



Human Computer Interaction Based on an Integrated Design of Real and Virtual World

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Abstract: This research has focused on the idea of Groupware Matrix and Roomware and placed them in the field of integrated design of real, physical, architectural spaces and virtual, digital information spaces. Roomware main idea is the computer-augmented components in rooms, e.g. furniture. The general approach is to gather information via examples from i-LAND project where developing various Roomware devices to introduce the meaning and the use of interactive information and cooperation design. It describe i-LAND that consists of DynaWall, Interact able, and ComChair. i-LAND requires and provides other components of human-computer interaction and new forms of computer-supported cooperative work (CSCW). This helps the designer to gather information from architectural spaces and implement a new work practices and design. i-LAND also consists of various "Roomware" components, i.e. computer-augmented objects integrating room elements with information technology. It present the current realization of i-LAND as an interactive electronic wall, an interactive table, and two computer-enhanced chairs.

Keywords: HCI, Roomware, CSCW, Augmented Reality, Virtual Reality

1. Introduction

The main concept of this research is to introduce I-land [4] [5], which is one of the methods of Roomwaring [1], thus before completely move into i-land, also have described a bit about Roomware concept. This paper also tried to bring examples of applications of I-land, recognize the advantages and disadvantages of I-land and try to give the reader knowledge on how and where to use the I-land concept to make a room comfortable for a teamwork project.

I-land method helps the designer to design Roomware components using real, virtual and digital environment, e.g. furniture, walls, chairs, tables and etc, in one sentence I-land leads to think how to use the technology to architecture the room components. The main methods that cover via I-land are DynaWall, Interact able, CommChair [1, 2]. Each of these methods helps in designing different components of room, e.g DynaWall concept is for covering the room walls with electronic equipment, or CommChair helps to design a chair

and so on.

Groupware matrix is represented according to time and place. This classifies the groupware system in to four parts. First column of the matrix introduce the same time or synchronous which e.g. is chat or audio/video communication when both receivers should be presented at the same time, the second column represent the asynchronous or different time e.g. email, or offline messages which in these cases the message has been received and the receiver should read the message when they will be online. Other component of matrix are the places, it is also divided in to two groups whether it is in same place or different places. In the case of chat or communication the receiver can be in different places and also for email receiving, it is in the case of different time and places since it's not necessary for the receiver to be in the same place or to be in a communication to get the email [8]. The main propose which is Roomware depends on same place and same time.

To understand the concept of Roomware first it can bring an example: First let's say a group needs to do a project, they

should meet up together and divide the work to individual. The group members should meet again to discuss the result together, for this purpose the room for project discussion, they will need a big display table that every member of a team will be able to see the project. They also need chairs they can move the chairs over the table to see the project from the different side. For this purpose need the Roomware conception, Roomware means the integration of elements like doors, tables, chairs or other furniture, with computer-based devices. Roomware purpose is to make the room comfortable for a project meeting, using different technology method [2]. Roomware is also depends on the environment of project. There are different forms some of them are represented here [1]. The i-LAND environment: The DynaWall, The CommChair, The InteracTable and The ConnecTable.

2. Literature Review

Through this research have searched many papers, and gain different information from different fields. This research is somewhat similar to the Roomware concept mentioned in Roomware toward the Next Generation of Human-Computer Interaction Based on an Integrated Design of Real and Virtual Worlds [1] and Roomware for Cooperative Buildings: Integrated Design of Architectural Spaces and Information Spaces [2] as both of them concentrate on Roomware and the design of real architectural space and virtual information space using CSCW, UbiComputing, AR approaches and their relations. It is important to say that most of the work it has consulted the case of Computer Supported cooperative work (CSCW) parallel related with their ideas. It used these works to be main reference, but the other works can be used as a sub references to help the reader to get a clear idea about this research.

Amongst this researches in the article "A Framework and Implementation of User Interface and Human-Computer Interaction Instruction" [12] gives a general concept of designing and implementing user interface related to Human-Computer Interaction. It used the concept for getting preliminary information about Human-Computer Interaction and the implementation before it get through the Roomware concept.

