A Study on General Ambient Architecture

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ABSTRACT: The advancement in the computer technology has led to the development of many computing devices and software which are helpful to the society. One such technology is ambient intelligence.This paper describes the general purpose multi agent layered architecture of ambient intelligence. It is known as the HI3 architecture. It is built by considering the criteria such as scalability, modularity, fault tolerance etc. Ambient intelligence is one of the most important advancements in information technology. Ambient intelligence is an approach in which there is an easy interaction between the people and the surroundings to enrich their lives. The idea can be applied in many sectors like the public transport, factories, military, hospitals and other environments. Ambient intelligence pattern builds upon ubiquitous computing where the computing is made to appear everywhere. The paper is organised as follows: The general ambient intelligence architecture followed by the HI3 architecture.

KEYWORDS: Ambient intelligence, Ubiquitous computing, HI3 technology, middleware, ISyRAmI.

I. INTRODUCTION

AmI helps in integrating electronic devices and people. In AmI people interact with the environment in a smart way. AmI refers to the electronic environments that are sensitive and responsive to the presence of people . AmI uses the concept of ubiquitous computing, pervasive computing, and context awareness.[1] Ubiquitous computing integration of microprocessors into everyday objects like clothing, furniture, toys etc. Pervasive computing devices are constantly connected and completely available.[2] Context awareness is necessary because the operation of devices is carried out based on the location. The integration of hardware/software components and communicational devices into the objects that people use has made the adaption of the environment to the use and habits of inhabitants. There are two approximations through which the identification of AmI system can be done. One is using an ad-hoc solution .This solution is not adaptive and it cannot be generalized which means the solution cannot be expanded to other environments. The other solution is to develop a general purpose architecture that could be expanded for any solution. Here the focus is on the second approach where the HI3 technology is used. The basic analysis involves identifying the desired requirements such as Connectivity and communication, scalability, modularity, security and privacy. As the system operates in the real world a multilayer design which operates on multiple elements is used. The paper consists of the HI3 architectural model and its components. Its aim is to create humanized, intelligent, interactive and integrated environments.[3].Following the advice of information society and advisory technology group(ISTAG) ,European Commission played an important role in the development of AmI.[4]

II. RELATED WORK

In order to transform high volume electronic communication from the current state to user friendly state, Philips formed a commission under the guidance of Eli Zelkha and Brian Epstein of Palo Alto Ventures. While developing ambient intelligence concept, they came up with the key note address for Digital Living Room Conference for Philips. They joined with Oxygen for the MIT Oxygen Project.
The IST Advisory Group (ISTAG) has made consistent efforts to get a higher level of focus and a higher pace in the development of ambient intelligence. [13]
 A series of research work is going on in the fields of ambient intelligence. A milestone in this field will be achieved only when all the devices are integrated in such a way that it becomes completely transparent.

III. NEEDS AND CHALLENGES

There are many requirements to design and develop AmI architecture. The basic requirement is communication between various devices like sensors, actuators, applications that are required by the users and the services that the application should provide. The communication is necessary to guarantee reliability which is in turn used to achieve availability. Reliability is the ability to replace the components if there is any failure. Security is another important aspect as there are sensitive information in the AmI system which should be encrypted. Different protocols should be supported by the AmI architecture to get hardware independence at sensor level. Reusability is another important factor to be considered as the AmI system components should change according to the environment and new needs should be solved as soon as possible by reusing the components. Modularity is required in order to maximize the reusable components. It is compulsory to have a set of tools to manage and monitor the behavior of the system. Adaption is necessary to dynamically adapt to the changing human environment.[3]

• *Basic Requirement for Ambient Intelligence architecture*: There are three different types of middleware based on the programming and communication models. Object based middleware, message-oriented middleware and the event-based middleware. In object based the distributed objects interact via method invocation. The event based and the message oriented middleware use the concept of message passing. In event based middleware events are the basic communication mechanisms.
The AmI system is built with different hardware/software components with different technologies. The middleware platform enables consistency of the programs written in different programming languages. Synchronous communication is necessary for interaction with various services. The AmI services should be enabled to notify other components about the changes in the internal state. This can be achieved by using event based communication.
The AmI system should continue to function properly in the event of failure. This is called fault tolerance. Fault tolerance is regarded as one of the crucial properties. The failure of one service should not affect another service within a particular system.
The next requirement is security .Security should be enabled in order to prevent the exploiting the important data that is required for the operation of the system. The programmers should be able to easily program with the middleware. Therefore ease of use is another important requirement.[5]
• *General Architecture*: ISyRAmI (Intelligent Systems Research for Ambient Intelligence) developed the architecture that interacts with the ambient intelligence. The main aim of ISyRAmI is to develop architecture for AmI system that implements the human intelligence on a computer and integrates it to the system. The general architecture developed by the ISyRAmI is shown in the figure 1.

