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A Review of Wearable Technologies for Textile Daily Live Applications for Vision Impaired Persons

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The vision loss severely restricts a person's lifestyle and activities. The mobility of the visually impaired is important and can be difficult due to the inability to determine their positions and the location of objects in the environment. For the visually impaired, it can be difficult to observe the surrounding environment to gain knowledge and navigate to find the shortest and easiest path to their final destination. They just have the ability to walk through static routines that are important in their lives, with mobility equipment and the memories stored in their exploration long-term. In this survey we will present different wearable technologies as solution of the daily live of vision impaired person.

Our aim was to study the concept of wearable technologies for developing assistive technologies for blind and visually impaired users is to focus on problems and to try and resolve them by compensating for the loss of vision. Some used techniques and electronic components dedicated to guide visually impaired persons and to solve the problem of navigation will be described.

Keywords: Disability; wearable smart textile; vision loss.

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1. INTRODUCTION

The constant search for performance leads the disable persons to use new materials and equipment. Textile equipment for disable persons and mainly impaired persons has been improved for the comfort to increase their safety. To improve his comfort, the disable person will seek equipments and cloths according to its needs and for more safety and autonomy. From a safety point of view, improving performance may be possible thanks to the elasticity of the textile which can cause a phenomenon of compression of the user facilitating the activation of his blood flow. But our review of the wearable technologies for visually impaired persons, we are looking for a way to have clothing that guides them during the daily life activities. In addition, the garment must serve the user and not hinder his movements [1].

In this study, we are interested in these visually impaired persons needs using smart textiles and wearable technologies, the disability and mainly visual impairment, which requires specific care for protection and mobility capacity, will be highlighted.

Designer-researchers pursue innovation and seek to find solutions based on the needs expressed by the user. Moreover, the relationship between design and technology brings us new applications and innovative products like smart textiles. In other words, to dig into the field of smart textiles, it is necessary to understand the relationship between design, science and engineering. The difficulty in the design/engineering collaboration is undoubtedly to find a ground of intelligence between the constraints imposed by the engineering and the innovations of use proposed by the design.

In our research we try to explore, how technologies and mainly wearable could be developed that would be comfortable to hold, easy to work with and provide an aesthetically pleasing and fun interaction by compensating for the lack of vision, we sought for ways that blind people could take delight in new technologies. We also wanted to create smart textile product helping them to make such technologies a part of their life.

2. SMART TEXTILES

Smart textiles are fabrics with integrated technologies that offer the wearer (consumer) increased functionality. These textiles have many potential applications, such as the ability to communicate with other devices, conduct energy, transform into other materials, and protect the wearer from environmental hazards. According to Patrick Renaud, smart textiles represent “the next generation of fibers, fabrics and clothing. The definition of these textiles could be the following: materials which act or react according to the external environment. This means that they can warm us up in a cold environment or conversely cool us down in summer. They could also enhance and facilitate our daily life. Many smart textiles are already on the market and their field of application mainly concerns protective and safety clothing.

Research and development (R&D) on smart textiles in developed countries is helping to find solutions for vulnerable persons. In addition, the research and development of textile-based wearable systems give protection, security and health monitoring, etc. In this context: Md Syduzzaman said that "Smart textiles activities include the management of personal health through the integration, validation and use of smart clothing and other networked mobile devices, as well as projects aimed at the full integration of sensors/actuators, energy sources, processing and communication within garments to enable personal applications such as protection/security, emergency and healthcare” [2].

The demand for smart textiles is growing in many different research disciplines such as design, chemistry, physics, materials science and technology.

According to Lena Berglin, smart textiles are possible alternatives to the following three developments:

- The first is the introduction of a new type of textile fibers and structures, for example conductive materials.
- The second is the miniaturization and simplification of electronics, which makes it possible to integrate electronics into textile products and structures.
- The third is a different type of wireless technologies allowing the technology to be portable while communicating with other devices such as cell phones or computers.

It was the smart textiles approach that led to the search for a solution to a technical problem. We are talking here about wearable technology that changes the notion of use. Moreover, the

introduction of smart materials in wearable systems offers the possibility of developing textiles that present new functionalities. The development of new technologies allowing the convergence between textiles and electronics is necessary.

Apart from behavior like sense, reaction and conducting electricity, the textile will be able to perform different operations like calculation, navigation, etc. We can say that smart textiles and computer technologies are helping to achieve a radical change in textiles, it is a shift from passive behavior to active behavior, also a shift from textiles with static functionalities to products with dynamic features. Therefore, research on smart textiles has made it possible to develop a set of new technologies such as new textile sensors and actuators, flexible electronics and textile yarns [3].

