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A Focus on Wearable Electronics

S. Sridhar[1*] and K. S. Arunlal[2]

[1]RVCT, R. V. College of Engineering, Bangalore, Karnataka, India.
[2]R. V. Centre for Cognitive Technologies, Bangalore, Karnataka, India.

Authors' contributions

This work was carried out in collaboration between both the authors. Author SS selected the topic of study, designed the study, performed the literature analysis and wrote the first draft of the manuscript. Author KSA managed the literature searches under the guidance of author SS. Both authors read and approved the final manuscript.

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Review Article

Abstract

Wearable electronics are electronic products which are implemented by using both electronics technologies and computing devices that a person can wear usually on a daily basis and integrated into clothing. Wearable devices come in many forms with various levels of complexity. Currently, the market for these products is quickly growing, especially within the devices targeted at the common consumer. This is due to the rapid improvements in electronic and computing technology during the last decade. However, despite these advances there still remain unanswered questions on the future success of these products. As a result both this technology and the potential benefits and drawbacks for everyday wearable electronics, a lot of research is on. The main aim of this study is to provide a literature focus to the researchers working on wearable electronics.

Keywords: Computing devices; computing technology; consumer; e-education; wearable electronics.

**Corresponding author: E-mail: deancccf@rvce.edu.in;*

1 Introduction

The terms “wearable Electronics”, “wearable devices”, and “wearables” all refer to electronic technologies or computers that are incorporated into items of clothing and accessories which can comfortably be worn on the body. Wearable devices may perform the same tasks as mobile phones or laptops. It is more sophisticated than the handheld technology. It provides sensor and scanning features not typically seen in mobile and laptop devices, such as bio-feedback and tracking of physiological function. Wearable technology has some form of communications capability and allows the wearer to access information in real time. It possesses some features like the data-input capabilities, local storage, etc. Examples of wearable devices include glasses, smart watches, wearable computers, tele-health, smart shoes, hearing aids etc.

2 Wearable Computers

As per the study of Joshua C. H. Ho, Chien-Min Wang, Chiou-Shann Fuh [1], Google Glass is explored, a modern wearable computing device, and developed a real-time system for the next decades of wearable computer, though Google has ended its retail sales recently. However, Vuzix and GlassUp and other manufacturers offer similar or even better devices. The proposed system helps maximize the user interactions via wearable computer user interfaces, augmentation services and social network services. In their proposed system, they utilized Glass Development Kit/Mirror API, open source social network engine, and the augmentation of face recognition to analyze the human behavior/interaction while adapting to wearable computers in the coming era of Wearable Social Network. They expect it to alter how human behaves and interacts with each other in the near future, as the wearable computers are getting more popular in our daily life. Moreover, some issues of system performance, recognition techniques, user’s privacy, limitation, and user satisfactions/interfaces are also discussed by them. Saideep Koppaka [2] in today’s digital world, everyone’s carrying a mobile phone, a laptop and a tablet. All the devices mentioned above need to be carried by an individual in his bag or in his pocket. Google tried to bring up a wearable revolution with the introduction of “Google glass”. It is a wearable computer with an optical head mounted display that is worn like a pair of glasses. This paper discusses the technology, working, benefits and concerns over the first wearable computer.

3 Wearable Device Capable of Displaying Information

Referring to Yu Shrike Zhang1, Fabio Busignani, Joao Ribas [3], Google Glass is a recently designed wearable device capable of displaying information in a smart phone like hands-free format by wireless communication. The Glass also provides convenient control over remote devices, primarily enabled by voice recognition commands. These unique features of the Google Glass make it useful for medical and biomedical applications where hands-free experiences are strongly preferred. Here, it is reported for the first time, an integral set of hardware, firmware, software, and Glassware that enabled wireless transmission of sensor data onto the Google Glass for on-demand data visualization and real-time analysis. Additionally, the platform allowed the user to control outputs entered through the Glass, therefore achieving bi-directional Glass-device interfacing. Using this versatile platform, they demonstrated its capability in monitoring physical and physiological parameters such as temperature, pH, and morphology of liver- and heart-on-chips. Furthermore, they showed the capability to remotely introduce pharmaceutical compounds into a microfluidic human primary liver bioreactor at desired time points while monitoring their effects through the Glass. They believe that such an innovative platform, along with its concept, have set up a premise in wearable monitoring and controlling technology for a wide variety of applications in biomedicine.

4 Pair of Lenses Just Like Interactive Touch Screen

As cited by Gulshan Kumar, Preeti Sharma [4], Google Glasses are a pair of lenses just like interactive touch screen primarily developed as an initiative to pervasive computing. Google Glasses have almost all the features of a smart phone and also of the Personal Computer. Google Glasses are obliging in browsing internet, clicking pictures, recording videos. Currently it is supportive and new technology to all individuals and celestial being for handicapped persons. In this research paper, it is discussed some pros and cons of a Google Glasses and how it can be helpful and also detrimental to the society.

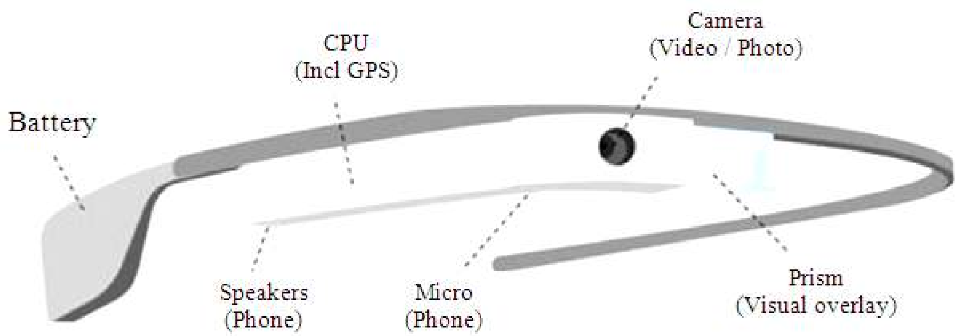

Fig. 1. Google glass

5 Medical Applications (Patient Care)

Natalia Wrzesinska [5], presents the results as follows:- Nowadays technical innovations appear rapidly. One of new possibilities is smart glasses – wearable computing devices wore as standard glasses. Although most smart glasses were not initially targeted at healthcare, they have been already implemented in multiple different medical applications across different specialties. In general such devices can be utilized whenever a screen or external monitor is already required. Head mounted displays can be implemented for very basic purposes such as education, simulation, live streaming of visualized data (i.e. vital signs, imaging studies, tests results, etc)., to more interactive functions such as video recording and digital photo documentation, for telemedicine, tele-mentoring and many others. Ultimately smart glasses would implement artificial intelligence engines in the daily clinical practice and several other promising application for the future. Digital health is already growing exponentially, and with no doubt, the market for smart glasses in healthcare will grow accordingly in the very near future. The aim of this paper is to analyze current possible applications of smart glasses in patient care as well as the advantages and drawbacks of this kind of devices in everyday clinical practice.