Fig 1: General architecture for AmI

There are four different modules in this architecture includes data/information/knowledge acquisition, storage, intelligent reasoning, decision support.

The first module is data acquisition which accepts input from the environment. The different sources of the data is plane data which is not processed from the sensors, intelligent agent perceives the environment through sensors and acts on the environments through actuators, speech recognition where the words which are spoken are translated into text, computer vision which deals with acquiring images, identifies human gestures to control equipment and human facial expressions to recognize the emotional mood. The input can also come from other sources like experts, web, friends etc. The main functionality of this module is, it takes input and joins the data. This module does not check whether input data is correct or not, complete or not, vague or not. ISyRAmI architecture accepts different inputs from different sources. Consider the example of tourism. If a person has to visit a new place the weather input is considered as an important data. This weather report can come from many different sources like, it can come from sensors directly such as 27 c, can come from web, media reports or from a friend of the tourist who lives in the same city such as it's very hot in spite of the weather being cool in the early morning.
The second module consists of data storage, conversion and handling which deals with storing information obtained from the first module. This module main deal with analyzing the data for any incompleteness for errors, missing information and for any uncertainty. This module prepares the items which mean data, information or knowledge so that it can be used by the reasoning component. This module also joins the data obtained from different sources to produce the items so that it will be validate the conditions in the expert system rules. Considering the above example

the inputs got regarding the weather such as when the thermometer indicates 27 degree Celsius and no rain and the weather forecast from the web indicates high temperatures and possibility of rain, and friend says its moderate temperature and it's raining.

The third module is intelligent reasoning which is based on the information obtained from the second module the conclusion is obtained which will be sent to the next module. The conclusion is obtained by using the expect system. It is a system which draws the conclusion by using IF-THEN rules. This layer performs high level reasoning processes with the inclusion of planning, knowledge discovery systems (process of developing new knowledge from the synthesis of prior knowledge).

The fourth module is the decision support which deals with taking actions on the environment either directly or indirectly. Some tasks will be assigned to the user and some will be assigned to the AmI system. If tasks are assigned to the humans then decision support system plays the role. The system will present a list of proposed actions, explain them to the user and the user should finalize the actions. If the system gives the solution which the user does not like then the system is not considered as an intelligent system. AmI system should be able to learn from user observation. Using this architecture many new AmI environments are developed. This research is restricted to only understanding the general architecture of the AmI system.[4][6]

C. *HI3 Architecture*: HI3 architecture enables the multiple technologies in the distributed AmI environment to be transparent.Transparency indicates that natural interfaces should be used for user interaction.Ubiquitous computing is an important part of AmI to address the mobility issues. Distributed computing has provided a way for component mobility.[7].Distributed computing is a model in which the systems in a network communicate and coordinate by passing messages.[8]

The architecture is made up of the following layers.

The model is divided into various levels where the communication is vertical between the layers and horizontal within the layers.

Device access layers : It is used to provide access to physical devices.It is made up of two sublayers[9].Device access APIs and Device drivers.This layer uses a set of APIs to transform the heterogeneous network into a homogeneous network.[10].

Sensing and Actuation Layer:The physical devices are accessed with the help of these layers.The physical layer consists of actuators,sensors and other hardware devices.The information from the devices can be accessed by the sensors .Actuation elements should provide necessary functionality to command the actuation.[12]

Service Layer: It provides service which is required to solve a particular task.One service can use multiple services to complete an activity or a task.It consists of a service repository which helps in managing the services.

Application Layer:The elements that are used to solve a particular functionalities are hosted in this layer.The service repository is used by these elements . Applications are managed by the application repository.

Context:It represents the state of the environment by managing the information that is generated throughout the system.

To solve the global architectural problems three support modules are included:

System Monitoring: This module monitors the state of a system to assure correct operation of the system.

Communication Module:A module that is used to enable communication between the devices irrespective of their locations and hardware devices type.

Security and privacy Module: This module manages the authentication and authorization of system and also controls the privacy of the system.[3]

All these modules make use of a multiagent framework.JADE Agent framework can be used to enhance the coupling with the elements in the architecture.JADE is a software framework that is implemented in java language[12].

IV. CONCLUSION

Ambient intelligence is an evolving technology in the field of computer science.This research paper describes the general architecture and the HI3 architecture model of ambient intelligence.Using this architecture high level applications can be designed easily.The hardware can be accessed in a homogeneous manner.The applications developed can be used for the benefit of the mankind.

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