It is also considered it necessary to have ideas or concepts about "Groupware", therefore it refer to other articles about Groupware and Computer-Supported Cooperative Work in the College Classroom [9] and Survey and comparison of CSCW Groupware applications [13] which together give a whole concept of "Groupware" and its application. In this research didn't go much through the "Groupware" but have mentioned thus it was necessary to have a concept.

To introduce the Roomware concept used some well-known methods e.g. i-LAND: An interactive Landscape for Creativity and Innovation [5], dynaWall, CommChair, connecTable, interacTable and passage mechanism from Software Infrastructure for Ubiquitous Computing Environments [14], Architecture of BEACH: The Software Infrastructure for Roomware Environments [4].

It has researched in articles which are related to Roomware concept, it is hard to mention huge differences, but there were articles, e.g. Human Computer Interaction: Concepts, Methodologies, Tools, and Applications [15] and The Human-Computer Interaction Handbook [16] which mostly concentrated on human-computer interaction. It has chosen these sources in a way that can have more concepts on Roomware, individually, related and their application in many different cases.

In these last decades there were many developments, implementation of applications and challenges in the field of human-computer interaction (HCI). A high usage of this field was/is in the fields of World Wide Web application, 3-D representations, and virtual reality. To help in improving human-computer interaction design and the related application development; decided to develop different approaches related to Roomware which will have a great affect in designing world. Based on this research it has select i-LAND Components: DynaWall, CommChair, InteracTable and ConnecTable. The main concept is to show the relation of i-LAND for creating a room component.

The incorporation, and explanations are all aligned with the this research hypotheses specified below-

How i-LAND can be used for design and implementation and head the reader for further innovation to develop workspaces based on virtual information space and real architectural space?

Among i-LAND components, didn't recognize any component that users have the ability to connect from their offices or homes. So it has decided to bring a new design idea which is integrated from i-LAND model component.

The general goal is to propose a new Roomware component using i-LAND components.

Before start this work and decide that exactly about what topic are going to write about first discussed about the methods of research in literature and tried to understand the methods, but since hadn't yet decided the topic it was not clear, that which method exactly fits to research. It is started to search through articles that where and how human computer interaction are used and virtual and real architecture, read about Collaborative computing, augment reality and ubiquitous computing and even about the time and place matrix in collaborative computing, which among these subjects encountered with the Roomware concept, which sounds interesting, but it was a wide area for research so it summarize this research topic, and start to search articles about i-Land method, which was one of the methods for constructing Roomware components in human computer interaction field.

Finally decided to choose inductive method, since it has decided to bring a new design idea which is integrated from i-LAND method different components, and it is mainly focused to be used in group meetings in office and main research was to read different and many articles around human computer interaction, Roomware and i-LAND topics and to see why i-LAND components are used in many places and what are the main concepts of i-LAND? Most of the sources

that have used were to search through internet, find different articles collect pictures regarding the topic of research, and find examples.

3. Extended Background

This section shows how room components are changed to a high tech room component using Human Computer Interaction (HCI) and how it fulfill the requirement during group meeting e.g. table, chair, board and other assembly tools of the next human generation.

In previous times people were using more papers, paper letters and calculators in their offices, and their offices were getting more occupied and confusing with papers and files. Nowadays with the presence of information technology designers can integrate technology with other room components and make more human-computer interaction based components for offices collaborative uses. It will not only help users to keep all the information and files in a distinct place but also will help them to do their daily work faster [1, 10].

Information technology also helps the organization teamwork, e.g. interactive table which is a project table where group members are able to connect their project to other group members and display in table instead of drawing or writing the project again from the beginning on a paper. The other advantage is that you would be able to do your work part from home, or other places. With this people's time will not be a big concern, since they can work in different time and places [1].

In these days offices are more used for group meeting than individual work places, since every partner has the ability and the opportunity to do the work, but for every project there are critical moments which force the group members to meet and discuss the project. It forces the interactive designer to think about methods or new interactive components to be dynamic and flexible. Thus, the room environment should be created for cooperative works rather than for individuals [1].

For developing Roomware, or in human-computer interaction need to have some background knowledge of different fields that human-computer interaction designers use, here it has brought a small description of augmented reality and ubiquitous computing [5].

In the field of human-computer interaction augmented reality helps the designer to integrate the real and virtual world, and add digital information to other components, and construct a new artifact and powerful component [5]. Augment reality also concerns how to extend our physical world with a virtual world, by using computational devices, and to use it everywhere in our life and not getting limited by a computer in an office [11].