3. Wearable Technologies

'Wearable Technologies' is the market's first universal innovation and development platform for technologies worn on the body, near the body or even on the body, this type of technological device is found in the form of an accessory or part of the material used in clothing. According to Vangie Beal: “Wearable technology is a category of technological devices that can be worn by a consumer and often include health and fitness tracking information. Other wearable tech gadgets include devices with small motion sensors to take photos and sync with your mobile devices. » . Additionally, the growing emergence of wearable technology in the healthcare, pharmaceutical, sports, nutrition, and fashion industries includes new and powerful products that can drive behavioral changes among consumers to achieve wellness goals [4].

One of the key features of wearable technology is its ability to connect to the Internet, allowing the exchange of data between a network and the device. This ability to send and receive data has propelled wearable technology to the forefront of the Internet of Things (IoT). Also, ‘wearable technology’ is a general term and related with electronics. There are several types of ‘wearable technology’. The most popular wearable technology devices are smart watches (example: alerting workers to changes in the production schedule), activity trackers (example: tracking productivity and collecting data relevant to the efficiency of workers) and sensory clothing (example: identifying workers through body proportion, movement and gestures) [5].

Wearable technology has become increasingly popular. Smartphones, mobile apps, computing and broadband connectivity have gained popularity in the market, but it has been part of how people have imagined the future for generations. We're talking today about the explosion in the wearable technology sector. The growth in popularity of mobile networks is one of the most important factors in the development of wearable technology [6].

The next sections will be dedicated to the links between electronic engineering and the functionalities of textile materials.

3.1 Electronic Engineering

Engineering is an activity carried out according to the rules of the art and scientific rigor. When talking about engineering, it should be noted that there are several branches of this activity, including electronic engineering, which is defined by the branch of engineering that deals with new technologies such as smart textiles. The electronics engineer crosses his brains to invent the technological innovations of tomorrow. Today, electronic engineering is part of our daily lives. Its environmental, sectoral and application constraints, its miniaturization, its performance, impose a constant technological watch on us. Through engineering and development in the fields of science, new wearable technologies are present in the market to provide medical monitoring capabilities. Electronic engineering is going more and more in depth in research on human comfort, it goes beyond these basic needs by going to the specific needs whether for a man breast or who is suffering from a disease or a deficiency [7].

3.2 The Functionalities of Textile Materials

The study of materials takes its place in advanced technologies; whether for sport, medicine, the automotive industry, materials play a major role today. Functional textiles are the result of innovation in the materials, processes and products themselves.

Researchers in the functional textile sector are developing textiles to be intelligent in order to design innovative, functional, comfortable and efficient products. Products such as sports clothing, in particular for disabled sports, can bring new properties to the textile surface, that is to say more functionality.

The individual wants to feel good in their clothes, especially individuals who have specific needs and requirements such as people who are ill or have a certain disability. Taking the example of sports clothing for the visually impaired, they must also have the main concepts of comfort, safety and performance, that means functions that seek to improve comfort, functions that ensure safety and health and functions that lead to a certain level of performance. It is necessary to indicate that comfort can be served by textiles, in other words navigation for the visually impaired is a success factor, so they need textiles that guide it such as textiles connected with high-tech materials such than electronic components [8].

4. THE STUDIED EXAMPLES

This research step consists of studying examples that are targeted for the visually impaired. We have chosen examples that already exist in the market, which are EyeVista, ALVU, Electronic Bracelet and Canne Kinect. This part aims to find which component and which method will be adapted and usable in our case study (visually impaired athletes) [9].

4.1 Example N°1: EyeVista, a Smart Jacket for visually Impaired Athletes

EyeVista is a wearable vest intended to assist visually impaired sprint athletes who may be on the move. Additionally, EyeVista is a lightweight, easy-to-use, affordable, and customizable vest that notifies the user through earphones or vibration. In this example the researchers use a computer vision-based approach with the use of the athlete's field of vision which is acquired by the Raspberry Pi camera module to reduce navigation complications. The researchers used the Open Computer Vision (OpenCV) library to implement most of the image processing treatments used in this work, which allows processing images and videos using cameras in real time.

