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# SENSORS AND μCONTROLLERS IN THE USE OF WEARABLES FOR RECORDING BIOMETRIC DATA

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***Abstract*— The requirements of modern times and particularly the last years or so, have imposed a rapidly developing technology in the field of health and sport have resulted in the creation of portable devices, called wearables. The term of wearable in technology is used to describe any product of a technology that is made to be worn by people or consumers. This thesis will be presented the study and implementation of a wearable in the field of health and sport, with the help of electronic or digital technology. The parts and sensors that make up an integrated digital wearable as well as the actuators that perform the automated system scripts will then be analyzed. The way of programming and how to communicate with the user of the machine will be presented in detail, and from all of the above, the conclusions of using the wearables systems will emerge. Finally, some proposals for the implementation of wearables as well as optimizations of existing systems are proposed.**

*Keywords*—**wireless communication, portable device, automated technology, smartwatch, microcontroller, actuators, sensors, cholesterol, virtual vision, programming wearable**

## I. INTRODUCTION

In recent years, so-called wearables or smart portable devices have passed into our lives to offer more capabilities to users and to meet as many of their needs as possible.
They have a plethora of applications that are easy to find and install by the user as they are in specific web sites. They also have toys that have begun to overtake both and tend to the three dimensions.
In general, wearables are becoming every day more and more necessary in our lives and the development of technology will become an integral part as they will cover more and more functions of a personal computer [1].

**Wearables and characteristic properties**

Wearable technology, wearables, fashionable technology, wearable devices, tech togs, or fashion electronics are smart electronic devices (electronic device with micro-controllers) that can be worn on the body as implants or accessories

**Characteristics of wearables:**

In order for a wearable device to be worn, a guide has been developed and designed to indicate the characteristics of these devices to provide the user with flexibility and protection. Below are listed their characteristics:

• Positioning: Depending on the needs we want to serve each device, there are specific placement points in the human body.

• Creation of the shape: The shape of the device is related to the dynamic human form ensuring comfort and stability to the user.

• Human motion: Taking into account every element that composes movement such as joints mechanisms, flexion and muscle extension, we see that human movement is an important factor in shaping wearables.

• Weight: The weight of the devices should not hamper the balance or movement of the human being [2].

**Advantages and disadvantages of wearables**

Advantages:

- Medical health:

The evolution of wearables technology on human health issues has resulted in the treatment of diseases that were difficult to detect until a few years ago.

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- Sector of society:

Wearables also contribute positively to the reduction of crime as they provide more security to the user such as placing a bracelet in a child so that it can be detected in case of danger.

- Sports:

Vehicle technology has greatly helped the athlete's performance and prevent accidents [2].

Disadvantages:

- Architectural structure of the device:

  The primary limiting factor until a few years ago was the size and volume of the wearable. Already, the size, weight and volume of the devices has been greatly reduced by the placement of smaller electronic components which give a more discreet form to the user but not obscure to the observer.

- Flexibility:

  Any device added to the human body should not be considered foreign to it. That is, not to restrict the user's movements.

That is why special attention should be paid to the ergonomics of the system.

- Energy Consumption:

The energy issue is considered to be an inhibiting factor in wearables devices [2].

## II. MODULES OF WEARABLES

The basic modules that make up all wearables are sensors and actuators. Sensors are considered to be physical quantity detection devices and their conversion to a measurable output so that they will be read by the observer who studies them. The structure of the sensors has evolved by finding applications in many electronic circuits [3], [4].

Sensor of Oximetry

Firstly, we will refer to one of the best known wearables that is the oxygen meter. In trade there are many wearables of oxygen measurement and heartbeats at the same time. The sensor contained in these devices is being called an Sensor of Oximetry. A small medical device called a pulse oximeter is clipped to some part of the body, usually in one of the fingers of the hand, and uses a sensor. This sensor harbors a light source, a light detector, and a microprocessor that compares and calculates the differences between oxygen-rich hemoglobin and oxygen-deficient hemoglobin. The percentage of oxygen saturation is reported as% SpO2 [3], [4].