In order to use augmented reality, it is required to have a wide spread of network information devices, in various ranges and sizes. This is the idea of ubiquitous computing; some of these devices can be represented as computers and others are "invisible" and allocated in the environment [5, 11].

Ubiquitous computing gives the opportunity to extend the human-computer interaction technology toward the outside

world and not just limit ourselves to a small office [11]. After building and embedding these devices in the environment, due to the existence of many devices, that are supposed to think first how to connect these devices together, either to send and receive information or other future uses, and second where these devices are placed [5].

To create a new component for a room it need to integrate different spaces. The following figure-1 is a summarized guide to how and what it should use and what is the main subject [1].

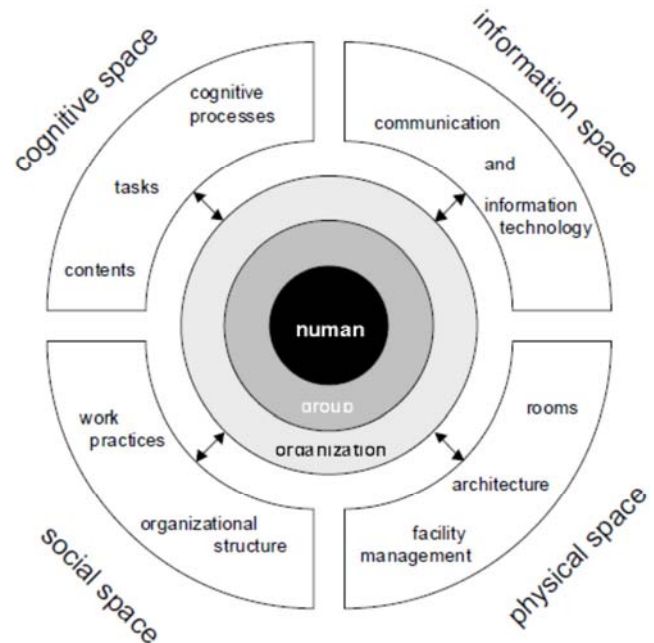


Figure 1. Four design perspectives for the work spaces of the future [1].

For creating a Roomware component it should first think that all have to do is to serve the human or a team which are working in a project. These spaces consist of social spaces, physical space, cognitive space and information space. If a designer was able to create the component by using all these four spaces, it may serve a large quantity of project teams. For example, a cognitive space guides the solution of a task, an information space gives the details which are necessary for creating the component, a social space prepares data about work practices and organizational base or structure, and physical space provides the component which will be integrated in order to create a new room component. The inner shells of this figure means that the organization divides into groups and groups are constructed from humans [2, 9].

4. Theoretical Concept on i-Land Components

Roomware in human-computer interaction means, integration of room components and computer technology to make a new hi-tech component for a room. The i-LAND method is one of the human-computer interaction methods which brings ideas and new forms for designing

room-component by means of human-computer interaction for offices and rooms, to make group mates work with artifact easier such as commChair, interacTable, dynaWall and connectable [5, 7].

In the end of this chapter have brought a new example HomeConnect, which is the integration of these four components with connection opportunity, although there exists other i-LAND components e.g. BEACH, palmbeach and magNet that in the future other developers can integrate the advantages of these components with HomeConnect because those have wider moving and connecting ability, but for the infrastructure of HomeConnect the three forms of i-LAND that will mention in the next chapter are enough [5].

Here it has presented four components of i-LAND which are: DynaWall, CommChair, InteracTable and ConneCTable [3].



Figure 2. Roomware (2nd generation), Design [3].

DynaWall is an electronic wall which integrates a wide computer screen with a tangible system. It is designed for group meetings room where the members of the group can see and integrate their information together. The tangible system of the DynaWall gives the benefit for the whole group to delete, create, move or copy different part of their project and replace it in different corner of the DynaWall. [5, 6].

The InteracTable is a table which a tangible screen laid on it. It is designed to be used by group members, while they are sitting together around the table to connect their projects together via the table. They can also use pen or marker to design or draw graphs or write extra information on the table, or simply use their finger for connecting, moving or removing different parts of the projects [2, 7].