6 Wearable Devices, Their Pros and Cons

Lakshay Garg, Abhishek Bhardwaj, Meetu Gupta [6]:- In this paper various things about the wearable devices have been discussed. It mainly focuses on two wearable devices that are smart watch and the Google glasses. What are wearable devices, what are their pros and cons, their features have also been discussed in this paper. Also the working of the Google glass and the smart watch have been discussed. As per Jasper Scheffel, Gizem Kockesen [7], Glass is a commercial head-mounted display which is currently being developed by Google. This paper provides a concise overview of the history and context of Glass, a technical overview of the hardware and GUI, as well as a overview of the Mirror API in which applications for Glass can be developed. Furthermore, the advantages and disadvantages of Glass as well as intended and unintended applications are presented. Finally, the reader gets an idea with a getting started' guide in which the basics of development for Glass are explained.

7 Future Development of Wearable Computing Device

Maro Klein, Angilberto Freitas, Silvia Elaluf-Calderwood and Christiane Drebes Pedron [8], viewed that Google Glass has been a promise of a first wearable computing device to be sold in a large scale. When it was launched, some experts claimed that Google Glass represented the future of computing, while other actors, such as journalists, lawmakers, artists and NGOs raised a set of concerns about how this device will be incorporated in our daily lives, for instance, regarding privacy issues. Therefore, there was an interesting controversy (a shared uncertainty) about wearable computing. The aim of this paper is to explore the controversy that arose with the launch of Google Glass in order to understand what are the views and expectations about wearable-ubiquitous computing manifested by the different actors involved. The research method was inductive and based on the collection and analysis of secondary data from the Web, following the method of controversy mapping. As research results, they map and analyze the different expectations (hopes and fears) about Glass, from the many different human actors involved in the controversy, such as developers, lawmakers, IT experts, consultants, artists and "ordinary people", among others. The role played by the non-human actors, such as smart phones, operational systems and clothing is also addressed. By understanding this controversy, they raise a set of issues and implications for the future development of wearable and ubiquitous computing.

8 Various Wearables Devices

Francisco de Arriba-Perez, Manuel Caeiro-Rodriguezand Juan M. Santos-Gago [9]:- Over recent years, we have witnessed the development of mobile and wearable technologies to collect data from human vital signs and activities. Nowadays, wrist wearables including sensors (e.g., heart rate, accelerometer, pedometer) that provide valuable data are common in market. These authors are working on the analytic exploitation of this kind of data towards the support of learners and teachers in educational contexts. More precisely, sleep and stress indicators are defined to assist teachers and learners on the regulation of their activities. During this development, it is identified interoperability challenges related to the collection and processing of data from wearable devices. Different vendors adopt specific approaches about the way data can be collected from wearables into third-party systems. This paper contributes to identifying key interoperability issues in this kind of scenario and proposes guidelines to solve them. Taking into account these topics, this work is situated in the context of the standardization activities being carried out in the Internet of Things and Machine to Machine domains.

Fig. 2. Smart watch

9 Wearabe Computers

Thad Starner, Steve Mann, Bradley Rhodes, Jerey Levine [10]:- Wearable computing moves computation from the desktop to the user. These authors are forming a community of networked wearable computer users to explore, over a long period, the augmented realities that these systems can provide. By adapting its behavior to the user's changing environment, a body-worn computer can assist the user more intelligently, consistently, and continuously than a desktop system. A text-based augmented reality, the Remembrance Agent, is presented to illustrate this approach. Video cameras are used both to warp the visual input (mediated reality) and to sense the user's world for graphical overlay. With a camera, the computer tracks the user's finger, which acts as the system's mouse; performs face recognition; and detects passive objects to overlay 2.5D and 3D graphics onto the real world. Additional apparatus such as audio systems, infrared beacons for sensing location, and biosensors for learning about the wearer's affect are described. Using the input from these interface devices and sensors, a long term goal of this project is to model the user's actions, anticipate his or her needs, and perform a seemless interaction between the virtual and physical environments.

Fig. 3. Wearable computers

10 Monitor Human Body with Sensors Placed on Body

As per Roozbeh Jafari [11], wearable computers bring to fruition many opportunities to continuously monitor human body with sensors placed on body. These platforms provide new avenues to continuously monitor individuals, whether it is intended to detect an early onset of a disease or to assess the effectiveness of the treatment. In the past few years, the community has observed a large number of wireless health applications that have been developed using wearable computers. There are still several challenges that need to be addressed before realizing the true ubiquitous use of the wireless health systems. In this talk, it is highlighted several wireless health applications including a wearable system with biofeedback intended for fall prevention, a device for monitoring activities of daily living (ADL) and a system that can coach users through senior fitness tests (SFT). The authors of this paper present several components of the wearable computing systems including the state-of-the-art technology and the signal processing/ resource management algorithms by highlighting challenges associated with reducing the form factor and enhancing the usability of the data obtained in users' natural environment by providing several engineering solutions aimed at addressing the aforementioned challenges incorporating holistic system-level optimizations.

11 Electronic Textiles

Referring to Joanna Berzowska [12], Electronic textiles, also referred to as smart fabrics, are quite fashionable right now. Their close relationship with the field of computer wearables gives us many diverging research directions and possible definitions. On one end of the spectrum, there are pragmatic applications such as military research into interactive camouflage or textiles that can heal wounded soldiers. On the other end of the spectrum, work is being done by artists and designers in the area of reactive clothes: “second skins” that can adapt to the environment and to the individual. Fashion, health, and telecommunication industries are also pursuing the vision of clothing that can express aspects of people’s personalities, needs, and desires or augment social dynamics through the use and display of aggregate social information. Joanna Berzowska develop an enabling technology for electronic textiles based upon my theoretical evaluation of the historical and cultural modalities of textiles as they relate to future computational forms. His work involves the use of conductive yarns and fibers for power delivery, communication, and networking, as well as new materials for display that use electronic ink, nitinol, and thermochromic pigments. The textiles are created using traditional textile manufacturing techniques: spinning conductive yarns, weaving, knitting, embroidering, sewing, and printing with inks.

