AI-Powered Education:
Smart Learning Environment with Large Interactive Displays

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ABSTRACT

Our university is currently developing an advanced physical-digital learning environment that can train students to enhance their presentation and discussion skills. The environment guarantees an efficient presentation and discussion among users with state-of-the-art technologies such as touch panel digital poster panels. It includes an automatic evaluation system that efficiently records, analyses, and evaluates the presenter's presentation and discussion skills. We also have developed a digital poster authoring tool, a novel tool for creating interactive digital posters displayed on the digital poster panels. The environment also allows the students for effective self-training of presentation by authoring digital posters and getting feedbacks of automatic evaluation of presentation. We call such education promoted by the AI technologies "AI-Powered Education."

1   INTRODUCTION

We have been developing an advanced physical-digital learning environment that can train students to enhance their discussion and presentation skills. The environment guarantees an efficient discussion among users with state-of-the-art technologies such as touch panel discussion tables, digital poster panels, and an interactive wall-sized whiteboard. It includes an automatic evaluation system that efficiently records, analyses, and evaluates presentations and discussions held inside our facility. We also developed a digital poster authoring tool, a novel tool for creating interactive digital posters displayed using our digital poster presentation system. Evaluation results show the efficiency of using our facilities: the digital poster panels and the digital poster authoring tool. In addition, our physical-digital learning environment has been further enhanced with a visual/auditory processing system that can detect interactions with the digital poster panels and analyze the content of interactions enabling an automated skill evaluation.

2   SMART LEARNING ENVIRONMENT

The new environment for learning shown in Fig. 1 is capable of giving poster presentations, creating discussion contents, and making valuable communications using digital poster panels (next section), discussion tables, and an interactive wall-size whiteboard.
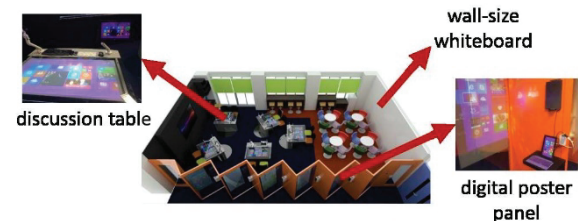

Fig. 1 Smart learning environment

Each student uses a tablet to connect with the facilities including the discussion table shown in Fig. 2. The content and operation history of the discussion table are automatically transferred and shared to the server, the meeting cloud. Previous table content can be easily retrieved, and any texts or images can be reused. Such reference and quotation operations are recorded and analyzed to discover semantic relationships between discussions. Furthermore, software that analyzes temporal changes of table contents with the corresponding users is also being developed.

Fig. 2 Discussion table

Our facility also houses a wall-sized whiteboard. Unlike the traditional whiteboards, we are able to physically and digitally write on the whiteboard. We use a special projector equipped with an infrared sensor to detect the location of the digital pen with respect to the wall. The writings and interaction on the whiteboard can then be recorded by cameras. The captured data using the camera can identify the physical interaction in combination with the given digital interaction information. This system is under development and we are working on proposing a new evaluation system that can enhance the presentation and discussion performance of students using this system.

3   DIGITAL POSTER PANEL

For poster presentations, a digital poster panel, shown in Fig. 3, is used for content and operation analyses. The panel helps the users create digital posters and analyze their creation process. The panel also supports the retrieval of previously presented posters and allows users to annotate them. Annotations are automatically sent to the author and are analyzed by the system to evaluate the quality of the poster. Poster presentations as well as the regular slide-based presentations are also broadcasted by streaming on the Web. The system collects and analyzes the feedbacks based on comments and reviews given by Internet viewers (e.g., Twitter users can associate their tweet messages with any scenes from the presentation based on the starting and ending timestamps).

Fig. 3 Digital poster panel

3.1 Digital Poster Presentation System

The digital poster presentation system running on the digital poster panels consists of an authoring tool for digital posters, an interactive presentation system with digital posters, and an online sharing system for digital posters. Poster presentations can be considered as a close communication with the audience and is also ideal for training in discussion not only for presentation. The digital poster presentation system makes the poster presentation easier. Tools such as PowerPoint slides can be integrated into the poster presentation. Additionally, the system will be extended for an interactive data acquisition. Hence, we believe that this system would significantly change the way of poster presentations.