The CommChair is a different form of RoomWare comparing to the other forms of the DynaWall and interacTable. It doesn't include a tangible system, but instead it consists of a chair with arms that anytime group members need to use for their group meetings they simply turn the chair's arm in 90 degrees and open the connected computer screen on the armchair.

The system gives the facility to group members that they can bring their laptop and just use the chair and desk or they can use the chair's connected computer. It is also flexible and has wireless connection which provide a connection among partners to transfer files via wireless, but users can also use their own private work spaces in CommChair Computers, and the computers has the system to identify their user information, so it is a benefit for security system to distinguish the users [5,

6].

Another component of the Roomware is the conneCTable; it is mainly designed for individual use although it can be used in small groups also. The ConneCTable has been constructed from a computer screen and a base which holds the computer and move it to different places in the room. This component has different features, the height of this component can be varied depending on the user either where he or she is standing or sitting, and it can be moved to different places in the room regardless of the sitting place. It has also wireless connection system [2, 5].

4.1. Proposed Component for i-Land

During this research, gained a lot of information, about the Roomware components based on "i-LAND". This information helps us to think of a new examples or components for a room, which is somewhat integrated from DynaWall, InteracTable, CommChair, ConneCTable and also how different devices or components are connected together in a room.

Nowadays most of the team workers are far away or are not able to be in a project meeting at time due to other problems e.g. transport or project with other groups, and meanwhile they are supposed to be present in their meeting, or other group partners need their information to complete their project. This force us to consider on how, and for what reasons to, create a new Roomware component which will help partners to be present in the meeting where necessary. It also helps them to not waste time during transportation. The component that think about to be designed in the future is, constructed from a tall and large glassy screen on a strong metal and will be allocated instead of chairs around the project table. This new device which is somehow has the CommChair features, has the ability to be moved and controlled along the room by the users via their offices. The same device is also located in the partners' office or its software is installed inside the computer or any other technology so it will start to act and behave as the new device, which will allow the project partner to login and to know the meeting schedule and connect to the project room via the screen.

The benefit of the controlling or moving the component, helps the user to turn the glass with different degrees of angle, to be able to watch other partners or the project table or wall and even move the glass over the room in different directions to use and connect to other devices in the room. These glassy screens are also able to transfer files from the users' device or screen to the main screen on the wall, the project table or other partners' devices that are using the same technology, so the others will be able to connect their project to the main project via the wireless connection or to draw a new project together since it is tangible, but it has input and output system where users can connect other devices to control the system, and this device can be charged by wires.

This device has a small but strong specific character. Sometimes there are critical moments which group members' need their partners' help, but the partner has turned off the device for sometimes, but it will turn on and call the user with the emergency signals, which can be located on a mobile and

other places, where they can find the user for sure. Beside all of these features, that are mostly concerned about the security of the device, so it is considered it's necessary that each group have their own username and password, and secondly they need to register for using the meeting room which is occupied with the components until they will finish their project completely.

4.2. Architectural Framework

The four components that have presented and explained about are more effective when a group is using all of them together at a meeting in a room. These systems have a high capability of sharing and connecting between different group members. They also provide the opportunity to add a new member to the group or for users to use new component in the room parallel to other Roomware components.

All the mentioned components in this article commChair, connecTable, interacTable and dynaWall has wireless connection ability, so it helps group partners to transfer files and get updates immediately. The connection that partners use in their room to connect to other team member is LAN [5]. The network will build using wireless router with HomeConnect device. HomeConnect has a USB port you can easily connect with your PC.

HomeConnect uses hardware components and software components together; they provide a wide range of use in human-computer interaction. Software components lets the HomeConnect display the project on the screen, to be transparence, colorful and three dimensions and play sounds [5]. This method serves groups in many various fields of works e.g. programming groups, management, architecture, university teaching system and supports the groups with IT fields.

To connect with HomeConnect device use software (e.g sound and graphic control software) that has ability to connect with i-LAND components. If install this software then user can use database and also share information with other i-land components. When user want to connect with i-LAND components at first he/she should use an identity and a password for login. The HomeConnect also use BEACH software, since it is integrated from other i-land components, and those components are also using BEACH software. BEACH software is for framework and other group work artifacts [5].

