Thesis Proposal Report

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Title of Thesis: *Wearable Obstacle Detection System Integrated with Conductive Fibers for Blinds*

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1. INTRODUCTION

The lacking of visual perception due to the physiological or neurological factors is known as blindness and the lack of visual perception is paralleled by a loss of independence. According to the world health report, about 314 million people are visually impaired; among them, 45 million are blind. This means approximately 45 million people are depended on other humans for movement, information processing and environmental interpretation due to the blindness [1, 2].

In today's society of social independence, the visually impaired, like everyone else deserve independence. They require assistive devices for navigating, for reading signs and text to be independent. In particular, outdoor and indoor navigation has always been a challenging problem for their mobility. This navigation concern restricts the visually impaired right access to many buildings, precludes their use of public transit and makes their integration into local communities difficult [3].

Thus in order to overcome navigation concerns of visually impaired, there is a significant need for a new assisted navigation system to help the blind people in the visualization of environment at an ease.

1.1 Purpose of the Project

The main objective of this project is to help blind or visually impaired people to navigate safely and quickly among obstacles and other hazards faced by blind pedestrians. In order to do this, an innovative approach based on the integration of electronic components on the textile structures will be investigated. With this approach, the design of a new wearable obstacle detection system that is flexible and comfortable for the human body will be issued.

The proposed wearable obstacle detection system will based on such principles; sensing the surrounding environment via sonar sensors and ensuring to the user stimuli by feedback process that informs about his/her localization. Then, the proposed system will be tested and the advantages and the disadvantages of the system will be compared with those of existing technologies.

1.2 Contributions to the Literature

On the basis of literature review, it is important for a usable electronic travel aid to let the visually impaired be hand free and comfortable during the navigation. The most suitable approach to let the user be hand free is embedding whole system into clothes. In the literature, this idea was suggested by some of the researchers. However, in their researches the implementation of electronic components into textile structures was not given in detail, they all considered to attach the components onto clothes [4-9]. To conclude, the design of the textile architecture in this concept is missing part such as to satisfy the electrical conduction between electronic components in the textile structure of the system, conductive fibers could be directly woven or knitted.

Furthermore, a new technology of using artificial muscles which has not been suggested yet in the literature can be applied. In this concept, artificial muscle can be used as an actuator instead of vibrotactile or audio feedback to guide the visually impaired.

Thus, to supply the deficiencies in the literature mentioned above, we will design a wearable obstacle detection system integrated with conductive fibers for the blind users which allow them to detect and avoid obstacles. The design of the prototype of this smart clothing in this research is consisted of the review on theories in both visually impaired and smart clothing [Figure 1.1].

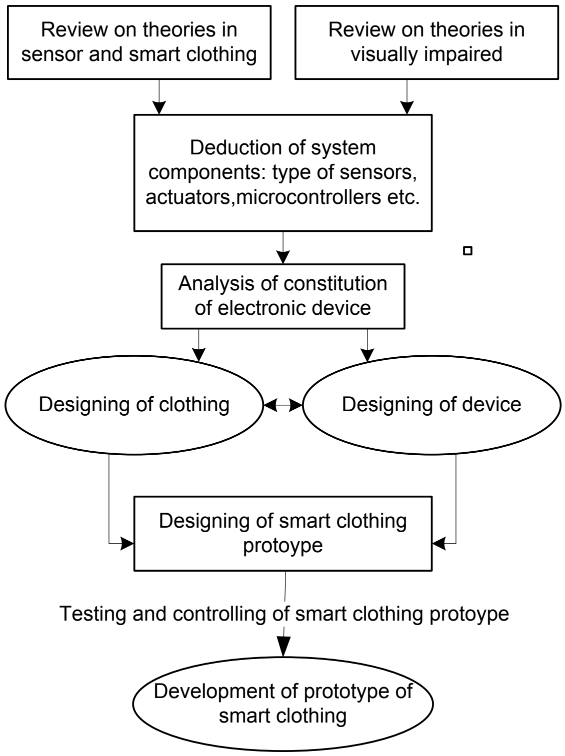

Figure 1.1: Flow chart for the study

2. SYSTEM ARCHITECTURE IN DESIGN

2.1 Software and Hardware Components

2.1.1 Type of Sensor

According to previous studies, there are three possible options to measure the distance to obstacle: ultrasound, laser and infrared (IR). When these sensors are evaluated due to the power consumption, cost, size, accuracy, maximum range and comfort level, the most suitable is ultrasound sensor. Despite the fact that laser sensors are highly accurate and directional, they are so expensive and they need significant amount of power. Unlike the lasers, infrared are inexpensive and power efficient but they are also sensitive to the fluorescent light and to the level of background. Therefore, ultrasonic sensor is chosen between laser and IR in this smart clothing system design since they are acquired, not sensitive to light, light-weight, easy to operate, they have low power consumption and low cost [Figure 2.1].