12 Use of a Wearable in Everyday Situations

Kent Lyons [13], says that wearable computers are a unique point in the mobile computing design space. In this paper, by examining the use of a wearable in everyday situations. Specifically, he discusses findings from a case study of an expert wearable computer user in an academic research setting over an interval of five weeks. He examines the use of the computer by collecting periodic screen shots of the wearable's display and utilize these screen shots in interview sessions to create a retrospective account of the machine's use and the user's context. This data reveals that the user employs the computer to augment his memory in various ways. Also it is found evidence of the wearable's use while engaged in another primary task. Furthermore, he discusses the intricate strategies developed by the participant that enable him to utilize the wearable in these roles. As per Hendrik Witt [14], Over the last decades desktop computers for professional and consumer applications have become a quasi standard, both in owning them and being able to use them for various applications. Recent years are, however, dominated by a new trend in computing: The mobile use of computers. The research presented in this thesis examines user interfaces for wearable computers. Wearable computers are a special kind of mobile computers that can be worn on the body. Furthermore, they integrate themselves even more seamlessly into different activities than a mobile phone or a personal digital assistant can. The thesis investigates the development and evaluation of user interfaces for wearable computers. In particular, it presents fundamental research results as well as supporting software tools for wearable user interface development. The main contributions of the thesis are a new evaluation method for user interfaces of wearable computers and a model-driven software toolkit to ease interface development for application developers with limited human-computer interaction knowledge. Besides presenting a prototypical implementation of the so-called WUI-Toolkit (Wearable User Interface Toolkit), empirical results of three experiments conducted to study the management of interruptions with gesture and speech input in wearable computing are discussed. Study results allow for deriving design guidelines for forthcoming interface designs. Both, the toolkit and the evaluation method, are essential parts of a generic user interface development approach proposed in the thesis. Summing up, the research presented motivates and validates the research hypothesis that user interfaces for wearable computers are inherently different to stationary desktop interfaces as well as mobile computer interfaces and, therefore, have to be designed differently to make them usable without being a burden for humans. In connection with this, the thesis provides new contributions for the design and evaluation of wearable user interfaces, mainly in respect to a proper interruption management.

13 Current Legal Precedents in Privacy

Stephen S. Intille, Ph.D. and Amy M. Intille, J.D [15]:- Wearable computing technology developed and deployed in the next 15 years will create fundamental challenges to personal privacy law. This paper reviews current legal precedents in privacy and surveillance law and identifies some of the issues that courts will inevitably be asked to address. They focus on one particular capability of future mobile computing devices: the ability to act as long-term archiving devices and memory aids by continuously recording everyday experiences from on-body sensors such as cameras and microphones. Here it is discussed how the law and social expectations may need to change to prevent the erosion of privacy protection as the use of wearable computing technology becomes pervasive throughout our society. As per Stephen Brewster and Ashley Walker [16], as computing devices drop in size and rise in power/bandwidth, novel interface techniques are needed to keep pace. Interfaces which rely on screens and keyboards/handwriting are not always effective in mobile computing scenarios. Visual displays are wasted on eyes engaged in navigational tasks such as walking or driving. Similarly, keyboards and handwriting-based interfaces are difficult to use whilst the arms and hands are involved in real world tasks (including posture control). Furthermore, these input techniques typically require a dedicated visual resource in the interaction loop. There are two aspects to our work. The first is looking how we can overcome some of the problems in current wearable or mobile displays by the addition of sound. The second aspect looks at doing away with the visual display altogether. The technique consists of an egocentric three-dimensional (3D) auditory display space in which natural head gestures control interaction. It overcomes the presentation bandwidth limitation inherent in audio displays by concurrently playing multiple spatialised sound streams (speech and non-speech) around a user's head. In turn, it overcomes the possibility of acoustic clutter in the resulting 'soundscape' by giving users powerful and natural mechanisms for swapping their attention between streams. By detecting the focus of a listener's auditory attention via his/her natural acoustic orienting gestures (i.e., which streams she orients her ears toward), the system can artificially raise and lower the volume of streams to enhance selective listening.

14 Measure the Comfort of Wearable Computers

James F. Knight, Chris Baber, Anthony Schwirtz and Huw W. Bristow [17], present a tool to measure the comfort of wearable computers. The comfort rating scales (CRS) measure wearable comfort across 6 dimensions. These dimensions are Emotion, Attachment, Harm, Perceived change, Movement and Anxiety. This paper also presents two studies in which the CRS have been used to assess the comfort of two types of wearable technology currently being developed at the University of Birmingham, these are the SensVest and the x3. The results of the studies show that the CRS can be used to aid designers and manufactures focus on what modifications are needed to wearable computer design to make them more comfortable. They also show that assessments of wearable computer comfort must be made in situations and environments to which the computer will ultimately be introduced. As per Edward O. Thorp [18], the first wearable computer was conceived in 1955 by the author to predict roulette, culminating in a joint effort at M.I.T. with Claude Shannon in 1960-61. The final operating version was tested in Shannon's basement home lab in June of 1961. The cigarette pack sized analog device yielded an expected gain of +44% when betting on the most favored "octant." The Shannons and Thorps tested the computer in Las Vegas in the summer of 1961. The predictions there were consistent with the laboratory expected gain of 44% but a minor hardware problem deferred sustained serious betting. The authors kept the method and the existence of the computer secret until 1966. As per Kalpesh A. Popat, Dr. Priyanka Sharma [19], wearable Computer, a sub branch of Mobile computing devices, means the computing device which we can wear on our body. Now a day's cell phones are the most powerful and day to day need of any human being. If we think about the past, we were doing our computing work manually. After the invention of basic calculator and further computers our most of work that we are doing will be with the help of computers. In its ancient age of computers the size of computers was too much big such that it occupies a space of approx two rooms. After invention of Integrated Circuits its size becomes much small. In the middle era of computers we were using desktop computers which can be fitted on a small desk. At present we are using Laptops and Smartphone, which helps us to do our computing task anywhere. We can take these computing devices with us everywhere. In other words we can say that we can carry our office with us. The new era that we are seeing in past few years or that we will see in next few years is the era of Wearable Computers. Spy camera, Spy voice and video recording device, watch with computer, Spectacles with computing capabilities are few examples of this kind of devices. This paper presents wearable computers with its history, present and perspective of its future and its hazards.

