerequisites of small size, portability, and low power.

Fall detectors are one of the most common devices currently deployed amongst the aging population giving them the flexibility to continue to stay independently while ensuring help is on instant reach. Although these devices do not prevent a fall, they provide a remote alarm that alerts family members or authorities of an adverse event. The key requirements of these devices are low power, small construction, and wireless connectivity. They must also be able to discern between a person sitting down quickly and an actual fall. Extended battery life is critical because changing a battery may require a caregiver visit or a third-party visit at an additional cost to the wearer. A dead battery means a monitor is no longer active, putting the wearer at additional risk. Fall detectors use low-g MEMS accelerometers to detect and distinguish type of motion.

Analog Devices ADXL362 is the industry's lowest power, 3-axis MEMS accelerometer. With an operating current of 1.8 Î¼A

@ 100 Hz operating data rate (ODR), 3 Î¼A @ 400 Hz ODR, only 270 nA when in motion activated wake-up mode, and 10 nA standby current, the ADXL362 can extend the battery life of a fall detector by many months.

Again, body-worn monitors require low power, a small size, and no compromise on performance. Analog Devices' AD8232 heart rate monitor (HRM) analog front end (AFE) effectively acquires bio-potential signals while maintaining low power usage and low cost. Key features include leads-off detection, fast restore, right leg drive, and a flexible architecture that enables the configuration of external filters to help reduce the effects of motion artifacts. Operating off a single supply at 175 Î¼A (typ), the AD8232 HRM AFE simplifies the development process.

Sports and fitness
One of the fastest growing market sectors for health monitoring is sports and fitness. The two categories of monitoring are fitness and safety. Traditionally, fitness management has been performed using heart rate monitoring devices in the form of a chest strap or in the handle bars of a treadmill machine. Electrode-based heart rate monitoring remains a popular approach to recording cardiac output. What is changing, however, is the way electrodes are formed. For instance, new textile technologies that use conductive material in the weave of the fabric enable larger surface areas on the body to pick up the bio-potential signals.

Optical devices that detect photoplethysmograph (PPG) signals offer another method for measuring heart rate. A PPG device, typically worn on the wrist, uses the ulnar artery to detect blood flow and hence, determine heart rate. This method is used in a number of monitoring devices targeting athletes.

Other vital signs that contribute to the determination of energy exertion, calorie burn, and general fitness level include:
â€¢ Activity monitoring (low power MEMS accelerometer)
â€¢ Respiration monitoring (thoracic impedance- or MEMs-based)
â€¢ Perspiration measurement (skin impedance)
â€¢ Temperature (surface flux and core)

When it comes to sports safety, concussion ranks as one of the highest sports-related injuries. As we learn more about the long term effects of repeated concussions, from high school through amateur sports to the professional games, the call for technology to help detect the severity of a head impact is increasing. Where to locate the impact sensor is a challenge. For many sports the problem is easily solved - MEMS inertial sensors can be placed in the helmet to detect impact from multiple locations. In the case of car racing, MEMS inertial sensors are placed in driver earpieces. However, not all impact sports require helmets or head gear. For those athletes, concussion-level impact is being detected and measured using impact sensors embedded in mouth guards.

In the office
The workplace may not be the first environment associated with health monitoring, but with the cost of provisioning health benefits at the corporate level, work-related health management programs are being introduced as a means to reduce healthcare benefits costs. The most common form of workplace health monitor is the pedometer. While these small devices can be carried in the pocket or tied to the shoe or hip, the embedded technology makes them smart enough to discern if the wearer is walking, running, or simply making erratic movements to try and fool the device. Analog Devices' ADXL362 low power MEMS accelerometer provides all of the necessary features to support pedometer applications.

Another area of workplace health management is stress detection. Stress can be measured through galvanic skin impedance and heart rate. Technology can be embedded into every day work-related devices such as the computer mouse or keyboard to measure these required vital signs. Analog Devices' ADuCM360 low power, precision analog micro-controller provides an ideal system-level solution for accurate measurement of galvanic skin impedance. The ADuCM360 is a fully integrated, 24-bit data acquisition system that incorporates dual high performance, multichannel, sigma-delta analog-to digital converters (ADCs), a 32-bit ARM Cortex-M3 processor, and Flash/EE memory on a single chip.

In the battlefield
Military personnel are exposed to the harshest of conditions, and the ability to remotely measure their vital signs through body-worn sensors is critical for their protection and well being. On the battlefield, a remote triage area for medics is vitally important to the safety of the medical team and the individuals affected. Being able to prioritize treatment amongst many and determine who needs medical attention first before stepping into a combat area can save lives. Heart rate monitors (AD8232), activity monitors (ADXL362), temperature sensors (ADT7320), stress indicators (ADuCM360), and impact sensors (ADXL377) can be used individually or collectively to monitor the health of our servicemen and women.

On the smartphone
Technology already exists within the smartphone in the form of an embedded accelerometer to support pedometer, activity

monitoring, or sleep monitoring applications. The CMOS camera sensor can also be used as a simple HRM through multiple techniques of image analysis to detect changes in blood flow. However, these technologies tend to burn power - not necessarily through the sensor but because of the way the technology has to be implemented to support these applications. This is a problem because smartphone power must be reserved for email and social media applications. Analog Devices' AD8232 single-lead HRM AFE and ADXL362 low power, 3-axis MEMS accelerometer have the size, performance, and power profiles necessary and, when either embedded or as an added gadget attached into a smartphone, can independently measure heart rate and motion, respectively.

In the car

Much research is underway to determine how we can monitor our vital signs effectively in the confines of our car. Emotion and stress sensors, heart rate monitoring, temperature sensing, C02 sensing, glucose monitoring, Sp02, and pollen are all potential applications targeted at improving driver safety and making the driving experience more pleasant. Telling the driver he might be having a heart attack could lead to panic and further disastrous consequences; however telling the driver to wake up is a practical application of heart rate monitoring. The steering wheel provides an obvious location for mounting vital signs monitoring equipment - AD8232 HRM can connect to embedded electrodes in the material covering the steering wheel. Additional, or even the same, electrodes can be used to measure the galvanic skin impedance to determine stress and emotion levels. Analog Devices' ADuCM360 low power, fully integrated, 24-bit data acquisition system-on-a-chip provides a platform for measuring the galvanic skin impedance and converting the output of the AD8232 to a digital format.

In summary, the concept of 'home monitoring' is taking on many new dimensions. With advanced technology, evolving support infrastructures, lifestyle diseases and the unquestionable need for healthcare cost reductions, personal health monitoring will become a natural part of our daily lives, available when and where we need it, blending into our personal telehealth ecosystem. Whether it is for managing disease outside of a hospital or clinic, supporting independence of the aging population, motivating healthy lifestyle habits, improving personal safety, or simply providing peace of mind, Analog Devices is at the forefront of this market dynamic, developing sensor and signal conditioning technology solutions to enable next generation vital sign monitoring.