Fig. 1. EyeVista, a smart jacket for visually impaired athletes [10]

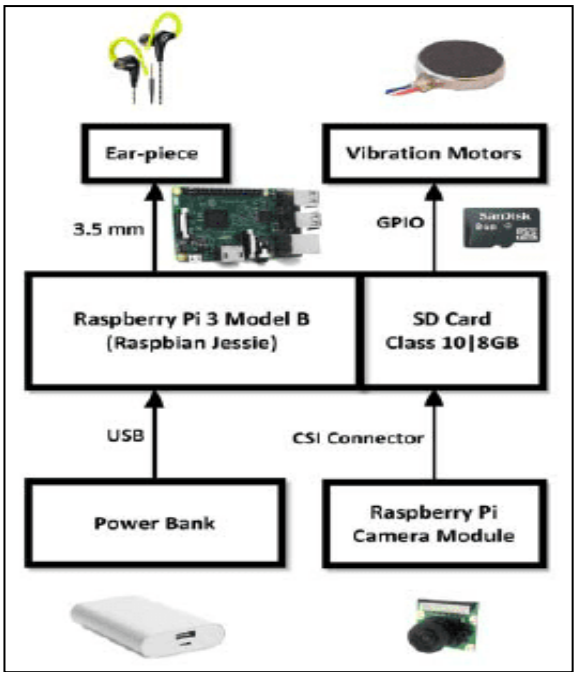

Fig. 2. EyeVista architectural system [11]

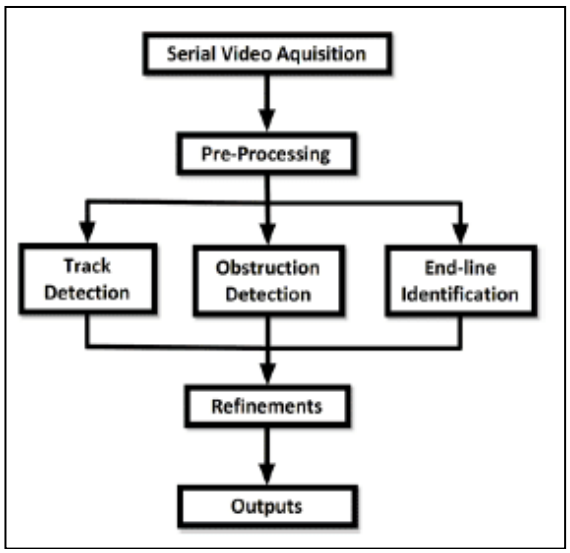

Fig. 3. EyeVista architectural software [12]

4.2 ALVU (Array of Lidars and Vibrotactile Units), a Wearable device for the Visually Impaired

ALVU is a portable, intuitive, and discreet device that allows visually impaired users to detect obstacles above and below as well as the immediate physical limits of the environment. Its objective is to have local navigation in confined and open spaces by allowing the user to distinguish free space from obstacles. According to the researchers, ALVU is “a new

portable system for safe navigation, effective in providing the user with detailed information about obstacles and the free space around them.

It is an integration of a set of sensors and feedback motors into this portable system to create an assistive navigation device for a visually impaired person. The overall system design consists of two parts: the sensor cluster consisting of a distance sensor belt and a haptic strap.

The Sensor Belt: This is a set of distance sensors worn around the user's waist, and pulses of infrared light provide reliable and accurate measurements of distances between the user and surrounding obstacles or surfaces.

The haptic strap: this communicates the measured distances via a set of vibration motors worn around the upper part of the user's abdomen, thus providing haptic feedback.

The diagram shows how a visually impaired person wearing the belt experiences distances from the environment via a haptic strap.

Engineers validated the device's capability in a large study involving 162 users and 12 blind users. Users wearing the device successfully traversed hallways, avoiding obstacles and detecting stairs.

Fig. 4. The ALVU, a wearable device for the visually impaired [13]
(A) shows a front view of a person wearing the system
(B) shows the haptic strap worn under the person's clothing, with the front unit circled in yellow.