Figure 1: Sensor of Oximetry

Sensor of Blood Pressure (NIBP)

The main function of the sensor blood pressure is to measure the rate of human heart rate. Most devices use the oscillometric method to measure blood pressure. . In a very short time the sensor incorporated in the device records the small oscillations due to the expansion and contraction of the arteries in the wrist (pulse) [3], [4].

Figure 1: Sensor of Blood Pressure

Sensor of Glucose measurement (Enlite)

The sensor of glucose is a small electrode that measures glucose levels. It is placed under the skin in the interstitial fluid, that is where cells receive oxygen and nutrients, including glucose. Commercial sensors detect four times more glucose deviations than normal blood glucose monitoring [3], [4].

Sensor of Electromyography

The sensor of electromyograph is mainly used in portable textile garments which contain sensor-electrodes that detect the activity of muscle movement. The measurement of muscle activity is detected by enhancing the electrical stimulation of muscle fibers during contraction. Since all the muscle fibers in

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the sensor monitoring and recording region are pulsing at a different rate, the signal detected by the sensor is a constantly varying potential difference between its positive and negative poles. Because of this, the density (width) of the generated electrical signal is proportional to the force of the contraction [5], [6].

Sensor of Accelerometer

The Accelerometers or different inertial sensors are basically sensors that detect linear acceleration along one or different directions. The Acceleration can be measured electrically with the natural changes in the reference weight shift relative to the reference frame. There are devices in the trade that use the accelerometer sensor such as monitoring human kinematic activities and burning calories [5], [6].

Sensor of gyroscope

The gyroscope is a sensor that is applied to many wearable devices such as mobile, tablet, smartwatch, and more. This is a sensor that calculates changes in the user's space. Its use is not limited to sports but also to medicine as there are smart devices such as glasses used for visually impaired people [5], [6].

In addition to the sensory key module of wearables are the actuators or other processors. Thus, actuators transform electrical signals into natural phenomena. The function of the actuators is to respond to the various stimuli they receive through the sensors after processing the data. Specifically, a processor performs four functions continuously:

a. fetch
b. decode
c. execute
d. store

A description of the processor architecture of a wearable system

The method of designing a wearable system is based on some architecture. The choice of architecture needs to be done carefully, otherwise it may not be practical. Architecture should have as low a cost as possible, be truly realistic (that is, not just a theoretical methodology), and be parametrization, that is to say give the designer the flexibility to modify some features that may be best of suited to the problem [5], [6].

In conclusion, a modern microprocessor can execute commands for which it is programmed at a high rate. In order to take full advantage of this powerful performance, the processor must be connected to a memory system that is too large and fast. If the memory is too small, it will not be able to keep enough programs to keep the processor busy. If it is too slow, the memory will not be able to provide commands as fast as the processor can perform. The longer a memory is, the slower it is. It is therefore not possible to design a single memory that is large enough and fast enough to keep a high-performance processor busy [5], [6].

Connectivity:

Connectivity refers to how wearing devices are related and is relevant to the Internet of Things. The term "Internet of Things" (or Internet of Things) was devised in the late 1990s by businessman Kevin Ashton. Ashton, who is one of the founders of the Auto-ID Center at MIT, was part of a team that discovered how to connect objects to the internet via an RFID tag. He has stated that he used the phrase "Internet of Things" for the first time in a presentation he made in 1999 - and this term has been used since then. But what characterizes IoT is that it is comprised of "smart" (ie computer-equipped) devices that are linked to each other and with servers to provide a host of services that use and rely on the data they provide the devices owned and used by people every day. Until recently, this idea was considered innovative and revolutionary, but IoT is not something new as an act, since it has relied on technology developments over the past decades. One of these developments is the computer segment, from computers to PCs, from PCs to notebooks and notebooks to portable devices (such as tablets, smartphones and wearables). The performance of these devices exceeds the performance of the bulky hosts of the past. In addition to the evolution of hardware in computers, progress on connectivity issues is equally important. Technologies such as 3G and 4G have enabled consumers to be connected wherever they are. At the same time, the connectivity features of the devices offer the ability to directly connect two or more devices to each other, or indirectly connect them via wi-fi to communicate with each other [6], [7], [8].

