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Pervasive Computing and Brain Computer Interface

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Abstract: The paradigm of pervasive computing describes environment that provide anytime and anywhere access to information services while making the presence of the system invisible to the user. Pervasive computing envisioned by Mark Weiser emerged at the conjunction of research and development in a number of areas which include embedded and devices and systems, wireless communications, and distributed, mobile and context-aware computing. This paper provides an overview of constituent components of pervasive computing and outlines the current progress made as a result of convergence of these areas of research. The paper closes with a discussion of usage of pervasive computing in brain computer interface.

Keywords*:* Pervasive Computing, Brain Computer Interface, RFID, Neuro Phone.

I. INTRODUCTION

Pervasive computing is a concept in software engineering and computer science where computing is made to appear everywhere and anywhere. Pervasive computing can occur using any device, in any location, and in any format. A user interact with the computer, which can exist in many different forms, including laptop, computers, tablets and terminals in everyday objects such as a fridge or a pair of glasses. The underlying technologies to support pervasive computing include internet, advanced middleware, operating system, mobile code, sensors, microprocessors, new I/O or user interfaces, networks, mobile protocols, location and positioning new materials. The concept of pervasive computing is based on a simple idea that with advances in technology, computing equipment will grow smaller and gain more power; this would allow small devices to be invisibly embedded in the everyday human surroundings and therefore provide an easy and omnipresent access to a computing environment. Pervasive computing touches a wide range of research topics, including distributed computing, mobile computing, location computing, mobile networking, context aware computing, sensor networks, human-computer interaction and artificial intelligence.

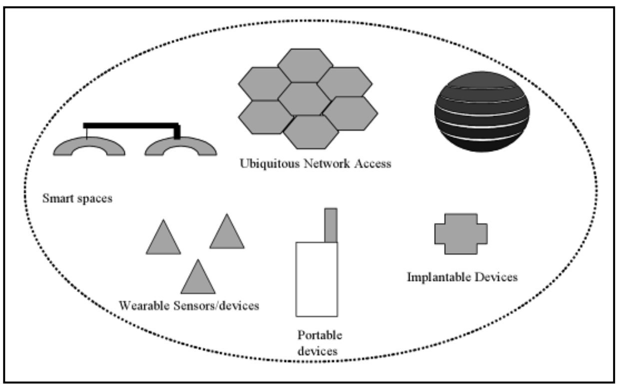

Figure 1: Pervasive Environment

The main characteristics of pervasive computing are given in the following sub section

A. Invisible Intelligent Device

It refers to electronic environments that are sensitive and responsive to the presence of people.

The features are-

1. Embedded-

Many networked devices are integrated into the environment.

2. Context Aware-

These devices can recognize you and your situational context.

3. Personalized-

They can be tailored to your needs.

4. Adaptive-

They can change in response to you.

5. Anticipatory-

They can anticipate your desires without conscious meditation.

In order for invisible intelligent device to become reality a number of key technologies are required-

- Unobtrusive hardware(Example-Nanotechnology, Smart Devices, Sensors)
- Dynamic and massively distributed device networks, which are easy to control and program(Example-Auto configuration)
- Human centric computer interfaces(Example-Intelligent agents, Multi model interaction)
- Dependable and secure systems and devices(Example-Self testing and self repairing software)

B. Wearable computing devices

Wearable computers, also known as body-borne computers or wearable are miniature electronic devices that are worn by the bearer under, with or on top of clothing.

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The features are-

- *Consistency*- There is a constant interaction between the computer and user i.e. no need to turn the device on or off.
- *Ability to multitask*- It is not necessary to stop what you are doing to use the device.

C. RFID (Radio Frequency Identification)

RFID is the wireless non contact use of radio frequency electromagnetic field to transfer data, for purposes of automatically identifying and tracking tags attached to objects.
The uses are-

- Access management
- Tracking of goods
- Tracking of persons and animals
- Toll collection and contactless payment
- Smart dust
- Timing sporting events

D. Autonomous sensors

Autonomous sensors are devices that are generally able to perform its task without being connected to the interrogation unit.

E. Context Awareness and Invisibility

Context-awareness is a vital factor enabling the invisibility of pervasive computing systems [1, 3, 4, 5]. Context-aware systems can adjust their properties and behaviour according to the information about the current state of the user, such as physiological state, behavioural patterns, orientation and position, geographical location, or properties of the surrounding environment, such as time of day, nearby users, objects and other systems [5, 6, 7, 8]. Section II contain some literature review, Section III include the conclusion and future scope is described in Section IV

II. STATE OF ART

In this section we are discussing about several applications of brain computer interfaces using the concept of pervasive computing.

A variety of sensors for monitoring brain activity exists, and could in principle provide the basis for a BCI. These include, besides electroencephalography (EEG) and more invasive electrophysiological methods such as electrocorticography (ECoG) and recordings from individual neurons within the brain, magneto encephalography (MEG), positron emission tomography (PET), functional magnetic resonance imaging fMRI), and optical imaging (i.e., functional Near Infrared (fNIR)).

