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REVIEW ARTICLE

Ambient Intelligence

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ABSTRACT

Ambient Intelligence (AmI) is a new world where computing devices are spread everywhere, which allows the human being to interact in physical environments in an intelligent and unobtrusive manner. Ambient Intelligence combines the concepts ranging from ubiquitous computing to autonomous and intelligent systems. The main vision of ambient intelligence is to ultimately provide empowerment to the computers with the benefits of added convenience, time and cost savings, and possibilities for increased safety, security, and entertainment. The technology has the potential to significantly impact the traditional business and government processes, as well as private life. The paper describes about the developments in ambient intelligence till date and its closely related counterpart, ubiquitous computing and communication. It discusses the driving forces behind this digital information technology, description on the equipment and devices involved and considers the future view of the technology.

INTRODUCTION

The term "ambient" is defined by Merriam-Webster's dictionary as "existing or present on all sides". Ambient Intelligence is defined by the Advisory Group to the European Community's Information Society Technology Program (ISTAG) as "the conjuction of ubiquitous computing, ubiquitous communication, and user adaptive interfaces". Ambient intelligence (AmI) refers to electronic environments that are sensitive and responsive to the presence of people. Ambient intelligence is a vision on the future of consumer electronics, telecommunications and computing. In an ambient intelligence world, devices work with the people to support them in carrying out their daily life activities, tasks and rituals in an easy and natural way using information and intelligence that are hidden in the network. By using the ubiquitous computing devices ,the objective of AmI is to increase the interaction between human beings and digital information technology. Conventional computing includes user interfaces (UIs) such as keyboard, mouse, and visual display unit; while the large ambient space that contains the user is not utilized as it should be. AmI on the other hand uses this space in the form of, for example, shape, movement, scent and sound recognition or output. Wireless networks will be the dominating technology for communication between these devices. The combination of simplified use and their ability to communicate will increase efficiency for users and will, therefore, create value, leading to a higher degree of ubiquity of computing devices. Examples of such devices ranging from common items such as pens, watches, and household appliances to sophisticated computers and production equipment. AmI involves three main components: ubiquitous computing, ubiquitous communication, and user adaptive interfaces.

Ubiquitous Computing

Ubiquitous computing involves the idea that something exists or is everywhere at the same time on a constant level, functioning invisibly and unconfidently in the background and freeing people to a large extent from tedious routine tasks. This is important when we want to understand the future implications that AmI will have on the environments we live and work in. The general definition of ubiquitous computing technology is that which permits human interaction away from a single workstation. This includes pen-based technology, large-scale interactive screens, wireless networking infrastructure, hand-held or portable devices, and voice or vision technology .In its ultimate form, ubiquitous computing is any computing device, while moving with you, can build an incrementally dynamic models of its various environment and configure its services accordingly. The devices will be able to either

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"remember" pa st e nvironments t hey ope rated i n, or pr oactively build up s ervices i n ne w environments.

Ubiquitous communication

Today, a num ber of o bjects a re e quipped w ith computers,so a relatively high level of ubiquitous computing i s a lready pr esent w ithin our environment. However, in most cas es t he computers do not ope rate a t t heir f ull pot ential since t hey c annot c ommunicate w ith e ach ot her . A m ajor ch ange i n the cor porate and home environments t hat w ill e ncourage ubi quitous communication s o that , ubi quitous c omputing is the e xpansion of w ireless ne twork technology, which e nables f lexible c ommunication be tween interlinked de vices t hat can be pl aced in v arious locations or c an even be por table. T o i mplement wireless technology , the wireless hardware itself must meet several criteria on the one hand, while easy int egration and administration as w ell a s security o f t he ne twork m ust be e nsured on t he other. The following wireless technologies that are available on t he m arket or c urrently unde r development. W ireless L AN, B luetooth technology, hi gh & l ow r ate W -PANs ,W ireless body a rea ne twork(BANs), R adio F requency Identification(RFID).

User adaptive interfaces

User adaptive int erfaces, the thi rd int egral p art o f AmI, are also referred to as "Intelligent social user interfaces" (ISUIs) . T hese i nterfaces go be yond the t raditional ke yboard a nd m ouse t o i mprove human i nteraction with t echnology by m aking i t more ef ficient and secure. T hey allow t he computer t o know and s ense f ar m ore a bout a person, t he s ituation the pe rson i s i n, t he environment, a nd r elated obj ects t han t raditional interfaces can. ISUIs contains i nterfaces t hat create a p erceptive com puter envi ronment r ather than one t hat r elies s olely on active and comprehensive us er i nput. ISUIs can be grouped into five cat egories : Visual r ecognition (e.g. face, 3D ge sture, and l ocation) a nd out put, S ound recognition (e.g. s peech, m elody) and out put, Scent r ecognition and output, Tactile r ecognition and out put a nd O ther s ensor t echnologies. Traditional us er i nterfaces l ike P C-controlled touch screens in a company environment and user interfaces i n por table uni ts s uch a s P DAs o r cellular phones can also become ISUIs. The key to an ISUI i s the ease of us e, in this c ase the abi lity to pe rsonalize a nd a dapt a utomatically t o particular us er be havior pa tterns (profiling) a nd different s ituations (context aw areness). ISUIs make network usage more secure as the interfaces can identify us ers aut omatically b y, for ex ample, face or voi ce r ecognition i nstead of requesting a password.