3.2 Digital Posters vs. Regular Posters

A digital poster is an interactive multimodal version of regular papers. The advantage of digital posters includes retrieval and reuse of content. However, one of the biggest problems is portability since a digital poster needs special hardware such as a digital poster panel and these devices cannot be carried elsewhere. Perhaps, in the near future, large and thin film-type screen devices, such as organic electro-luminescence displays, will be available and tools for digital posters will be commodities and easily acquired.

3.3 Authoring Digital Posters

Authoring of digital posters is very simple but some preparation is needed. The users should prepare resources such as images, videos, and slides in advance. We also developed an online resource management system for memos, images, videos, and slides. The digital poster authoring tool can import any resources submitted or shared in the resource management system.

The digital poster authoring tool shown in Fig. 4 has three parts: the main menu, the resources menu, and the poster field.
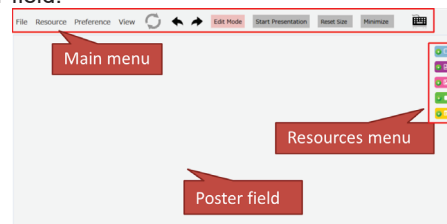

Fig. 4 Main screen of digital poster authoring tool

The main menu provides the basic functionalities of the tool such as creating, opening, and saving of poster files, setting up the desired preferences, and choosing different creation modes. The digital authoring tool is also able to create both portrait and landscape orientation posters as needed.

The resources menu shown in Fig. 4 lets the users add different types of blocks to the poster field. Each block automatically downloads a certain type of resource depending on the selected block from the online resource management system, except for the layout and text blocks. Selecting an image block will automatically scan for images in the resource management system while selecting a video block will automatically scan for videos in the resource management system. For the slide block, existing PowerPoint slides will be selected.

When the user taps a block in the resource menu, a list of thumbnail images is displayed in the window that appears from the right edge of the screen as shown in Fig. 5. The user can easily arrange the layout of the poster using a layout block and interactively change a position of a block's borderline. When the user wants to place any resource in the block, he/she should just drag and drop the thumbnail image from the resource list to the target block as shown in Fig. 6.
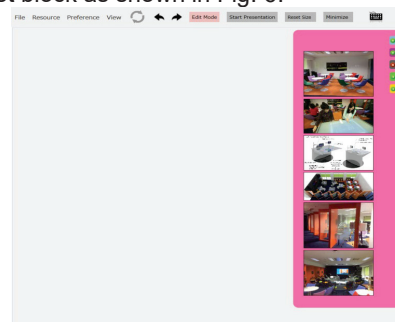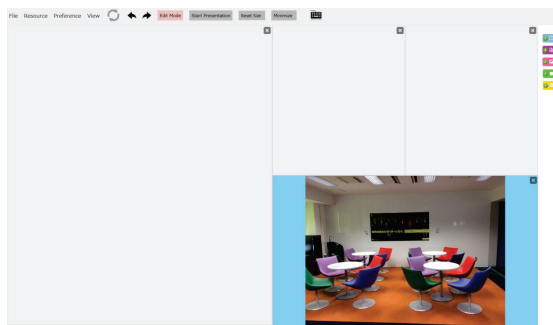

Fig. 5 Image resource menu

Fig. 6 Image resource placement in layout block

Other resources, such as videos and slides, are inserted in the blocks in a similar way. An example of a created poster using the described authoring tool is shown in Fig. 7. When the user finished editing the digital poster, the final poster can be stored in the online poster sharing system. It can be used for presentations by searching the digital poster at any time. During presentation time, the enlargement of images and the playback of videos and slides in the poster can be done.

Fig. 7 Example of digital poster

3.4 Data Acquisition from Interactions with Digital Posters

Digital posters are not only for a presenter to make a presentation but also for an audience to view in detail by interacting with the poster. Posters are unlike slides, where the complete content is summarized in one piece, which is more suitable to understand the content quickly. Visitors can easily retrieve and view the digital posters using the digital poster panel whenever they like. Interaction histories when visitors have interacted with the posters are recorded automatically. The number and time of poster views, views of the elements in the poster, and data such as browsing the order of the poster elements can be obtained by this system. This data is used to evaluate the posters and the skills of the poster author.

4 AUTOMATIC EVALUATION

A study on developing oral presentations skills embedded oral presentations and assessment to their curriculum [1]. In their case study, they included at least one oral presentation in three of their courses and used a rubric to assess the oral presentations. Their results indicate that students better understood their weaknesses, strengths, and areas for improvement with their presentations. In our study, we also implemented the same design to improve the presentation skills of the students. We used the poster presentation format instead of the regular oral presentations because of the interactivity of poster presentations. In poster presentations, the students are able to engage in conversation with people, giving them more opportunities to improve their communication skills. Also, poster presentations enliven the student presentations because students interact with each other more instead of just passively observing like in formal presentations.

