Ergonomics of Wearable Technologies

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Research's Summary

An introduction :

Technological developments has changed the user's behavior, who is now able to use things that were considered in the past as dreams that are impossible to achieve in real life, wearable technologies are considered as one of those technological developments that have changed both behavior and lifestyle of the user. Many of these technologies have been innovated in several and different aspects, but most of them have focused on achieving individual solutions for particular individuals or situations, in addition, human beings and ergonomics aspects have often been neglected in the design of those technologies, resulting in reducing users levels of acceptance.

Keywords: wearable technology, physical comfort , user interface , ergonomic considerations , industrial design

Research's Issue :

With technological developments in all aspects of life, wearable technologies have provided many solutions and benefits to users and those who wear them in different places and working environments. However, many of the studies and surveys conducted on those who wear these technologies have shown that they do not feel comfortable while wearing them, that is because many of those technologies contain several flaws such as not being thin or flexible, or may not be adjustable enough to fit with different users' types of bodies or it may hinder their natural movement due to the omission of some human and ergonomics aspects in design.

Research's objective :

This research aims to develop the design of wearable technologies and to handle associated problems based on some of the ergonomics considerations which are to be applied in the design of these technologies to achieve Human Centered Design .

Research's Methodology:

The research follows the extrapolative approach based on the reading of scientific researches in the subject of research and descriptive analytical approach to solve the problem of research.

Theoretical framework:

First: The concept and history of wearable technologies, reasons and motivations behind individuals willingness to use them, and current applications ...

1- **The concept and history of wearable technologies**
1.1. The concept of wearable technologies:
Wearable technologies devices that are integrated into daily life, used continuously and actually worn, it is required for these technologies to fit with any user according to different sizes of bodies, culture , attitude, ... etc.

1-2- The history of Wearables:
The historical development of wearables is as follows:

The use and wear of wearables has become common, wearables have been developed over long periods of time. Some have actually supported and increased the capabilities of their users in many different fields, the historical development of these technologies was presented.

2. Reasons and motivations behind individuals' willingness to use wearable technologies

Here are some of these motivations:

(A) It is not easy to lose them or to place them in wrong place for who wears them

(B) May help who wears them to accomplish several tasks and provide an immediate response enabling to rely on them.

(C) Being private to who wears them and enables to easily take them off whenever wished.

(D) increase the engagement of who wears them with the environment in which they are used.

(E) work on supporting and enabling who wears them to increase the extent of capabilities and accessibilities, wearables can provide memory, sensing, knowledge, and logistical skills, monitor the health condition , remind of names, and enables rapid and easy access to information.. etc.

3. Current applications of wearable technologies:
There are many wearable technologies applications that have been presented.

Second: Some advantages and disadvantages of wearable technologies, basic components, and some specifications that the user considers when buying them:

1. Some advantages and disadvantages of wearable technologies:
Wearable technologies have many advantages and disadvantages:

(A) Some of the advantages of wearable technologies include:
- Increase the wearer's productivity and enable to solve issues at a faster rate.
- Increase the satisfaction of who wears them.
- Enable employers to track the health and fitness of employees helping them to reduce health care costs.
- Helps to get higher benefits of other technologies.
- Can contribute in maintaining the safety of employees and handling safety issues in the workplace.

B- Some disadvantages of wearable technologies:
- High prices of wearable technologies, as they tend to be highly expensive for many users.
- Some wearable technologies are not stand-alone devices and usually have to be connected to smart devices, which means additional costs for the employer if he has to provide the employees with them on his own cost.
   - May pose security risks, as wearable technologies are not fully secured.
   - May have risks on health as it may increase exposure to radio waves, etc.

- Limited battery life, as well as the lack of standardization.
- One of the most important disadvantages is high increase of batteries' temperature .
- Can distract who wears them from work tasks.
- Using inconvenient materials to the user in manufacturing some of wearable technologies.
- The lack of **human and ergonomics aspects** and accessibility requirements in many of those wearable technologies is considered to be one of the important problems due to its limited interface options and complexity of visual interfaces through variable lighting conditions and transparency of the display.

