Making Multimedia Meeting Records More Meaningful

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ABSTRACT

Meetings contain a large amount of rich project information that is often not documented. Capturing audio and video of a meeting can provide a comprehensive meeting record. However, finding detailed information in that record can be challenging because there is no structural information other than time to help the user navigate. This paper surveys various ways of creating indices into meeting records and introduces the notion of creating indices based upon user interaction with domain-specific artifacts. As an example, we present a prototype system that uses general team artifacts to provide meaningful pointers into the meeting record.

1. INTRODUCTION

Meetings are an important communication and coordination activity of teams: status is discussed, decisions are made, alternatives are considered, details are explained, information is presented, and ideas are generated. As such, meetings contain a large amount of rich project information that is often not formally documented. Thus, capturing all of this informal meeting information has been a topic of research in several communities in the past decade.

The most common way to capture meeting information is through note-taking. While studies [11] show a general satisfaction with note taking, 70% of people reported that there had been occasions when they wished they had written better notes. The major difficulties encountered with note taking are failure to note facts that turned out to be crucial later, not enough time to write everything, reduced ability to participate, and inadequacy of notes for later detailed understanding.

The prospective benefits of having a meeting record on the one hand and the problems with traditional meeting recording on the other hand have triggered the use of technology to create meeting records. While technology automatically captures meeting activities, humans are left free to actively engage in discussions and synthesize what’s going on around them, without worrying about tediously preserving details for later memory.

The method of the choice for recording meetings has been audio and video, which can provide a comprehensive meeting record that allows people to see who was present and what was discussed. Moreover, this recording technology is unobtrusive and ideally does not require any further interaction during the meeting once recording has been started.

The greatest problem with audio/video recordings is that they are sequential and do not provide any structural information but time to navigate[13]. A team member will not exhaustingly watch one hour of a meeting when she can go ask a colleague who attended the meeting for a quick summary. Multimedia records of meetings will only be generally useful if tools or technologies exist that help users avoid replaying much of what has been recorded [6]. People need to be able to quickly browse and access those elements of the record that are of interest to them. This kind of directed browsing, searching, and visualizing of meeting records requires meaningful indices that act as semantic pointers into the multimedia record. In this paper, we advocate using indices based on user-interaction with domain-specific work artifacts as a way of creating smarter meeting records. In Section 2, we discuss various methods of indexing meeting records, and briefly survey existing work, most of which just scratches the surface with the kinds of information that can be used as indices. In Section 3, we introduce the notion of indexing based on domain-specific artifacts, which is a little explored area. Finally, we present a prototype to serve as an example of the type of indexing we are exploring.

2. MEETING INDICES

Research has addressed the problem of indexing meeting records in various ways. We categorize existing indexing approaches into online, occurring during the synchronous activity, and offline, occurring after the activity. We further categorize indices as explicit versus derived, based on the underlying technology gathering the indices. Explicit indices are those created through direct user interactions with the capture and access software, such as an electronic whiteboard. Derived indices are implicit, sensed, or inferred through other means and are not related to direct user actions, such as using sensors or media stream analysis. The combination of these two categories leads to the matrix depicted in Figure 1.

Offline explicit indices, for example, can be created through user interactions while reviewing the captured meeting, such as allowing users to mark important sections (post-hoc bookmarking), or creating hot spots from the most frequently replayed portions of meetings. Since most of the indexing work has focused on either explicit online indices created during the
meeting or derived indices created through signal analysis of media streams, we will examine these in more detail.

Figure 1. Index categories and some related work examples

<table>
<thead>
<tr>
<th>Online</th>
<th>Offline</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. handwritten notes [2, 3, 11, 12]</td>
<td>e.g. post hoc bookmarking</td>
</tr>
<tr>
<td>e.g. slide detection [1, 5]</td>
<td>e.g. speaker identification [5]</td>
</tr>
</tbody>
</table>

Explicit Derived

3. DOMAIN SPECIFIC ARTIFACTS

Based on previous work and studies of capture and access systems and our experience with capture and access [10], we believe that an important factor in making meeting records meaningful is their connectedness with the rest of the work environment. Meetings are part of a collaborative work process. Meeting-related activities also take place before and after a meeting. During a meeting people modify existing work artifacts or create new artifacts that are persistent beyond the scope of that particular meeting. Those domain-specific artifacts often connect several meetings, with the outcome of one meeting serving as the input for future ones, such as tasks being assigned and followed up in subsequent meetings. We argue that indices into a meeting record based upon interaction with those artifacts can provide effective ways to access a meeting record and add value to the meeting record by connecting it to the actual work of a team.

Consider the following example: During a weekly meeting, a design team decides to change a system component, and “Bob” is assigned to investigate the effects of this decision, and to modify the design document accordingly. After the meeting, Bob uses his action item list to return to the meeting record where he was assigned this task in order to listen to other team members discussing possible ramifications. As he makes changes to the design document, Bob links those changes to the portion of the meeting where the design decision was made. As Bob further investigates, he visits portions of meetings linked to a section of the document to make sure he understands the original design. In the next meeting, Bob reviews the document changes he made. Months later, Sue, as part of the development team, does not understand one of the changes Bob made. She revisits the meeting where Bob reviewed his changes and hears his explanation.

