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Sensor Based Smart Learning Environment using Ambient Intelligence

S.Vetrivel *[a], S.Pandikumar [a]

[a] Associate Professor, Department of Computer Science, Subbalakshmi Lakshmipathy College of Sciecne,Tamil nadu, India.

* e-mail id: vetri76@gmail.com

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Abstract: AmI (Ambient Intelligence) play an important role in education by engaging, motivating and enriching the learning environment, increasing students' access to information, filtering information traffic and helping students' active learning and collaboration by enhancing their learning environment to significantly motivate them to learn. To address the problem of distraction due to information traffic and the absence of motivation system in the institutions for the student's paves the way to implement ambient intelligent system with a sensory unit which the institutions are ready to offer. Leveraging these resources to attack this issue requires creating a chain reaction to be initiated. On the other hand it exposes the student community to concentrate in class room sessions and make the learning environment conducive. Automation of this process also needs in-depth understanding of both institutions infrastructure and latest development in electronics. Without developing this intelligence system the distraction or unfocussed class room leads to lack of knowledge of students throughout the country. Devising Ambient Intelligent system in the class rooms is the only way to eliminate this issue. This paper exposes the ideology and working way of AmI in education and smart environments.

Introduction

Designing smart learning environments is a goal that appeals to researchers in a variety of disciplines, including artificial intelligence, pervasive and mobile computing, robotics, middleware and agent-based software, sensor networks, and multimedia computing. Advances in these supporting fields have called as ambient intelligence [1]. Ambient Intelligence is a technological paradigm has the potential to make a significant impact upon daily human life by positively altering the relationship **between** humans and technology. In an AmI environment, "people would be 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 and often invisible way"

AmI is sometimes confused with similar but not equivalent terms: Smart Environments and Pervasive Computing. AmI gives more importance to the user, the idea of human-centered design and the intelligence needed to allow the system to anticipate needs of the user. This shapes the decision-making of these systems in a different way and can be summarized as "a digital environment that proactively, but sensibly, supports people in their daily lives" [8]. Equally, AmI should not be confused with Smart Homes. Smart Homes are only one form of the many possible realizations of AmI, which include Smart Classrooms, Smart Offices, Smart Cars and others. However, Smart Homes are so far the most extensively explored of those applications.

Such technologies offer students increased access to information within an augmented teaching environment which encourages active learning and collaboration, enhancing their motivation to learn. The main objectives of ambient intelligence learning are

- understanding the needs and wishes of learners and teachers
- presenting personalized educational material in a pervasive way
- supporting "natural" interaction with digital and traditional learning content
- monitoring the learning progress at an individual and classroom level
- detecting difficulties and problems, and offering personalized help
- supporting learners and teachers in classroom activities
- extending learning beyond the classroom

Revolution of Smart Learning

A significant element in the development of AmI is the evolution of technology. Computers were initially very expensive as well as difficult to understand and use. Each computer was a rare and precious resource. A single computer would typically be used by many individuals. In the next evolutionary step, many users no longer needed to take turns to use a computer as many were able to access it simultaneously. The PC revolution in the 80s changed the ratio to one user per computer. As industry progressed and costs reduced, one user often was able to access more than one computer. The type of computational resources that we have at our disposal today is dramatically more varied than a few decades ago. Access to multiple computers does not necessarily just mean owning either a PC or a laptop (Fig.1).

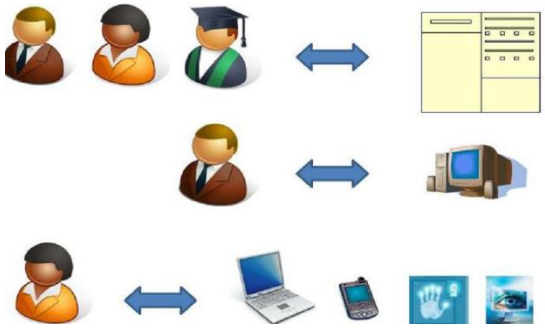

Fig 1. Revolution of Smart Learning

In 21st century the user can not own computer and software, everything is ubiquitous and mobility. The user can access the content through any kind of computation device in ambient intelligent environment. Background Study

