# AUTOMATIC CONTEXT INTEGRATION FOR GROUP-AWARE-ENVIRONMENTS

**B. Hurler[1], L. Petrak[1], Th. Fuhrmann[1], O. Brand[2], M. Zitterbart[1]**

**[1]Institute of Telematics, University of Karlsruhe**
**fuhrmann|hurler|petrak|zit@tm.uka.de**

**[2]Learning Lab Lower Saxony, Hanover**
**brand@learninglab.de**

## 1 ABSTRACT

Tele-collaboration is a valuable tool that can connect learners at different sites and help them benefit from their respective competences. Albeit many e-learning applications provide a high level of technical sophistication, such tools typically fall short of reflecting the learners' full context, e.g., their presence and awareness. Hence, these applications cause many disturbances in the social interaction of the learners. This paper describes mechanisms to improve the group awareness in e-learning environments with the help of automatic integration of such context information from the physical world. This information is gathered by different embedded sensors in various objects, e.g., a coffee mug or an office chair. This paper also describes first results of the integration of these sensors into an existing CSCW/CSCL framework.

## 2 INTRODUCTION

Many e-learning environments provide means for tele-collaboration among a group of learners at different sites. Typically, these environments collect various pieces of technical information about the participants, e. g., user names, IP-addresses, machine names, kind of learning scenario, lists of shared documents, etc. But most of them lack means for the integration of context information from the physical world of the learner, e. g., user location, his or her attention to the e-learning environment, potential distraction by other people, or such simple context information as temporary absence of the learner.

This paper describes mechanisms to improve the group awareness in e-learning environments with the help of automatic integration of such context information that is gathered from the physical world into the collaboration application. The underlying data is collected by various types of embedded sensors, e. g., in the office chair, the coffee mug, etc. A second step then extracts context information from this data. E. g., when the chair slides away from the computer screen, it can be assumed that the learner is distracted by some event. This context information is then reflected in the e-learning environment to inform the other participants.

Collaborative workspaces have attracted significant interest over the recent years. (See, e.g., Lopez, P.G. and Skarmeta, A.F.G. (March 2003) for a recent proposal that also gives good overview of the topic.) Similarly, embedded sensor devices are often employed to create innovative human-computer interfaces. (See Fuhrmann, Th. and Harbaum, T. (June 2003) and the references therein.) But despite the great potential, the combination of both fields has not been considered explicitly, so far.

This paper is structured as follows. To introduce common problems occurring in tele-collaboration scenarios, section 3 describes a typical episode of a (tele-) group discussion. Section 4 then shows possibilities how to deal with the specific difficulties presented in section 3. The first part of section 4 concentrates on the options of the current MACS (Modular Advanced Collaboration System) (Brand, O. Petrak, L. Sturzebecher, D. Zitterbart, M., 2000) to overcome those difficulties, whereas the second part proposes the integration of sensors to enhance the effectiveness of existing features. Section 5 explains the exemplary integration of a pressure-sensitive chair into MACS. Section 6 presents the underlying technique and general implementation information. Section 7 gives a summary and a short outlook on future work.

## 3 TYPICAL GROUP DISCUSSION SCENARIO

In this section a real-life scenario is introduced which could be seen as a typical example for a (tele-)group discussion with its common problems and difficulties.

Four students want to discuss a new project which they have to accomplish in a team. Because they all live far from each other they decide to use an audio/video conferencing tool for verbal discussion and a whiteboard application to exchange Internet links and other project related objects like sample code or pictures. The hardware of the group members is not homogeneous. For example, sending and receiving video streams is not possible for some participants due to small bandwidth of the network connection and/or missing video camera.

Right after the start of the conference the group is discussing the main principles of the project with everyone fully concentrated on the talk. During the intensive discussion the door bell of one group member (Leo) is ringing. So Leo is obliged to leave his room for a minute to open the door. Back to the discussion he realizes that the topic has changed in the meantime and the others has started to ignore him, because he did not respond to directly posed questions during his unexpected absence. So he is forced to burst into the ongoing discussion to announce his return.

Later on specific details of the project are discussed, which are not in Leo's responsibility. Therefore, he does not pay full attention any longer, he leans back and turns his chair to look out of the window. Few minutes later essential issues of Leo's part of the project are mentioned. Because the other participants are not aware of Leo's distraction they do not inform him about the topic change. So Leo remains passive, thus loosing important information.