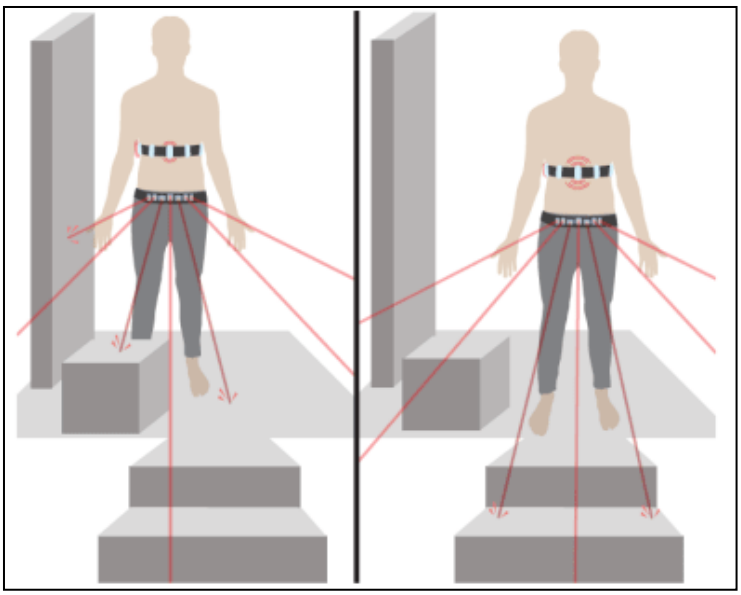

Fig. 5. Principle of operation of the sensor belt and the haptic strap communication [13]

4.3 Electronic Bracelet and Belt Compatible with Vision for the Mobility of Visually Impaired People

A portable assistance system is proposed to improve the mobility of the visually impaired. This system was implemented in the form of a bracelet and a belt.

A camera and ultrasonic sensor are attached to a personalized belt and wristband. The proposed system is an additional aid with a white cane and a belt that detects the distribution of obstacles on the way. This modular system transmits the required information to a subject via a monophonic monitor by activating the relevant spoken messages. The electronic bracelet helps the visually impaired to verify this information and to perceive the location of obstacles.

The electronic bracelet can be worn on the left or on the right, at the convenience of the user.

Fig. 6. A blind volunteer showing a typical posture for the use of the electronic bracelet and the vision-activated belt system (EBVEWB) [14]

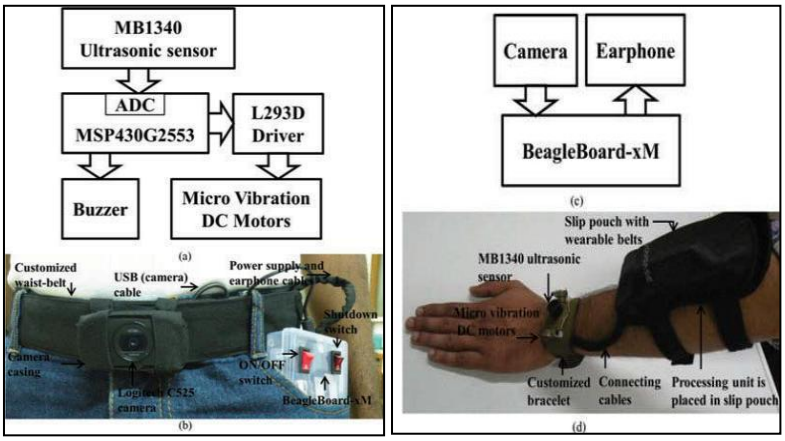

Fig. 7. Electronic bracelet and belt system involving vision: (a) block diagram of the belt allowing vision, (b) prototype of the vision belt, (c) block diagram of the electronic bracelet, and (d) prototype of the electronic bracelet [15]

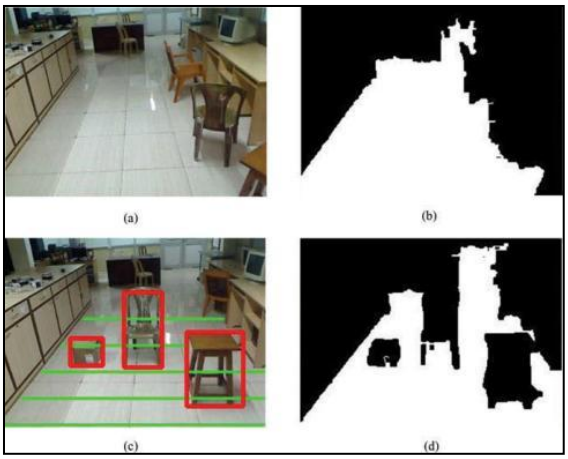

Fig. 8. Detection of path and obstacle to vision with belt (a) image of the input path, (b) resulting segmented path, (c) input image (obstructed path), and (d) resulting segmented obstacles [15]