During the past decade, research focused on augmenting the classroom environment by assisting the teaching process, recording lecture activity, enabling collaboration among students, supporting remote student telepresence, and encouraging active student's participation and contribution in the learning process. The system reported in [4] aims to improve the teaching experience by offering automated device control and creating a suitable environment for each detected situation. For example, when an instructor logs on to the classroom computer, the system infers that a computer-based lecture will be given, automatically turns off the lights, lowers the screen, turns on the projector, and switches the projector to computer input. Similarly, Y. Shi et al. in [5] try to facilitate the lecturers by providing alternatives for command execution that do not require being in direct contact with the computer. In this approach, the teacher can use a traditional laser pen to indicate and circle a point of interest, while a camera detects the user's intention and sends a mouse click message to the computer. In order to endorse students' collaboration and active participation in the learning process H. Breuer et al. [6] developed a platform to support the programming of distributed applications running on different platforms. In their approach, applications running on different platforms and sharing an object will have automatically the status of the object synchronized. An interactive whiteboard application is offered, named "DeepBoard", that implements a gesture-based interaction paradigm and a hierarchical semantic to store and retrieve data, created on the fly, by free-hand writing. Furthermore, collaboration among students is also supported in the Smart Classroom proposed by S. Yau et al. [7], in which each student owns a situation-aware PDA. Students' PDAs dynamically form mobile ad hoc networks for group meetings. Each PDA monitors its situation (locations of PDAs, noise, light, and mobility) and uses the related information to trigger communication activities among the students and the instructor for group discussion and automatic distribution of presentation materials.

Ambient Technologies for Learning Environment

The sheer diversity of technologies involved means that neither the list nor the terminology can be definitive, but it does provide hints about the sets of technologies that will be essential for AmI and the technological trajectories that they imply.

According to Cook et al. [2], any smart environment can be adequately decomposed in four fundamental layers: physical, communication, information and decision. But this paper compress layers into three that is information layer cut out from the field. Each layer performs a different role in the environment, facilitating diverse operations and addressing specific requirements. To this end, some fundamental requirements have to be addressed by smart environment architecture in order to enable ambient intelligence in a classroom. This paper classifies AmI environment into three layers based on their physical architecture (fig 2).

The physical layer act as an input/output medium. This layer gets input from users or environment and give the output to the same. The communication layer used to transmit a data from physical layer to decision layer. Decision layer is the primary part of the system because it process the users input and make the correct decision based on the data patterns and pass the output to physical layer through the communication layer.

In general physical layer comprise all sensors, actuators, scanners, display units etc. this layer have hardware and software interface to communicate user and upper layer. The software interface manages hardware and provides services to users and upper layers. The communication layer uses to pass the data from the hardware into decision system through the sensor network, wireless sensor, and LAN or WAN. This layer performs based on networking protocols.

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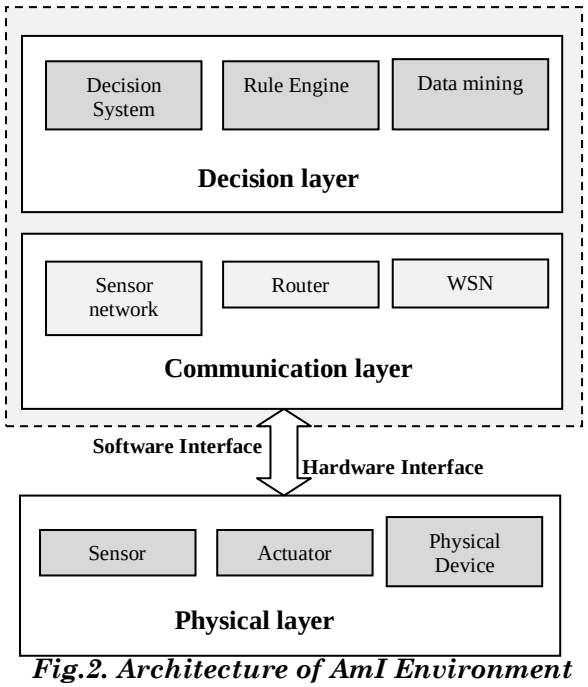

Fig.2. Architecture of AmI Environment

Decision layer perform data processing based on the user behavior and he environment behavior. All the information keeps in data warehousing and centralized databases. These data will process by data mining and decision supporting policies.

