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Exploiting the Ambient Intelligent Paradigm for Health Care

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ABSTRACT

Recently, ICT produces a new computing paradigm known as ambient intelligence (AmI). It is a multidisciplinary field of research includes: software engineering, data base technology, human-computer interactions, social sciences, artificial intelligence, and knowledge engineering and computer networks. AmI is characterize by invisible and embedded computational power in everyday usage, application and other common physical objects, including intelligent mobile and wearable devices. AmI enables a system to understand human states and feelings and to share this intimate information. AmI aims to detect anomalous events from seemly disconnected ambient data that we take for granted. It is made possible by the convergence of affordable sensors, embedded processors, and wireless ad-hoc networks. AmI yields an emergent smart technology that enables the elderly people and people with disabilities to change and improve their quality of life, overcome many barriers and offer them an effective way to use the ICT-based electronic devices and systems in the information society. This paper discusses the promising applications of AmI for healthcare and everyday-life problems for elderly people and people with disabilities .Current research topics and challenges are discussed as well.

Keywords: Intelligent information systems, ambient intelligence, disabilities, human-centric computer interaction, embedded computational ,health care.

1. Introduction

Recently, ICT produces a new computing paradigm known as ambient intelligence (AmI) [1, 8]. It is a multidisciplinary field of research includes: software engineering, data base technology, human-computer interactions (HCI), social sciences, artificial intelligence, and knowledge engineering and computer networks. AmI is characterize by invisible and embedded computational power in everyday usage, application and other common physical objects, including intelligent mobile and wearable devices [6]. The concept of AmI provides a vision of the information society, where the emphasis is on greater user-friend lines, more efficient services support, user empowerment, and support for human interactions. People are surrounded by intelligent intuitive interfaces that are embedded in all kinds of objects and an environment that is capable of recognizing and responding to the presence of different individuals in a seamless ,unobtrusive(i.e, , many distributed devices are embedded in the environment , not intruding upon our consciousness unless we need them) and often invisible way.

AmI computing is anticipated to have a profound impact on the everyday life of people in the information society [3, 4]. A variety of new products and services will be made possible by the emerging

technological environment, including home networking and automation, mobile health management, interpersonal communication, and personalized information services. Many of these applications and services are anticipated to address a wide variety of domains and tasks that critical for elderly people and people who are disabling. For example, in the health care domain, AmI technologies will have the potential to greatly compute to improve services for everyone .A sensors measuring heart rate, blood pressure, and other vital signs will provide the possibility of accurate and real-time control of the user's state of health, with mobile communication devices automatically dispatching emergency call if necessary. Portable positioning systems (e.g. GPS) can also help in identifying the location of a patient and various mobile communication devices can be used to obtain access to a patient's health–care record from any place and at any time. The deployment of telemedicine systems in AmI settings will also contribute to continue care and patient education, assist patients in taking medications, and improve healthcare delivery.

2. Main Aspects of AmI

- AmI is a new paradigm that enables a system to understand human states and feelings and to share this intimate information.
- AmI refers to electronic environments that are sensitive and responsive to the presence of people.
- AmI aims to detect anomalous events from seemly disconnected ambient data that we take for granted.
- AmI is a vision on the future of consumer electronics, computing and telecommunications that was originally developed in the late 1990s for the time frame 2010–2020 [2]. Figure 1 shows the time frame of the AmI.

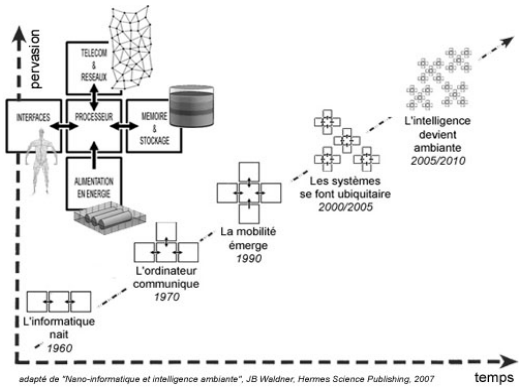


Figure 1: Timeframe 2010-2020

- AmI is made possible by the convergence of affordable sensors, embedded processors, and wireless ad-hoc networks.
- AmI paradigm builds upon ubiquitous computing and human-centric computer interaction design.
- In an ambient intelligence world (see figure 2), devices work in concert to support people in carrying out their everyday life activities and tasks in easy, natural way using information and intelligence that is hidden in the network connecting these devices [5].

Figure 2: Ambient Intelligent World

3. AmI Technologies and Disciplines

AmI is characterized by systems and technologies that are: Embedded, Context Aware, Anticipatory, Adaptive, and Personalized. Figure 3 shows the AMI cycle. This cycle is composed of the

following five phases: (a) Embedded; where many networked devices are integrated into the environment, (b) Context Aware; where devices can recognize situational context of the person, (c) Anticipatory; Anticipate your desires the personal desires without conscious mediation, (d) Adaptive; change in response to the person and (e) Personalized; tailored to the personal needs.

