Wearable technology for health
By Caberlotto Matteo and Somero Michele

With “wearable technology” we mean smart electronic devices that can be worn as clothes or accessories. These devices can be bracelets, socks, watches and a lot of other clothes and accessories. All these new devices, that are a part of what is called PAN (Personal Area Network), are connected tools that can monitor human parameters, send and receive notifications and instructions. The purpose of wearable technologies is to help human life in a lot of different features. Nowadays these kinds of smart devices are bringing lots of new applications in healthcare, in fitness, in entertainment, and in many other areas.

In the last two decades, researchers predicted several applications in healthcare, but they never implemented them. Only in recent years, engineers work side by side with doctors to integrate this technology in the current healthcare systems. Some wearable devices already implemented are glucose monitor, heartbeat monitor, etc. These devices have also led to new self-management, that encourage people to do more physical activity and take more care of their health.

Because of this, Wearable technology is promising to assume a new central role in the new healthcare system, due to its cost and its ability to keep tracking of vital parameters.

The old information landscape in healthcare was focused on hospitals and clinics that keep the information of the patients because the data were acquired there. Due to this, these structures managed all the processes like diagnosis, intervention and prevention.

The new information landscape is completely different: the patient’s information is more distributed and focuses more on the patient. The data can be acquired from independent devices that collect all parameters real-time, at a higher velocity and at higher volume, due to the continuous measurement and to its raising utility.

Digital health is shaped by wearable computing in several ways:

- Preventive medicine: Wearables have the potential to identify many early physiological and behavioral markers of chronic diseases;
- Clinical support: Capturing complex clinical processes using digital data management models could improve healthcare treatment and decrease errors;
- Monitoring and intervention: Wearables are ideal for tracking many health-relevant behaviors, activities, etc.;
- Integrating wearable and clinical big data: Integrating data from clinical sources and wearable monitors provides the potential to yield new biomedical knowledge.

These are some of the main integrations implemented, but the most influential is the one that integrates behavioral, genomic and environmental exposure data.

This integration allows doctors to study the genetic predisposition and identify individual health risks, moreover, it allows the doctors to prevent diseases studying the environment and the behaviors of the patients. In this field, there are already researches that are using wearables to keep patient’s vital parameter tracked.

To better explain this concept, we will bring a research experiment made in Taiwan on wearable devices used in long-term care.

This experiment leads to improve health care inside a long-term care institution where there are several residents, each one with specific needs. The care improvement is made using several wearable devices
connected with a central server that computes all the data and, in case of emergency, can rapidly call caregivers, otherwise, the data are collected and doctors or, if able, residents can access to them and use to manage residents health care.

All physical parameters are collected real-time by wearable devices that can send via wireless all data to a service server used to analyze users’ vital signs and produce some graphs. If the parameters point out abnormal values, the server will transmit an emergency message to the caregivers.

At the first step, the parameters’ collection is done using three different devices:

- Smart clothes: these clothes, designed to be comfortable, are made with conductive fiber in order to collect electrocardiography signals (ECG), located in the clothes there are four different electrodes that contact with the skin to receive data
- Smartwatches: these wearable accessories are used to measure blood volume, photoplethysmography signal, with a specific sensor, the device also uses an ECG sensor to collect ECG signal and it is also equipped with a three-axis acceleration sensor in order to monitor sleep quality, daily walking steps and in general all resident’s attitudes
- Body tags: these smart devices are equipped with a gyroscope and a three-axis accelerometer that also help to monitor resident’s attitudes.

All collected data are real-time sent to the central server using a WiFi connection with a TCP (Transmission Control Protocol) protocol. All other wireless interaction, data for indoor positioning and warnings to caregivers, are made using BLE (Bluetooth Low Energy) that is also used to control the devices.

The server can then use all collected data to create, analyzing, some valuable data with graphs that caregivers and doctors, in some cases also residents, can later use. in fact, the care notification system used for this experiment can achieve three specific goals:

- Dynamic change in resident lifestyle using collected data: caregivers and residents can see all behaviors and can change thresholds for abnormal notifications or change some behaves in the resident
- Emergency notification: if some parameters are not optimal or there are some specific problems, or the values are over the abnormal threshold, an emergency message is sent to caregivers to assist the resident.
- Personal health knowledge messages and questionnaires: all residents can see tables and graph of values of personal physical parameters and act in consequence of them, also, some questionnaires are compiled by the residents so that the care services can adapt on each specific resident

The whole experiment has been imported on several elder residents, some of them were elderly who has chronic high pressure, high blood sugar and other chronic. Another group were made by 10 dementia elders. The experiment took place between October and January (2018-2019) for 93 days.

the system was able to individuate several abnormal events about stays too long, improved walking in elder residents and helped the caregivers to detect abnormal events and rapidly act to solve problems. With this system of warnings, the residents could remember to move frequently, and for those who were not able to do so, the on-site staff could remind them.

CONCLUSIONS

The revolution that researchers think Wearable Computing will bring to the healthcare system is still far, but the progress we made, and the continued improvement of this technology, will, one day, lead to this new integration. A lot of new technologies nowadays are developed on the idea of IoT (Internet of Things), where
all devices are connected and can interact with each other; with all these connected devices wearable devices can be implemented in different health care structures: hospitals, community, etc.

Also, in daily life mode, in the houses, these new devices can be a big step in self health care: knowing ourselves’ physiological parameters can help us to be self-conscious of our health and also to improve our quality of life.
Bibliography