At the end of the discussion the group realizes that not only Leo but other group members as well did not follow the discussion all the time. They cannot find out exactly which parts of the discussion individual members either received or missed. Therefore, they decide to meet physically next time thus allowing absence or distraction to be observed directly.

## 4 USING SENSOR DATA FOR IMPLICIT CONTEXT INFORMATION

With MACS, an earlier development of a group-aware collaboration tool (Institute of Telematics, University of Karlsruhe, 2002), the above described scenario would be handled as follows.


**Fig. 1** Virtual meeting room in MACS

Leo creates a session and invites all participants to a virtual meeting room (see Fig. 1). In this room all participants are displayed by small thumbnails. Each member is able to see all of the thumbnails. Various information about the participants' resources are represented within the thumbnails. In this context, resources refer to available multimedia equipment. Leo, for example, who is capable of sending and receiving audio data but cannot deal with video streams, has a small microphone and speaker icon displayed above his thumbnail, whereas he lacks the video icon.

Furthermore, there exist different levels of user states. These states reflect the "degree of presence" (Brand, O. Petrak, L. Sturzebecher, D. Zitterbart, M., 2000). Each user has the possibility to change his current state manually using his thumbnail's context menu. Currently four states are provided in MACS, which range from "fully present", "bored", "asleep" to "temporarily absent". When Leo's door bell is ringing and he decides to stand up and open the door, he is required to change his state to "temporarily absent" by clicking the accordant context menu item. The other participants are notified of Leo's absence by the text "back soon" written across his thumbnail.

In a similar way Leo should announce his reduced attention, when the discussion topic moves to subjects he is not interested in. By knowing Leo's inattentive state the group can call him directly, when issues of Leo's field of interest are discussed. In this case Leo can reset his state to "fully present" again thereby indicating the group that he is receiving all information and is taking part in the discussion.

Providing such context information of and to all users allows the group to have more effective discussions. Unfortunately in most of the situations causing a change of state, it is not comfortable or even not possible to inform the rest of the learning group explicitly about the current circumstances.

A more sensible way to collect and propagate this kind of context information would be to omit the explicit input channels and use implicit methods instead to supply context information. Integrating a pressure sensor in the seat of Leo's chair would make it possible to manage the user state "temporarily absent" implicitly. When Leo stands up, MACS can immediately propagate his absence. Sitting on the chair again, the state changes back to "fully present" without the need for Leo to explicitly declare his return.

Leo's decreasing attention during certain parts of the group discussion could be discovered by a pressure sensor in the backrest of his chair, combined with rotation detection. As soon as he leans back and turns his chair away from screen, a lower degree of attention can be assumed. Staying unmoved and passive for a longer time, detected by acceleration sensors, may indicate non-attention, too.

## 5 EXEMPLARY INTEGRATION OF A PRESSURE SENSIBLE CHAIR INTO MACS

To substitute the explicit "temporarily absent" context information by an implicit one an office chair was equipped with a pressure sensor.

The sensor is integrated in the seat and connected with a micro controller card, which is fixed at the rear backrest of the chair (see Fig. 2). Both, the micro controller card and the desktop system, where MACS is running on, are equipped with a Bluetooth module to allow wireless communication between them.

When a session is started within MACS it initiates a Bluetooth connection to the micro controller card of the chair. During the MACS-session, pressure data is collected periodically, sent to the desktop system via Bluetooth, and handed over to MACS using a Java Native Interface (JNI) construct.

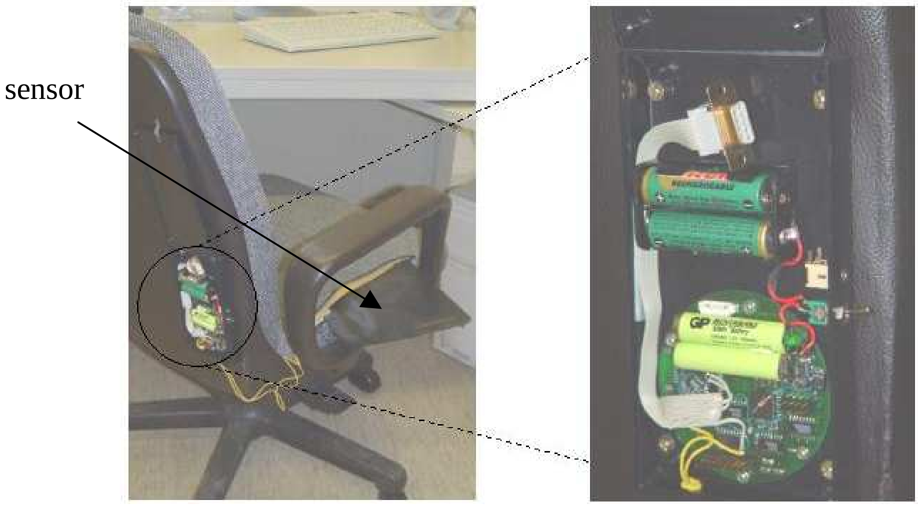


**Fig. 2** Office chair with exposed pressure sensible seat (left) and micro controller attached to the backrest (enlarged on the right)

