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Enhancing Ambient Learning through Multimodal Interfaces and Various Technologies

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ABSTRACT-
Ambient learning is a combination of mobile learning, situated learning and context awareness, where the learners wish to learn anytime, anywhere and anyhow. The context of ambient learners is dynamic and they tend to engage in short bursts of learning, where the learning content must be adapted to the dynamic nature of their learning needs. Research in the fields of pervasive computing and ambient intelligence [1] has resulted in multimodal interfaces and various technologies that enable communication between technology and people to be more natural and efficient. This paper differentiates ambient learning from e- learning and gives the overview of different types of interfaces and technologies used to attain ambient learning.
Keywords **-** Ambient learning, Ambient Intelligence, E - learning, multimodal Interfaces, Technologies.

I. INTRODUCTION

Ambient learning is a pragmatic and easy to use training system which is designed to deliver highly individualized information by combining several content sources and providing them via multimodal interfaces by using broadband and other various technologies.

Ambient Learning addresses two key issues through the usage of recently established technologies enabling ambient intelligence as well as context aware services in ambient environment. The main aim being to provide a pragmatic, easy to use e-learning service, allowing any time anywhere, anyhow, access, that is being adapted to individual needs, to high quality learning material to the learners. To achieve this objective, ambient learning uses multimodal broadband access, context management and content integration and various ambient technologies in ambient environment. A key technology emerging from this field is user interfaces used in intelligent enironment and particularly natural user interfaces. The advancement of spoken dialogue systems [2][3][4] and multimodal interfaces[5][6][7] offer new ways of interaction replacing the traditional keyboard and mouse. This paper outlines the concept of Ambient Learning using Multimodal interfaces.

II. RESEARCH OBJECTIVES

a) Distinguish E – learning from Ambient Learning.
b) Services provided by Ambient Learning.
c) Multimodal Interfaces that can be used for Ambient Learning.
d) Technologies used for Ambient Learning

III. DISTINGUISHING AMBIENT LEARNING FROM E- LEARNING

The main aim of ambient learning is to provide a pragmatic, easy-to-use eLearning service, which allows anytime, anywhere and any how access to personalized, high quality learning information efficiently and effectively. The main distinguishing features of the ambient learning service to other e-learning [8] approaches are shown in figure 1 and described in details below.

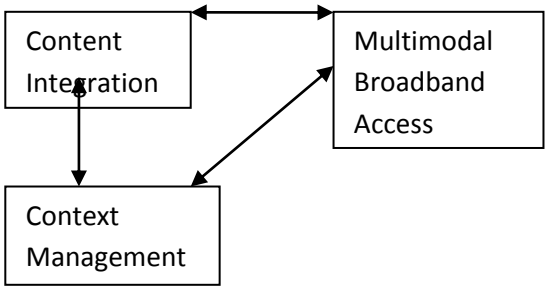

Figure 1: The main distinguishing factors of ambient learning.

A. Multimodal Broadband Access which allows the user access to eLearning content anytime, anywhere and anyhow according to his/ her convenience. Explanation: The user can use the eLearning system via different existing broadband networks (e.g. LAN at the office, WLAN at a specific hotspot, GPRS/UMTS on the move) employing the most suitable modality and technologies (interactive learning objects on the Office-PC, text-to-speech readout while

driving in the car, mobile PDF while sitting in the train, SDS etc.).

B. Context Management enables the provision of eLearning objects based on the context of the user. Explanation: The context of the user includes factors like schedule, tasks, personal profile, know-how and interests etc. Based on the context; learning content, which suits the user perfectly can be delivered according to the context using the above mentioned multimodal broadband access.

C. Content Integration allows access to existing knowledge catalogues and eLearning resources. The system can integrate already existing eLearning objects and other high-quality content.

IV. CATEGORIES OF AMBIENT LEARNING

1. Hybrid interface ambient learning (HIAL): Learning can be achieved anywhere, anytime by using available location dependent (fixed) devices and mobile devices.
2. Mobile interface ambient learning (MIAL): Ambient Learning using mobile devices
3. Fixed interface ambient learning (FIAL): Ambient Learning using location dependent devices

V. Services provided by Ambient Learning

A. Ambient Learning helps in imparting vocational training to the busy professionals according to their schedules.

Explanation: The busy professionals prefer articles out of scientific or professional magazines as their main source for vocational training. The ambient learning service allows her to structure and define her personal training needs. Based on professional's context (driving car, cooking or any other personal work) and his/ her personal interest the learning content is downloaded from a scientific magazine database to her mobile device and is read to her with a TTS engine (text-to-speech) while he/ she does his/ her personal work.