A. NeuroPhone : Brain-Mobile Phone Interface using a Wireless EEG Headset-

Like mobile phones, neural signals are ever present in our everyday lives. Given the recent availability of low-cost wireless electroencephalography (EEG) headsets [1,2,3] and programmable mobile phones capable of running sophisticated machine learning algorithms, we can now interface neural signals to phones to deliver new mobile computing paradigms—users on-the-go can simply "think" their way through all of their mobile applications.

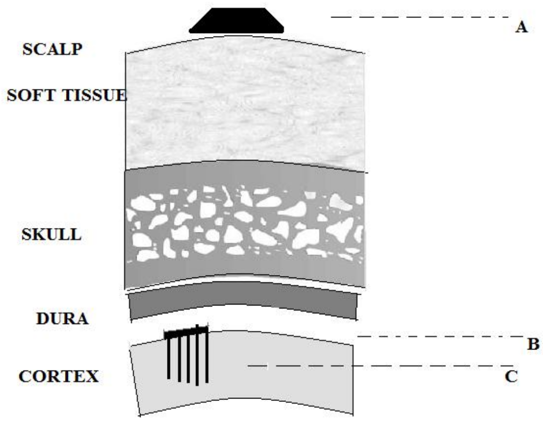

Figure 2 Different types of sensors most commonly used in BCI research.
(A) Electrodes are placed non-invasively on the scalp (electroencephalography (EEG)).
(B) Electrodes are placed on the surface of the brain (electrocorticography (ECoG)).
*(C)*Electrodes are placed invasively within the brain (single-neuron recordings). (From [15])

Figure3 NeuroPhone in use

For example, instead of hand dialling your friend while driving you can simply wink or think of him while your phone displays your contacts.
We also imagine new many-tone mobile applications; for example, a teacher of a foreign language is interested in seeing exactly how many students actually understood the last question she asked. The students are all wearing EEG headsets and their data is being streamed in real-time to the teacher's mobile phone. She simply takes out her mobile phone and it gives her up to the second statistics on each of her students. She quickly glances at the aggregate class statistics and realizing that the students really did understand her difficult question, proceeds with her lecture.
Other scenarios may soon be possible; for example, a person enters a room (e.g., bar, club, meeting, and classroom) and instantly has a sense of the overall emotional state of the space (i.e., happy, tension, frustration, sad, bored, and hostile). There is prior work

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classifying EEG signals into different bands of frequencies corresponding to different emotions such as meditation and activity [9]. In addition, the Emotive headset [2], this is designed primarily for gaming purposes, is also capable of detecting certain facial expressions (e.g., smile, laugh, shock – eyebrows raised, anger – eyebrows furrowed) and non-conscious emotions. If one could read the emotional state of people moving through a building then the notion of mood music would take on a literal sense.

B. There are many commercial brain sensing devices. Some of them are listed below-

1. MUSE

Figure 4

MUSE is light and portable, and for now it can guide you to relax or focus before you perform any mentally challenging task. This is just the beginning, though, as the final purpose of MUSE is to allow you to control your iPhone or Android device with your mind power.

2. NeuroSky MindWave

Figure 5

NeuroSky is a user-friendly neuro-headset that's especially designed to improve your kid's brain. Heck, it even has a custom app store with 79 ready-built apps, showcasing educational to casual games and even life improving- applications.

3. Brain Driver

Figure 6

Brain Driver is actually a project utilizing the power features of the Emotiv EEG headset, and it presents us with an alternate future that could be more awesome than the Google Driverless Car – we can control the car by mere thoughts!

4. DARPA's Prosthetic Arm

The greatest benefit of science is that, it gives hope to human with disabilities. In neuroscience, this DARPA's Prosthetic Arm is set to take over a real arm, letting the receiver control it with their thoughts, fired up by brain cells. This is a better alternative to a prosthetic arm in function and for them to regain motor skills, and subsequently independence.

Figure 7

Figure 4-7: Application Brain computer Interface

III. CONCLUSION

Pervasive computing has emerged as multi-disciplinary area of research and development. Constituent disciplines and technologies bring years or decades of established results to the area of pervasive computing. However, it is in the convergence of these diverse areas, that brand new issues have emerged and provided the research and development community with a new frontier. From the original ideas of intelligent computing systems available anytime and anywhere developed by Mark Weiser over 25 years ago, pervasive computing has evolved into a prolific discipline where research goes hand in hand with practical developments that are brought to the forefront of consumer market. Many technological advances made by the academia and the industry led to a plethora of systems and devices with a wide range of capabilities, many of which have been enthusiastically embraced by the consumer. Today, mobile and smart phones have established themselves as a ubiquitous device that offers a variety of functions in addition to anytime anywhere connectivity, which remains to be the main attraction to mobile users. It is the human nature to strive for connection with other individuals, groups and activities, which can be fulfilled by pervasive environments providing access to ubiquitous information services. Mobile and smart phones are currently positioned as the best tool to access such services until there are more natural and practical interfaces providing for a better interaction with pervasive environments.

IV. FUTURE WORK

We have presented the evaluation of an initial prototype that brings together neural signals and phones to drive mobile applications in new ways. There is a limited amount of related work in this area. By these concepts of brain signals and sensors we can develop a device which detects a person's mood in a crisis situation.

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