Scalability from different perspectives

The processing perspective - Ambient Intelligence de vices ar e ex pected to provide scalable p rocessing pow er at every l evel of t he networked i nfrastructure. F lexibility, bot h programmability and re-configurability is required to support s calability: mos t A mI de vices w ill be flexible, in order to provide adequate performance under w idely v ariying c onditions. T o address t he scalability ch allenge i n view of t echnology and design complexity, limita tions, ha rdware architectures f or A mI will ha ve w idely va rying characteristics de pending on t he ne twork t ier where t hey ar e de ployed. B elow i s a br ief overview on t rends in de vices for t he t hree network types.

The fixed base network-Devices f or t he f ixed network infrastructure ar e f astly evol ving t oward parallel ar chitectures. Single-chip m ultiprocessors area na tural e volution o f c urrent s ingle-processor solutions is an effort to support truly scalable data processing, even general-purpose s ingle-chip processors f or hi gh-end s ervers a re be coming increasingly di stributed a nd highly p arallel. Explicit pa rallelism is s ought to avoid architectural bot tle-necks (such as g lobal r egister files a nd i nstruction fetch & de code l ogic) and t o ensure l ong-term s calability across s everal technology generations. M ost ne wly-designed high-performance pr ocessors a re hi ghly pa rallel architectures, w ith m ultiple pr ogram counters. One s tep f urther, ne xt-generation architectures are focusing on parallelism not onl y at the micro-architectural l evel, but al so across t he ent ire memory hierarchy.

The wireless base network- When c onsidering the wireless base network, the push toward highly parallel mu lti-processing architectures i s ev en stronger, coupled with a trend toward single-chip integration. T his c onvergence t oward m ulti-processor s ystem-on-chip (MPSoC)platforms i s also motivated by the quest for scalability. Energy efficiency and cost con straints a re muc h tighter than f or hi gh-performance s ervers, and the computational re-quirements can be matched onl y by r esorting t o heterogeneous ar chitectures(in contrast w ith hom ogeneous general-purpose processors),which pr ovide c omputational pow er

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tailored to a specific class to handle the design challenges of AS-MPSoCs, architectures and design flows .Computational elements must be programmable to provide the much needed post-fabrication programmability and in-field adaptation.There should be a standardization to ensure software portability and to facilitate interfacing with other computational elements, memories and input-output devices. Next generation wireless base network devices will include tens to hundreds of application-specific processors(e.g.,MAC accelerators, digital MODEMS, cryptoprocessors), as well as several general-purpose processing cores(e.g.,FPGA fabrics, DSP cores,VLIW multimedia processors,FP coprocessors,RISC controllers,etc.),a significant amount of on-chip storage (both volatile and non-volatile).various peripheral units(e.g.,external DRAM controllers,interfaces to various on-board busses,various RF front-ends ,BIST units,etc.).The connective fabric for this multitude of devices will be a NoC.

The sensor network-The nodes of high-density sensor networks will be the most critically power and cost constrained. Scalability will most likely be achieved by compromising to some degree flexibility at the node level, focusing on maximum energy efficiency and minimum cost. Ambient intelligence will therefore be obtained as a result of coordination of a very large number of simple node through distributed, adaptive protocols for information transfer , processing and active energy management. The node itself will not be highly scalable, but the sensor network as a whole will be , mostly thanks to its protocol-level scalability.

The communication perspective

Emerging devices for AmI are characterized by shrinking size and increasing density. From the perspective of wireless communication, a high density of nodes implies competition over limited bandwidth, and the devices' small physical size suggests a limited battery capacity. So we can say that, communication in AmI devices utilize these resources efficiently. We advocate two design philosophies for energy-efficient communication. First, it is crucial that energy-efficient communication software be based on sound models of the hardware on which it will operate. Second, two power management techniques used widely by hardware designers hold great promise for protocols:application-specific design and energy-quality scalability.

The software perspective

As wirelessly networked intelligent sensors become the majority of AmI devices that deeply embed into the physical world, the amount of gathered information, the complexity of software development, and the cost of system testing will soon surpass what current technologies can support. The vision of AmI requires a fundamental paradigm shift on system architectures, programming models,and algorithm designs.

