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REAL-TIME COLLABORATIVE MODELLING OVER LOW-BANDWIDTH NETWORKS

Abstract: ModellingSpace is an open learning environment, which permits building of models by collaborating partners in various educational settings. This paper describes briefly the main features of the ModellingSpace environment and in particular issues related with coordination and communication during problem solving, as well as architectural considerations of this distributed peer-to-peer application relating to low bandwidth network issues. This is an interactive paper followed by a computer presentation of the described software.

KEYWORDS

Coordination of collaborative problem solving, floor control mechanisms, real-time computer-supported learning, groupware.

1. MODELLINGSPACE SYSTEM ARCHITECTURE

MODELLINGSPACE (MS)[1] software is a client-server distributed application, which comprises a suite of interconnected tools to support collaborative modeling activities. MS is an environment that supports individual and collaborative building of various kinds of models. It includes tools that permit building and editing of primitive multimedia entities, building and exploring models that are constructed using these primitive entities, synchronous and asynchronous interaction of students, collocated or at a distance who collaborate in building models. The open character of MS means that students have access to an open set of primitive entities that can be used for building these models. A result of this characteristic is that the collaborating partners may reason using heterogeneous sets of primitive entities, in order to obtain a solution, as discussed by Komis, Avouris & Fidas (2003).

The main functionality of the MS environment is described through figure 1, which shows a typical model building activity, which involves two partners at a distance. MS is based on the concept of *shared artefact,* represented in a work surface. In contrary to some other collaboration applications, in which emphasis is in communication (argumentation tools, decision making etc.), in our case the distant partners collaborate mainly by sharing the model in the work surface, which thus becomes a cognitive space. In this case the communication through the artefact is important, where one participant's manipulation of shared objects can be observed

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by the other participants. This communication through-the-artefact can be as important as direct communication between participants, as observed in (Avouris et al. 2003a). A key requirement in this context is to support sharing of a view of the model in synchronous modelling activities over low bandwidth connections, as is often the case with school laboratories connections to the Internet. In contrary to other shared workspace environments in which heavy graphical information is exchanged among partners, in MS we use a replication of the libraries of primitive entities and tools. As a result only light control messages, shown as (a) in fig.1, are exchanged among partners. In addition support of direct communication among the participants through an instant messaging tool (*chat*) is shown as (c) in fig.1.

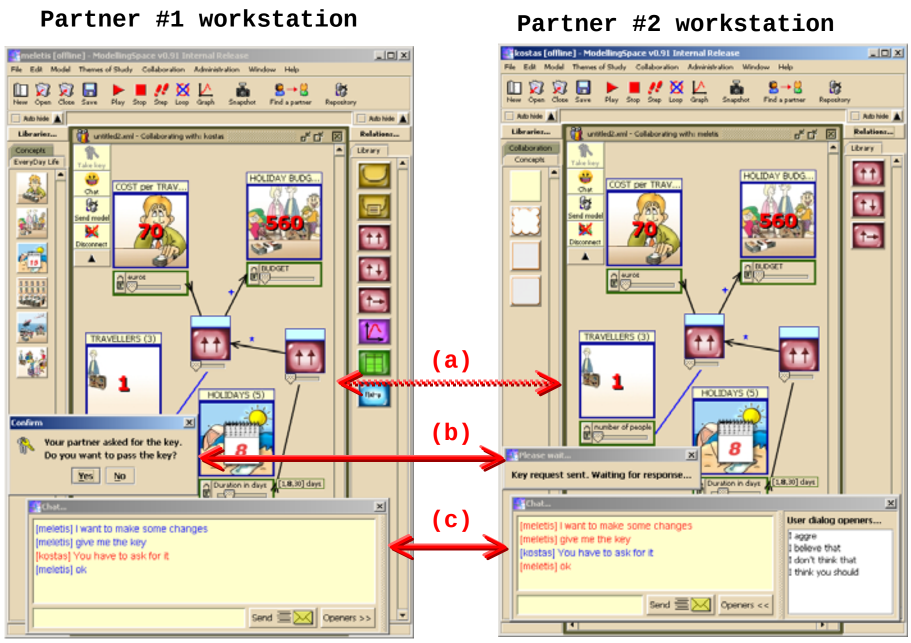

Figure 1. ModellingSpace interaction through exchange of shared workspace control messages (a), coordination control messages (b) and chat messages (c)

2. COORDINATION & COMMUNICATION DESIGN

In the frame of the collaborative use of MS, a dialogue tool has been integrated, which is based on an instant messaging protocol, using the same point-to-point connection and protocol discussed in the context of the shared activity space. Through this, text messages are exchanged during collaborative problem solving. This chat tool, which is activated from the collaboration panel, is equipped with dialogue openers. This way the user can select the opening phrase of the utterance and thus classify indirectly the speech act. This is based on a parametric approach, where the researcher is able to decide on the dialogue openers if they need to be introduced.

The coordination of partners' activity in the shared activity space is another very important aspect of the architecture. Two alternatives have been provided in relation to coordination mechanisms for ModellingSpace design. The first mechanism involves a token, the *Action Enabling Key*, which is owned by one of the participants at any given time. This key owner can then act in the shared workspace, while the other participants just observe this activity. This mechanism is supported by *key request*, *key accept*, *key reject* functions. In fig.1 partner #2 has requested the key from partner #1, the corresponding dialogue messages are shown in the two workstations. The interchanged coordination control messages are shown as connection (b) in fig.1. The effectiveness of this approach has been studied in various experiments, see (Fidas et al. 2002) and (Komis et al. 2002).

An alternative that has been also implemented, proposed especially for small groups of partners, involves complete lack of floor control mechanism. The partners can manipulate parts of the model at any time during problem solving. For reasons related to distributed data consistency, only a temporary locking mechanism of objects selected by one partner is imposed during an operation. The coordination of activities is left to the partners to decide in this case. So, the activity of a partner cannot be inhibited and no conflicts can occur over key possession. Nevertheless, in this case, implicit social protocols of organisation need to be established by the students, as discussed in Avouris et al. (2003b), in order to facilitate coordinated group activity, since explicit coordination is not imposed.

3. CONCLUSIONS

In this paper we discussed a peer-to-peer architecture that permits real-time collaborative modelling at a distance. The approach involves exchange of just control messages for maintenance of effective WYSIWIS (what you see is what I see) of the shared workspace, as well as text chat messages for direct communication and coordination control messages. These messages are at the most a few Kbytes long and therefore can be exchanged without disruption of interaction even under low bandwidth peer-to-peer connections. The effectiveness of this approach has been proven through a number of case studies in authentic educational settings, reported in Avouris et al. (2003), Komis et al. (2003).

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