Attentive Interfaces – Summary

Svetlana Slavova
Department of Computer Science
sds797@mail.usask.ca

ABSTRACT

This work is a summary of five research papers in the area of Attentive Interfaces. Its main goal is to provide a description of an attentive user interface and its current state by presenting some of the existing systems. These systems refer to a common question – how to augment the modern mobile devices in order to provide intelligent tools that understand the users' focus and react in a proper manner, depending on the situation? In addition, the summary presents several solutions as well as some of their limitations.

Keywords

User Interfaces, Attentive Interfaces, Summary.

INTRODUCTION

The IT industry has progressed significantly since its beginning – from mainframe computers and personal computers, to mobile and ubiquitous devices such as laptops, cell phones, PDAs, and BlackBerries, connected via wireless network [1], [4]. The different hardware generations require appropriate human-computer interaction environments. However, the user interfaces do not provide a common environment so that all computing devices to be used at any time and to increase the user's productivity. Instead, the devices work stand alone and each of them requires the user's attention [1], [5]. At the same time the user's attention is a limited resource that could not handle unlimited interruptions from the computing systems [1], [4], [5]. On the other hand, the devices may interrupt the user in inappropriate moments [3], due to the "lack of knowledge about the task focus" of their clients [4]. All this results in the appearance of the following essential question: How to design and manage different by nature devices, so that they could communicate, negotiate, and achieve agreement with one another, learn from the user's behavior, and prioritize the tasks, rather than distracting the user all the time?

The solution is to integrate a system that follows the user's focus and activity and prioritizes his/her tasks in order to increase the client's efficiency. This lead to the appearance and the development of a new category user interfaces – Attentive User Interfaces, "that are sensitive to the user's attention" [1].

ATTENTIVE INTERFACES

Attentive Interface is a user interface whose goal is to sense the users' behavior [1], [2]. The systems that provide such interfaces analyze different measures about past, present, and future interests of their users and as a result, prioritize at run-time the information and the tasks related to the consumer. In order to optimize the clients' attention, the attentive interfaces could be divided into two different types – explicit and implicit [2]. The former allows the user to specify their intentions explicitly (via user interface, for example). The latter focuses on perceiving client's behavior and measures his/her attention. When dealing with a sensing system, the main features are the locus of the user's attention and the corresponding span. Another characteristic, taken into consideration when building an attentive interface, is the implemented sensing technology. The sensing technology is much simpler in the explicit attentive interfaces than in the implicit ones. In the first case, a pointing device can be used, whereas in the second case, the whole body language of the person such as body-, head-, eyes-orientation, and voice is analyzed. The correct assessment of a whole set of human actions requires good understanding of the user's focus and makes the implicit sensing technology complex. In addition, the attentive interface system may store behavior patterns in the form of models about the evaluated measures. Those models can be used by the system in order to adjust to the current interests of the clients. Finally, as a result, the application may impact on the user's attentive load as well as on the system and the network performance by increasing or decreasing it.

<table>
<tr><th colspan="5">Attentive User Interfaces</th></tr>
<tr><th>Type</th><th>Sensing technology</th><th>Measured features</th><th>Impact</th><th>Model usage</th></tr>
<tr><td>Implicit</td><td>Based on body language</td><td rowspan="2">Locus/ Span</td><td rowspan="2">Increase/ Decrease load/perfor mance</td><td rowspan="2">Yes/ No</td></tr>
<tr><td>Explicit</td><td>Pointing device</td></tr>
</table>

Table 1. Features of the attentive user interfaces, presented in [2]

Vertegaal in [1] specifies that along with the body language – user presence, body-orientation, and eye-tracking, the user's speech should be taken into consideration as well in the implicit sensing mechanism. The author suggests that the attentive interfaces should be realized using a turn-taking process, so that just one device requests for the user's attention, rather than several devices at a time. In addition, instead of interrupting the user, the system may signal its request in a progressive manner.

Table 1 summarizes the presented features of the attentive user interfaces, according to [2].