Unobtrusive Hardware

Miniaturisation is assumed to follow its historic pattern to permit the necessary enabling developments in micro and optical electronics. Molecular and atomic manipulation techniques will also be increasingly required to give advanced materials, smart materials and nanotechnologies. In addition there will have to be:

- Self-generating power and micro-power usage in objects
- Breakthroughs in input/output including new displays, smart surfaces, paints and films that have smart properties
- Active devices such as sensors and actuators integrated with interface systems in order to respond to user senses, posture and environment or smart materials that can change their characteristics and/or performance by stand alone intelligence or by networked interaction (e.g. smart clothing)
- Nanoelectronics and other nanotechnologies that permit miniaturisation trends to extend beyond the limits of micro-devices through hybrid nano-micro devices. Nanodevices would yield lower power consumption, higher operation speeds, and high ubiquity.
- A human factors design emphasis so that the widespread embedding of computers produces a coherent AmI landscape rather than just a proliferation of electronic devices with IP addresses.

A Seamless Mobile/fixed Web-based Communications Infrastructure

Complex heterogeneous networks need to function and to communicate in a seamless and interoperable way. This implies a complete integration (from the point of view of the user or network device) of mobile and fixed and radio and wired networks. Probably all the networks would be operating with some equivalent of IP technology. Core and access broadband networks are likely to converge.

Dynamic and Massively Distributed Device Networks

The AmI landscape is a world in which there are almost uncountable interoperating devices. Some will be wired, some wireless, many will be mobile, many more will be fixed. The requirement

will be that the networks should be configurable on an ad hoc basis according to a specific perhaps short-lived task with variable actors and components. Databases whether centralized or distributed should be accessible on demand from anywhere in the system. This complexity extends well beyond the current capabilities of system software and middleware, and calls for wireless 'Plug and Play' solutions as well as dynamic, multi-domain networking.

A Natural Feeling Human Interface

A central challenge of AmI is to create systems that are intuitive in use – almost like normal human functions such breathing, talking or walking. On the one hand 'artificial intelligence' techniques will have to be employed for this especially dialogue-based and goal orientated negotiation systems as the basis for intelligent agents and real time middleware. The key issue will be to move from relatively narrow domain by domain and highly structured databases to families of systems that can operate across domains to very general levels. These kinds of artificial intelligence techniques will be equally important for developing intuitive machine to machine interaction.

Dependability and Security

A consistent theme of the scenario work is the requirement for a safe, dependable and secure AmI-world. The technologies should be tested to make sure they are safe for use. On the one hand this refers to physical and psychological threats that the technologies might imply. It will also be important to have AmI systems that are secure against deliberate misuse. The scenarios assume techniques for secure ID authentication, micropayment systems and biometrics.

Methodology of Ambient Learning Proces

The IST Advisory Group lists the key technologies that are required to make AmI environments a reality. Among all the technologies they list, the learning process will be highly influenced by those technologies oriented to provide the environment with intelligence. These are sensing, reasoning and acting technologies. Sensing systems allow perceiving the state of the user and the environment by means of sensors, then, reasoning systems use that data to decide how to act upon the environment to get the intended goals, and finally, acting systems carry out these decisions.

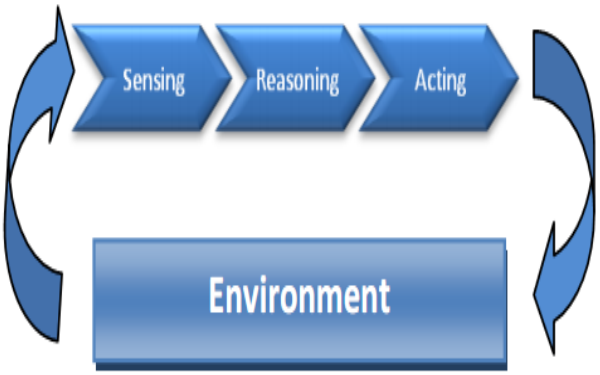

Fig.3. AmI methodology

Sensing plays two important roles in AmI systems. On the one hand it provides data to learn how the user behaves, and on the other hand it provides information about the current state of the environment in order to make correct decisions at each moment. Even the sensing process can be divided in two main areas; (a) monitoring of the user and his/her activities, and, (b) monitoring of the environment itself. User's behavior monitoring, tracking and identification of people in an environment is an important issue in AmI systems. Motion sensors have been used in many applications to track users.