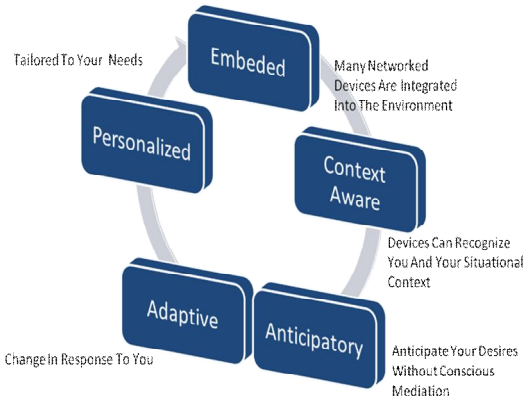


Figure 3: AmI Cycle

Figure 4 classifies the key technologies which cooperate to deliver AMI system. The main 5 classes of these technologies and their corresponding technologies are:

1. **Human-centric computer interfaces**
   (a) Intelligent agents.
   (b) Multi Model Interaction.
   (c) Context awareness.
2. **Dynamic and massively distributed device networks**
   (a) Service discovery.
   (b) Auto-configuration
   (c) End user programmable devices and systems
3. **Unobtrusive hardware**
   (a) Miniaturization
   (b) Nanotechnology
   (c) Smart devices
   (d) Sensors
4. **Seamless mobile / fixed communication and computing infrastructure**
   (a) Interoperability
   (b) Wire And Wireless Networks
   (c) Service Oriented Architecture
   (d) semantic web
5. **Dependable and secure systems and devices**
   (a) self testing
   (b) self repairing software
   (c) privacy ensuring technologies

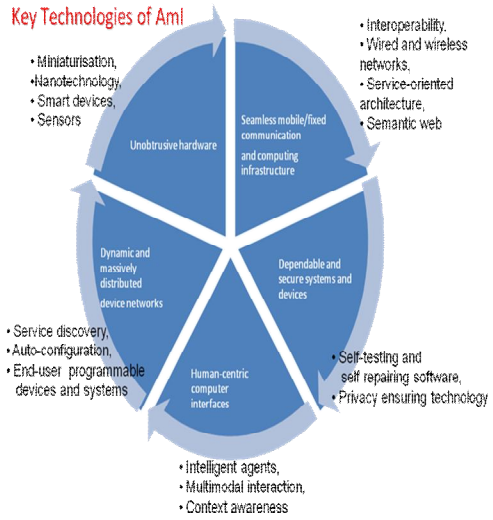


Figure 4: Key Technologies of AMI

Figure 5,6 shows the main scientific disciplines and their related topics which contribute in building AMI system. The three main disciplines with their corresponding topics are:

1. **Artificial Intelligence**
   (a) Expert Systems
   (b) Computer Vision
   (c) Natural Language Processing(NLP)
   (d) Robotics
   (e) Intelligent agents
   (f) Data Mining and Knowledge Discovery (DM & KD)
2. **Computational Intelligence**
   (a) Neural computing
   (b) Genetic algorithms
   (c) Decision trees
   (d) Rough sets
   (e) Fuzzy logic
   (f) Case Based Reasoning (CBR)
3. **Web Intelligence**
   (a) Web mining
   (b) Web framing
   (c) Web log mining
   (d) Web information retrieval
   (e) Web knowledge management
   (f) Semantic web

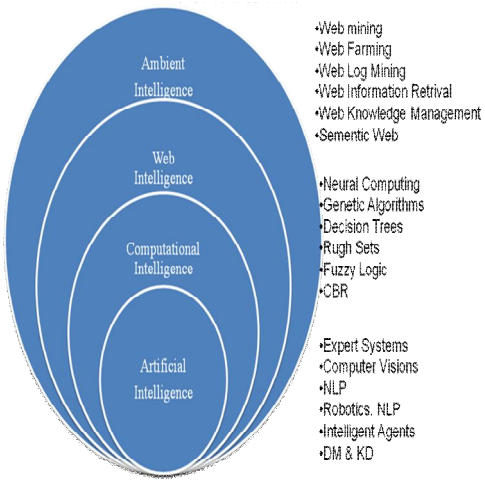


Figure 5: AMI Scientific Disciplines and Communities from AI to AMI

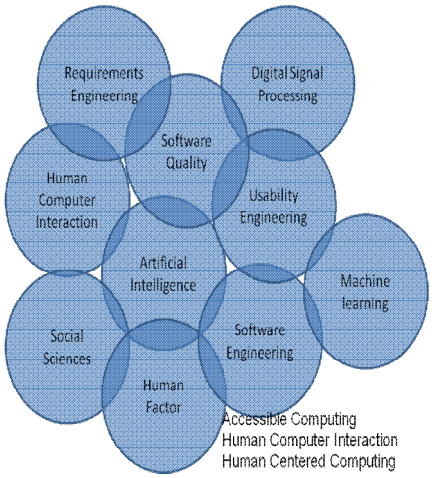


Figure 6: AmI Disciplines

Figure 7 shows the AmI from the computational perspectives.