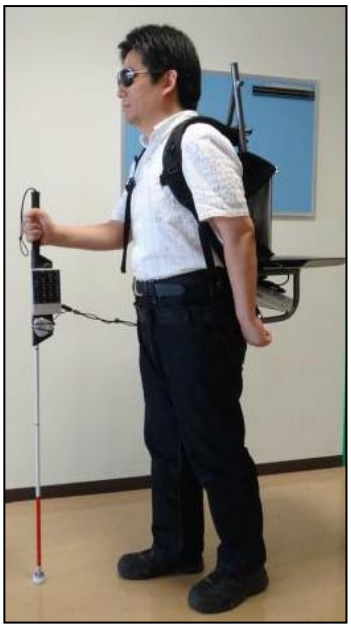

Fig. 9. Prototype of Kinect rod [16]

4.4 Kinect Cane: An Assistance System for the Visually Impaired Based on the Concept of Object Recognition Assistance

Canne Kinect is an assistance system that aims to help visually impaired users to find objects. The advantage of this system is the ability to recognize different objects such as chairs and stairs. Furthermore, the system is designed to return a minimum of required information relating to a user's instructions so that the user can obtain the necessary information more efficiently. The concept was implemented as a wearable assistive system consisting of a white cane, Microsoft Kinect sensor, numeric keypad, tactile feedback device, and more.

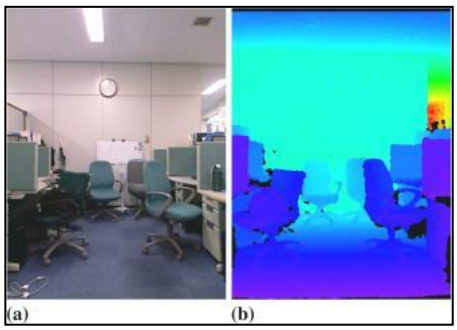

Fig. 10. Color image and depth data obtained by a Kinect sensor in an office environment [17]
(a): A color image
(b): Depth data

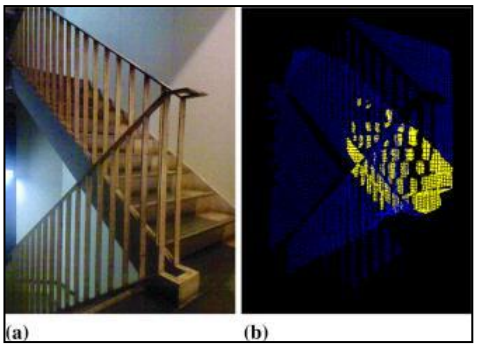

Fig. 11. Environment comprising a staircase and the corresponding recognition result [18]
(a): Ascending stair environment.
(b): Recognition result

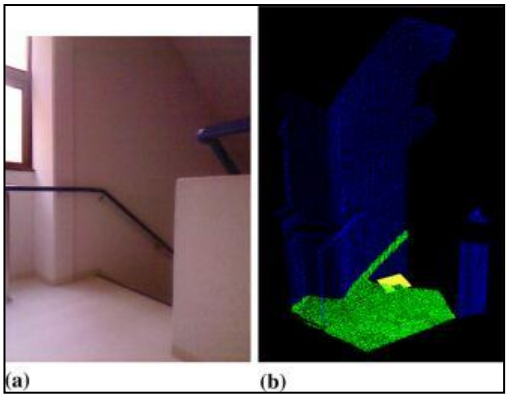

Fig. 12. An environment comprising a descending staircase and the corresponding recognition result [18]
(a): Descending stair environment.
(b): Recognition result

This system was able to recognize floors, chairs and ascending and descending stairs from the depth data obtained by the Kinect sensor. The system is evaluated through two types of experimentation: object recognition test and study of 'user [19-26].

5. CONCLUSION

Our research work is to review the wearable technologies for visually impaired persons, which is smart, innovative, multifunctional clothing and accessories containing electronic components, it is a synergy between textile design and electronic engineering.

Indeed, the major problem for these disabled people is mobility. The lack of this independent mobility reduces the feeling of comfort and security for these people. For this reason,

disability has a major impact, not only on the lives of disabled people, but also on their surroundings, their social relationships and their sports activities. The necessities of these persons which can be served by their clothing are three; Physical and psychological comfort, safety and protection and improvement of performance. That is why in this survey, we reviewed wearable technologies and we focused on their needs of assistance, to be guided by focusing on disability; visual impairment, emphasizing the importance of mobility for the visually impaired and listing some types of aids for the visually impaired.

We presented the role of new technologies for those applications; we focused on innovation centered technologies in functional textiles. We have cited examples of applications that help impaired persons during their daily activities.

This handicap, visual impairment as well as the needs of people with this visual deficiency, can be over passed through the use of functional, smart textiles integrating wearable technologies which are at their daily live, and why not in practicing other activities such as sport.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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