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CONCEPTION OF ERGONOMIC SPORTSWEAR FOR THE VISUALLY IMPAIRED PERSON: SYNERGY BETWEEN TEXTILE DESIGN AND ELECTRONIC ENGINEERING.

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ABSTRACT: Nowadays, the technology is in progress, especially for the wearable technology. A garment or accessory with advanced computer and electronic components can be called wearable technology. The wearable technology is making a widening appearance in different fields like the healthcare, pharmaceutical, sports, nutrition and fashion industries. This appearance gave birth to new and powerful products that have the potential to drive changes in customers behaviors. All of this aim to change the wellness goals of the consumers. A wearable assistive system is proposed to improve the mobility of visually impaired people especially the athletes. This system has been implemented in the shape of sports clothing in order to increase its comfortableness and external appearance.

KEYWORDS: Sportswear, VISUALLY IMPAIRED PERSON, Technical Innovation, User-Centered Innovation, DesignInnovation

1. INTRODUCTION

According to the World Health Organization 2011report [1], the 15% of the world population is struggling with at least one type of disability, such as visual, physical or hearing impairments. It is necessary to rethink the concept for ITSs (Intelligent Transportation Systems), which should be a technologically innovative driver for inclusive services. As reported by the European Disability Strategy 2010- 2020 [2] it must invest and advance in the demolition of infrastructural obstacles.

For the visual impairment, in 2010, the WHO estimates that from 39 countries the number of people of all ages visually impaired is estimated to be

285 million, of whom 39 million are blind, with uncertainties of 10–20% [3]. For this huge spectrum of visually disability, we decided in this review to focus in the visually impaired people how practice the running sport specially the athletes of Paralympics games which are the pinnacle of sport for many athletes with a disability. In addition, sport activities for visually impaired people are stated at the article 30 of the Convention on the Rights of Persons with Disabilities [4]. The visually impairment is also called low vision, is an impairment of vision characterized by visual acuity less than 3/10 and greater than 1/20, which corresponds

to categories 1 and 2 defined by the WHO [5]. We can say that the Visual impairment is the limitation of actions and functions of the visual system. This handicap cannot be correctable by standard glasses, contact lenses, medication or surgery that interferes with the ability to perform activities of daily living.

In general, this loss of eyesight severely restricts a person's lifestyle and activities. Mobility for visually impaired is important and can be challenging due to the inability to determine their positions and objects location in the surrounding environment. For the visually impaired people, it is may be difficult to observe the surrounding environment to gain knowledge and navigate to find the shortest and easier road to their final destinations. They have just the possibility only to walk in static routines that are major in their lives, with mobility equipment and the stored memories in their long-term exploration. For solving the problem of navigation for the visually impaired especially the athlete, we propose a design of an independent wearable system (sport clothes) that can help him to know his path during the Paralympic games (running). In order to guide the athlete, it is very important to know his real position and his final destination and this is the physical problem. All these things can be made by wearable system. After knowing the positioning, it needs to have a map of the area of athletic line. In

addition, every time we need to get the new position and to create a signal to the visually impaired person for the correction, because if this visually impaired person go out of the athletic line, he will miss his road and maybe it results in a collision of the athletes. When the visually impaired person approached the wall, we have to tell him go right or left (depending on the case and his position) and it is for create a correction. Therefore, we need to compare the position of the person with limits created by us to make an instruction for the correction of his path.

For the critical discussion, in case when the path is a high way with 60 meters, there is no

problem to use GPS because it is limited to about 15-meter accuracy [6]. To better understand, we take the case of a car; however, 20 meters has no problem to go high with the car. If 20 meters in a normal street, there is no problem to go by the car because of the accuracy of GPS is 15 meters. Therefore, in this application of guiding the car is not problem to use GPS.

In addition, the accuracy of GPS data depended on many factors like the quality of the GPS receiver, the position of the GPS satellites at the time the data was recorded, the characteristics of the surroundings and even the weather, so it is very complicated for our case.

To keep up with the demand for athletic training in outdoor environment, especially for the visually impaired people, GPS is a problem. If the line of athlete is one meter, we cannot use the system that is

1.5 meters accuracy, we will never be sure of the position of the visually impaired athlete. If we have one-meter path and the accuracy of the system is two meters, here we cannot know if he is in the inside or outside of the road, so we need a more accurate system like Localino which is consists of anchors and tags. With the Localino, we are able to build a very price competitive indoor location system [7]. Therefore, after knowing the position, we need to bring the map in a computer, so we need two things; current position of athlete and the map. When the athlete is running, we must know his new position and compared with the map for creating the correction. This can be made with Localino.

In order to solve this problem and to use Localino in the operation, it is necessary to go in the stadium and to put in specific places the transmitters. However, the problem here is that should some body go there and put the transmitters and it is the negative point of Localino. But, in other side we get a high accuracy.