5. Analysis and Results

The i-LAND application is to serve a team project by helping a Roomware interactive designer with new guides for creativity and innovation with new functionality and techniques. i-LAND gives the ability and makes it comfortable for a team to work with new ideas. It also makes it possible to present wide information on a big screen like DynaWall, or InteracTable which also allows the partners to connect their project together and display it at once.

To present a new i-LAND component, it is also necessary to know what the lacks are and problems for teamwork projects, so i-LAND will help to gather new information about the requirement and how to make connection between these

components and new components.

Like every other component or device, HomeConnect also has advantages and disadvantages, and it also depends on where people what to use the component, and for what purpose. Here brought the advantages and disadvantages of HomeConnect that will allow the user or interactive designer to think about the use of this component.

If partners are not able to present to the group meeting in a room, this new component will allow them to be present at once in the meeting without losing time. The device has the ability to send and receive files from and different technologies which uses wireless connection. It is designed to control and move the device over the room and get connected to other components, and share information and the projects, it is designed to be dynamic and connection ability. It also helps to connect to other group rooms and discuss their project with two or more groups together without previously scheduled meetings. It has a high security, so the partners are supposed to login and the device will check and identify and let them too use it, because this device has the ability to keep the files and projects for the next meeting of the group. The device constructed of many output-input parts that can put CD to install new program, update the device, connect to mouse or keyboard, printer or other useful devices.

The cost is high, to use this device, it should use different and highly cost equipment, and after all it should be also prepared and used more than one, because it serves to a project group. If others need to use this device in a room from their places, they should first install the software, and due to the different technologies this device software may or may not work appropriately.

6. Conclusion and Future Works

In this paper presented that how can integrate and implement different part of i-LAND forms together and create a new component for a room with real and virtual architecture. Although i-LAND method have facilitate interactive and cooperative works but new integrated components will also make easier for group works in different time and places.

It has developed a new example of Roomware device, homeConnect, using i-LAND. It is somewhat related to the CommChair. It is mainly concentrated on how to make it easier to for a group partner to use the project room, from their offices, due to the distance and the places, and the relation of this component with other i-LAND component. At first it has more concentrated on the meaning of Roomware and its component and how those components are related and work together by using different developments as ubiquitous computing, augment reality, computer supportive cooperative work (CSCW). The main concerns of this paper was to represent i-LAND technology more deeply and the components which are developed by this concept. Then explained and discuss about DynaWall, CommChair, InteracTable, ConnecTable and their functionality in a room. It has chosen to do this because it helps team partners to do their projects faster and present an effective work and avoids from

doing basic mistakes or wasting time, since saving time is an important issue in group meetings and especially for multi-job employees.

In the future when it will be necessary to develop a new component for a room using i-LAND technology, this paper can give a fast and thorough description, basic information and also given example can lead the designer to create its own example or to integrate and use other i-LAND, Roomware component or parts. This example with compare to other Roomware examples is that it allows the user to connect to other partners and to transfer and receive files from other users via the components' wireless, infra-red or other file transferring methods, and also be able to watch and move over the room. It is also considered it necessary to bring the advantages and disadvantages of the devices, because it acts like a guide to show the designer the reasons of creating this new idea and since most of the interactive designers were not familiar with the i-LAND method and its components, this would be a good opportunity for gathering information and i-LAND offers different configuration and combination of components, and how the given idea match with i-LAND.