ATTENTIVE INTERFACE SYSTEMS

There are several systems (Priorities, GAZE, EyeR, EyeContact, eyeLook, and eyePliance) based on implicit attentive interfaces that have been discussed in [2], [3], [4], and [5]. The systems are examples of techniques that have been developed in order to sense and analyze the users' focus and to decrease the number of users' interruptions by the ubiquitous mobile devices. Some of them are based on a turn-taking process which is similar to a conversation between people in a group.

A brief description of the main approaches is provided in the following subsections. The last subsection represents a summary of the discussed solutions.

Priorities

Priorities is a notification tool that prioritizes dynamically e-mail messages [2], [3], [5]. It is based on attentive information about the user such as rate of sent messages to particular people. The e-mails with high priority are provided to the client's pager, whereas those with low priority are not offered to the user's attention. The limitation of this approach is that it is based on statistical data about past behavior of the user. However, it is possible that the focus of the client is not the same at the current moment of time.

GAZE

GAZE is a video conferencing system that takes into account the eyes-orientation of the user as well as his/her speech action [2], [3], [5]. The main principle of the system is based on the fact that people are silent and look at the person who speaks.

EyeR

EyeR is an eyes-movement detection system in the form of augmented glasses [2], [5]. It is based on an infrared sensor that detects whether the user looks towards another device or person that has EyeR.

EyeContact

A system, called EyeContact, which helps reducing inappropriate interruptions by cell devices, is given in [3] and [5]. The authors present an attentive cell phone that is able to detect whether or not the user participates in a face-to-face conversation. It is an extension of the GAZE and the EyeR systems, mentioned above. When the user is the speaker, the speech detection is realized via microphone headsets. However, when the user is just a participant, another technique must be used. The system in [3] takes into account the eyes-orientation of the user from a wireless video camera, relying on the fact that "speakers look at the eyes of their conversational partner for about 40% of the time".

According to the collected data about the speech activity and the eyes-orientation of the user, the attentive cell phone is able to make conclusion whether or not the consumer participates in a face-to-face conversation. As a result, it updates the contact list with the current status of the user [5].

EyeLook

EyeLook is a turn-taking attentive device that is based on the EyeContact system, described above. It observes the user's attention in order to sense when the user looks at the mobile device [4]. Two applications have been developed that are built on the eyeLook system – EyeTV and EyeTXT. The former plays video when the user looks at the device and stops it when the user's attention is not on the display; the latter is a system that shows words on the display when the user looks at it. The advantage of this tool is that it allows the communication between the device and the user to be done only when the consumer desires to interact with it.

EyePliance

EyePliance is another turn-taking device that represents an attentive appliance – a combination of an EyeContact sensor and a house-hold appliance [5]. The user is able to control the EyePliance by looking at it and giving verbal commands at the same time. Since two factors are needed – eye contact and a speech command, this approach can be applied as a "pointing device for the real world" [5], in order to make easier and faster the communication between the devices and their users.

Summary

The systems, discussed in this section, represent different approaches that improve the communication between people and ubiquitous computing devices. They are examples of augmented devices that observe the users' behavior via sensing. Most of the approaches are inter-related – for example EyePliance and EyeLook are based on EyeContact; on the other hand, EyeContact is found on GAZE and EyeR. The systems are able to sense one or more attentive feature (such as eyes-orientation, eyes-movement, and speech) in order to react appropriately to the users' actions.

CONCLUSIONS

The presented papers discuss a common problem – the ubiquitous computers act independently from one another, requiring the consumers' attention at any time. On the other hand, the user's attention is a limited resource that has to be managed efficiently. These facts lead to the necessity of the development of smart devices. Instead of competing for the limited resource – users' attention, these devices should be able to observe the users' behavior, to communicate with one another, and to react appropriately, according to the users' focus and interests, without disturbing them at any moment of time.