- **Related work**

In the available literature, there exist many approaches for obstacle detection and mobility visually impaired. For example, Hiranya Peiris et al., 2016 [8] have proposed an approach for a wearable jacket to facilitate visually impaired sprint athletes where it can be activated while in motion. In this system, the searchers have used the Open Computer Vision (OpenCV) library to implement most of the image processing algorithms used in this work, which contributes the practicability to process images and videos using real-time cameras. But for our problem, this solution doesn't apply because of using a camera. The athlete when he turns, camera will also change the direction and that can disrupt the athlete. Another paper writing by Robert Katzschmann et al., 2018 [9] discuss a system which enables people who are totally blind to complete key activities that they normally perform with a white cane in a similar amount of time, while providing the benefits described above. But in our case, it's not functional for an athlete, it's hard to use a cane when he is running. A new system proposed by SHRIPAD BHATLAWANDE et al., 2014 [10] it is a wearable assistive system proposed to improve mobility of visually impaired people. The system has implemented in the shape of a bracelet and waist-belt in order to increase its wearable convenience and cosmetic acceptability. A camera and an ultrasonic sensor are attached to a customized waist-belt and bracelet, respectively. The proposed modular system will act as a complementary aid along with a white cane. The electronic bracelet module assists the subject to verify this information and to perceive distance of obstacles along with their locations. It a good assistive for our case for detection the obstacles but we cannot use cane for the athletes. There is another paper that that talk about technology assistance writing by Hotaka Takizawa *et al.*, 2015 [11]. The

system searches for an object that a visually impaired user instructs the system to find and then returns a searching result to the user via the tactile feedback device. The major advantage of the system is the ability to recognize the objects of various classes, such as chairs and staircases, out of detectable range of white canes. It is good for visually impaired people but for the athletes it can be impossible to apply it.

1. MATERIAL AND METHODS

a. Materials:

The technological system we plan to use are; Localino navigation, vibrator ERM and LRA, cables, power bank, tag, smart phone and mapping of the place through a computer. We are going to use the Localino to localize the visually impaired people during the course. In addition, we will use the vibrators ERM and LRM for obstacle detection, cables to connect them (the Localino and the Vibrator), the tag is for sends signals to the anchors and the anchors measure the time between the transmission and the reception of the signals. Using also the power bank to gain more energy for the system, a smart phone for the application and the mapping of the stadium to know exactly the position of the visually impaired.

b. Methods:

The Localino is based on a Decawave UWB transceiver, a STM32F1 series MCU and the anchors offer a WIFI backup link. This way it can be integrated into any already existing wireless network and transport the ranging data to a server in nearly real time. The indoor accuracy is within 10cm [12]. We need to study Localino in different geometry in a square and to put receiver in different positions that to increase the square, in a typical example we want to measure the distance between transmitter and receiver. In order to do this measure first we put minimum three transmitters in specific positions and the receiver in the center, and we take the measurement (D1). After that, we change the position of receiver and calculate

again the distance (D2) to compare it with (D1). However, the important step is to connect the rotor, the anchors and the transmitter.

First experimentation: indoor experimentation (without vibrator)

The first step was to connect the rotor and the anchors with the power. After that we selected the WI-FI icon on the computer, we opened the network and changed the settings, then we chose the wireless networking, and we clicked on the internet protocol version 4, then we chose the properties, used the following IP address, "fileLocalino, TCP-IP settings".

The second step, we connected the anchors with the power, we opened the Localino file, we chose the Localino processor, and then we opened the Localino application. After that, we went straight to configuration settings, then we had to make sure that once the Localino was connected with the anchor and WI-FI, the anchors must blink fast, which seemed to be working. Now that the rotor and the anchors are connected, we still have to make the tag also called transmitter work.

The third step was to make a plan for a house, which we divided into two bedrooms, a living room, a study room, a kitchen, and a bathroom. In order to discover how the Localino works. It is very important to make the experiment indoor first. We fixed three anchors in different places, and we tried to make a large distance between them (Number 1 in the bedroom, number 2 in the study room and number 3 in the living room). After that, we put the transmitter in the clothing of the person; now he was ready to change his position, so we can be able to measure the distance between the anchors and the transmitter. Anchors are located at fixed locations in a room and the person that should be tracked wears the tags. The tag then sends signals to the anchors and the anchors measure the time between the transmission and the reception of the signals. So the anchors can estimate how far away from the tag they are which means if you have three anchors you get

three range measurements and you have three circles around the anchor and you can triangulate and measure the intersection and know where the position of the tip. So, the more accurate the range measurement is the more accurate the intersection and the more accurate the position. Then once this range was measured, the anchors transmit these range measurements over WI-FI after each other to an application.



