Am I?

THE ARCHITECTURE OF AMBIENT INTELLIGENCE

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"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."
–Weiser 1991

INTRODUCTION

In its purest state, Ambient Intelligence is smart computing whose presence is not apparent to the human senses except in response and actions. The original intentions and origins of Ambient Intelligence began with the need for more efficient and unobtrusive management of our everyday activities. Synonymous with ubiquitous computing, Ambient Intelligence, or AmI, consists of: *UbiComp*: the integration of microchips and computers into everyday objects; *UbiComm*: the ability of these objects to communicate with each other and the user; and *Intelligent User Interface* which allows inhabitants of the environment to interact with the system with human gestures (Riva 2005). Put together, these components are basically personified computers. The key factor in Ambient Intelligent communities is that the microscopic computers are aware of their surroundings and their purpose just as human beings are. With the ability to self-program and react to new software, they eliminate the need for humans to program them, decreasing maintenance and programming time. These concepts and technologies raise important questions. What happens when the system disappears? Are we ready as a society to see a certain degree of power taken away from us by anticipatory computers? This short paper will provide an overview of AmI and why it is important for architects to embrace, explore, and engage this emerging technology.

TECHNOLOGY

The primary mechanical components of AmI are Smart materials, MEMS Technology, ubiquitous computers, sensors, and adaptive software. Adaptive software is the most important element of AmI because this allows the AmI system to adjust and learn new behaviors from various users in various environments. The sensors communicate to an AmI module that processes and distributes information to applications. This creates a "sensing architecture" that is receptive to light, temperature, humidity, pressure, and other conditions of interest.

The intelligence of AmI is multi modal and responds to shapes, sound, motion, smells, and emotions. These "behaviors" are facilitated by a complex system of media management and handling, natural interaction, computational intelligence, contextual awareness, and emotional computing. What makes an AmI system effective is its ability to recognize the specific objective/purpose of the user and identify the tools needed to accomplish the specific task.

When the mechanics and intelligence are incorporated to create a system it becomes a Physical Service Environment (PSE) as it now consists of pervasive computing and context awareness. The goal of AmI PSE's is to create more user friendliness, decrease system overloads, provide more effective services, and basically "build on human strengths and compensate for human weaknesses in order to enhance experiences…." (Cai 2004). Physical Service Environments are classified by the types of services they provide, which are either information provisioning (the delivery of personalized context-dependent content), or physical environment awareness and control (the access to information collected from sensors in order to control the physical environment) such as opening and closing doors (Riva 2005).

ARCHITECTURAL APPLICATIONS

Typical applications for AmI at this stage are predominantly in housing, automobiles, and health care. Applications for ambient intelligence must first provide a service and then the physical devices must define the generic typology of the need. For example, in a Smart Conference Room a service would be automatically switching the projector to the person's presentation upon sensing their presence or dimming the room lights upon sensing the start of a discussion (Markopoulos 2004). The generic typology is then divided into three "channels" that determine the event, goals, and operations. The event channel allocates events, the goals channel passes the constructed goal to the appropriate assistant component, and the operations channel passes concrete function calls to the actor or sensor.

Another residential example is the Philips Homelab, an offspring of MIT's Project Oxygen that actually utilizes a team of psychologists, engineers, and scientists (MIT 2007). This approach is unique because it delves into the psychological implications of living with AmI on a daily basis. The process entails subjects actually inhabiting an AmI environment for several days while observing and measuring their trust levels with the system through behavior.

Behavior-based navigation is an application in the healthcare industry based on a system's learning of the properties of the environment and adapting them to improve the user's perspective of space. The system recognizes changes in the environment and the relationship between them perceptively, topologically, and through terrain. These applications will then respond accordingly with light, color, or changes in topography to a user moving through the space after first acknowledging what their orientation goals are. For instance, if a person is confined to a wheelchair the AmI environment could inform the user as to the path of least obstruction through the building. Or, if the user informs the system that they have poor vision, the walls would then brighten in color to lead the path.

Even basic materials used in building can be integrated with AmI. In an application for a concert hall the paint can be programmed to change its noise insulation properties, but on a more conventional level in a home, the paint can self heal from scratching (Gartner 2006).

A system of different AmI technologies is being experimented with in the Home Depot Smart Home at Duke University. Technologies include LMS (Least Mean Squares) Algorithms that filter out unwanted background noise, voice commanded lights, theater, and temperature, and microphone arrays; all connected by a decentralized system of sensors that communicate with one another. An advanced HVAC system learns inhabitant behavior patterns as they relate to temperature, leading to reduced energy costs in the home (Duke University 2007).

ONTOLOGICAL AND SOCIOLOGICAL IMPLICATIONS

The great controversy with ambient intelligence environments is the user's ability to trust the system and the level to which an independent, self-adapting computer network can be controlled. Being that trust is a reciprocal understanding a person has with a tangible object bound by a relationship, it is difficult to discern what this new type of trust will be with an invisible object. This is not only a sociological issue, but also an ontological issue. The ontology of invisible technology is an intriguing one with the emergence of AmI and nano technologies. The phenomenal relationship between the environment and the user(s) shifts into the metaphysical realm, literally. Thus, AmI poses no simple challenges to architects, social scientists, and psychologists. While the effect of one's actions is seen reflected in the environment, the agency and the mode of environmental change remains invisible. This goes counter to the conventional wisdom and modes of design that architects have been accustomed to for ages.

A misconception about AmI environments is that the system is controlled by one "mother node" that can be trusted to control all the information of the smaller nodes, but in fact a true pervasive computing system is comprised of many independently operating computers (Clark, et al. 2006). This circumstance provides more opportunity for information misinterpretation, miscommunication, or overall system failure.

Ambient intelligence has been thought to be a positive innovation because it limits the amount of technological "stuff" in the environment by utilizing a multiplicity of nanotechnologies, but this creates a massive amount of personal information being openly circulated.

CONCLUSIONS

Ambient Intelligence is a paradigm that holds great promise and challenges for architects. In the next five to ten years, we can begin to see some revolutionary developments in how we view computing, intelligence, and their application in architecture. AmI aims at integrating computational intelligence into the environment in a mostly invisible fashion. It also aims at providing robust computational environments where the intelligence does not depend on a central agency or a mother computer. Nano technology is a key to the development of ambient intelligence devices.

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