

ORIGINAL RESEARCH ARTICLE

Competitive advantage of wearable technology in sports training

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ABSTRACT

This document outlines wearable technology and the sources, related topics and authors of major publications on this subject in recent years. It is worth mentioning that wearable or wearable technology is also called “wearables” in English. It refers to the incorporation of microprocessors, sensors and transducers that we wear daily, which acts as a computer that always works with users, and can be used in a defined space for continuous interaction with users, wearable technology can be defined as an electronic device that can be embedded into human body to continuously obtain information. The purpose of this paper is to understand the development and current situation of this new technology, and apply it to new research findings and the development of wearable devices. The disciplinary connection between different knowledge fields provides a clear starting point for the development of research topics. In specific case of interest, the research focuses on the devices applied to sports, which are used to analyze the strength, flexibility and speed of athletes’ lower limbs, and generate sports evidence related to numerical data, so as to further analyze, explain and produce conclusive results. Electronic engineering performs all data processing similar to electricity, thus defining a part of wearable design for adaptation during physical activity. In the field of programming, system engineering is very important for the data conversion of sensors and the representation of these data in a way that people can understand. This new technology allows the generation of a wide variety of data, but integrates multiple disciplines at the same time. With the understanding of sports, people will test the complex problems around the human body and how to correctly explain the results of clothing elements that can be designed technically.

Keywords: Internet of Things; wearable; electronic devices; microprocessor; multitasking; smart watch; health monitoring wristband; wearable; wearable technology; GPS sneakers

1. Introduction

The technology in wearable components is gradually increasing, enabling us to take actions that decades ago or even in recent years could not have been imagined. Wearable devices are generated

from these new technologies which are considered to be portable electronic devices embedded in some part of an individual’s body. These devices have sensors that can calculate data, such as measure brain waves or the number of daily walks, a person’s sleep. Wearable technology mainly focuses

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on monitoring a person's physical activity for medical care, but there are several wearable electronic devices with various functions on the market, some of these are: Pebble, Fixbit, Google for android wear, Jawbone. Among the different types of wearable devices that may exist, the most used are:

-Wearables for sports: They measure biological variables, most commonly heart rate and calories consumed.

-Wearables for health: They are the ones that monitor medical variables such as glucose, blood pressure and cholesterol.

-Wearables for daily use: They speed up daily activities, allowing various functions such as voice recognition.

2. Current situation of wearable technology

The emergence of internet and the development of new technology make it possible for clothing elements to establish communication with public or private databases, which is an important way to establish man-machine relationship; allowing to have different devices in our daily life to promote different tasks and improve the quality of life. Therefore, the Internet of Things (IoT) has consolidated the technological progress for the monitoring of micro-integration wearable devices, miniaturized digital components that can be carried without being perceived, and at the same time contain communication interfaces.

The technology began with abacus rings made in China in the 17th century. In 1961, a group of MIT students built a computer inside a shoe in order to cheat in a roulette wheel in Las Vegas casinos. Following to this appears Steve Mann, the predecessor of Google Glass. He is recognized as one of the leaders in the field of wearable computing^[1].

At present, wearable devices can be found in different fields such as health, safety and sports in the global market. Google has launched a new in-

novative product on the market, called Google Glasses, which is controlled by voice commands and provides a screen that displays the information required by users. The tool also allows you to capture images and record video in high definition.

In the medical field, wearable elements with sensors are being developed to monitor the glucose level of diabetic patients and control diabetes by automatically injecting the required amount of insulin, so as to obtain the general health data of patients.

2.1. Projection of wearable technology in Colombia

The internet and other information and communication technologies have contributed to social growth and connectivity between cities in the country. Although government agencies such as Colciencias try to promote the implementation of technology projects, the investment impact of encouraging researchers to develop projects that directly combine engineering and health is not extensive. However, the application of wearable technology in Colombia has begun, as described in search on the Publinde platform^[2]. The competition of large international research groups in providing wearable technology devices is obvious. This statement is based on relevant publications, and then the feasibility of putting the theoretical model into practice and commercialization. Some previous theoretical suggestions are now easily related to early entertainment applications, which are realized through bracelets or monitoring watches called "smartwatch".

By searching on the Publinde platform^[2], with the search formula: Wearable Technology, the following is related publication:

Magazine: *Electronic Vision*, publication title: Wearable device with frozen gait of parkinson's disease in 2019. According to Publidex, in Colombia, the proportion of articles published under the concept of wearable technology is very low, because some categories are related to other similar search criteria and belong to the scope of engineering and health science keywords. Although the Publinde

database does not provide information with bibliographic analyzer functions such as SCOPUS or Web of Science, it allows us to observe some topics related to the proposed topics, which focus on the regional background.

