IOT based Smart Healthcare Applications for People with Disabilities

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***Abstract*—IoT (Internet of things) is one of the ubiquitous terms being heard all over the world. IoT unifies the complete world using common infrastructure helping the human kind to connect and control various things. At present IoT is more an explanatory term of a vision that the whole thing should be connected to the internet. IoT will be elementary in the future because the concept opens up opportunities for innovative services and fresh innovations.**

This paper presents the concise outlines of the IoT, the basic requirements & some of the IoT applications. Smart health care is one of such significant applications. In this paper how IOT based Smart Healthcare can help handicapped people and support them to be efficient in daily life is discussed. A number of such healthcare applications for the people with disabilities, including visually impaired, hearing impaired and physically impaired people have been detailed.

Keywords—IoT; Smart Objects; Health Care; Person with Disabilities; Physically Impaired; Visually Impaired

I. INTRODUCTION

The *Internet-of-Things* (IoT) is a latest phrase; however at the same time an aged one. Kevin Ashton first coined this in the year 1999, during a presentation at Proctor & Gamble. Ashton used this term to connect the proposal of *Radio Frequency Identification* (RFID) to the then emerging topic Internet [1]. He established how the RFID tags were connected to objects for storing, and using object‘s information on the internet (closed loops) in supply chains. Since then the use of this term has flourished and major companies have forecasted an increase in IoT [2]. One forecast is that the number of connected things in the world will have a thirtyfold increase between 2009 and 2020, thus by 2020 there will be 26 billion things that are connected to the Internet [2].

In simpler terms, Internet of Things (IoT) is the correlation between devices, which can be uniquely identified through the IP addressing scheme and which have the capability to communicate with other devices to attain the required objectives. IoT makes every effort for providing the ability to the interconnected devices in a network to transfer data without the need of human-human interaction or human-machine interaction. It aims to provide services directly based on machine-machine interaction.

Internet-of-Things (IoT) is mostly used to refer to both: (i) the resulting global network interconnecting smart objects by means of extended Internet technologies, (ii) the set of supporting technologies necessary to realize such a vision (including, e.g., RFIDs, sensor/actuators, machine-to-machine communication devices, etc.) and (iii) the group of applications and services leveraging such technologies to open new business and market opportunities [3, 4].

From a theoretical point of view, the IoT builds on three pillars, related to the ability of smart objects to: (i) be identifiable (anything identifies itself), (ii) to communicate (anything communicates) and (iii) to interact (anything interacts) either among themselves, building networks of

interconnected objects, or with end-users or other entities in the network.

At the single component level, the IoT will be based on the concept of ‘‘smart objects’’, or, simply, ‘‘things’’ which will complement the existing entities in the Internet domain (hosts, terminals, routers, etc.). The other key word of the phrase Internet of Things describes smart objects that have the following characteristics [5].

- Things are entities that can be identified uniquely
- They can be defined by their physical nature in shape, size, etc.
- They can communicate by receiving and sending messages
- They can perform basic to complex computation
- They might be able to sense their environment (i.e. temperature, light)

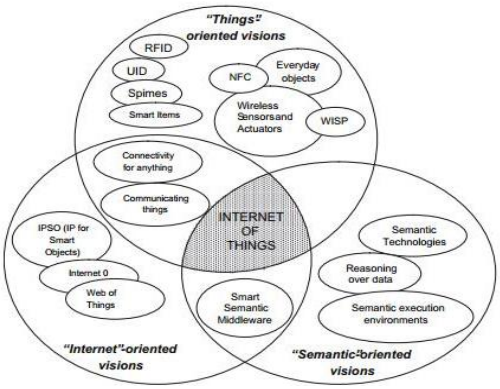

Figure 1: The components of the different IoT visions [3]

IoT offers several important applications in various sectors. Some of them [5- 7] are as follows:

- Transportation
- Logistics
- Health care
- Smart environments
- Security applications

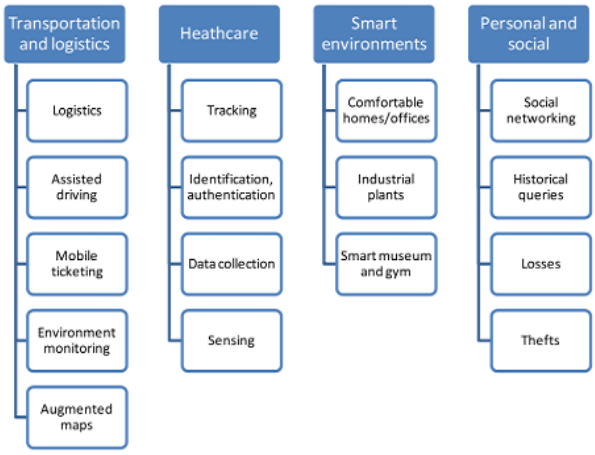

Figure 2: The current sectors included in the IoT [3]

Millions of people suffer from some kind of disability which makes them ineffective in both of society and economy and thus a burden for their families. IOT can help handicapped people and support them to be effective in daily life. Handicapped people face a lot of problems in their daily lives such as rising upstairs, using the transportation and communication devices and the difficulty of mobility for blind and paralyzed people.