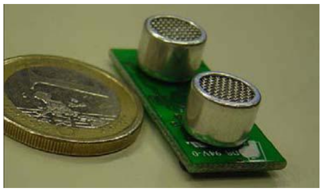

Figure 2.1: Ultrasonic sensor [8]

2.1.2 Type of Actuator

Based on sensor type, in this smart clothing system vibration or artificial muscle will be tried to be used as an actuator to ensure the user stimuli through feedback process. Those devices are small and light enough to be embedded on cloth [Figure 2.2].

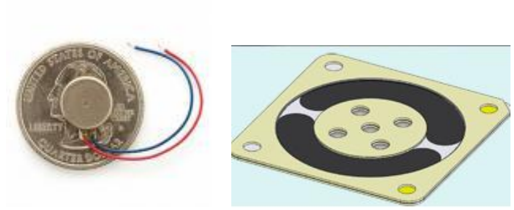

Figure 2.2: Vibration motor (left), Artificial Muscle (right): P-25: Planar-Mode Haptic Actuator with dimension of 25x25x1.1mm and with 1 g of weight [10].

2.1.3 Signal Processing

The main function of the signal processing unit is analog signal filtering, signal amplification and digitizing. To convert the measured signal to meaningful data, assess the data and to send the output signal (analog signal to digital signals), we will use PIC 16F877 microcontroller unit. To conclude, the microcontroller will gather the information from the ultrasonic sensors as signal directly proportional to the distance of the nearest obstacle. Afterwards, it will measure the width of transmitted pulses and it will convert it into empiric distance. This distance will then be converted into a voltage command for appropriate feedback. As a summary, signal processing unit will transform the information gathered from ultrasonic sensors to the vibration motor or artificial muscle that will be used as an actuator. To process these signals, routines will be written using PIC-C Compiler.

After the routines written in PIC-C Compiler, the design and layout of circuit will be issued. To give the user conformability, integrated circuit should be miniaturized and flexible. Flip chip technology and embroidery with flexible substrate could be used as seen in figure 2.3 [11].

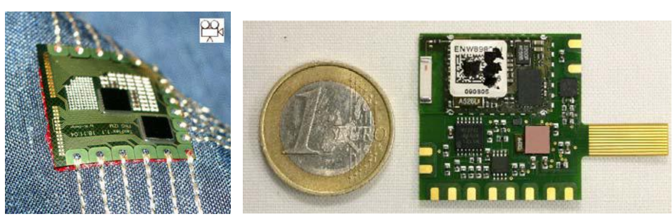

Figure 2.3: Flexible electronic test module connected with embroidered conductive yarn [11]

2.1.4 Power Consumption

For the power consumption of this smart clothing, the energy directly gained from the human body or environment can be used: solar cells, mechanical or thermal energy [12, 13].

Instead of the power generators, we can also use a thin flat battery as seen in figure 2.4. This thin battery also presents us some advantages like ease of removal before washing. It is attached with snap fasteners for easy replacement and recharging [11]

Figure 2.4: The flat battery can be removed for washing and charging [11].

2.2 Encapsulation of the Electronic Components

Electronic components and their interconnections require protection and this can be achieved by encapsulation. For this reason, LOCTITE Hysol GR 9800 molding compound as used in one of the previous study for EKG Tshirt development [Figure 2.5], could be also used for encapsulation in our study [11].

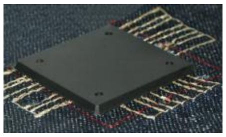

Figure 2.5: flexible module molded on jeans fabric [11]

2.3 Proposed Smart Clothing System Working Principal

With above specified components, the proposed smart clothing system will work in such principles: Ultrasonic sensors will detect the obstacles, signals gathered by sensors will be processed in signal processing unit, microcontroller will convert the signals as a stimulus, finally vibration motor or artificial muscle will alert user. The connection between electronic parts will be ensured by conductive yarns woven or knitted on the textile structure. The proposed system overview is shown in the figure 2.6.