As long as pressure is put on the seat, the user thumbnail remains unmodified. Once the user stands up and thus the sensor reports a pressure of zero, MACS changes the user state information of the thumbnail now indicating the user's temporary absence. This information is propagated to all participating MACS instances. So all members of the current session are aware of the user's momentary absence.

As soon as the user sits on the chair again, the sensor reports pressure exertion and the context information gets refreshed and indicates the user's return.

## 6 SENSOR BOARD INTEGRATION INTO LEARNING ENVIRONMENTS

Integrating sensors into an e-learning environment should be a simple task without the need for handling with hardware settings and plugging cables etc. Therefore, an autonomous unit consisting of a micro controller combined with a Bluetooth module is used to gather and transmit sensor data.

In this project the micro controller Atmel AVR ATmega 128 is used. Its built-in UART provides connection to the Bluetooth module. The whole unit is a further development of the hardware design used in the BlueWand project (Fuhrmann, Th. Klein, M. and Odendahl, M., April 2003). The detailed design of the architecture can be found there. Nearly any kind of sensor can be connected to this unit. The micro controller takes control over the Bluetooth module and the attached sensors. It accepts connection requests from MACS over Bluetooth, reads sensor data, and sends them to MACS either periodically or by request.

The workstation, where MACS is running on, has to be equipped with a Bluetooth module. At present the open-source Bluetooth stack BlueZ of Linux is used on the desktop side to establish the Bluetooth connection. To achieve a certain degree of platform independence on the MACS side, a Java interface was created. Over a Java Native Interface (JNI) attached to the C implementation of the BlueZ stack, MACS can establish a Bluetooth connection to any sensor board. For transmission of control and sensor data the l2cap protocol of the Bluetooth stack is used.

## 7 SUMMARY AND FUTURE DIRECTIONS

In this paper we described how sensors can be integrated into an existing e-learning environment. The integration of sensors into MACS is a transparent task for both, the learner using sensors for context information and his co-learners seeing his context. The context information is collected implicitly without compelling the learner to enter this information explicitly into the computer. Other users, which may or may not have adequate sensors, are not affected by this. They just see the user's context, whether it was announced explicitly by a user interaction or implicitly by sensor data.

In addition to the already integrated pressure sensitive chair, a wide variety of sensors can be thought to be quite useful for context information. Acceleration sensors have already been integrated in the sensor board but not yet used for context information purposes. By defining special cues it would be possible to qualify the momentary attention state of the user much more exactly. Detecting rotations or straight movements in one direction can be attributed to states like nervousness or boredom.

Not only chairs but many other artifacts can be equipped with sensors so that they can reveal important context information. By using this information common problems of (tele-)group discussions like unexpected absence of group members, negotiation of speaking turns, etc. can be solved. Ideally, most of the social customs which determine a 'real' meeting can be preserved in the distributed case.

## 8 BIBLIOGRAPHY


Brand, O. Petrak, L. Sturzebecher, D. Zitterbart, M. (2000). Supporting Tele-teaching: visualization aspects. Journal of Network and Computer Applications 23.

Fuhrmann, Th. and Harbaum, T. (June 3-6, 2003). Using Bluetooth for Informationally Enhanced Environments. To appear in: Proceeding of the IADIS International Conference e-Society 2003, Lisbon, Portugal.

Fuhrmann, Th. Klein, M. and Odendahl, M. (April 2003) The BlueWand as Interface for Ubiquitous and Wearable Computing Environments. Proceeding of the 5th European Personal Mobile Communications Conference (EPMCC'03). Glasgow, Scotland, 22-25.

Institute of Telematics, University of Karlsruhe. (2002). MACS Project. [On-line]. Available: http://www.tm.uka.de/projects/macs.

Lopez, P.G. and Skarmeta, A.F.G. (March 2003). ANTS framework for cooperative work environments. Computer, Volume 36, Issue 3. Pages 56-62.