Fig 1: Doing the plan of the house and the measurements between the anchors and point zero



Fig 2: Connecting the anchors with the power

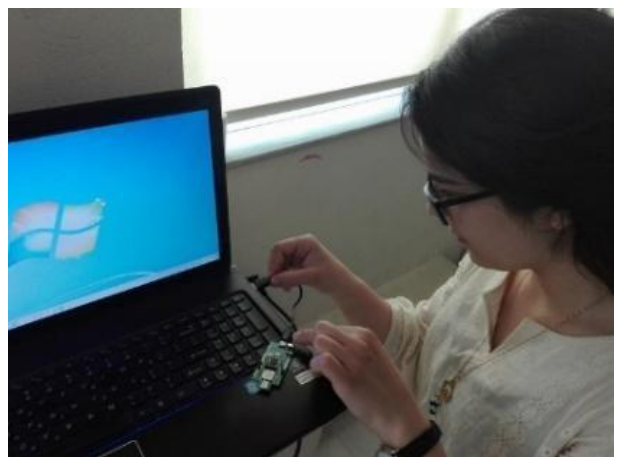


Fig 3: Connecting the tag with Laptop

The experimentation gives us a graphical representation, it represents the timestamp between the transmission and the reception of the signals, the anchor identifier, the tag identifier and the distance between the specific tag and anchor pair.

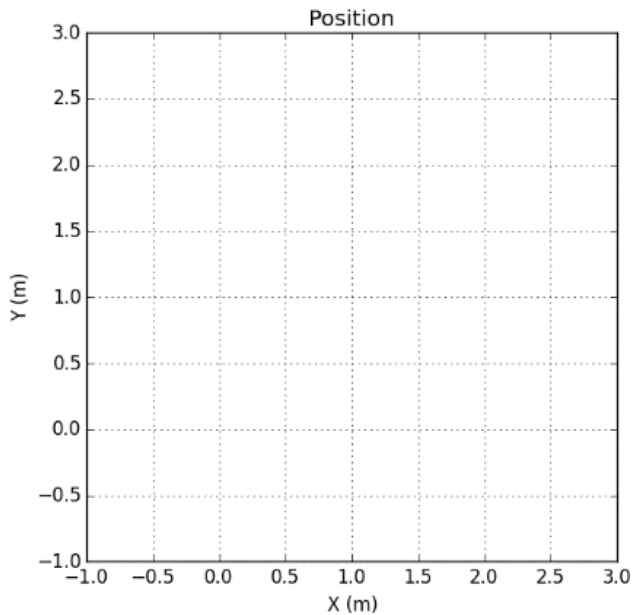


Fig 4: Localino position before connecting the tag and the anchors

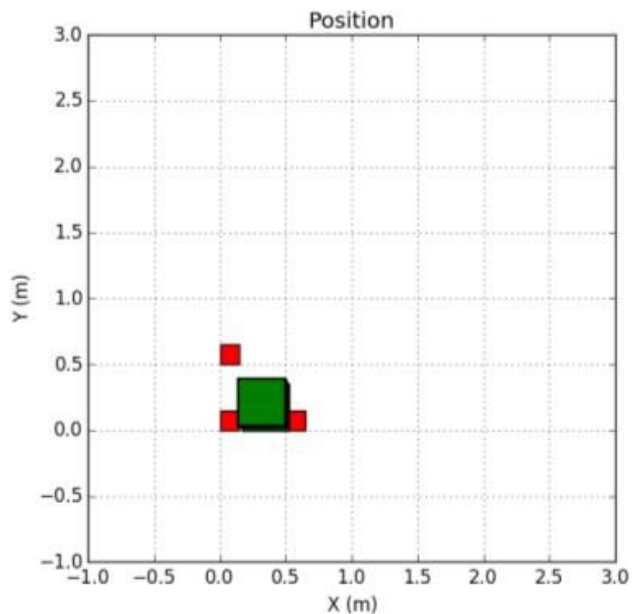


Fig 5: Localino position after connecting the tag and the anchors

	A	B	C	D	E	F	G	H	I
1	H&L Localino processor raw data		-1						
2	1527121842.365005	b	2000		b	1000		b	4.554337
3	1527121842.973406	b	2000		b	1000		b	4.591859
4	1527121843.597407	b	2000		b	1000		b	4.498052
5	1527121844.205808	b	2000		b	1000		b	4.634073
6	1527121845.641011	b	2000		b	1000		b	4.620002
7	1527121846.249412	b	2000		b	1000		b	4.652834
8	1527121847.591014	b	2000		b	1000		b	4.591859
9	1527121848.308616	b	2000		b	1000		b	4.272915
10	1527121853.831025	b	2000		b	1000		b	5.370459
11	1527121855.157028	b	2000		b	1000		b	3.752285
12	1527121857.933833	b	2000		b	1000		b	10.956674
13	1527121860.585837	b	2000		b	1000		b	3.864854
14	1527121862.02104	b	2000		b	1000		b	10.905080
15	1527121873.59626	b	2000		b	1000		b	3.766357
16	1527121875.031463	b	2000		b	1000		b	10.759679
17	1527121951.518397	b	2000		b	1000		b	3.892996
18	1527121966.541223	b	2000		b	1000		b	11.116146
19	1527121968.725227	b	2000		b	1000		b	4.394864
20	1527121969.536429	b	2000		b	1000		b	3.813260

