

system minimizes the barrier to entry for both the person taking the notes and the person reading the notes with a novel combination of a well-known word processing application and an easy-to-use method for incorporating multimedia data within the document it produces.

3. System Description

The following usage scenario is enabled by our system. A salesperson attends an important marketing research meeting at the company headquarters. He pulls out his laptop and starts typing notes in Word as the presentation is delivered. When a key slide full of sales figures and marketing statistics appears, he inserts a placeholder where he would like to have the actual slide image, and perhaps the audio, appear inside his report. A day later when he returns to his office, he connects his laptop to the Internet and opens up his report, the slide full of numbers is automatically inserted where he intended, along with a 5-minute audio clip. After putting on finishing touches, he attaches the report in an email to his coworkers.

3.1 Capture Environment

We developed a meeting capture infrastructure called the Intelligent Meeting Room, shown in Fig. 1 that serves as an integration platform for captured media and a common interface for client development. During a presentation, several capture devices are used including a Presentation Recorder that captures an image of every projected slide as well as an audio track, a Meeting Recorder that saves an omni-directional mpeg2 video of the conference room, and a digital camera that can save whiteboard images [7].

During a presentation, information about the captured media streams is sent to a server and

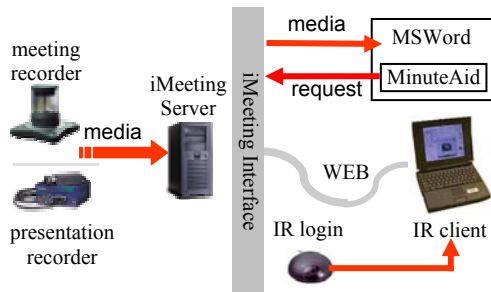


Figure 1 The MinuteAid system consists of a client module running inside MS Word that communicates with the meeting room capture infrastructure to allow users to insert captured multimedia into a Word file.

made available to client applications through an http-based interface. The interface includes a query language for referencing captured media objects by session ID, media type, media time or index number. For example, a query like “Slide #5 from session 12345” returns the slide image. “Audio for current slide (in current session)” returns an audio clip that starts at the beginning of the current slide until the time of the request. The interface also supports queries for notes made by other users, meta information such as meeting title and location, authorization procedure, as well as a synchronization mechanism for clock-skew correction.

In our current implementation, slide images can be accessed in real-time. Arbitrary audio segments can be requested with a 15 second delay. Since postprocessing is required on the video, video requests cannot be processed until the end of meetings. The specification and data size of these media objects are shown below. Meeting header information is currently entered manually. However, this can be automated by applying OCR on the title slide and face detection on the video.

image	audio	video
640x480jpg	16kbps mp3	320x240wmv
30KB/img	120KB/min	1.80MB/min

3.2 MinuteAid Client

The MinuteAid client is implemented in the Visual Basic for Applications (VBA) supported by the standard Microsoft Office Suite. It has been used on PC’s running both English and Japanese Windows and can be run on laptops used in our Intelligent Meeting Room. The code modules and forms, along with other layout and formatting guidelines, are distributed as a Word template (.dot) file.

When a user opens MSWord with this template, the MinuteAid module is started and a toolbar is created, as shown in Fig.2. Users can edit their meeting minutes in the same way they would any Word document. They can also request multimedia objects from the live presentation they are attending using the MinuteAid toolbar. When a *request* is made, a bookmark is placed at the cursor position where the multimedia objects will be inserted, and the context of the referenced multimedia objects is cached in the document.

Before the data corresponding to a request can be inserted in the document, MinuteAid must know the IP address of the server and have access to the session. In addition to manual

entry in a dialog box, we also provide an automatic authorization mechanism with infrared (IR). When the laptop comes in range of an IR login receiver, it obtains an IP address, session ID and password. This sign-in process must take place some time during the presentation to prove physical presence in the meeting room.

Another requirement for retrieving the data corresponding to a request is having a network connection to the server. To reduce the amount of user effort required, users do not have to configure a live server connection at every presentation they attend (a sign-in process is still needed). Instead, MinuteAid caches requests and places bookmarks where multimedia objects are to be inserted. When the document is opened later, MinuteAid checks for a server connection and automatically processes cached requests.

After a request is processed, it is removed from the document and the requested data is formatted as a table and inserted at the bookmark location, as illustrated in Fig.2. The inserted image or audio can be manipulated or played just like a regular picture or a sound clip. This document can be copied and emailed to other people as a regular Word document.

Whenever a request is processed, meta data for the associated session is stored on the user's laptop. This provides a permanent record of the presentations a user attends and populates a calendar interface that can be used to request data from previously attended meetings.

4. Discussion

The Intelligent Meeting Room infrastructure has been in regular use in our lab for more than two years. In that time, we've recorded more than 200 meetings that consume over 600 GB and include 150 hours of audio and video as well as 35,000 slide images. We provided several web interfaces to this data and made it easy for people to access it.

We observed many cases when this infrastructure was useful for analyzing brainstorming meetings in which conclusions were reached after long discussions. Also, users frequently accessed structured presentations based on PowerPoint slides. In both cases, people attended those meetings who were required to create a summary that could be shared with other people outside our lab. The MinuteAid system directly addresses this need.

One of the early design issues we considered was the choice of client application for note composition and data access. The most intuitive

and common solution is to build special software. However, this often restricts users to a feature-limited composer and a template-based browsing interface. The proprietary data format and application prevents sharing with people outside the target environment. Another approach provides generic access to captured media through a web interface where slide images, text notes and url's can be dragged-and-dropped into a note editing application. However, it is difficult to extend this approach to support flexible access to audio and video objects. It also requires a constant connection to the server while taking notes. Our approach leverages the multimedia support and wide adoption of MSWord to provide the same interface for composition and access, and facilitate easy distribution and reuse of the data.