3. General query in database for wearable technology

Quering in SCOPUS^[3,4] by searching for wearable and technology, we found that China and

the United States are the countries that have most published on wearable technologies, followed by the United Kingdom, there have been a total of 28,874 articles related to this topic.

With regard to the number of publications and their publication dates, we can note that the number of publications increased between 2012 and 2014. As a background, it can also be said that this is the result of the rapid development of technology and the increasing number of researches.

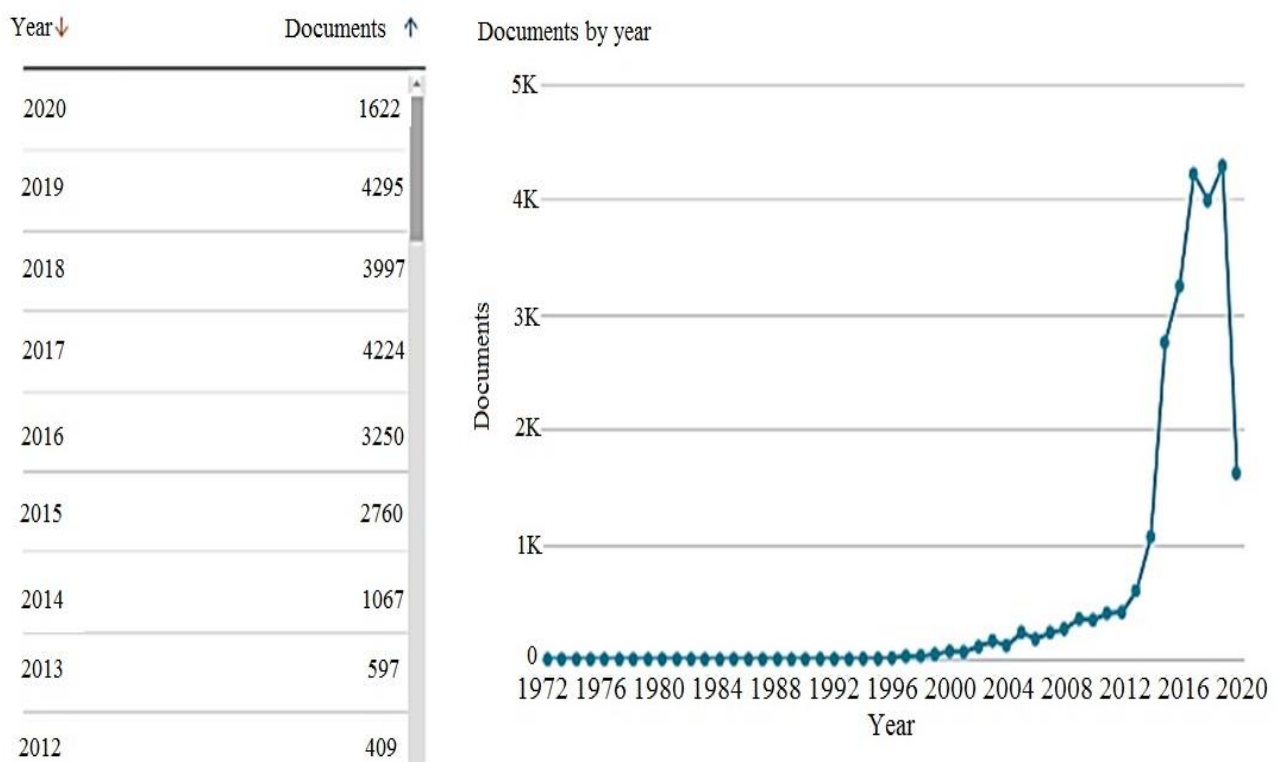


Figure 1. Matching search of wearable technology.

Source: SCOPUS

It can be seen from **Figure 2** that the relationship by the type of topics is also growing, that's to say that, if we talk about health technologies in 2011 and 2012, an ascending curve begins that identifies the starting point of the interest of researchers, for they show their results with the publication that relate each line and work theme. We can also discuss topics related to wearable technology, such as artificial intelligence and computing science applied for bioengineering.

From the author's relevant search, we can find that Wang ZL in China is the most published author on wearable technology, followed by BeniniL. From the origin of the authors in **Figure 3**, some of them are of oriental origin, which leaves a picture and imagination for the readers of this article, that is, where may be the largest production place of wearable technology now and in the future.

