Wearable Devices: Concepts and Applications

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Abstract. Understanding the human system is essential to describing, monitoring and evaluating human performance based on the signals produced. These signals produced generate information from the human organism, which can be obtained through a technology called, know as wearable sensor. This technology means that by incorporating advanced science and technology into everyday life, it is possible to design and develop wearable devices that can meet the needs of various fields and users. In view of this, this paper presents a review of various applications and concepts of wearable technology, which are currently being discussed by authors in their literatura.

Keywords: wearable sensors, technology, overhaul, applications, concepts.

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1 Introduction

Human beings can be considered as an individual system [2, 1, 22, 3, 5, 15, 28, 5, 19, 18], which performs different functions and produces signals relevant to daily activities. And according to [22], it is essential to understand the human system [16, 17] to describe, monitor and evaluate human performance based on the signals produced.

Human systems include for example the nervous system, respiratory system, digestive system and others. And each type of system of the body allows the possibility of obtaining relevant information related to health and functionalities of the human body.

In recent decades, with the development of technologies, is used to obtain information from the systems of the human organism, a technology called *wearable*. Known as wearable sensors, it has been increasing its potential as an intelligent and automatic solution for assessing human activities in daily life [22].

According to [10] *wearable* means that by incorporating advanced science and technology into everyday life, it is possible to design and develop wearable devices that can meet the needs of various fields and users. These are essentially computers that operate through independent operating systems.

Currently, *wearable* technology has had a number of interesting applications, which bring these devices an advantage because of their relatively wide availability potential, and some of these applications will be presented in the following sessions.

Already, a topic that has been much discussed in the articles, is the application of these devices in the field of study related to children. Where one of these applications is said in [5], where it brings a *wearables* application to help children of different abilities play together. When a child has a disability, it can affect their ability to develop life skills such as communication, problem solving, social motor skills, affecting their ability to develop these skills. And the application of *wear-*

able appears as an opportunity to work with children using Augmented Reality games without the influence of prior knowledge, [5].

2 Applications

Applications for wearable technology can be as diverse as possible. [2] proposed a comparison between real games and virtual games using a prototype of a suit equipped with different types of sensors. Thus, the work proposed an improved way of implementing real games, enhanced with smart clothes and different types of motion detection technologies.

When it comes to fashion, wearable technology is gaining more prominence. In 2005, [24] proposed a smart clothing model capable of predicting environmental situations through different types of sensors installed. Thus, the clothing is able to warn the user when an adverse situation occurs, such as rain, showers or any nearby obstacle.

Still in this context, [27] proposed in his work the implementation of an interface to be installed in clothes. Thus, the handset has a miniature size, capable of wireless connection and able to connect to a wide range of equipment, aiming at flexibility and comfort for the user. The motivation for this work by [27] is based on the difficulties encountered regarding the adaptation of users to the wires and connections of a work previously developed by the author in this same line of research. Fig. 2 shows the interface intended by the author.

Empirical research, responsible for data collection and pattern recognition in decision making, has a prominent place in the *wearable* technology scenario. [21] in his work, surveys the reasons why doctors and researchers used or not wearable technology to aid exams and other medical procedures. Thus, the study found that ease of use and comfort are the main factors for the dissemination of technology in hospitals in that region.

The *wearable* technique can still be implemented in the context of home automation, taking into consideration that both subjects are part of the set called IoT (Internet of Things). [12] 's work is an example of this case. In the work in question, an interaction system between a glasses and a smart watch was developed.

In the biomedical field, [8] expects mobile health to play an increasingly prominent role in health provision due to the advent of aging society. Especially when daily monitoring of human life through wearable technology is able to prevent lifestyle diseases, which may possibly increase the number of elderly patients in need of medical care.

Figure 1: Model of designed smart clothing.

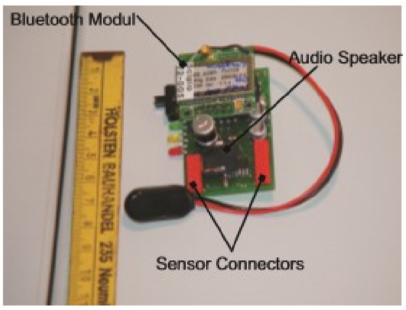

Figure 2: Interface designed for application *wearable*

In this scenario, work by [8] describes a noise tolerant Instant Heart Rate (RSI) detection algorithm for a wearable ECG monitoring system. This assessment is useful for detecting heart disease, analyzing heart rate variation and estimating exercise intensity. Its implementation was made in low power hardware, and the system can be seen next in Fig. 3.