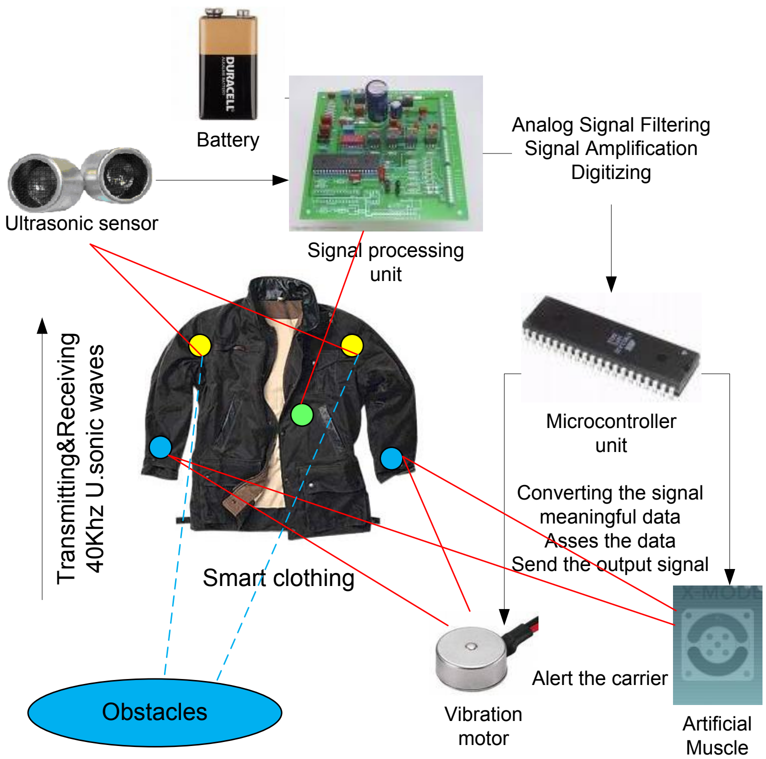

Figure 2.6: Proposed smart clothing system overview

2.4 Wearability performance requirements

When designing a smart clothing, apart from electronic hardware and software concept, the wearability of the system is also critical issue. In wearability concept, some performance requirements such as lightweight, breathable, comfortable, easy to wear etc. have to be taken into account [14]. Our proposed system the whole wearability performance requirements are expected as seen in the figure 2.7.