In a survey of users in our lab, we found four people who are required to produce summaries of meetings they attend. Based on their familiarity with our meeting capture system, they all saw cases where MinuteAid would be extremely useful. Obviously, this is because it is often more effective to see someone say what they mean than it is to paraphrase what they intended in written form. This is particularly true in an international environment in which the recipient of a message might not be completely fluent in the original language and would prefer to see a multimedia explanation (e.g., a video clip of a demo) to reading a written explanation.

Furthermore, based on interviews with our Japanese colleagues, we found that it is common practice for someone to be designated as the minutes taker for a meeting. Their reports often include related material as attachments and are distributed to others. The MinuteAid should also be useful in this environment.

One open issue in our system is the handling of concurrent sessions. One scenario is that a user moves between parallel tracks in a conference before a session ends. Since a media object can no longer be uniquely identified based on time stamps, we could require either an explicit sign-in process or an implicit location reference using a wireless protocol, for example.

5. Conclusions

We described the design and implementation of the MinuteAid system for facilitating multimedia note-taking in an automated meeting capture environment. Based on over two years of experience with an Intelligent Meeting Room that captured audio, video, and slide images, we

determined that people need an easy-to-use method for creating notes that include multimedia data captured in such a room. The MinuteAid does this and makes the multimedia data accessible from Microsoft Word, allowing users to create self-contained Word documents that can be easily distributed and reused. This novel combination of technologies makes it easy for users to incorporate multimedia data in their everyday work practice. We expect that this will increase the demand for multimedia capture systems and significantly improve the efficiency of people who take notes during meetings.

6. References

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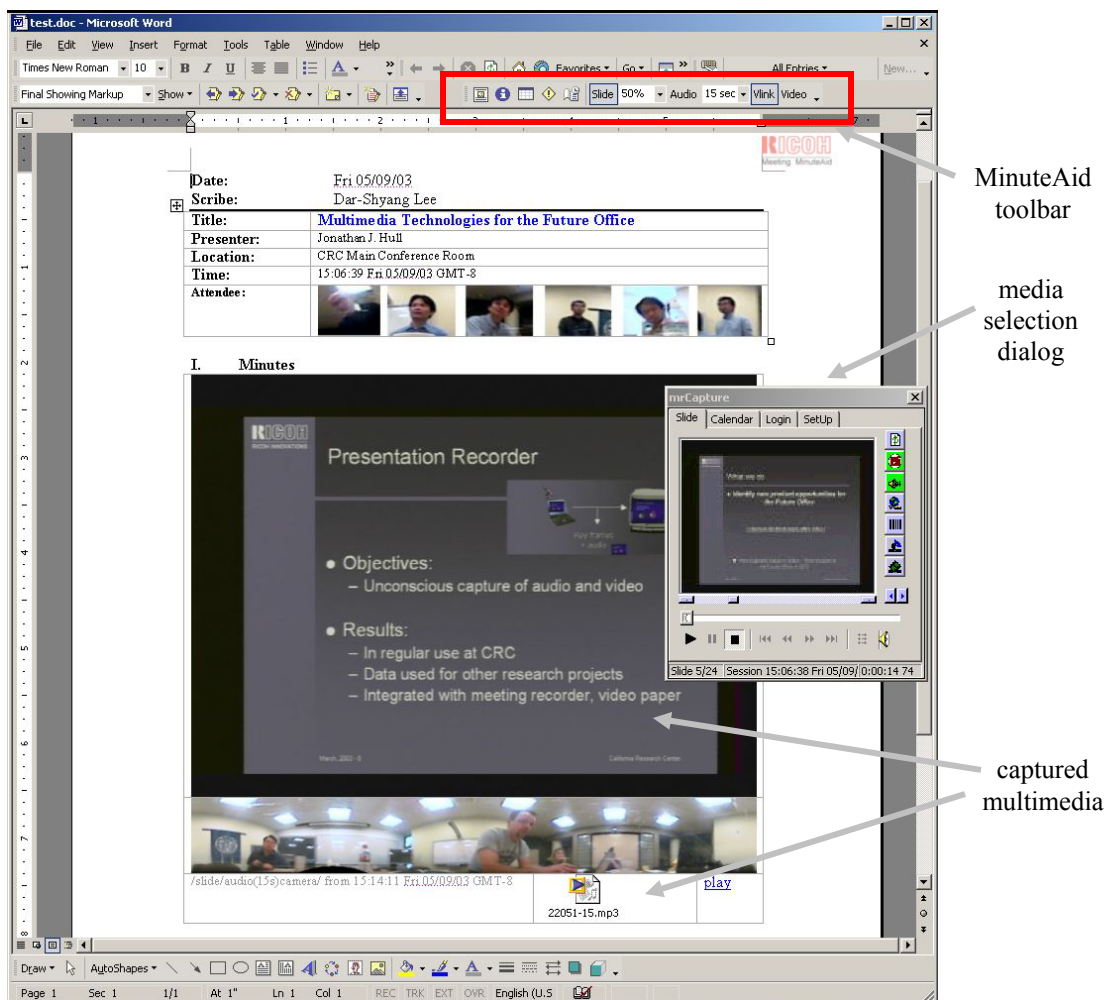


Figure 2 – An example a Word document created by MinuteAid. The meeting header table and slide table are inserted as a result of multimedia data requests.