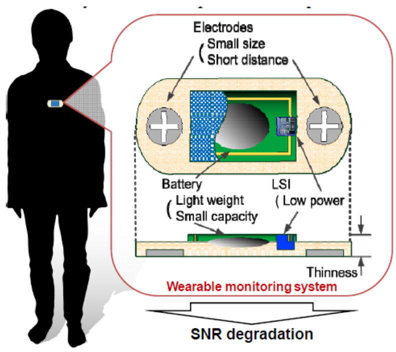

Figure 3: Monitoring system restrictions *wearable*.

2.1 Wearable in Physical Activities

Another considerable application of wearable is in the field of performance and monitoring during sports, because people today focus more on training and physical exercise.

Automatic classification of daily activities can be used to promote health-enhancing physical activity and a healthier lifestyle [14] .Second [20] Using measured acceleration and angular velocity data collected from With low cost and wearable sensors, it is possible to detect transitions between pre-selected locations and to recognize and classify sitting, standing and walking behaviors. Figure 4 shows how the prototype instrumentation was applied.

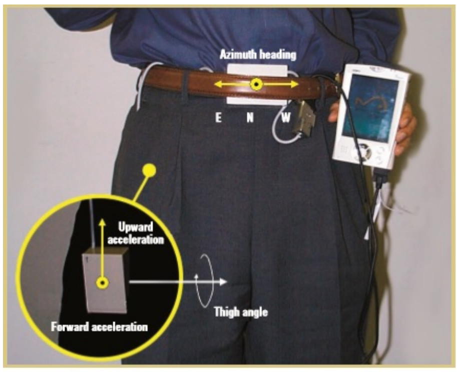

Figure 4: Implementation of wearable in Motion Recognition

Physical activity has a positive impact on people's well-being and can also decrease the occurrence of chronic diseases. Recognition of wearable sensor activity can provide the user with feedback about their lifestyle in relation to physical activity and sports and thus promote a more active lifestyle. So far, activity recognition has been studied primarily in supervised laboratory environments. [7]

Wearable sensors are required to assess physiological and kinematic signals of the body during exercise. These sensors need to be easy to use and ideally the complete system fully integrated with a garment. This would allow users to monitor their progress as they go through a physical training program without the need to connect external devices. [26]

According to the work of [13] a support system has been proposed to improve the golf swing using wearable sensors, with the aim of providing appropriate advice to beginners without the need for a human trainer. We first introduce the basic types of golf swing and the steps of a golf swing. In Figure 5, it is shown how the balance is made by the individual when practicing the sport and how the *Werable* acts during this physical activity.

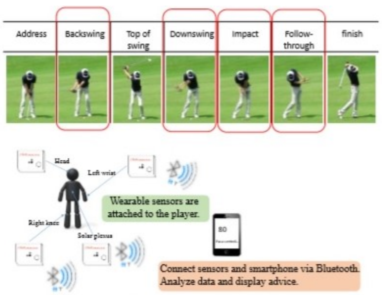

Figure 5: Application of Wearable in Golf

[25] in this work, a prototype for state-of-the-art racket sports training has been made. To validate its performance, a wearable wireless sensing device (WSD) based on microelectromechanical motion sensors was used to recognize different badminton strokes and rate the skill levels of different badminton players

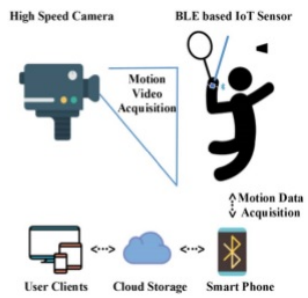

Figure 6: Wearable in badminton

. The system includes a custom sensor node for data collection, a mobile application and a cloud-based data processing unit. The developed WSD is inexpensive, easy to use and computationally efficient compared to video-based methods for analyzing badminton scams. It offers the advantage of dynamic monitoring of various players indoors and outdoors.In Figure 6 an example of how this prototype performs its function is shown.

With regard to movement monitoring during exercise, it is extremely essential that particular attention be given to the study of sensitive sensors for detecting falls in the elderly group. Research by [6] shows that by introducing small non-invasive sensors in conjunction with a wireless network, Ivy Project aims to provide a path to a more independent life for older people. Using a small device worn at the waist and a network of fixed wires in the home environment, we can detect a fall and the location of the victim.