References

- [1] Roomware: Toward the Next Generation of Human-Computer Interaction Based on an Integrated Design of Real and Virtual Worlds. Norbert A. Streitz, Peter Tandler, Christian Müller-Tomfelde, Shin'ichi Konomi, Human-Computer Interaction in the New Millennium, J. A. Carroll, ed., Addison-Wesley, 2001, pp. 553-578.
- [2] Roomware for Cooperative Buildings: Integrated Design of Architectural Spaces and Information Spaces. Norbert A. Streitz, Jörg Geißler, Torsten Holmer GMD - German National Research Center for Information Technology, IPSI - Integrated Publication and Information Systems Institute Proceedings of the First International Workshop on Cooperative Buildings (CoBuild'98), Darmstadt, Germany, February 25-26, 1998. Lecture Notes in Computer Science 1370. Springer: Heidelberg, pp. 4-21.
- [3] Roomware: Computers Disappear and Interaction Evolves Thorsten Prante, Norbert A. Streitz, Peter Tandler, Fraunhofer IPSI, Darmstadt, Germany. 0018-9162/04/\$20.00 © 2004, IEEE December 2004, Published by the IEEE Computer Society.
- [4] Architecture of BEACH: The Software Infrastructure for Roomware Environments Peter Tandler GMD – German National Research Center for Information Technology, IPSI – Integrated Publication and Information Systems Institute, AMBIENTE – Workspaces of the Future. CSCW 2000: Workshop on Shared Environments to Support Face-to-Face Collaboration, Philadelphia, Pennsylvania, USA, December, 2000.
- [5] i-LAND: An interactive Landscape for Creativity and Innovation Norbert A. Streitz, Jörg Geißler, Torsten Holmer, Shin'ichi Konomi, Christian Müller-Tomfelde, Wolfgang Reischl, Petra Rexroth, Peter Seitz, Ralf Steinmetz GMD – German National Research Center for Information Technology IPSI – Integrated Publication and Information Systems Institute, Germany Published in Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI'99), Pittsburgh, Pennsylvania, U.S.A., May 15-20, 1999. ACM Press, New York. pp. 120-127.
- [6] Roomware®– The Second Generation Norbert Streitz, Thorsten Prante, Christian Müller-Tomfelde, Peter Tandler, Carsten Magerkurth Fraunhofer Gesellschaft für angewandte Forschung e. V., IPSI – Integrated Publication and Information Systems Institute, AMBIENTE – Workspaces of the Future Dolivostr. 15, D- 64293 Darmstadt, Germany Publication: Proceedings, Publisher: Association for Computing Machinery, Inc. Date: Apr 20, 2002, Copyright © 2002, Association for Computing Machinery, Inc.
- [7] Roomware- IPSI-Institute Integrierte Publications' and Information's system [Dr. Dr. Norbert Streitz, 2003].
- [8] Computer Supported Cooperative Work Marek Mrázik, Advisor RNDr. Richard Ostertág, COMENIUS UNIVERSITY FACULTY O.
- [9] MATHEMATICS, PHYSICS AND INFORMATICS DEPARTMENT OF COMPUTER SCIENCE, BRATISLAVA, SLOVAKIA BRATISLAVA, MAY 2007.
- [10] Groupware and Computer-Supported Cooperative Work in the College Classroom Journal article by Lynne M. Scalia, Benjamin Sackmary; Business Communication Quarterly.
- [11] Interfacing with the Invisible Computer Kasim Rehman, Frank Stajano, George Coulouris. Laboratory for Communications Engineering, Cambridge University Engineering Department, Source Nordic Conference on Human-Computer Interaction; Vol. 31 archive Year of Publication: 2002, ACM: Association for Computing Machinery, ACM New York, NY, USA.
- [12] Living in Augmented Reality: Ubiquitous Media and Reactive Environments. William A. S. Buxton (1997) Computer Systems Research Institute, University of Toronto& Alias | Wavefront Inc., Toronto, Video-Mediated Communication, 363–384. Hillsdale, NJ: Lawrence Erlbaum.
- [13] A Framework and Implementation of User Interface and Human-Computer Interaction Instruction, Alan Peslak, Penn State University, Dunmore, PA, USA.
- [14] Survey and comparison of CSCW Groupware applications, JITEN RAMA, University of Pretoria, South Africa and JUDITH BISHOP, University of Pretoria, South Africa, Proceedings of SAICSIT 2006, Pages 1 –20.
- [15] Software Infrastructure for Ubiquitous Computing Environments: Supporting Synchronous Collaboration with Heterogeneous Devices, Peter Tandler, GMD – German National Research Center for Information Technology, IPSI – Integrated Publication and Information Systems Institute, AMBIENTE – Workspaces of the Future, Dolivostr. 15, D-64293 Darmstadt, Germany.
- [16] Human Computer Interaction: Concepts, Methodologies, Tools, and Applications, Panayiotis Zaphiris, City University of London, UK, Chee Siang Ang, City University of London, UK.
- [17] The Human-Computer Interaction Handbook, Andrew Sears, Julie A. Jacko, 2005.