## III. APPLICATIONS OF WEARABLES IN MEDICINE HEALTH AND SPORT

Wearable Cardiology Devices

The progress of technology has resulted in the creation of small, reliable and flexible portable devices such as smartwatch, to meet the needs of the human being.

Recently, electrocardiographic monitoring devices for consumers such as the Kardia device have been marketed.

The Kardia device marketed by AliveCor Inc. connects to a nearby smartphone and provides ECG data analysis and transmission for remote interpretation without the need for prescription physician [7], [8].

Wearable clothing and sports footwear

The earliest athletic wearables were the smart clothes, the clothes that controlled the athlete's physical condition through

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special sensors placed on the clothes. Such wearable is also the Wealthy jacket, "and the Wealthy jacket is based on" smart sensors "embedded in the garment fibers and yarns as well as signal processing technologies and wireless networks of third generation 3G. In particular, when the user wears the Wealthy jacket, signals of the vital functions of the body, such as heartbeats, breathing rate, movement and stop, temperature and oximetry, are also monitored that give the sensors information about the natural functions of the person (calm, action , exercise, judgment, etc.) [7], [8].
In addition to smart clothes, the Athletic Technology has crafted sports footwear such as FootStriker, an innovative technology that helps users run properly without injuries. The FootStriker uses a pressure sensor that is placed inside the shoe bottom. Whenever the runner goes wrong with the back of his leg first, a signal is transmitted to a patch that is attached to the back of the leg. This sends a small dose of electricity, causing the muscles to be energized to correct the leg's position in the next step and the foot step first with the front [7], [8].

## IV. CONCLUSIONS

From the study of this research work, we concluded that wearable technology in both Medicine and Sport has made a spectacular contribution to meeting human needs. However, there are devices that carry some optimizations to serve more needs. Here are some suggestions and optimizations for device wearables technology [9], [10].

Wearable device for measuring cholesterol

From published studies we have noticed that the percentage of people who have cholesterol, and tend to be at risk from various diseases, is enormous. For this reason, it is imperative to create specific devices for measuring blood cholesterol levels. As there are devices that detect the concentration of glucose in both blood and sweat, we equally recommend creating devices that detect blood cholesterol concentration [9], [10].

Glasses that detect eye pressure

Most people are concerned about their blood pressure, but few are the ones who control eye pressure.
However, control of the eye pressure is necessary as if it climbs dangerously it can damage vision. The advancement of the technology can correct this problem by creating special eyewear that will detect eye pressure by means of special sensors (incorporating a special camera) that will calculate the corneal thickness, since the limits of the eye pressure are 10mmHg to 21mmHg. All data will be sent to the user's smartphone so that there is a complete logging control so that the patient's treating physician can treat the patient if who sees a problem [9], [10].

Acoustic video-otoscope and sound recorder (acoustic)

Hearing problems are very common. They can occur at any age, but with increasing age they are more frequent Sudden hearing loss is a condition in which we have, without a distinct cause, a one-sided neurosensory hearing or deafness.
We suggest creating headphones that contain a built-in camera and an audiogram (that is, recording the user's volume) so that patients in distant regions can sense the problem in time [9], [10].

Wearable pregnancy ultrasound

There are devices such as the wearable Bloomlife device for pregnant women that monitor pregnancy contractions in real time. As mentioned, the device contains electrodes that monitor the contractions and send the data to the application on the user's smartphone. In the same device, we recommend the use of ultrasonic waves so that the image of the fetus appears.

It is a fact that these proposals sound like scenarios of science fiction. The recent development of technology has proven exactly the opposite. We believe in the advancement of technology and we hope that these proposals will be feasible in the future [9], [10].

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