Recognition of high-level, long-term activities has great potential in areas such as medical diagnosis and human behavior modeling. So far, however, activity recognition research has focused primarily on low-level, short-term activities. [9]

Providing accurate and timely information about people's activities and behaviors is one of the most important tasks of widespread computing. Numerous applications can be viewed, for example, in medical, security, entertainment and tactical scenarios. While recognition of human activity (HAR) has been an active field for over a decade, there are still important aspects that, if addressed, would constitute a significant change in the way people interact with mobile devices. [9]

2.2 Wearable Robotics

Wearable devices related to dress sensors in people differ from wearable robotics. In the work done by [11], the author brings this difference in the development of a Humanoid robot using *wearable* to model human behavior. Since this anthropomorphic robot detects user behavior and has internal models to learn the process of human sensory motor integration. Then this robot begins to predict the next user behavior using the learned models. Wearable sensory devices that make up the humanoid without muscle or skeleton can be seen in Fig. 7.

And the prototype presented by this same author in his work can be seen next, in Fig. 8.

[11] also reports in his work that wearable computing differs from robotic *wearable*, pointing out that more recent research on robotics using these sensors is motivated by interest in assistive devices. with power. They are usually heavy and consume a lot of power for mobile use.

2.3 Wearable on Children Creativity

In a report by [23], in primary and secondary schools around the world, wearable technologies, *wearable*, are becoming increasingly common. Augmented reality, combined with wearable technology, has the potential to benefit students' learning in different environments. The author also says that this combination can potentially be used to support children's problem solving and creativity.

Creativity is a skill of the human being, it is something that is related to our thinking and ability to innovate. The process of creativity also involves exploring and gathering different inspirations, ideas, experiments, and ultimately the creation and sharing of results.

The work proposed by [23] conducted a study using wearable technology to increase and enhance creative tasks, providing different types of feedback during times of high and low creativity. Wearable technologies spoken by the author involve wrist devices such as smart watches and trackers; items used in clothing, such as electronic fabrics and stickers; and monitors mounted as augmented reality and virtual reality.

The results obtained by the author aim to better inform the explorations of creativity, as well as an initial exploration to increase children's creativity using *wearable*

2.4 Techniques Wearable in Immersible Rehabilitation in Virtual Reality in Children with Neuromoter Disabilities

An immersible Virtual Reality rehabilitation training system equipped with Wearable Haptics is proposed in [4] for children with neuromotor disabilities. This paper aims to increase patient involvement and provide multisensory afferent feedback during motor exercises that benefit the flexibility of Virtual Reality in adapting exercises to patient needs. In this study, an experimental rehabilitation session was conducted with children with cerebral palsy and developmental dyspraxia to evaluate the usability of the system and the proof of concept of the approach proposed by the author.

One of the sessions described by [4] deals with the development of two games for the practice of motor and cognitive skills of children (5 to 15 years old) with movement disorders and motor developmental delays. The games allow a playful training of directed movements, based on typical rehabilitation exercises (reach, path comprehension, hand orientation).

The two games introduced, both using wearable technology, were: the first, Moneybox Game, focused on pinching and reaching with inclination, and the other, Labyrinth. Game, is a marble maze focused on pointing and tracking movements, requiring joint coordination of the eyes and hands and upper limbs, whose image of the games can be seen below in Fig. 9.

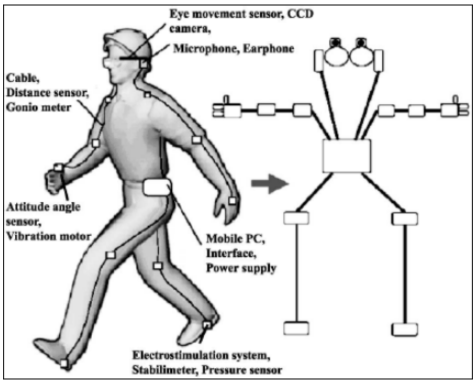

Figure 7: Wearable sensory devices used in Wearable Robotics.

Figure 8: Parasitic Humanoid Prototype.

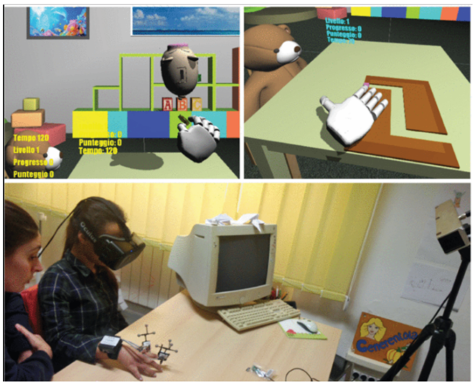

Figure 9: Moneybox (upper left), Labyrinth (upper right) - Children with Cerebral Palsy while performing kinesiological evaluation with the Games.

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