Multimodal data capture and analysis of face-to-face interactions through interactive tabletops

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INTRODUCTION AND MOTIVATION

Collaboration skills are recognised as important both in learning settings but also for supporting training and group work at organisational levels. Important cognitive processes that improve learning and the generation of new knowledge only occur when individuals explain their possible solutions to others, maintain mutual understanding of the subject, and integrate present and past knowledge.

Teachers or facilitators ought to encourage enhanced collaboration skills. They may give feedback according to groups' needs. They also may use strategies within the groups so students can be more aware about their collaborative interactions. However, in practice, teachers and facilitators have to **divide their attention** between multiple groups work simultaneously. Therefore they are unaware of the processes followed by some groups.

New pervasive technologies are very promising to help collaborative work in education. Multi-touch **tabletops** and other groupware devices provide a shared space and the technology support to empower collaborative work. At the same time, they open new opportunities to capture and analyse the collaborative processes of the face-to-face interactions. These make it feasible to build tools that can support the facilitators' efforts or adaptively attend to students' requirements.

The **key contribution** of this project is the exploration of ways to capture and analyse the interactions of group members to offer adapted support to collaboration at the tabletop. We exploit the *audio and application log trace*s of activity that can be automatically captured and used in real time to help groups and their facilitators to be more aware about the status and progress of the group collaborative process.

RESEARCH QUESTIONS

Specifically, we state the following research questions:
1) Can we automatically detect **collaborative moments** or **potential problems** in group work at an interactive tabletop?
2) Can we find **patterns of interaction** that can be linked with collaborative group behaviour?
3) How can we provide **adapted support** to the collaborative activity to help learners and their facilitators?

APPROACH

Our approach has two parts. First, we have implemented **pedagogical software** that supports the creation of shared artefacts on a collaborative environment. We capture a multi-modal set of data that consists of the real time collection of the digital footprints of the users while interacting with personal devices, the tabletop and other learners.

These data include:
- ❑ *Automated speaker identification,*
- ❑ *Proximity of learners around the table,*
- ❑ *Application logs identifying who is touching the surface,*
- ❑ *Snapshots of the status of the task.*
- ❑ *Video analyses*

The second part comprises the tools for **analysing and providing support** to learners and teachers. Among the techniques we use in the project to analyse the user interactions we include *group modelling* and *data mining* techniques. These assist in the identification of patterns of interaction and moments of activity that can be used by the system to offer adapted support to both the learners and their facilitators. We also designed *visualisations* of the collaborative process to mirror information about groups' collaboration and performance back to the group members and facilitators.

INFRASTRUCTURE

Our infrastructure (Figure 2) starts with the integration of individual work performed before the group sessions into the collocated collaborative activity at the tabletop (1). We currently support the *concept mapping* activity but we plan to extend our approach to other domains. Then, we developed an application that permits group members to merge and discuss different perspectives of the same topic at the tabletop (2).
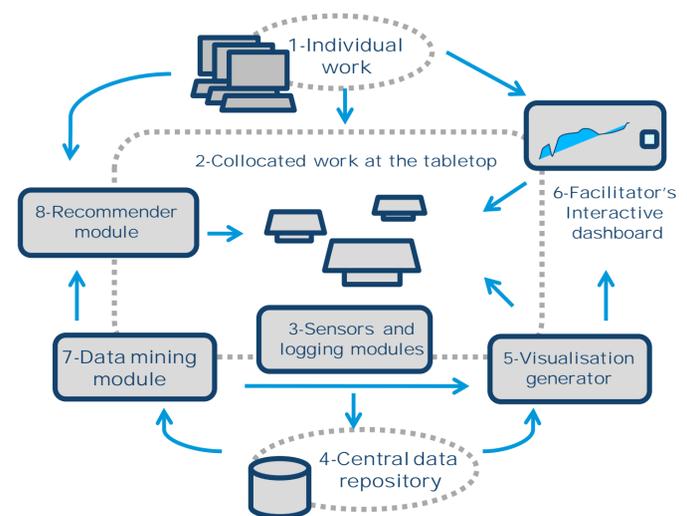

Figure 2. System architecture

We identify and capture the touches and body locations of learners around the tabletop using a *depth sensor* located over each tabletop (see Figure 1) and the speech of each individual using a *microphone array*. All the application logs are gathered at a central data server (4). Then, a number of service modules exploit the data generated in real time. These include: a visualisation generator that analyses the data and produces a visual representation of the groups activity to be presented to the facilitator (6) or back to the tabletop.

The data mining module (7) serves to analyse the data making use of machine learning techniques to highlight frequent patterns of interaction. These can offer recommendations to the group members, their facilitators, or to feed visualisations (8).

The ultimate goal of this research is to capture the model of group members working at the tabletop in order to provide adapted support to their collaborative activity, supply the resources they need to complete the task and distill the generated information to empower facilitator's judgement.

Figure 1. Tracking users' actions at the tabletop

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