Figure 2: Vocational Training through Ambient Learning

B. Ambient Learning helps in imparting training to professionals using innovative solutions as a service.

Explanation: If a professional is travelling by train the technical specification is downloaded from the intranet as a PDF-document to his Notebook. During the train-ride he/ she have the chance to read the specification. If he/she is travelling by plane, the technical specification is converted to mobile flash and he can access the learning content on his PDA, while he/ she is flying to the customer. If he is on his way by car, he/ she is informed about the main new features via TTS (text -to- speech).

VI. MULTIMODAL INTERFACES THAT CAN BE USED FOR AMBIENT LEARNING

Multimodal Interfaces: Multimodal interfaces are computer interfaces which enable more than one mode of interaction using advanced hard wares. Advances in hardware (eye tracking, touch screens, microphones, and camera and data gloves) have enabled opportunities whereby interfaces are no longer restricted to the traditional keyboard and mouse input.

Multimodal Mobile Interfaces

The development of speech and pen as complimentary interface modalities is supported by their growing usage within mobile applications. A pervasive device needs an interface where the user is not restricted to a physical location and where their hands or eyes may be occupied doing other tasks. Oviattet al. [7] provide an extensive review of speech and pen-based gesture systems and suggest that these complimentary methods amongst others, support improvement of efficiency, satisfy higher levels of

user preference and accommodate a wider range of users, tasks and environmental situations. Many projects have focussed specifically on multimodality in mobile devices including The Mona Project [14], SmartKom Mobile [15].
The use of multiple modalities is ideal within multi-user collaborative environments. A study on children's collaborative interactions [16] suggests that sharing a physical display with multiple input devices may improve collaboration due to a heightened awareness of the other user's actions and intentions.

Spoken dialogue systems

Spoken dialogue systems (SDS) provide a means for an interface to understand and provide spoken language. Speech recognition, a major component within spoken dialogue systems, is the process by which an auditory signal, i.e. a spoken sentence, is parsed as a sequence of words. Due to the amount of processing and memory needed for automatic speech recognition (ASR)[10][11][12], limitations occur when using ASR on a mobile device. Processing power and memory requirements are the limitations of mobile devices which are prejudicial. These embedded ASR[13] systems are suitable for PDAs and mainly support small vocabulary sizes which are ideal when the utterances require single words or low level intentions. Network speech recognition (NSR) captures speech input on a client with limited computational power and performs complete recognition processing on a server. Distributed speech recognition (DSR) systems process the speech in two parts. The characteristic extraction occurs on the client side (PDA) whereas the ASR search, which is the computationally high-priced part, resides on the server.

Embodied agents

The face provides important means of providing non-verbal communication, such as raising an eyebrow, smiling and frowning. Eye movements show a person's interest or lack of it and the face transmits emotions and offers cues for natural turn taking protocols. Embodied agents are virtual representations of a person or character which provide and recognise nonverbal communication modalities. There are many potential benefits of having an embodied agent in multimodal systems which include: grabbing the user's attention, social interaction, naturalness and non-verbal feedback. The application of agents in educational software has many benefits as they can collaborate with the student.

Guidelines

Some mandatory feature should be kept in mind while the Ambient Interfaces are designed. Table 1 outlines the guidelines for designing the Ambient Interfaces. [17]

Table 1.Guidelines for Designing Ambient Interfaces

Sr. No.	Rules	Explanation
1	Effective	Quality in terms of how good the ambient interfaces does what they are supposed to do. For instance, one basic goal for ambient interfaces was to make use of users' peripheral awareness, not disturbing the user from performing the foreground task.
2	Efficient	Way an ambient interface supports users in carrying out their tasks. For instance, pressing the arm of RoboDeNiro for logging in to the TOWER environment relieves users from typing user names and passwords.
3	Safety	Protection of the user from dangerous and undesirable situations. For the PC a considerable body of knowledge on hardware ergonomics exists. For ambient interfaces, especially if they are multimodal, little knowledge on ergonomics exists.
4	Utilization	Right kind of functionality so that users can do what they want and need to do. Ambient interfaces should be used for easy input for simple actions or for subtle presentation of simple information. They are not well suited for complex information.