The technologies included in the reasoning step are the key in the process of providing the environment with intelligence. Figure 2 illustrates the relationships among these technologies.

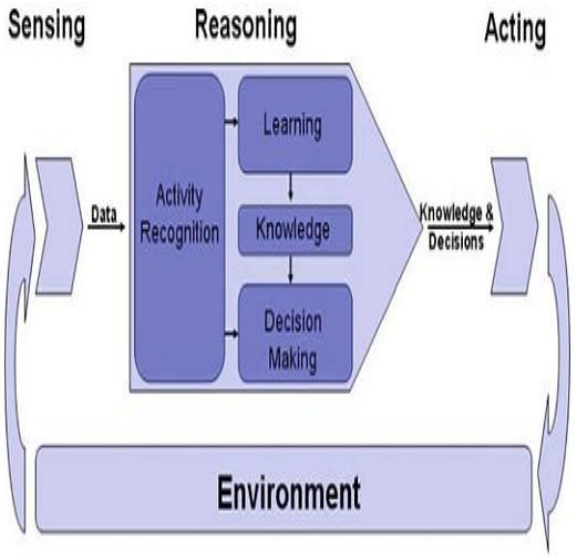

Fig.4. Processing Methodology of AmI

Acting intelligently demands to recognize the action/activity the user is carrying out at each moment as well as the general action/plan the person is performing. The approaches to consider differ according to the type of sensors and the set of activities to recognize.

Intelligent environments can act over the environment in a variety of ways. Following the

decision making process the system may decide that some conditions need adjustment (for example, closing the curtains or starting the heating) or interaction with humans is needed (for example, to alert a carer if a person in the house has fallen). The most natural way of acting is by means of actuators integrated in standard devices. The use of friendly multimodal user interfaces that aim at making the interaction as close to human-to-human communication as possible (e.g., through voice and image processing technologies) can also be considered. Acting necessarily involves users so that these aspects are considered in the learning process.

Related Applications

Research towards Ambient Intelligence in the classroom is the ClassMATE smart classroom framework [3], aiming to provide a robust and open ubiquitous computing framework suitable for a school environment that: (i) provides a context aware classroom orchestration based on information coming from the ambient environment, (ii) addresses heterogeneous interoperability of Ambient Intelligence services and devices, (iii), facilitates synchronous and asynchronous communication, (iv) supports user profiling and behavioral patterns discovery and (v) encapsulates content classification and supports content discovery and filtering.

ClassMATE smart classroom framework in order to provide context – aware assistance to the students, enhancing thus their learning process during reading with the retrieval and presentation of related material and, during writing, through the provision of assistance to accomplish their writing tasks whenever appropriate.

The ClassBook Application is the electronic version of the physical book, displaying the currently open book page. The images and exercises displayed on any page are selectable, and upon selection the appropriate applications are launched to display relevant content (e.g., the Multimedia Application is launched if an image is selected or the Multiple-Choice Exercise if an exercise is selected).

The Hints Application is launched only when the student explicitly asks for help about a specific exercise. It supports three kinds of hints that are presented to the student gradually in order to assist the development of critical thinking skills. If the first hint is insufficient for the student to solve the exercise, the he can ask for a second and a third one.

Conclusion

This paper argued AmI learning is the vital one for modern learners. Through the AmI learning the knowledge sharing and assessment will be very effective. Around 80% of the learners like to use AmI learning environment because of its robustness and accessibility. This paper discussed the methodology and generic architecture of AmI learning environment. The wireless sensors are the backbone of the AmI environment. In future AmI learning will be dominating the entire education methodology with the contribution of teachers.

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