Intelligent Interaction

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Abstract

Interaction with computers is in most cases predefined. Computer systems are not learning and thus are not adapting to situations. As a result the effectiveness of today's interaction interfaces is limited, users are often not enabled to optimize work flow, or even worse, tasks cannot be accomplished at all. By the lack of contextual understanding of the underlying system, the elements of interfaces become generalized, so they fit in as many situations as possible. This again leads to confusion on the user side and results in a longer learning curve. Simply stated, an adaptive system lets the user concentrate on the task and finally the clutter of interfaces vanishes. In building adaptive system, we face different problems. The key problem of making an intelligent application is: how will the application evaluate the situation? How will it choose the best action? To solve these questions, and to find out more about how "natural" interaction between humans and machines happens, we built the intelligent room. Before the actual implementation of a learning system started, we decided to test our assumptions with a faked system. By this we came to the conclusion that many methods can be used to interact between humans and computers and second that learning by a system can help the user accomplish the tasks.

Keywords

intelligent room, machine learning, adaptive system, human computer interaction.

Research question

How can an adaptive system improve interaction between humans and computers?

To whom is it relevant

The intelligent room example is used as a proof of concept. An intelligent application that adapts the computer's behavior to the context can be relevant for everyday life. As a result an implementation of these concepts could run on modern cell phones or PDA's, which have sensors like accelerometer and GPS. These devices would adapt their behavior according to the context of its environment.

Despite numerous projects [1,2,3] in the domain of intelligent rooms, interaction in the living room has not changed significantly, since the invention of the remote control. If successful, our work could help taking the domain to the next level.

Evaluation and implementation

How do humans interact with systems that claims to be intelligent

In the field of human-computer interaction, a Wizard of Oz experiment is a research experiment in which subjects interact with a computer system that subjects believe to be autonomous, but which is actually being operated or partially operated by an unseen human being [4].

In our case the Wizard of Oz aims to find the best relationship between user movements and the system. The results help modeling the system's behavior. In our experiment we instructed the users to interact with the room as a master, considering the room as their slave.

The numbers of participants in the experiment were six. There were two 22 year old German students with a computer science background, a 25 year old Cameroonian student with an information technology background, a 22 years old German woman studying history, a 21 years old French women studying German language and a 40 year old teacher assistant.

Instructions for the experiment were provided in advance. The users were asked to play a simple game:

1. Projector is on standby. Please activate!
2. Follow the instructions on the presentation slide
3. Select any music track to play and relax
4. Maybe you would like to turn on the fan and refresh yourself
5. Thank you! Please turn off the lights and kindly leave the room

We then observed the spontaneous interaction between the users and the fake system. Our setup for a potential intelligent room contained a projector, a fan, a table, a chair, a lamp, speakers and a camera to record user's actions. The users had to fulfill simple tasks like playing music with a media player, scrolling up and down slides of a presentation, turning the projector on, turning the light on and off and turning the fan on and off. The users were informed that the system is capable of understanding what they want.

The analysis of the experiment gave new ideas to design the system. The experiment showed "dimension of movements" (distance to screen, movements of limbs, different gestures) that work easily and can be easily picked by users.

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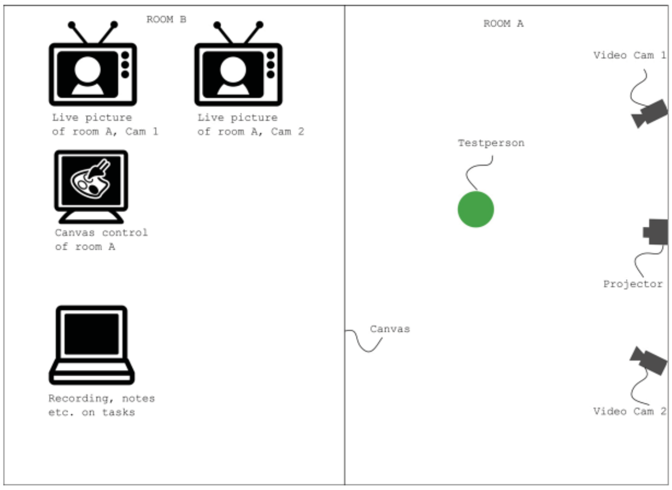

Figure 1

Observations:
• Free interaction of users with the system meaning users choose their own way of interaction. The user has not to give his attention to the interface. The user feels independent of the technology running in the background.
• Users provide natural language or other unscripted input to interact with the system.
• Some Users were uncomfortable doing hand gestures.
• If users are given the freedom to invent their own gestures, then they use complex and absurd gestures.
• Users expect system to be smart enough to take their feedback and implement it.
• Users became happy and satisfied if the system works smartly with minimum of effort from user.
• Users use mental model concepts to adapt to the new system.
• Users get surprised and confused if the system behaves automatically and it makes the user to think, how it happened?
• Computer science background people adapt easily to the system. Users who took time to adapt got frustrated.

How can feedback from the user be evaluated?
Modeling as system that adapts to people's changing usage patterns adds new interaction capabilities.

Our system consists of four main subsystems: action detection system, world model, critic system and actuation system. The subsystems when integrated, work as an intelligent system. The world model of our intelligent room basically consists of all possible states occurring in the environment along with associated actions and events which are likely to take place at each state in an period of time. Along with a critic system the world model is considered the core system of our intelligent environment. It generates all possible states and instances, along with the possible actions for every state. Being at a state "x", the user has a limited number of possible actions to take as well as possible events which will take place at that point. The feedback of the user is very important for the adaptive system.

Moreover, at each level, the system compares the set of actions at that state with the implemented action by the user and analyses which action should be taken for future simulations. In other words, the World Model has a method which calculates the distance between the current and the given state, and checks if the distance is reasonable, thus choosing the best reasonable action to be taken among the set of output actions provided by the world model. In addition, the world model connects with the critic system through an XML infrastructure; it calculates the reasonable states according to a given state (provided by the critic system), and informs the critic system about possible actions at this given state as well. The critic system assigns rewards for such actions and sends feedback to the world model which itself will update the set of actions specifying any new modification to the appropriate set of actions associated with the given state.

What are the parts of ou adaptive system?

As mentioned earlier our system is divided into different parts which integrate into a pluggable subsystem. Communication takes place with XML-formed messages. One part of the system reflects the current state of the environment, it is an instance of our surrounding world. To be able to catch changes in the environment the room has sensors built in that detect the actions of the user or variances of the setting like temperature and light level. As a result movements of the user from one part to another of the room, gestures (with the help of accelerometers) and other inputs are noticed by the action detection. The world model holds the current state of the environment and communicates with the critic system to enable rewarding of actions and to give a list of reasonable system actions as an input to the critic system. The main function of the critic system is to assign a value to each possible action computed by the world model. This value is based on a specific algorithm to select the best action to be taken among a set of actions. This selected action is then executed by the actuation system. This includes the facilities that enable the room to take actions like turning the projector on or off, switching the light or playing some music.

Conclusion

The architecture for the intelligent room has been designed. We are working on the integration of the four subsystems. Basic features of the intelligent room are working already. To improve our system, we have planned to test our system after each iteration of development. After each iteration, we would be doing the Wizard of Oz experiment, for testing our real subsystem and by faking only unfinished parts.

When ready, our system can be translated to other environments. One way to do this would be to built small instances of parts of the environment. This could be applied to mobile devices enabling adaptive and context aware systems.

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