15 Man Machine Symbiosis

Referring to Thad Starner [20], forty years ago, pioneers such as J.C.R. Licklider and Douglas Englebart championed the idea of interactive computing as a way of creating a “man-machine symbiosis” where mankind would be enabled to think in ways that were previously impossible. Unfortunately, in those times, such a mental coupling was limited to sitting in front of a terminal and keying in requests. Today, wearable computers, through their small size, proximity to the body, and usability in almost any situation, may enable a more intimate form of cognition suggested by these early visions. Specifically, wearable computers may begin to act as intelligent agents during everyday life, assisting in a variety of tasks depending on the user’s context. As per Cliff Randell [21], the many opportunities offered by wearable computing have triggered the imaginations of designers and researchers in a wide variety of fields. The inevitability of computers and interfaces which are small enough to be worn on the human body has inspired the creation of devices and applications which can assist with specialized professional and personal activities, as well as aiding and augmenting everyday life in the modern world. In reality limitations imposed by factors such as battery life, processor power, display brightness, network coverage and form factor have conspired to delay the widespread introduction of wearable computers. In this paper wearable computing applications are reviewed from the early aircraft maintenance and military designs; through current production models including designs for personal entertainment, communication and health monitoring; to prototype implementations for real world gaming and smart fashion textiles. The challenges presented by these applications are identified and discussed.

Fig. 4. The bodymedia sensewear armband

16 Many Opportunities

As per Smita Jhajharia, Dr. S. K. Pal, Dr. Seema Verma [22], wearable technology offers many opportunities which trigger the thoughts and imaginations of people of all fields. In this age of technology, the dependence on computers and other interfaces required them to be omnipresent. This requirement paved way for the development of wearable technology, computers which can assist specialized professionals in personal activities by aiding and augmenting everyday life with the tech savvy world. In reality obstacles imposed by factors such as battery life, processor power, display brightness, network coverage and form factor have led to the delay in the widespread introduction of wearable computers. However in the past 10 yrs many successful implementations and the continuous relentless effort to miniaturize computers promise the emergence of viable applications. In this paper wearable computing applications are reviewed from the early aircraft maintenance and military designs to current production models including designs for personal entertainment, communication and health monitoring. This paper also highlights the scope and market of wearable technology in India and the way in which it can bring revolutionary changes in our country. The hurdles presented by these applications are identified and discussed. As per Aleksandra Labus, Milos Milutinovic, Dorde Stepanic, Mladen Stevanovic [23], emerging technologies such as mobile computing, sensors and sensor networks, and augmented reality have led to innovations in the field of wearable computing. Devices such as smart watches and smart glasses allow users to interact with devices worn under, with, or on top of clothing. This paper analyzes the possibilities of application of wearable computing in e-education. The focus is on integration of wearables into e-learning systems, in order to support ubiquitous learning, interaction and collaborative work. It is presented a model for integration of wearable technology in an e-education system and discuss technical, pedagogical and social aspects.

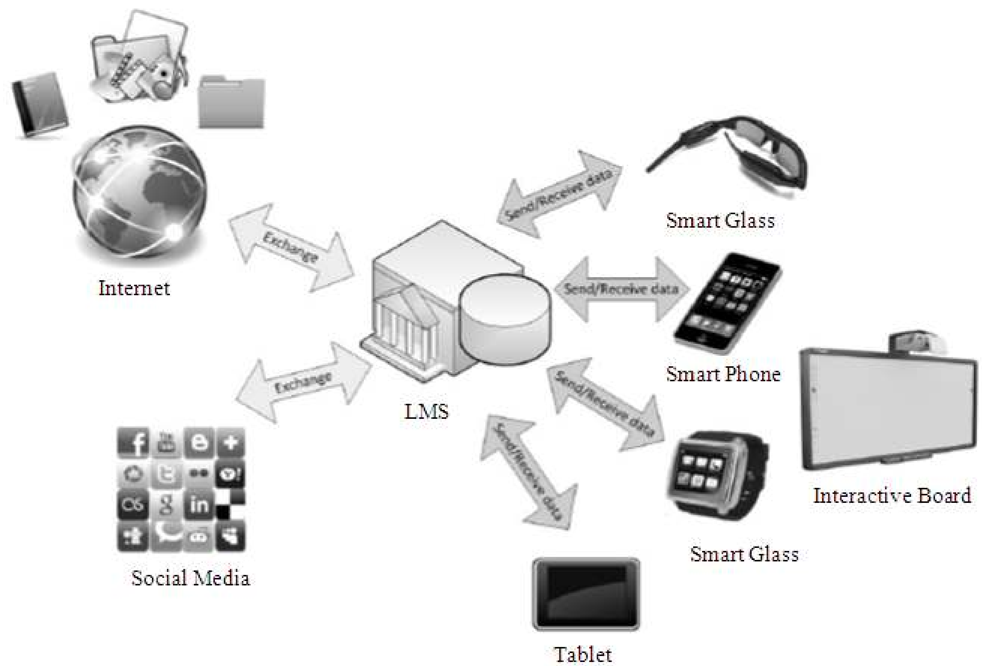

Fig. 5. Wearable computing in e-education

17 Tele Health

Referring to Vahid Hosseini [24], Diabetes is an epidemic disease of the 21st century and is growing globally. Although, final diabetes treatments and cure are still on research phase, related complications of diabetes endanger life of diabetic patients. Diabetic coma which happens with extreme high or low blood glucose is one of the risk factor for diabetic patients and if it remains unattended will lead to patient death or permanent brain damage. To reduce the risk of such deaths or damages, a novel algorithm for wearable devices' application, especially for smart watches are proposed. Such application can inform the patient's relatives or emergency centers, if the person falls in coma or irresponsive condition based on readouts from smart watches' sensors including mobility, heart rate and skin moisture. However; such an application is not a final solution to detect all types of coma, but it potentially could save lives of many patients, if widely used among the diabetic patients around the world. As per Xinxin Zhu, Amos Cahan [25], Tele-health is the use of technology for remote patient monitoring and care. Wearables are small electronic devices that can seamlessly collect data about a patient for prolonged periods of time and support the implementation of telemedicine in the patient's natural environment. In a reality where patients are becoming older and sicker, medicine is becoming more and more a multidisciplinary team work and healthcare resources are limited, tele-health holds promise as a way to improve patient care while cutting on costs. It may improve coordination between care providers, allow for bringing top notch expertise to remote, rural settings, provide a more complete picture of the patient's condition and support independent living of the elderly and patients with chronic diseases. In this chapter, it is reviewed some of the related technology and application and portrait how they may be integrated in the near future in the healthcare delivery system.