Documents per year by source

Compare the document counts for up to 10 scores [Compare sources and view CiteScore, SJR, and SNIP data](#)

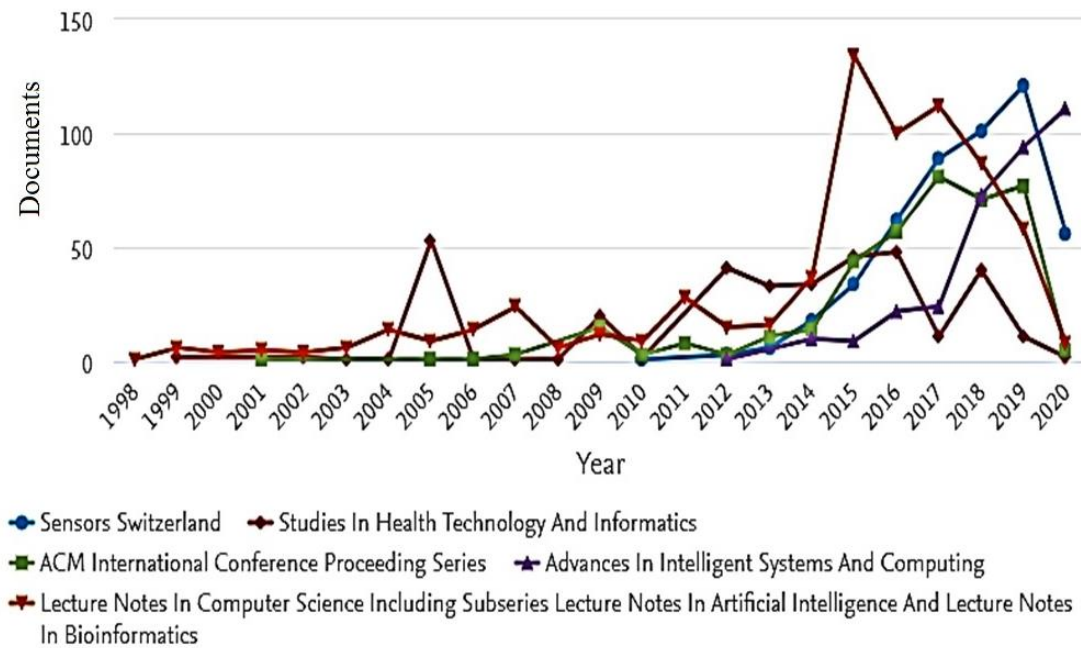


Figure 2. Documents by source and year.

Source: SCOPUUS

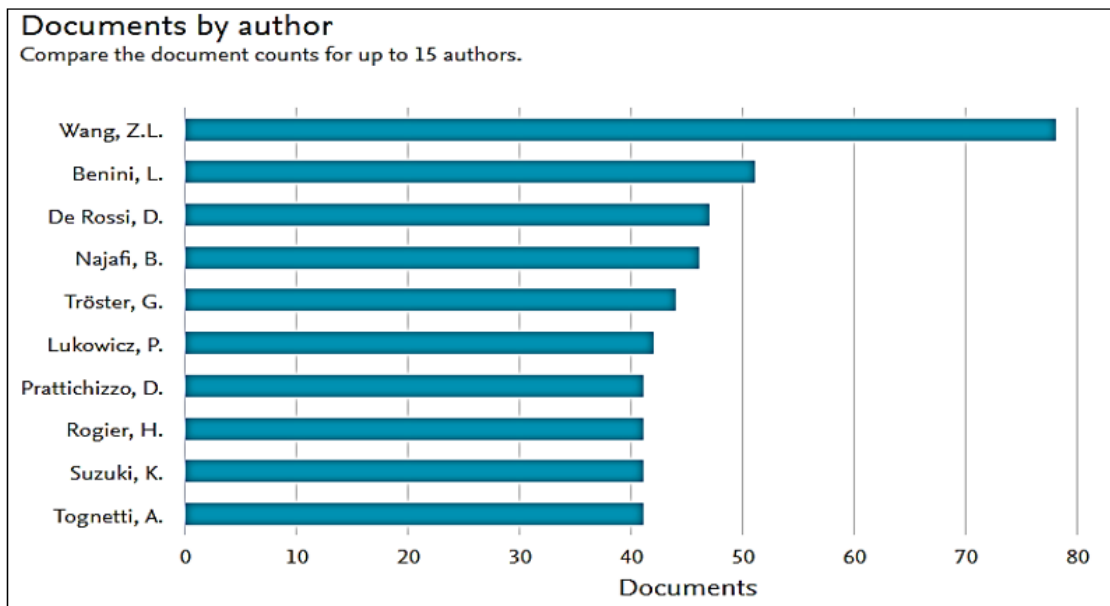


Figure 3. List of authors and number of publications.