II. IOT APPLICATIONS FOR VISUALLY IMPAIRED PEOPLE

A. Using body micro and Nano-sensors

Human eyes could be affected by some diseases like *Retinitis Pigmentosa* and age-related *Macular Degeneration* which may cause blindness because of the loss of rod and cone cells which receive the external light [8].

Using a special camera fixed on the patient glass and an artificial implant composed of body micro-sensors placed on the affected outer retina can solve the problem. The camera works as a receiver of the images and then transmits them to the implanted chip. The images data, which are received by the camera and are transmitted as electrical impulses activate the goal neurons, which in turn convert the impulses into nerve signals transmitted to the brain through the optical nerve.

In the future, scientists could design an artificial retina by using Nanotechnology which will transmit images to the brain in the same way. The artificial retina could also send images to the caregivers to facilitate the guidance of visually impaired people and help them to avoid obstacles [8].

B. RFID- based assistive devices

The navigation system helps blind people & people with vision impairments to walk safely on top of the sidewalk or through a new road, keeps them far from obstacles and protects them from exposure to accidents [8]. The system stands on two kinds of components: RFID tags, which are dispersed through the middle of the way in a predefined track and separated by particular distances, and an RFID reader placed on the blind cane [9].

The RFID reader broadcasts radio waves and the RFID tag within its range receives the signal, uploads its stored data (the tag ID) on the signal and transmitted it back to the reader. The reader, in turn, sends the tag data to the monitoring station by using a communication technology such as ZigBee or Bluetooth and the monitoring station sends the data to the remote server [10].

The system is able to identify the blind person position and the distance between him and the road edge [11]. The system is able to send alerts in the form of voice messages or vibration when the blind person is close to the sidewalks border [9]. Directing the blind person to his destination is also done through voice messages reaching the monitoring station (his smart phone) when the separation distance between him and the obstacle is short, allowing him to walk safely [8, 10, and 12].

For identifying the obstacles and keeping away of them, an ultrasonic sensor is attached to the RFID cane and many sensors are fixed on the blind's shoe. Both of them extend the range of perceiving the obstacles which in turn increases the safety level [13].

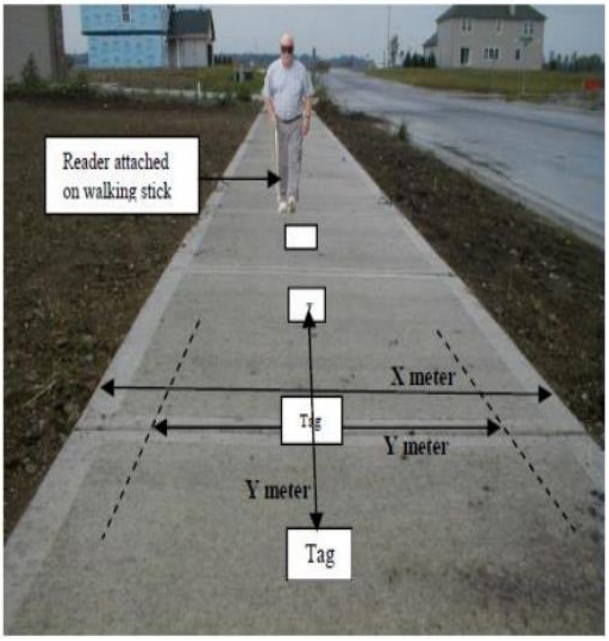

Figure 3: Distance of the frequency detection [9]

A combination of GPS and RFID technologies can also be used to help visually impaired and blind people to wake safely [8].

III. IOT APPLICATIONS FOR HEARING IMPAIRED

Sensors can be distributed everywhere, they are of different types, able to sense and record different events and to interact wirelessly with assistive devices attached to hearing impaired ears. Assistive devices can be external or internal (inside the ear) sensors able to detect sounds and events like door bell, telephone bell, clock alarm sound, and oven alarm sound and send alarm signals to monitoring stations which in turn amplify the signals and resend them to the assistive devices. Hearing impaired persons can receive vibration and visual signals [14].