18 Wearable Systems for Health Monitoring

Marie Chana, Daniel Esteve, Jean-Yves Fourniols, Christophe Escriba, Eric Campo [26]:- Extensive efforts have been made in both academia and industry in the research and development of smart wearable systems (SWS) for health monitoring (HM). Primarily influenced by skyrocketing healthcare costs and supported by recent technological advances in micro- and nanotechnologies, miniaturization of sensors, and smart fabrics, the continuous advances in SWS will progressively change the landscape of healthcare by allowing individual management and continuous monitoring of a patient's health status. Consisting of various components and devices, ranging from sensors and actuators to multimedia devices, these systems support complex healthcare applications and enable low-cost wearable, non-invasive alternatives for continuous 24-h monitoring of health, activity, mobility, and mental status, both indoors and outdoors. Methods: Herein, these authors review the current research and development of and the challenges facing SWS for HM, focusing on multi-parameter physiological sensor systems and activity and mobility measurement system designs that reliably measure mobility or vital signs and integrate real-time decision support processing for disease prevention, symptom detection, and diagnosis. For this literature review, they have chosen specific selection criteria to include papers in which wearable systems or devices are covered. Results: they describe the state of the art in SWS and provide a survey of recent implementations of wearable health-care systems. It is described current issues, challenges, and prospects of SWS. Finally concluded by identifying the future challenges facing SWS for HM.

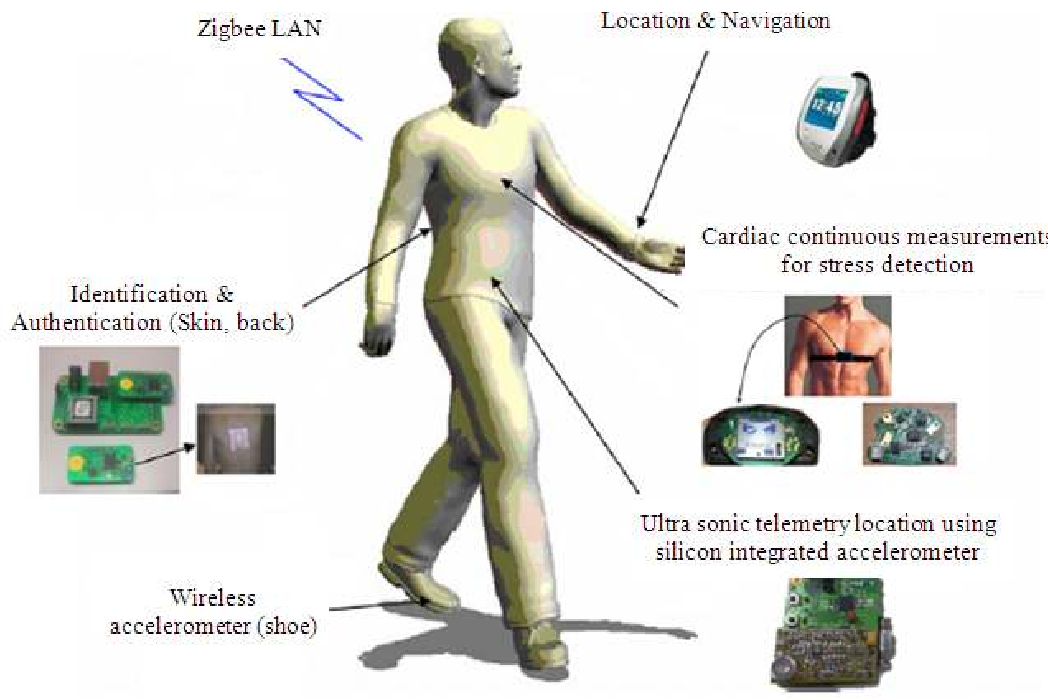

Fig. 6. Wearable systems for health monitoring

19 Field of Wearable Sensors and Systems

As per Shyamal Patel, Hyung Park, Paolo Bonato1, Leighton Chan and Mary Rodgers [27], the aim of this review paper is to summarize recent developments in the field of wearable sensors and systems that are relevant to the field of rehabilitation. The growing body of work focused on the application of wearable technology to monitor older adults and subjects with chronic conditions in the home and community settings justifies the emphasis of this review paper on summarizing clinical applications of wearable technology currently undergoing assessment rather than describing the development of new wearable sensors and systems. A short description of key enabling technologies (i.e. sensor technology, communication technology, and data analysis techniques) that have allowed researchers to implement wearable systems is followed by a detailed description of major areas of application of wearable technology. Applications described in this review paper include those that focus on health and wellness, safety, home rehabilitation, assessment of treatment efficacy, and early detection of disorders. The integration of wearable and ambient sensors is discussed in the context of achieving home monitoring of older adults and subjects with chronic conditions. Future work required to advance the field toward clinical deployment of wearable sensors and systems is discussed. As per Rajib Rana , Margee Hume, John Reilly, Jeffrey Soar [28], A worldwide increase in proportions of older people in the population poses the challenge of managing their increasing healthcare needs within limited resources. To achieve this many countries are interested in adopting tele-health technology. Several shortcomings of state-of-the-art tele-health technology constrain widespread adoption of tele-health services. They present a framework - wHealth (short form of wireless health) for effective delivery of tele-health services. It extracts personal health information using sensors embedded in everyday devices and allows effective and seamless communication between patients and clinicians. Due to the non-stigmatizing design, ease of maintenance, simplistic interaction and seamless intervention, our Health platform has the potential to enable widespread adoption of tele-health services for managing elderly healthcare. They discuss the key barriers and potential solutions to make the wHealth platform a reality.