Fig 6: Measurements for the anchor 1 (2000)

	A	B	C	D	E	F	G	H	I
320	1527121838.589799	b	2002		b	1000		b	4.807616
321	1527121838.995399	b	2002		b	1000		b	4.685667
322	1527121839.713001	b	2002		b	1000		b	4.943636
323	1527121841.741004	b	2002		b	1000		b	4.760712
324	1527121845.03261	b	2002		b	1000		b	4.854519
325	1527121855.983829	b	2002		b	1000		b	4.957707
326	1527121863.471842	b	2002		b	1000		b	4.765403
327	1527121864.173844	b	2002		b	1000		b	4.756022
328	1527121866.841448	b	2002		b	1000		b	4.802925
329	1527121867.559049	b	2002		b	1000		b	4.779474
330	1527121868.167451	b	2002		b	1000		b	4.756022
331	1527121870.211054	b	2002		b	1000		b	4.835758
332	1527121872.987859	b	2002		b	1000		b	4.680976
333	1527121873.64306	b	2002		b	1000		b	4.488672
334	1527121874.407462	b	2002		b	1000		b	4.896733
335	1527121875.749064	b	2002		b	1000		b	4.680976
336	1527121877.901868	b	2002		b	1000		b	5.131250
337	1527121878.619469	b	2002		b	1000		b	4.315128
338	1527121915.981535	b	2002		b	1000		b	4.995230
339	1527121916.699136	b	2002		b	1000		b	5.412672

Fig 7: Measurements for the anchor 2 (2001)

	A	B	C	D	E	F	G	H	I
77	1527121838.589799	b	2001		b	1000		b	5.225058
78	1527121838.979799	b	2001		b	1000		b	5.210986
79	1527121839.697401	b	2001		b	1000		b	4.061849
80	1527121840.321402	b	2001		b	1000		b	4.132204
81	1527121841.023403	b	2001		b	1000		b	4.043088
82	1527121841.756604	b	2001		b	1000		b	4.057159
83	1527121842.365005	b	2001		b	1000		b	4.155656
84	1527121842.989006	b	2001		b	1000		b	4.150966
85	1527121843.597407	b	2001		b	1000		b	4.122824
86	1527121844.237009	b	2001		b	1000		b	4.118133
87	1527121845.01701	b	2001		b	1000		b	4.165037
88	1527121845.641011	b	2001		b	1000		b	4.155656
89	1527121846.265012	b	2001		b	1000		b	5.318865
90	1527121846.967013	b	2001		b	1000		b	5.117179
91	1527121847.591014	b	2001		b	1000		b	5.454885
92	1527121848.308616	b	2001		b	1000		b	5.107799
93	1527121849.010617	b	2001		b	1000		b	5.089037
94	1527121849.728218	b	2001		b	1000		b	5.037443
95	1527121850.352219	b	2001		b	1000		b	4.999920
96	1527121851.069821	b	2001		b	1000		b	5.337626

Fig 8: Measurements for the anchor 3 (2002)



Fig9: the T-shirt of the experimentation

Column A is the timestamp between the transmission and the reception of the signals
Columns B and C denote the anchor identifier, i.e. anchor one, two or three.

Columns E and F denote the tag identifier. We had only one tag.

Columns H and I denote the distance between the specific tag and anchor pair.

2. RESULTS AND DISCUSSIONS

The results of the experience were encouraging. The "Localino" successfully detected the place of the tag. However, it did not perform very fast. This problem was definitely related to the quality of "Localino". Despite this, the most important thing now is that the "Localino" was able to give us the place of the visual impairment person. Therefore, the visual impairment person will be able to walk through the house in a reasonable and defined time after a bit of training.

Concerning the first results of the first experiment, we noticed that for a precise period, the distance between the specific tag and the anchor pair has changed slowly and the Localino gave undetermined results. However, we could not get the expected results that contain the specific detection of the person in the whole place if we replace the current Localino with a Localino that has more functions. That is why it is necessary to redo the

experiment with a new Localino to have in order to achieve the expected results.

CONCLUSION

In the present work, we developed a complementary assistive system for improving the mobility of visually impaired people. It is important to consult with and involve blind and visually impaired users when developing such devices for a richer life experience. Indeed, we must highlight the importance of involving visually impaired users in all phases of the assistive device development and the need for appropriate blind user interfaces.

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