Glove is equipped with a wireless communication technology is used to enable hearing-impaired people to interact with other people who are not used to deal or understand the American Sign Language (ASL). The wireless glove is cheap and equipped with sensors able to sense and record the fingers flexion related to the (ASL) and to send the

sensed data to a monitoring station such as a smartphone using Bluetooth technology.

At the monitoring station, the received data are compared to ASL signs data stored in the station database; if they correspond with the stored data, they are converted into text and voice [8, 15].

Figure 4: The hand Talk glove [15]

IV. IOT APPLICATIONS FOR PHYSICALLY IMPAIRED PEOPLE

A. Using Body sensors, actuators, and neuro-chips

Sensors implanted close to the motor nerves have the ability to sense the desire of the physically impaired people to use a particular muscle. Sensors and actuators are used to stimulate the paralyzed extremities and actuators can trigger and activate paralyzed muscles to move again [8, 16].An external power resource connected wirelessly to the Sensors, neuro-chips or actuators is used for generating radio frequency waves and digital command data to the micro-implants which in turn transmit electrical pulses to stimulate the motor neurons and the paralyzed muscles.

The motor neuron disturbances which occur after a stroke or spinal cord damage could cause disability in extremities or other limbs. Using sensor technology enables the paralyzed body parts to regain the movement by means of the electronic stimulation operation. Many applications used this technology to perform *Functional Electrical Stimulation* (FES) such as neuroprostheses applications which enable restoring the movement ability [8, 17]. Neurochips applications which are tiny battery-powered implantable *Brain-Computer Interfaces* (BCIs) have been developed by American researchers. Neurochips have been implanted in animals firstly and nowadays it was launched to be used on humans [8, 18].

The body's willing movements like extremities movements are done and controlled by the motor cortex cells in the brain which sends commands to the spinal cord to control the contraction of extremities muscles.

Neurochips have the ability to keep the activity of motor cortex cells which works as a stimulus used over and over again to send signals to both of spinal cord and muscles as an artificial neural connection used by the human brain as an alternative to other impaired neural connections inside the body. BCIs (*Brain Computer Interfaces*) are classified as the future technology for controlling the human brain [8].

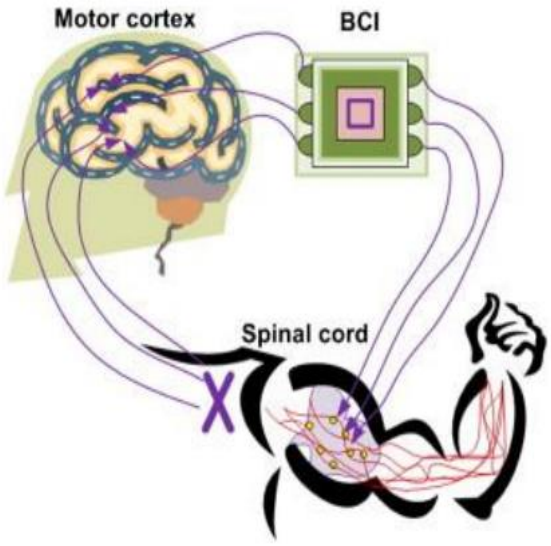

Figure 5: BCI for spinal cord injury [8]

B. Body sensors and RFID technology

Physically impaired people may suffer from bed wetting problem; integrating sensors with RFID technology can help them to treat the problem. Wetness sensors with *Radio*

Frequency Integrated Circuit (RFIC) antenna are combined together on an FPCB (*Flexible Printed Circuit Board*) and implanted into the patient bed. They can sense the wetness and send the data to a close RFID reader unit provided with Bluetooth transmitter for transmitting the gathered data to the monitoring station in real-time where caregivers can take the suitable decision [8, 19].

CONCLUSION

A number of IoT based smart healthcare applications for people with disabilities, including visually impaired, hearing impaired and physically impaired people applications have been detailed in this paper. Using implanted sensors and a camera can provide vision to blind people was discussed. Similarly Systems that use RFID technology can help blind people to walk safely on the sidewalk and keep them far from obstacles or exposure to accidents was mentioned. External or internal assistive devices and sensors attached to hearing impaired people's ears help them to detect sounds. Wireless glove equipped with sensors is able to sense and record the fingers flexion related to (ASL), which can be interpreted later to a text or voice is briefly explained. How Sensors and actuators are used to help physically impaired people by stimulating the paralyzed extremities and triggering paralyzed muscles to move again also discussed. Finally we wrap up that there is a constant call for more committed research towards enhancing the quality of life for the peoples with disabilities.

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