Source: SCOPUS

4. Wearable technology and wearable devices

The concept of “wearable” can be translated into “wearable”, “dressable” or “usable”. That

means you can wear it. Wearable technology is defined as an electronic device designed to be wearable as any supplementary element in clothing or accessories.

At present, the abbreviation WT is used for “Wearable Technology”, and relevant devices WD is used for “Wearable Device”^[5].

Wearable technology can perform various tasks performed by computers and mobile devices, but this technology is more complex because it uses sensors that can interact with users and their environment.

An important feature of wearable technology and wearable devices is their wireless connection ability, which enables users to always obtain real-time information.

The purpose of wearable technology is to access electronic devices in a stable, easy to access, transparent and innovative way in people’s daily life.

4.1. Terms related to wear resistance technology

The following is a list of terms related to WT and WD and other terms that refer to other concepts.

- Tech togs: Refers to clothing elements with built-in technology, allowing connection.
- Fashionable technology: Technology of fashion, which is considered to be an element of technical clothing, but is more inclined to design and appearance.
- Fashion electronics: Electronics of fashion, which is similar to the above concept.
- Soft circuit: Refers to the use of soft materials, such as conductive fibers, using circuits and sensors as clothes.
- E-sewing: Electronic sewing, which refers to the concept similar to the above, that is, using conductive wire instead of textile thread to manufacture clothing.
- E-textile: Electronic clothing. This term refers to clothing with embedded electronic devices.
- Ubiquitous computing: Ubiquitous computing, refers to the operation of executing wearable

technology to obtain the basic functions of the computer, no matter where or when the computer is located.

- DIY wearables: Homemade devices. This term refers to devices specially designed to load them and perform functions during data collection, connection and other operations.

4.2. Wearable technology attributes

In his article^[5] in 1997, Steve Mann proposed eight basic attributes that a specific device must have in order to be regarded as wearable technology:

- Constant: It may have some kind of sleep mode, but the device must be awake.
- No restriction for the users: Users may be performing different activities, and the he himself should not interfere.
- They do not monopolize users’ attention: Using it should not isolate users from the outside world.
- User observation: can be configured to generate notifications or alerts.
- User controllable: the user can fully control the equipment at any time.
- Pay attention to the environment: Environmentally friendly.
- Communicating with others: It can be used as a medium of communication or expression at any time of need.
- Personnel: It can only be controlled by someone other than the owner. If the owner authorizes it, it must be inseparable from the body.

4.3. Advantages and disadvantages of wear-able technology

Wearable technology aims to make full use of all the advantages of technological progress in recent years.

- Wearable technology aims to improve the quality of life of anyone who decides to use it, because it is not only suitable for the consumer market, but also focuses on the fields of medical treatment and nutrition.
- Using wearable devices to store information, in addition to transmitting and processing information, it also allows to store local information or perform real-time synchronization on the network and other devices.
- Low radiation because these devices are characterized by very small size and produce less radiation than other portable devices.
- It has multiple application fields, because wearable technology uses the latest technological innovation, which helps it occupy a lot of space in the market and generate competition, thus contributing to the improvement of products.
- Multi-sensor devices, such as the well-known wearable technology, are also characterized by obtaining real-time data to produce continuous measurement of measured parameters.
- It is transparent to users. Because wearable technology has the great advantage of interaction between users and real-time environment, the system will act as a hands-free device.
- Compared with mobile phones or tablets, wearable devices have lower weight and have no weight problem.
- Combined with fashion, wearable technology is characterized by the combination of fabrics and fashion items designed for wearing, so that this technology can be combined with our clothes.
- Wearable devices with high configuration level have the advantage of high configurability, allowing users to change various parameters by enabling or disabling functions, so as to allow the presentation of data.
- The exclusion of technology and the ignorance of society about this new technology show the natural exclusion of change.
- Privacy, information that users don't know what they do with is unsafe.
- Due to technology dependence, users may refuse to use these devices for fear of technology addiction.
- Distrust. If you use any of these devices to provide users with incorrect or incomplete information, you will have distrust when you use the device again.
- Due to the lack of practicability, users may not see the functions of these devices because they find that this new technology has nothing to do with their daily life.
- Lack of consistency, if users intend to use this device occasionally, rather than as a necessary use in daily life, they will find how useless it is.
- High prices, the high prices of these devices, because of their innovation, make the public see that it is too expensive to reach their market consumption.
- Battery duration and charge, these devices show good charging duration, although they are small, and considering that they need a continuously activated interface.
- Due to the problem of heat dissipation, many devices are heated due to long-term use, which limits their durability and practicability.