In order to satisfy these needs, a new category of user interfaces has appeared – Attentive User Interfaces. Its goal is to sense the people's verbal and nonverbal utterances and actions and to prioritize users' tasks in order to assure more natural and cooperative interaction between the ubiquitous devices and their consumers, as well as to reduce the number of inappropriate users' interruptions.

As shown by the discussed papers, the Attentive Interfaces is an important area which reflects the future usage and development of the different by nature ubiquitous computing devices. Significant efforts have been invested and various systems have been developed so far. However, the main questions are still open – how exactly to sense the human behavior and what kind of sensing techniques and measures should be applied and taken into account when mobile devices interact with people in various social situations?

Different solutions are proposed by the researchers, some of them combine together one or even more approaches, in order to obtain a better representation of the users' interests and focus in different context and environments. Various features are used when observing the humans' activity – body language (such as head- and eyes-orientation, eyes-movement, nonverbal cues, gestures and looks, distance between people) as well as verbal utterances (such as speech and laugh). The semantics of the situations is crucial as well, since people behave in a different manner depending on the social context.

Most of the tools, presented in this work, are based mostly on the current behavior of their users (such as GAZE and EyeContact). It is important that the systems take into consideration not only present, but also past and future information about the users' actions. This would allow such attentive interface systems to evaluate, analyze, and relate past behavior to the current situations, as well as to predict the future activity of their consumers. In addition, models, representing behavior patterns, can be taken into account, in order to assure a more accurate representation of the users' focus and interests. However, due to the lack of appropriate learning techniques, very few systems based on the past attention of the users are built (for example, the Priorities system refers to this group). Furthermore, it is a challenge to develop a tool that is able to predict precisely the future behavior of the users. Sometimes, such a prediction is even impossible, since the humans' actions may not follow any known pattern.

On the other hand the further development of the attentive interface systems, which follow the actions and the whole focus of their users, rise "socio-technological issues" [5]. Augmented devices, which are connected to one another and are able to cooperate and to negotiate in order to achieve agreement about users' focus and interests, would lead to some social and ethical concerns (like trust, safety, and personal space and identity) that should be taken into consideration.

REFERENCES

1. Vertegaal, R. Attentive User Interfaces. *Communications of the ACM*, March 2003, Vol. 46, No 3, 31-33. http://delivery.acm.org/10.1145/640000/636794/p30-vertegaal.pdf?key1=636794&key2=5303618511&coll=GUIDE&dl=GUIDE&CFID=874454&CFTOKEN=16097872
2. Vertegaal, R. Designing Attentive Interfaces. *ETRA'02*, New Orleans, USA, 2002, 23-30. http://delivery.acm.org/10.1145/510000/507077/p23-vertegaal.pdf?key1=507077&key2=7853018511&coll=ACM&dl=ACM&CFID=810505&CFTOKEN=58771052
3. Vertegaal, R., Dickie, C., Sohn, C., Flickner, M. Designing Attentive Cell Phones Using Wearable EyeContact Sensors. *CHI 2002*, Minneapolis, USA, April 20-25, 2002, 646-647. http://delivery.acm.org/10.1145/510000/506526/p646-vertegaal.pdf?key1=506526&key2=3091718511&coll=GUIDE&dl=ACM&CFID=874454&CFTOKEN=16097872
4. Dickie, C., Vertegaal, R., Sohn, C., Cheng, D. eyeLook: Using Attention to Facilitate Mobile Media Consumption. *UIST'05*, Seattle, USA, October 23-27, 2005, 103-106. http://delivery.acm.org/10.1145/1100000/1095050/p103-dickie.pdf?key1=1095050&key2=1498428511&coll=ACM&dl=ACM&CFID=894459&CFTOKEN=98781103
5. Shell, J., Selker, T., Vertegaal, R. Interacting with Groups of Computers. *Communications of the ACM*, March 2003, Vol. 46, No 3, 40-46. http://delivery.acm.org/10.1145/640000/636796/p40-shell.pdf?key1=636796&key2=0932828511&coll=ACM&dl=ACM&CFID=894459&CFTOKEN=98781103