2. Main components of wearable technologies:

A wearable technology system consists of number of key components, briefly explained as follows:

- **Interface:** Interface consists of sensors that are used to obtain information to be processed by the person wearing it, confrontation surface is the tool used to exchange and transfer data and information between the devices and the users of that technology as well as between him/her and the outside world, and is divided into:

a- **Input Interface:** Through which the wearer of that technology can enter data and control the wearable technology using buttons or keyboards, there are several types of input interfaces, including pads and other types that work by voices recognition, ..etc.

b- **Output interface:** Provides information to the wearer, and is divided into:

- Vibrating interfaces, which are tactile, (such as vibration function in mobile phones, by which the user is silently alerted about incoming calls).
- Audio interfaces,
- Optical interfaces, including seven section screens or a bitmap display .. etc.
- **Communication:** Which refers to transferring data and information.
- **Data management:** This involves storing and processing data, storing technologies are used to keep information such as music, photos or data bases, etc.,
- **Energy management:**   Which monitors, observes and controls energy consumption to maintain it.
- **Integrated circuits (ICs):** integrated circuits are an essential component of electronic circuits used in wearable technologies.

3- Some specifications that the user wishes and expects to find in the wearable technology when making the decision of buying it :

Consumers and users of wearable technologies consider some of the specifications they expect and prefer to have in these technologies, including :

  -conductivity (or data transfer) : The ability of this technology to process the data, and containing Conductivity options for data input and transfer such as Wi-Fi, Bluetooth, ..etc.

  -Value : Provides accurate data and that technology is able to extract and analyze data, allowing users to take correct decisions.

 -communication : The technology has to have the ability to communicate with wide range of wearable devices, systems, services and programs, etc.

-Comfort : The technology is easy to use, comfortable, portable and light in weight, and does not hinder user's movement.

-Intelligence : The technology is responsive and provides high interaction with user's hand movements.

-Sensors : That this technology is capable of performing its function it was designed for (e.g. distinguishing the user's actions, measuring activities levels, distances covered ..etc..)

-Portability : This technology provides the lowest time to charge the battery, removable and accessible at any time.

-Multi functional : This technique can perform variety of functions.

Third: Some of the ergonomic considerations that must be available in the design of wearable technologies:

From the above, the researcher concludes that the wearable technologies have two basic requirements: engineering or technical requirements and ergonomics requirements related to the user, both requirements must be addressed in an integrated manner, the following are some of the ergonomic considerations that must be considered in the design of those technologies in order to achieve the principle of Human Centered Design:

1. Usability Comfort and wearability:

Both **physical comfort and user interface** are key factors in determining the usability of a wearable technology in the workplace, **comfort** includes acceptable weight, shape, acceptable level of temperature and texture to the user etc.. , and to fit users and allow them to perform their tasks and body movements in all normal and unusual situations.

For the **user interface**, it's design must Take into consideration that user interface needs to be clear, simple and intuitive to use and be highly responsive.

Wearable displays must be readable in different work environments.

2. Accessibility :

Wearable technologies should provide solutions for users who suffer from some disabilities or weaknesses by providing touch controls, voice control, or gesture recognition controls gesture ...etc.

3. Human Centered design:

Both the user and ergonomics must be included in all stages of designing those wearable technologies in terms of considering their physical and cognitive limitations and all usage situations and environments in which they will be used

4. Safety and Reliability :

These technologies should not cause any harm (physical or physiological harm) to the wearer, for example, many problems such as high temperature or electric shocks,..etc. must be avoided.

5. Security and privacy :

Wearable technologies should provide privacy and confidentiality for users' data and information.

6. Adjustable: In the design of those technologies, the possibility that workers may change these wearable technologies with each other in the workplace must be taken in consideration , so these technologies must be adjustable to fit.

7. Achieving the aesthetic aspects:
The aesthetic values of wearable technologies represents one of the important factors that improve user's level of acceptance.

Extract included are as follows :

-Rapid technological development in the field of wearable technologies has resulted range of problems and issues related to the relationship between the user and these technologies (such as data display, processing, energy consumption and discomfort feeling the user has while wearing them due to inappropriate fitting to user body.. etc), and the design of many wearable technologies may not fit with the weight, size, shape and physical characteristics of the wearer's body, which may be the cause of not fulfilling assigned working tasks.

Conclusions came as follows :

-The industrial designer has the responsibility of designing wearable technologies in a desirable and acceptable manner to the user body to become more like a cover for the user's body without hindering the movement or being a burden, and solve the problems of use and interaction between these technologies and users by including ergonomic and human aspects in their design, to achieve the principle of User Centered Design.

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