5	Easy to learn and remember.	Ease for the users to learn a system and to remember how to interact with the system. For ambient interfaces this is particularly challenging, because users do not have experience yet; novel metaphors are used; and traditional help systems are not available.
6	Functional Visibility	Clear communication to the user at any time which choice she has and what the system is expecting from her. Visibility can be easily achieved through the physical affordances of the ambient interfaces.
7	Feedback Adequacy	Information to the users to tell her that her input was received and analysed properly, and that the corresponding actions have been or will be performed. The feedback for the login function of the RoboDeNiro is a negative example: as pressing the arm can mean a login or a logout, the users often were not sure if they logged in or out.
8	Constraints	System awareness of the user's current situation and possible next steps and appropriate actions of a user. For the ambient interfaces we built constraints play a minor role, because the functionality of input and output in quite simple and easy to handle and does not require complex interaction or multi-step interaction.
9	Adequate Mapping	Mapping between controls and their effects should be adequate. This is a particular challenge for a multimodal, distributed multi-client system. In TOWER, the effect of the input often cannot be seen on the ambient interface per se, but rather on other indicators
10	Consistent functionality.	Similar operations and similar control elements should be used for achieving similar tasks. In a distributed participatory design and development process, consistency can only be achieved by frequent exchange among the different sites.
11	Adequate target domain.	Adequacy for the target domain such as the environment, in which the ambient interfaces are installed; the users, who will use the system; and the tasks that will be performed on the ambient interfaces. For homogeneous target domains such as in TOWER, adequacy can be achieved easily.
12	Participatory design and development.	Stimulation of users to contribute to the design of the ambient interfaces at very early stages. The experience from the TOWER project has clearly shown that users somehow liked the ambient interfaces designed and developed by others, but that they had much more fun when developing their own ambient interfaces.

VII. TECHNOLOGIES USED FOR AMBIENT LEARNING

Ambient Display Types

When asked to come up with usable ambient display types[20], some participants described in some form or another existing displays already used to convey information, e.g. "flat screens in the porch", "whiteboard in room", "digital screens, placed on walls or tables", "display embedded in the mensa", "advertisement board", "large display billboard", "Big Clocks mounted on walls".

Others described enhanced versions of technical appliances, so far not necessarily used to convey additional information beyond their intended purpose, e.g. "Speed Control", "Smart Pen", "automatic dough analyser", "smarter electrical toothbrush", "mp3 player", "weights displays", "power outlet", "mobile devices", "bus stops" and "desk".

Although all the mentioned appliances pragmatically fulfil their specific functionality, they apparently lack a certain degree of feedback on the respective user actions performed with the appliances. New display types utilising mainly visual appliances (example windows, glass or mirrors, "view from any window", " window, mirror in any

room", "glass display", "car windows") were then described by the remaining participants.

Table 2 portrays the various scenarios and the corresponding technologies[18][19] that can be used to achieve Ambient Learning.

Table 2. Ambient Technologies used in different scenarios

Sr. No.	Scenarios	Technologies Required
1	Imparting vocational training to busy professionals from a scientific magazine database	Text – to Speech Engine
2	Help Desk: Responding to the queries of students/ clients etc.	Natural language generation
3	Tutor speaks and the input gets converted to the plain text. This plain text can be displayed on the screen as important points to be noted by the students.	System input recognizer/ Generator (Sensor)
4	Virtual Teaching by a non existing character	Embodied Agents
5	Automatic slow music generation for meditation when light gets dim.	Light Sensors

VII. CONCLUSION

Ambient learning is a pragmatic and easy to use training system which is designed to deliver highly individualized information by integrating several content sources and providing them via multimodal interfaces by using broadband and other various technologies. The main distinguishing features of the ambient learning service to other e-learning approaches are – 1. Multimodal Broadband Access 2. Context Management 3. Content Integration. Multimodal Interfaces that can be used for Ambient Learning are: Multimodal Mobile Interfaces, Spoken dialogue systems and Embodied agents. Ambient Learning facilitated by various technologies makes learning more easy, efficient and effective as compared to E learning.

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