As the above scenario illustrates, meetings are often centered around the artifacts that people are working with, such as brainstorming, sketches, models, designs, code, web pages, and documentation. These artifacts are often viewed, talked about, and modified during a meeting. There are artifacts that represent articulation work, the organization of work, such as project plans, schedules, action items, milestones, issues, and decisions. There are also objects documenting meetings themselves, such as agendas, notes, and minutes. All of these items exist outside of a meeting, and are aspects of the discussion during a meeting. Many of them are also valuable outcomes of a meeting, such as lists of action items and decisions made. We can record and time-stamp many basic interactions of people with these artifacts, such as opening, creating, editing, and closing objects, which then serve as indices into the meeting record. There are also many more specific interactions we can examine such as manipulating a model, annotating a document, or checking off
agenda items that provide even more meaningful structure. Thus, capturing the use of these various artifacts will capture valuable context and structure of a meeting.

The difficulty with using domain-specific artifacts during a meeting is that most tools that manipulate those artifacts have not been designed to be used in a synchronous fashion during a meeting. So in practice meeting-support tools need to be first created or customized to support domain-specific artifacts. Meeting scenarios will likely drive the design and the development of such artifact support. Common meeting types such as budget meetings, (software) design meetings, decision-making meetings, brainstorming meetings, status meetings, or general meetings [8] will involve support for different artifacts and interactions.

Tivoli [8] is an example of a system exploring domain-specific objects that is based on the general notion of note-taking but allows users to transform notes into editable objects via pen-based gestures (e.g., lists of items can be written, reordered, grouped and regrouped together). Domain-specific objects, such as cost items or budget center objects, can be created with gestures supporting specified behavior. While Tivoli provides persistent domain-specific objects, it only supports creating and manipulating relative simple content, rather than the full range of objects we have discussed above and was not originally integrated with a multimedia meeting record.

We have been exploring this notion of recording interactions with artifacts with TeamSpace [4], a system that supports artifacts used in general and status meetings. The design has been influenced by fieldwork on systems development meetings of Integrated Product Teams (IPTs) [9]. These findings suggested the use of artifacts that support articulation work, such as action items, as well as general meeting objects such as agendas and presentations.

4. TEAMSPACE

TeamSpace [10] was conceived as a web portal to teamwork: it provides a shared workspace that allows team members to manage their shared work processes and artifacts in a project. As such, it was designed to support long-term distributed team collaboration. TeamSpace is a collaborative online place that provides a persistent object store for team artifacts and at the same time, integrates synchronous team interaction. Thus, functionally it can be considered as a blending between asynchronous team repositories and synchronous conferencing.

The synchronous conferencing component of TeamSpace captures audio, low-bandwidth video, and meeting artifacts. The following description focuses on the various indices created and used for review. For more details on TeamSpace, see [10].

- The system features access to meeting-specific artifacts such as the agenda that has been created before the meeting or the action items that have been attached to the meeting. Users can visit, check-off, edit, and ink-annotate the agenda and action items. Modifications to these artifacts are simultaneously updated on the server and indices are created correspondingly.
- We also provide a shared whiteboard that allows importing and annotating PowerPoint, Word, and PDF documents on the fly during a meeting. We create indices for page flips as well as for all the textual and hand-written annotations.
- Users can attach private or public bookmarks to the meeting record. Bookmarks may carry short textual notes. Bookmarks are the only private index we currently support.
- Indices are automatically created for users joining or leaving a meeting. This can be also done manually by checking off participants who cannot join the meeting electronically.

After a meeting is completed, the meeting records are automatically available on the server for retrieval. The MeetingViewer component can be used to view and playback these meetings (see Figure 2). MeetingViewer integrates all of the meeting information based on time. The viewer uses a two-scale timeline (1) for navigating a set of selected meetings, providing random access playback. The timeline is painted with interesting events as both a visual summary of the meeting, and as an aid for navigation (2). Events are based on the indices we created during the session. Hence, we display *session indices* of people joining and leaving, *intentional bookmarks* and interactions with meeting-related artifacts: agenda items being discussed, action items created and modified, and slides visited.

Users can control which of these events they view and can use the events to find relevant portions within a meeting to playback. Playback of a meeting not only involves playing the audio and video, but also involves playback of all of the recorded events of a meeting such as slide visits, agenda item discussion (3), or ink annotations. The remainder of the meeting information is displayed on a series of tabbed panes (4). Users can view each artifact and can also navigate to the parts of the meeting where these items were the focus of attention. Navigation is provided through blue target icons (5) that lead to the relevant portion of the meeting record. Another means of navigation are text or hand-written annotations on documents. MeetingViewer shows a gray preview (6) of the annotations if they had not been created at the current time point in the meeting. Clicking on the annotation navigates to the portion of the meeting where the annotation was been attached to the slide.

5. CONCLUSION

TeamSpace tightly integrates capture and access into a team environment. By providing access to domain-specific artifacts during a synchronous meeting, we are able not only to create meaningfully indexed meeting records but also to relate the meeting to the rest of the work context. TeamSpace mainly focuses on explicit online indices as discussed in our index categorization, but goes further than other capture systems at including indices based on session-related activities, user intention, and interaction with domain-specific artifacts. However, we are still not even scratching the surface of all the possibilities of indexing meetings. To make the system most useful for a broad range of meetings, we focused on the general meeting domain with the hope of adding more support for specific artifacts and interactions as we continue our research.

In this paper, we have introduced the notion of explicitly gathering meaningful indices based on interactions with artifacts. We now need to understand how these indices can be used to navigate meeting records, how they should be presented, and which are most valuable. To that end, we are deploying and evaluating TeamSpace to understand the use of its general meeting-related artifacts and interactions.
6. REFERENCES