Scalable software infrastructure.AmI systems need drastically different software infrastructure support than the current Internet or desktop system.A scalable AmI software infrastructure also needs effective ways to manage tasks and resources. An AmI system should have the ability to filter out distractions, keep attention on critical tasks, and maintain a notion of co-herent tasks across the boundary of embedded, mobile and fixed networks. An AmI system should have the ability to filter out distractions, keep attention on critical tasks, and maintain a notion of coherent tasks across the boundary of embedded, mobile and fixed networks

Scalable algorithms. Scalable AmI systems need resource-aware algorithms and modern ways of resource management. Resource-aware algorithms adapt to the available CPU cycles, bandwidth, sensing modalities, and battery power and may provide a spectrum of answers, quantitative ones or qualitative ones, with different fidelity

Ambient Intelligence Applications

AmI at Home

Domotics is a consolidated area of activity. After the first experiences using domotics at home was a trend to refer the Intelligent Home concept. However , Domotics is too centered in the automation , giving the capability to the user to control the house devices from everywhere. We are still far away from the real Ambient Intelligence in homes at the commercial level. Several organizations are increasing experiences to achieve the Intelligent Home concept. Some examples are HomeLab from Philips, MIT House n, Georgia Tech Aware Home, Microsoft Concept Home, and e2 Home from Electrolux and Ericsson.

AmI in Vehicles and Transports

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Since the first experiences with NAVLAB Carnegie Mellon University has developed several prototypes for Autonomous Vehicle Driving and Assistance, NAVLAB 11, is an autonomous Jeep(the last project). Many car industries are doing research in the area of Intelligent Vehicles for several tasks like car parking assistance or pre-collision detection. Another example of AmI application is concerned with the Intelligent Transportation Systems (ITS). The ITS Joint Program of the US Department of Transportation identified several areas of applications, namely: arterial management; freeway management; transit management; incident management ; emergence management ; electronic payment; traveler information; information management; crash prevention and safety; roadway operations and management, etc.

AmI in Elderly and Health Care

As the percentage of population with health problems will increase in the future, it will be very difficult for the Hospitals to maintain all patients.. There is a clear interest to create Ambient Intelligence devices and environments allowing the patients to be followed in their own homes or during their day-by-day life. We can embed medical control support devices in clothes, like T-shirts, collecting vital-sign information from sensors (blood pressure, temperature, etc). With this we will be able to moniter the patients at long distances. The surrounding environment, like the patient home, may be made aware of the results from the clinical data and can even perform emergency calls to order an ambulance service. For instance, the IST Vivago ® system (IST International Security Technology Finland), it is an active social alarm system, which monitors the user's activity profile and is combined with the intelligent social alarms.

AmI in Tourism and Cultural Heritage

Tourism and Cultural Heritage are good application areas for Ambient Intelligence. Tourism is a growing industry. In earlier times, tourists were satisfied with pre-defined tours, which was vs ame for all the people. However there is a trend in the customization and the same tour can be altered to adapt to tourists according their preferences.Some of the examples are Immersive tour post ,MEGA is an user-friendly virtual-guide to assist visitors in an archaeological area with ancient Greek temples in Agrigento, located in Sicily, Italy.

AmI at Work

A prominent time of human beings are spend in working places like offices, meeting rooms, control centres, , manufacturing plants etc. SPARSE (A project) is initially created for helping Power Systems Control Centre Operators in the diagnosis and restoration of incidents ,it is a good example of context awareness since the developed system is aware of the on-going situation, capable of acting in different ways according to the normal or critical situation of the power system. This system is evolving for an Ambient Intelligence framework applied to Control Centres .Decision Making is a social activity in which the results consider as a combination of rational and emotional aspects. ArgEmotionAgents is (a project) the application of Ambient Intelligence in the group argumentation and decision support considering emotional aspects and running in the Laboratory of Ambient Intelligence for Decision Support.

AmI in Sports

Sports involve many high-level athletes and pro create sports assistance devices and environments. FlyMaster NAV+ is a free-flight on-board pilot Assistant (e.g. gliding, hangliding , paragliding), using the FlyMaster F1 module with access to GPS and sensorial information. FlyMaster Avionics S.A., a spin-off, was created to commercialize these products.

CONCLUSION

The emergence of Ambient Intelligence (AmI) is a trend that is unstoppable which will have a huge impact on everyday life. AmI systems will radically differ from today ' s systems. We will need to rethink everything we know about embedded-system and hardware design. The AmI requires scalability of processing, communication, and software infrastructure in many aspects. It is clear that the design community faces a alot of interesting challenges.

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