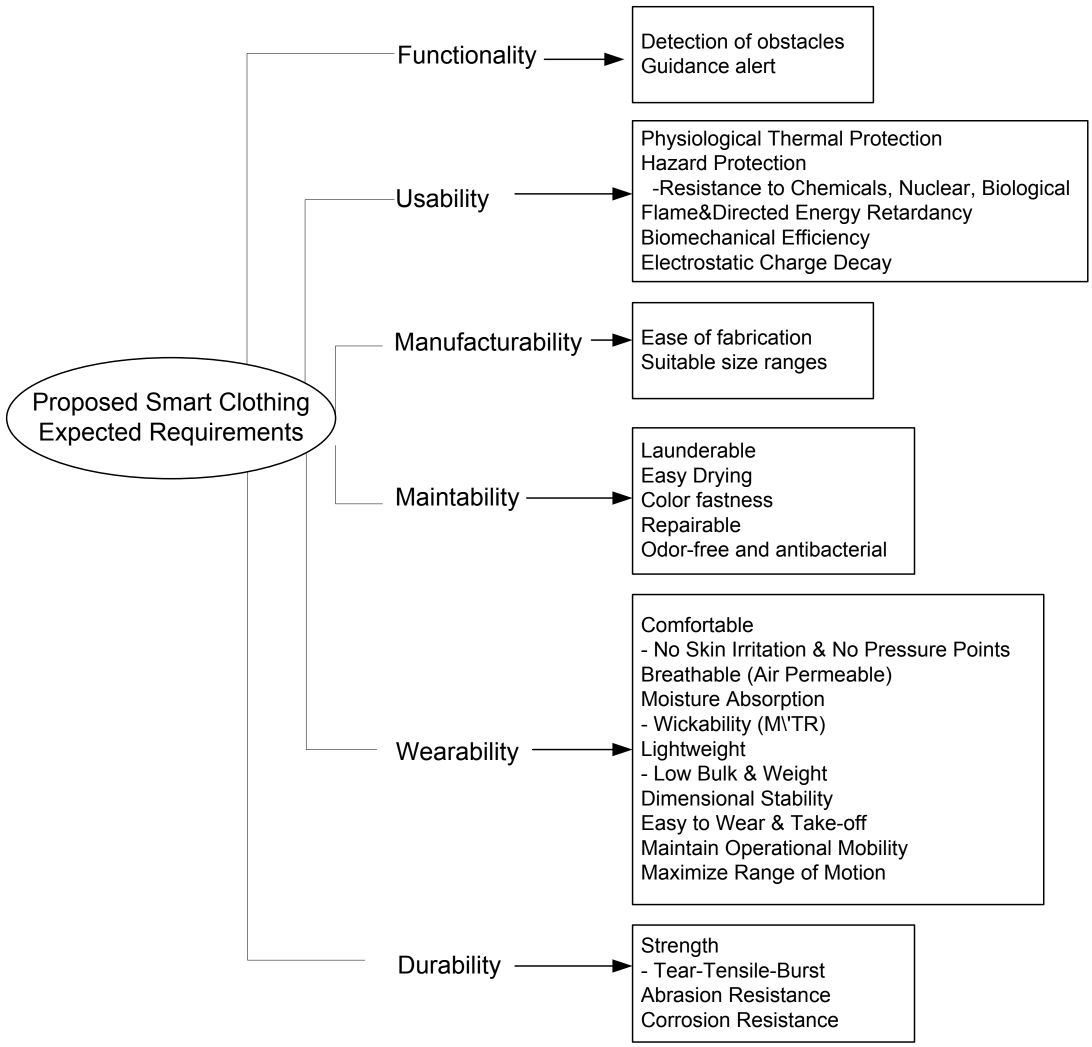

Figure 2.7: Wearable Performance requirements of the proposed system

2.5 Materials and Manufacturing Technology for Textile Structure

Based on the properties of the different fibers and materials, the property of textile structure will change. Furthermore, type of manufacturing technology will play a great role to meet the desired requirements of the system. The possible materials and manufacturing technology associated with their parameters that can be used for our proposed system is shown in the figure 2.8

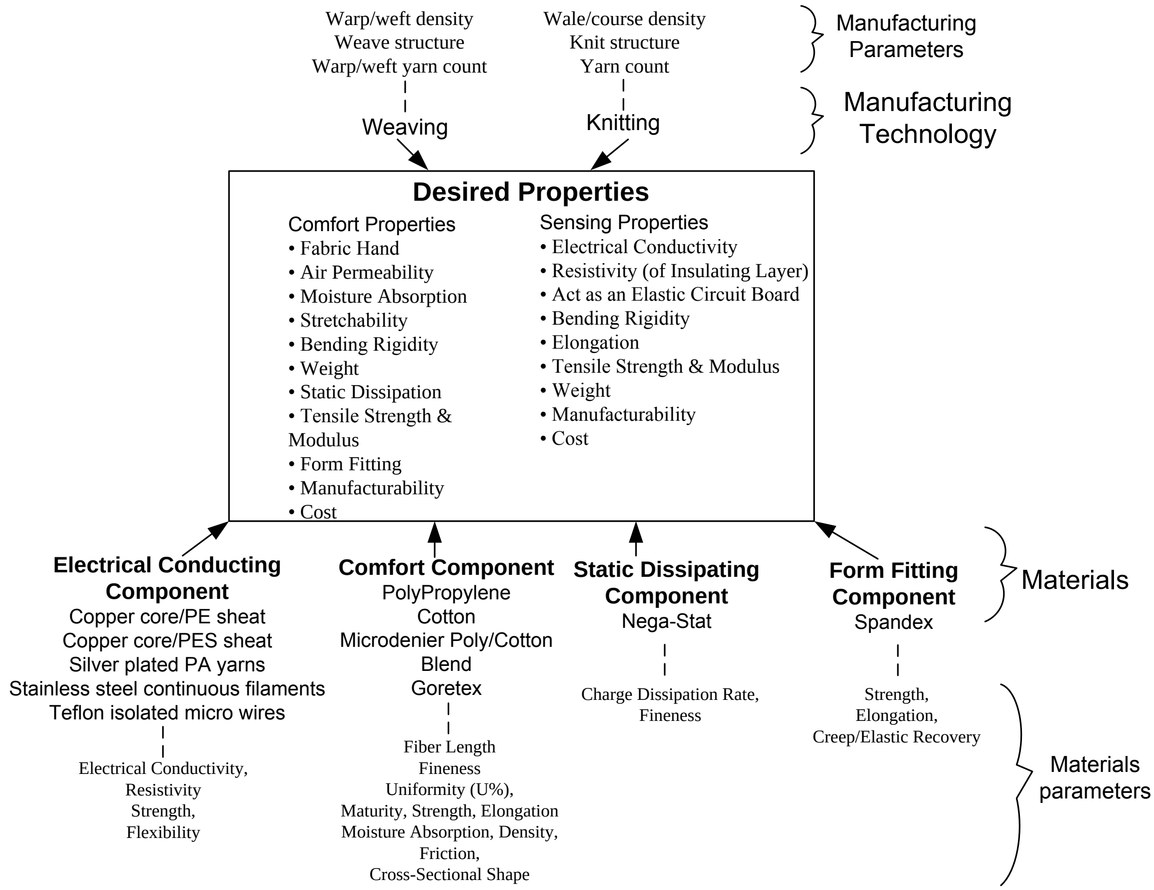

Figure 2.8: Possible materials and manufacturing technology for proposed smart clothing

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