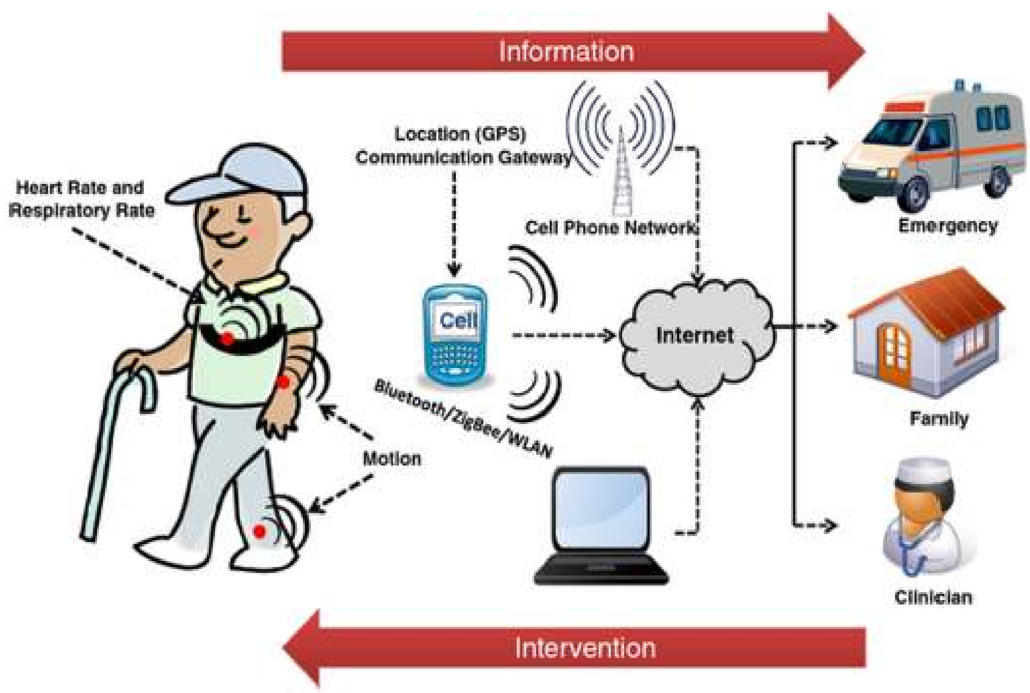

Fig. 7. Remote health monitoring system based on wearable sensors

20 Remote Health Care Monitoring System (RHCMS)

Referring to Khalifa AlSharqi, Abdelrahim Abdelbari, Ali Abou-Elnour, and Mohammed Tarique [29], Remote health care monitoring system (RHCMS) has drawn considerable attentions for the last decade. As the aging population are increasing and at the same time the health care cost is skyrocketing there has been a need to monitor a patient from a remote location. Moreover, many people of the World are out of the reach of existing healthcare systems. To solve these problems many research and commercial versions of RHCMS have been proposed and implemented till now. In these systems the performance was the main issue in order to accurately measure, record, and analyze patients' data. With the ascent of wireless network RHCMS can be widely deployed to monitor the health condition of a patient inside and outside of the hospitals. In this work they present a ZigBee based wireless healthcare monitoring system that can provide real time online information about the health condition of a patient. The proposed system is able to send alarming messages to the healthcare professional about the patient's critical condition. In addition the proposed system can send reports to a patient monitoring system, which can be used by the healthcare professionals to make necessary medical advices from anywhere of the World at any time.

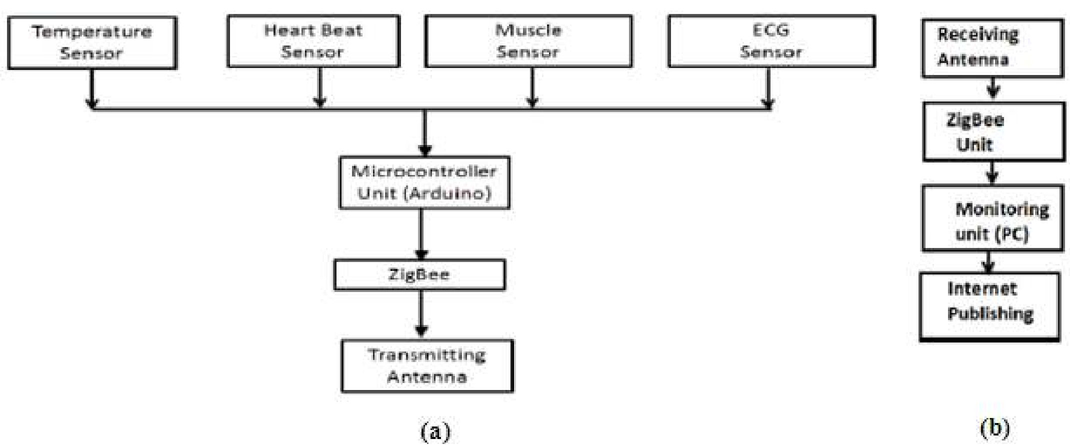

Fig. 8. Zigbee based system block diagram. (a) Transmitter section, (b) Receiver Section

As per Steve Warren and Richard L. Craft [30], The United States health care industry is experiencing a substantial paradigm shift with regard to home care due to the convergence of several technology areas. Increasingly-capable tele-health systems and the internet are not only moving the point of care closer to the patient, but the patient can now assume a more active role in his or her own care. These technologies, coupled with the migration of the health care industry to electronic patient records and the emergence of a growing number of enabling health care technologies (e.g., novel biosensors, wearable devices, and intelligent software agents), demonstrate unprecedented potential for delivering highly automated, intelligent health care in the home. This editorial paper presents a vision for the implementation of intelligent health care technology in the home of the future, focusing on areas of research that have the highest potential payoff given targeted government funding over the next ten years. Here, "intelligent health care technology" means smart devices and systems that are aware of their context and can therefore assimilate information to support care decisions. A systems perspective is used to describe a framework under which devices can interact with one another in a plug-and-play manner. Within this infrastructure, traditionally passive sensors and devices will have read/write access to appropriate portions of an individual's electronic medical record. Through intelligent software agents, plug-and-play mechanisms, messaging standards, and user authentication tools, these smart home-based medical devices will be aware of their own capabilities, their relationship to the other devices in the home system, and the identity of the individual(s) from whom they acquire data. Information surety technology will be essential to maintain the confidentiality of patient identifiable medical information and to protect the integrity of geographically dispersed electronic medical records with which each home-based system will interact.

21 Wearable Technologies for Health Monitoring

Referring to Jorge Cancela, Matteo Pastorino, Alexandros T. Tzallas, Markos G. Tsipouras, Giorgios Rigas, Maria T. Arredondo and Dimitrios I. Fotiadis [31], Wearable technologies for health monitoring have become a reality in the last few years. So far, most research studies have focused on assessments of the technical performance of these systems, as well as the validation of the clinical outcomes. Nevertheless, the success in the acceptance of these solutions depends not only on the technical and clinical effectiveness, but on the final user acceptance. In this work the compliance of a tele-health system for the remote monitoring of Parkinson's disease (PD) patients is presented with testing in 32 PD patients. This system, called PERFORM, is based on a Body Area Network (BAN) of sensors which has already been validated both from the technical and clinical point for view. Diverse methodologies (REBA, Borg and CRS scales in combination with a body map) are employed to study the comfort, biomechanical and physiological effects of the system. The test results allow us to conclude that the acceptance of this system is satisfactory with all the levels of effect on each component scoring in the lowest ranges. This study also provided useful insights and guidelines to lead to redesign of the system to improve patient compliance. As per Oresti Banos, Claudia Villalonga, Miguel Damas, Peter Gloesekoetter, Hector Pomares and Ignacio Rojas [32], Technological advances on the development of mobile devices, medical sensors, and wireless communication systems support a new generation of unobtrusive, portable, and ubiquitous health monitoring systems for continuous patient assessment and more personalized health care. There exist a growing number of mobile apps in the health domain; however, little contribution has been specifically provided, so far, to operate this kind of apps with wearable physiological sensors. The PhysioDroid, presented in this paper, provides a personalized means to remotely monitor and evaluate users' conditions. The PhysioDroid system provides ubiquitous and continuous vital signs analysis, such as electrocardiogram, heart rate, respiration rate, skin temperature, and body motion, intended to help empower patients and improve clinical understanding. The PhysioDroid is composed of a wearable monitoring device and an Android app providing gathering, storage, and processing features for the physiological sensor data. The versatility of the developed app allows its use for both average users and specialists, and the reduced cost of the PhysioDroid puts it at the reach of most people. Two exemplary use cases for health assessment and sports training are presented to illustrate the capabilities of the PhysioDroid. Next technical steps include generalization to other mobile platforms and health monitoring devices. Shaguftah, Mohd Maroof Siddiqui [33], this paper is an overview of sleep apnea and recording of EEG signals. It can be used in medical practice guidelines. Sleep apnea is breaks in breathing or they are instances of deep or limited breathing during night sleep. This paper also includes the symptoms, treatment and causes of sleep apnea and types of sleep apnea. EEG recording technique can be used in sleep research. EEG recording includes computer digitization along with EEG filtering and fast Fourier transform.