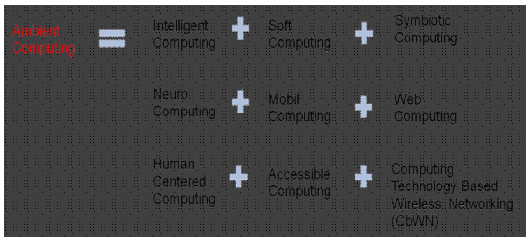


Figure 7: AmI from Computational Point of View

4. Role of AI in AmI for Disabilities: Some Examples

1.**Neural computing to improve linguistic word predication.** Word prediction is the most frequently used technique in writing systems designed to assist people with disabilities.

2. **Vision-Based human computer Interfaces.** Intelligent eye tracking systems to implement eye mouse to provide computer access for people with severe disabilities.

3. **Virtual reality technologies.** Patients with disabilities can be trained with virtual reality systems to judge architectural barriers and tackle environmental obstacles.

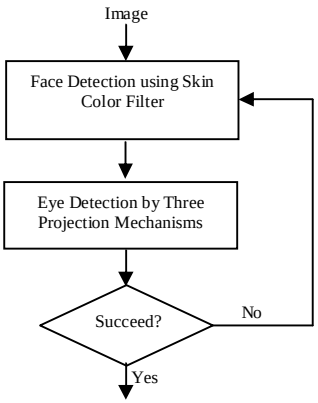
4.**Accelerometer-based human computer interface for people with severe disabilities.**

5. **Mobile technologies for people with disability.**

5. Eye Tracking System for People with Severe Disabilities

There are several different ways to track the directions of eye movements, such as refection of light and electrooculographic potential (EOG) [7]. Figure 8 shows the ideal components of the eye tracking intelligent system.

1. An efficient face detection filter based on the skin color information is employed to locate the user's face taken from a low cost web camera.
2. Three projection histograms are integrated to find the eyes.
3. The Fuzzy C-Means (FCM) algorithm is employed to locate the pupils.
4. The direction information of eye movements is computed via inferring a fuzzy system.
5. The computed direction information of eye movements is used to manipulate the computer.



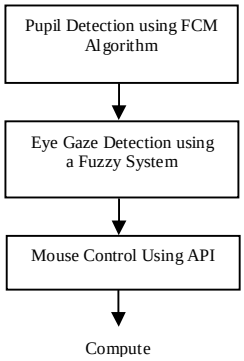


Figure 8: Eye Tracking System

6. Applications of AmI Technologies in Health Care

A variety of new products and services will be possible for elderly people and people who are disabled. E.g. home networking and automation, mobile health management, interpersonal communication and personalized information services.

Sensors measuring heart rate, blood pressure, and other vital signs will provide the possibility of accurate and real-time control of the user's state of health, with mobile communication devices automatically dispatching emergency call if necessary.

Portable positioning systems (e.g. GPS) can help in identifying the location of a patient, mobile communication devices can be used to obtain access to a patient's healthcare record from any place and at any time.

Telemedicine systems in AmI settings will contribute to continued care and patient education, assist patients in taking medications, and improve healthcare delivery.

7. EMERGING CHALLENGES OF AMI

- The distribution of interaction over devices and modalities.
- The balance between automation and adaptation and direct control.
- The identification of contextual dependencies among services.
- Health and safety issues.
- Privacy and security.
- Social issues.

7.1 The Social and Political Aspects of AmI

The ISTAG advisory group suggests that the following characteristics will permit the societal acceptance of AmI:

(a) AmI should facilitate human contact.
(b) AmI should be orientated towards community and cultural enhancement.
(c) AmI should help to build knowledge and skills for work, better quality of work.
(d) AmI should inspire trust and confidence.
(e) AmI should be consistent with long term sustainability - personal, societal and environmental - and with life-long learning.
(f) AmI should be made easy to live with and controllable by ordinary people.

7.2 Business Models for AmI

The ISTAG group acknowledges the following entry points to AmI business landscape:

(a) Initial premium value niche markets in industrial, commercial or public applications where enhanced interfaces are needed to support human performance in fast moving or delicate situations.
(b) Start-up and spin-off opportunities from identifying potential service requirements and putting the services together that meet these new needs.
(c) High access-low entry cost based on a loss leadership model in order to create economies of scale (mass customization).
(d) Customer's attention economy as a basis for 'free' end-user services paid for by advertising or complementary services .
(e) Self-provision – based upon the network economies of very large user communities providing information at near zero cost.

8. CONCLUSION

- Ambient intelligence is anticipated to have a profound impact on the everyday life of people in the information society and to potentially permeate a wide variety of human activities.

- AmI computing yields smart technologies that enable the elderly people and people with disabilities to change and improve their quality of life, overcome many barriers and offer them an effective way to use the ICT-based electronic devices.
- AmI technology is a new wave of high tech of assistive technology that increases and improves the functional capabilities of individuals with disabilities.

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