4.4. Application of wearable technology

Accessories and complements: Watches, rings and bracelets that are activated by identifying fingerprints. These devices store information in people's daily life^[6], as shown in **Figure 4**: Heart rate, mileage, sleep time, accelerometer and gyroscope information.



Figure 4. Accessories and complements.

Source: author

Safety: Wearable technology aims to greatly improve work safety. At present, a fire helmet is being designed to monitor oxygen level and temperature so that the users capable of withstanding in the event of a fire. In addition, it is equipped with GPS to locate users in the user's location.



Figure 5. Security.

Source. website: <https://blue2310.tistory.com/1462>

Textile industry: Clothes that can measure the baby's body temperature and send an emergency message when it exceeds normal body temperature. The utility model relates to a sportswear, which provides support for users to perform the appropriate movement for a certain sport

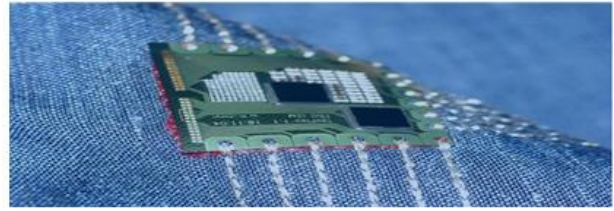


Figure 6. Textile industry.

Source: website. <https://url2.cl/lfsnb>

Fashion: Design clothes that can shrink or move to avoid users' replacement, so as to save time; discolored clothes, built-in energy-saving solar panels to ensure that smartphones will not run out of batteries.



Figure 7. Fashion.

Source: author

Drugs: Although more research is under way in this field and many devices have not been implemented, wearable technology has completely changed this field. For example, a sensor capable of controlling the glucose of diabetic patients has been developed so that the electronic distributor can inject the precise amount of insulin required by patients.



Figure 8. Drugs.

Source: <https://www.dispositivoswearables.net/>

5. Discussion

According to the number of papers published so far, it is worth noting that the publication rate of papers has increased since 2012, but the papers directly related to computer science, artificial intelligence and electronic progress reached the highest level in 2015. Since then, the number of publications has increased. In the past five years, the output has increased, showing an exponential curve in some

cases, in 2019 and 2020. It has been published the most in recent years.

Through the investigation of the current situation of wearable technology in the world and considering the different applications provided by wearable technology, this is the starting point for starting the theme that has not been fully explored. Therefore, the theme is to implement devices oriented towards monitoring in the human body through wearable technology, which allow to understand the movement of lower limb joints, generate physical activity records, and analyze flexibility, strength and speed variables^[8,9].

Through the exploration of this paper, the importance of the contribution of the field of health and engineering to the development of new equipment is explained. Based on this observation, the strategic need to combine three different knowledge sectors was identified, namely: System engineering, electronic engineering and sports^[11]. Now the discipline of Santo Thomas University focuses on the research and development of new wearable technology devices.

6. Conclusions

The research carried out enables people to know and understand the progress made by wearable technology over time and its important applicability in the daily life of a new generation, so as to build a productive and integrated society. On the other hand, it was pointed out that despite the wide range of applications of these technologies, many innovations had not been carried out as expected due to the advantages and disadvantages of their implementation, but the implementation of these technologies was being sought to expand career and job opportunities and promote activities in the health sector.

The research scope of wearable technology is very wide, which has been proved by many publications in recent years. Most publications are interested in business trends, which open the door for research and publication in the field with more ac-

ademic background and more in line with human life needs. If social methods can be adopted in this field, they can improve people's quality of life.

Physical culture and sports are the areas where wearable technologies are applied and used most. Despite this reality, there are still a large number of publications dealing with applications in use and commercial applications. The research group has a lot of room for work. They hope to continue to make new suggestions related to such technologies and establish new publications with different focuses on this subject.

Conflict of interest

The authors declare no conflict of interest.

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