22 Smart Shoes

Referring to Nagaraj Hegde, Matthew Bries and Edward Sazonov [34], Footwear is an integral part of daily life. Embedding sensors and electronics in footwear for various different applications started more than two decades ago. This review article summarizes the developments in the field of footwear-based wearable sensors and systems. The electronics, sensing technologies, data transmission, and data processing methodologies of such wearable systems are all principally dependent on the target application. Hence, the article describes key application scenarios utilizing footwear-based systems with critical discussion on their merits. The reviewed application scenarios include gait monitoring, plantar pressure measurement, posture and activity classification, body weight and energy expenditure estimation, biofeedback, navigation, and fall risk applications. In addition, energy harvesting from the footwear is also considered for review. The article also attempts to shed light on some of the most recent developments in the field along with the future work required to advance the field. As per Y. Wahab1, M. Mazalan, N. A. Bakar, A.F. Anuar, M.Z. Zainol, F. Hamzah [35], Gait analysis measurement is a method to assess and identify gait events and the measurements of dynamic, motion and pressure parameters involving the lowest part of the body. This significant analysis is widely used in sports, rehabilitation as well as other health diagnostic towards improving the quality of life. This paper presents a new system empowered by Inertia Measurement Unit (IMU), ultrasonic sensors, piezoceramic sensors array, XBee wireless modules and Arduino processing unit. This research focuses on the design and development of a low power ultra-portable shoe integrated wireless intelligent gait measurement using MEMS and recent microelectronic devices for foot clearance, orientation, error correction, gait events and pressure measurement system. It is developed to be cheap, low power, wireless, real time and suitable for real life in-door and out-door environment. John Kymissis, Clyde Kendall, Joseph Paradiso, Neil Gershenfeld [36]:- As the power requirements for microelectronics continue decreasing, environmental energy sources can begin to replace batteries in certain wearable subsystems. In this spirit, this paper examines three different devices that can be built into a shoe, (where excess energy is readily harvested) and used for generating electrical power "parasitically" while walking. Two of these are piezoelectric in nature: a unimorph strip made from piezoceramic composite material and a stave made from a multilayer laminate of PVDF foil. The third is a shoe-mounted rotary magnetic generator. Test results are given for these systems, their relative merits and compromises are discussed, and suggestions are proposed for improvements and potential applications in wearable systems. As a self-powered application example, a system had been built around the piezoelectric shoes that periodically broadcasts a digital RFID as the bearer walks.

Fig. 9. Block diagram of a smart shoe

23 Wearable Technologies and Smart Textiles

As per Venere Ferraro [37], The lately huge development of information technologies (ICT), wearable technologies and smart textiles has changing the way to conceive sport and well-being concepts. New kind of performing textiles, especially the electronic ones are nowadays used in several applications thought all everyday activities. The textile has become the supporting platform to integrate the technologies, add more functions to what we wear and exploit high-tech innovation. In this way, the textile, also adding computational technologies into, is “smart” and allows people to be interactive. We assist to a shift into textile from a static dimension to a dynamic one that consequently creates new dynamic products. This switch into the textile structure adds functionality but also create new behavior. The paper will describe the results of an educational activity carried out inside the Sportswear Studio Lab of Master Degree in Fashion Study at School of Design of Politecnico di Milano. The students were asked to generate a new advanced concept for sport application exploiting the potentiality of smart textile and wearable technology. The projects developed by the students followed a design process suggested by the author that requires the understanding of: (i) the what (the purpose of the concept); (ii) the how (the used technology); (iii) the where (the context in which the product is used) and finally (iv) the wearability issues connected to the role of technology in human body changing and perception.

24 Wearable Systems (SWS) For Health Monitoring (HM)

As per Katrin Hansel, Natalie Wilde, Hamed Haddadiy, Akram Alomainy, Katrin Hänsel, Natalie Wilde, Hamed Haddadiy, Akram Alomainy [38], there is a current trend of wearable sensing with regards to health. Wearable sensors and devices allow us to monitor various aspects of our lives. Through this monitoring, wearable systems can utilise data to positively influence an individual's overall health and wellbeing. Katrin and et.al envisage a future where technology can effectively help us to become fitter and healthier, but the current state of wearables and future directions are unclear. This paper describes an overview of current methods used within wearable applications to monitor and support positive health and wellbeing within an individual also highlight issues and challenges outlined by previous studies and describe the future focuses of work.

25 Sustainable Wearables

As per Jaewoon Lee, Dongho Kim, Han-Young Ryooand Byeong-Seok Shin [39], this paper aims to elicit insights about sustainable wearables by investigating recent advancements in wearable technology and their applications. Wearable technology has advanced considerably from a technical perspective, but it has stagnated due to barriers without penetrating wider society despite early positive expectations. This situation is the motivation behind the focus on studies by many research groups in recent years into wearable applications that can provide the best value from a human-oriented perspective. The expectation is that a new means to resolve the issue can be found from a viewpoint of sustainability; this is the main point of this paper. This paper first focuses on the trend of wearable technology like bodily status monitoring, multi-wearable device control, and smart networking between wearable sensors. Second, the development intention of such technology is investigated. Finally, this paper discusses about the applications of current wearable technology from the sustainable perspective, rather than detailed description of the component technologies employed in wearables. In this paper, the definition of sustainable wearables is discussed in the context of improving the quality of individual life, social impact, and social public interest; those wearable applications include the areas of wellness, healthcare, assistance for the visually impaired, disaster relief, and public safety. In the future, wearables will not be simple data trackers or fun accessories but will gain extended objectives and meanings that play a valuable role for individuals and societies. Successful and sustainable wearables will lead to positive changes for both individuals and societies overall.

