A Review of Ambient Intelligence System: Bringing Intelligence to Environments

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Abstract

Ambient intelligence is a promising emerging discipline which brings intelligence to our everyday environments and makes those environments sensitive to us. Ambient intelligence (AmI) research builds upon advances in sensors and sensor networks, pervasive computing, and artificial intelligence. AmI research has strengthened and stretched in recent years since its contributing fields have experienced tremendous growth. AmI research is growing and the resulting technologies augur well to transform daily human life by making people's surroundings flexible and adaptive. This present paper reviews the technologies that comprise ambient intelligence and of the applications that are dramatically affected by it and making it "intelligent". A few application case studies have been discussed and innovative suggestions for the future proposed.
Keywords: Ambient Intelligence, Artificial intelligence, Sensors, Decision making, Context awareness - Distributed Electronics, Ubiquitous Computing

1. Introduction

Ambient Intelligence (AmI) is about sensitive, adaptive electronic environments that respond to the actions of persons and objects and cater for their needs. This approach includes the entire environment–including each single physical object–and associates it with human interaction. [1], [4] The option of extended and more intuitive interaction is expected to result in enhanced efficiency, increased creativity and greater personal well-being. Ambient intelligence is the vision of a technology that will become invisibly embedded in our natural surroundings, present whenever we need it, enabled

by simple and effortless interactions, attuned to all our senses, adaptive to users and context-sensitive, and autonomous. High-quality information access and personalized content must be available to everybody, anywhere, and at any time. Ambient intelligence supports the human contacts and accompanies an individual's path through the complicated modern world. From the technical standpoint, distributed electronic intelligence is addressed as hardware vanishing into the background. Devices used for ambient intelligence are small, low-power, low weight, and low-cost; they collaborate or interact with each other; and they are redundant and error-tolerant. This means that the failure of one device will not cause failure of the whole system. Since wired connections often do not exist, radio methods will play an important role for data transfer. This paper reviews various aspects of ambient intelligence, from applications that are imminent since they use essentially existing technologies, to ambitious ideas whose realization is still far away, due to major unsolved technical challenges.

2. Discussions

Ambient intelligence is an emerging discipline that brings intelligence to our everyday environments and makes those environments sensitive to us. AmI research builds upon advances in

- sensors and sensor networks
- pervasive computing
- artificial intelligence

Considering an example scenario by applying AmI in our homes to make it "Smart Home" the following sequence of events can happen on our return back to home on a typical day

- recognized by intelligent surveillance camera
- door alarm switched off, door unlocks, opens
- house map indicates her husband Peter is at an art fair, her daughter Charlotte is in children's playroom
- In kitchen family memo frame lights up to indicate there are new messages
- she switches to video on demand channel to watch latest news program
- watch virtual presenter that informs about programs and information that have been recorded by home storage server

The basic idea behind AmI is that by enriching an environment with technology (e.g., sensors and devices interconnected through a network), a system can be built such that acts as an "electronic butler", which senses features of the users and their environment, then reasons about the accumulated data, and finally selects actions to take that will benefit the users in the environment. [3]

The ambient intelligence paradigm builds upon pervasive computing, ubiquitous computing, profiling practices, context awareness and human-centric computer interaction design and is characterized by systems and technologies that are [2]:

- **Embedded:** many networked devices are integrated into the environment
- **Context aware:** these devices can recognize you and your situational context
- **Personalized:** they can be tailored to your needs
- **Adaptive:** they can change in response to you
- **Anticipatory:** they can anticipate your desires without conscious mediation.
- AmI is closely related to the long term vision of an intelligent service system in which technologies are able to automate a platform embedding the required devices for powering context aware, personalized, adaptive and anticipatory services. "AmI is a digital environment that proactively, but sensibly, supports people in their daily lives"

3. Relationship Between AmI and Contributing Technologies

3.1 Sensing: Effective use of sensors is vital and without such physical components theoretical algorithms overshadow practical applications. Sensing and acting provide links between intelligent algorithms and real world in which they operate. Sensors are the key that link available computational power with physical applications Ambient Intelligence algorithms rely on sensory data from the real world[2], [5]

3.2 Reasoning: In order to make such algorithms responsive, adaptive and beneficial to users a number of types of reasoning must take place including user modeling, activity prediction and recognition, decision making, and spatial-temporal reasoning [6]

3.3 Acting: AmI systems tie reasoning to real world through sensing and acting. Intelligent and assistive devices provide mechanism by which AmI systems can executive actions and affect system users. [7]

3.4 Human–computer interaction: A characteristic that is necessary to further societal acceptance of AmI is that AmI should be made easy to live with. This is further detailed as a need to define human-centric computer interfaces that are context aware and natural. [8]

3.5 Privacy and security challenges: AmI can take away control when:
- environment performs wrong action
- it forces humans to perform extra or corrective actions
- when it shares information with third parties
- it gives monitoring and data collection access to third parties

AmI potentially gives more control to humans by making their environments more responsive to intended actions, by supplying humans with customized information, and by reducing cognitive or physical effort that is required to perform task

Figure 1: Relationship between AmI and contributing technologies

4. Applications

AmI has found applications in almost all spheres of life:

- Health monitoring and assistance
- Smart homes
- Emergency services
- Education

Cases:

4.1 Virtual Fitness Coach: It motivates and monitors users to get active by creating a personal 'coach'—actually, a machine—which provides data and even spurs the user on to greater achievements. The Coach monitors physiological signals and calculates training intensity. The Coach turns the physical feedback into data that users interpret, helping them determine the success of their training regimens.

4.2 Smart TV experience: We are natural-born peripheral viewers. People naturally take in more than just the screen when they watch television; hence the extra space can be put to effective use. Its's many preset colours and white tones as well as custom settings, allowing for complete personalization of one's smart TV viewing experience.

5. Conclusions

Ambient Intelligence is fast establishing as an area where a confluence of topics can converge to help society through technology. There are still many challenges ahead and improvements are needed at all levels for AmI systems to be widely accepted and more important of all, be useful to society like infrastructure, algorithms and human–computer interaction. In the years to come, people will relate to electronics in more natural and comfortable ways than they do now. 'Smart' technological breakthroughs will also allow integrating 'smart electronics' into more friendly environments.

'Ambient Intelligence' would aid in making people living easily in digital environments in which the electronics are sensitive to people's needs, personalized to their requirements, anticipatory of their behavior and responsive to their presence.

6. References

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