26 Aspects of Monitoring Physiological Parameters

Referring to Anindya Nag and Subhas C. Mukhopadhyay [40], the technological advancement in the past three decades has impacted our lives and wellbeing significantly. Different aspects of monitoring physiological parameters are considered. Wearable sensors are one of its most important areas that have an ongoing trend and have a huge tendency to rise in the future. The wearable sensors are the externally used devices attached to any individual to measure physiological parameters of interest. The range of wearable sensors varies from minuscule to large scaled devices physically fitted to the user operating on wired or wireless terms. Many common diseases affecting large number of people notably gait abnormalities, Parkinson's disease are analysed by the wearable sensors. The use of wearable sensors has got a better prospect with improved technical qualities and a better understanding of the currently used research methodologies. This chapter deals with the overview of the current and past means of wearable sensors with its associated protocols used for communication. It concludes with the ways the currently dealt wearable sensors can be improved in future. As per Mohit Savner, Nitin Arun Kallole, Prof. V Ravi [41], Wearable GPS Shoe is an unimaginable cogitation for the human society. It monitors the real time location of the shoe wearer to ensure safety. GPS Shoe is inevitable for the patient of Dementia and Alzheimer also for spying on people. This paper proposes a new method to trace people's location with their shoe. GPS trace down the NMEA sentences which further extracted in latitude and longitude for navigating the shoe wearer.

27 Hearing Aids

As per Bernard Widrow [42], a directional acoustic receiving system is constructed in the form of a necklace including an array of two or more microphones mounted on a housing supported on the chest of a user by a conducting loop encircling the users neck. Signal processing electronics contained in the same housing receive and combine the microphone signals in such a manner as to provide an amplified output signal which emphasizes sounds of interest arriving in a direction forward of the user. The amplified output signal drives the supporting conducting loop to produce a representative magnetic field. An electroacoustic transducer including a magnetic field pick up coil for receiving the magnetic field is mounted in or on the users ear and generates an acoustic signal representative of the sounds of interest. The microphone output signals are weighted (scaled) and combined to achieve desired spatial directivity responses. The weighting coefficients are determined by an optimization process. By band pass filtering the weighted microphone signals with a set of filters covering the audio frequency range and summing the filtered signals, a receiving microphone array with a small aperture size is caused to have a directivity pattern that is essentially uniform over frequency in two or three dimensions. This method enables the design of highly-directive-hearing instruments which are comfortable, inconspicuous, and convenient to use. The array provides the user with a dramatic improvement in speech perception over existing hearing aid designs, particularly in the presence of background noise, reverberation, and feedback. As per Ankit Rana, Mohit Anand [43], One may encounter numerous forms of hearing losses in daily life. From conductive to sensor in neural form of it, there has been a strong surge to develop compensating means which could stand sufficient, both on the performance and the economic scale. From the seventeenth century itself, hearing aids had made their presence felt as a gift for the impaired, but the aspect of their bulkiness, high cost and relatively lower flexibility and poor efficiency overshadowed them. Over the decades, digital domain's utilization for hearing aid's operation has curbed the mentioned drawbacks significantly. The present paper deals with the details of how a digitized counterpart scores over the obsolete ones and also how measures can be incorporated to effectively utilize the frequency spectrum in order to curb the hearing impairment density across the globe. Several simulations were carried out over a cochlear prosthesis simulator and results on a comparative basis were tabulated too. The authors have also concluded that this adaptive digitization in the implementation of cochlear hearing-aids possesses good future potential.

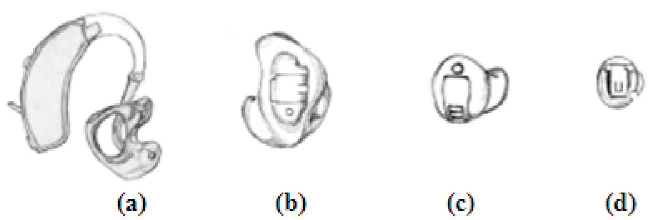

Fig. 10. Hearing Aids: (a) behind-the-ear, (b) in-the-ear, (c) in-the-canal (d) completely-in-the-canal hearing aids

28 Benefits of Frequency Modulation (FM) Amplification Usage

Referring to Jennifer Lynn Franks [44], the benefits of Frequency Modulation (FM) amplification usage among school-aged children is widely researched and established. The benefits provided from FM systems for students with a hearing impairment (HI) would suggest that consistent usage among these students would be high. However, interactions with various-aged HI students and their teachers have shown the opposite: there appears to be a lack of consistent usage. Previous research has looked at what influences people with a hearing loss not to wear their hearing aids. Research investigating reasons why FM systems are not used is limited. There are well-known benefits of FM usage among those with hearing loss. This leads to the question why those with hearing loss are not using their equipment consistently. This is the basis for the following qualitative research that surveys students with hearing impairments, their parents, and various staff to examine the phenomenon. As per Chiau-Ching Chen, Hsu-Shih Shih [45], Wearable technology is one of popular emerging trends in 2014 Consumers Electronic Shows, which can be applied in many devices or gadgets and added some functions to create innovative and diverse services or goods for making people's life quality better. However, SPOT, a prototype of smartwatch, was introduced by Microsoft in 2004, but it has not been popular because of lacking appealing and replaceable contents. Now, the wearable technology is noticed again. Will it be successfully attract consumers to accept it or not? Traditionally, many studies of predicting a new technology being accepted usually utilized Unified Theory of Adoption and Use of

Technology (UTAUT) model which was proposed by Venkatesh, Morris, Davis and Davis in 2003 and viewed as a better robust model than the others with similar purposes. Besides, the original contents of UTAUT, Analytical Network Process (ANP) can further examine the detailed priorities of factors inside the dimensions or clusters. These detailed results are benefit of the firm which tries to understand the acceptance of wearable technology in the market in the future, in view of Chengcheng Huang [46]. Therefore, in this paper the authors exploit some key influential factors of the using intention and actual using behavior of customers on wearable technology in Taiwan by\ applying ANP under the structure of UTAUT.

29 Conclusion

The main aim of this study is to provide a literature focus to the researchers working on wearable electronics which is going to be hot cake in future in many application areas. When mobile phone was introduced, initially people were not showing interest. Then gradually, when mobile phones become cheaper and the usage is understood by people, nowadays even the milk-man is using it and almost all common people use mobile phones. Like mobile phones, in a span of another 8 years, may be by 2025, common people will think of using wearable electronics, by seeing the utility value, ease of use and price reduction, as “Make in India” products in the light of Dr.APJ Kalam, the former President of India!

Competing Interests

Authors have declared that no competing interests exist.

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