Our digital poster panel can analyze the structural comprehension and conciseness of poster content, but that is not sufficient for presentation skill evaluation.

In addition to the introduction of research content by presenters, poster presentations have close interactions with the audience. Therefore, it is necessary to evaluate the presenter's discussion skills in interaction with the audience. Therefore, the automatic evaluation system for presentation performs presenter's voice processing and analyzes the speech acoustically and linguistically.

4.1 Acoustics-Based Method

At a discussion, presenters need to discuss a topic, analyze the meaning of audience members' statements, and communicate their argument in an easy-to-understand manner. "Voice size," "speech speed," "pause," "conciseness" etc. are mentioned as ways of making speaking easy-to-understand [2]. On the basis of this, we set eight evaluation indicators based on acoustic features and based on linguistic features.

The indicators that are used to evaluate only acoustic features are as follows.

A. Voice size: voice should be large enough for a speaker to be heard, while it is better for it to not be too emotional and too big. Therefore, we measure and evaluate the volume [dB] of each statement being uttered.

B. Voice intonation: speech without intonation is a factor that makes a listener bored. We measure the height of a voice in a statement (fundamental frequency F0, described later) [Hz] and evaluate the statement with high standard deviation values used to indicate a good evaluation.

C. Speech speed: a statement will be hard to hear if it is too fast or too slow. Therefore, if the speech speed [the number of syllables per hour (syllable is described later)] is within an appropriate range, it is evaluated as good.

D. Fluency: speech with a lot of silence and

disfluency is difficult to understand. A good evaluation is given to statements with few filled pauses (vowel extensions), such as "eh" during speaking and few periods of silence of more than two seconds.

E. Tempo: it seems easy to understand speech when emphasized parts are clear. It is effective when statements are not monotone, such as when a person speaks slowly a part that they want to emphasize and sets a pause before the emphasized part. Therefore, the tempo of a statement is evaluated on the basis of the standard deviation of the speech speed and the number of "pauses" ("pause" is defined as a period of silence of less than 2 seconds).

Here, the fundamental frequency (generally written as F0) is a value expressing the periodicity of sound, which is the acoustic feature quantity that governs the pitch of sound. There is periodicity in voiced sound (vibrating of the vocal cord), so the reciprocal of that period (basic period) is the fundamental frequency.

In addition, the syllable used to calculate the speech speed is a type of segmental unit that separates consecutive voices and is a group of sounds heard. Typically, it is a voice (group of voices) consisting of one vowel and its vowel alone or with one or more consonants before and after the vowel. In the case of Japanese, syllables may use a segmental unit called a "mora" (beat) that does not necessarily agree with the syllable. Strictly speaking, the mora is used instead of a syllable. The main difference between a syllable and mora is that a long vowel, geminate consonant, and syllabic nasal are integrated with the preceding vowel in the case of a syllable, but, in the case of the mora, it is one mora.

4.2 Linguistics-Based Method

Evaluation indicators based on linguistic features are as follows.

F. Conciseness: it is easier to understand a statement if it is concise. Therefore, for the sake of evaluating conciseness, we compare the number of syllables of statements (strictly mora) in a meeting obtained by speech recognition and the number of syllables of the corresponding statements in the minutes of the meeting. Since a secretary describes the content of the statements in a summary, if the number of syllables of the statements and number of syllables of the corresponding statements of the minutes are close, the statements can be regarded as concise.

G. Relevance to topic: statements should be relevant with the subject of discussion as much as possible. If the content of response statements has much in common with the content of a topic-raising statement, the statements can be regarded as relevant with the theme.

H. Consistency of context: response statements need to be coherent or consistent with the question statements. In other words, the content of a response statement and the content of its related question statement must be semantically related, so it is important to evaluate the degree of consistency. We use a machine learning technique to judge whether a statement is consistent and decide the evaluation value on the basis of the judgment.

5 AI-POWERED EDUCATION

By collecting, analyzing, and feeding back data during training, presentation and discussion skills can be improved. Poster presentation is the most suitable activity for expressing research contents in a compact manner and interactively explaining to others. Digital posters are not only easier to create than paper posters, but they are also easier to analyze. Moreover, detailed evaluation can be performed by analyzing the voice data of the presenter. The evaluation of the semantic content of presentations and evaluations with ambiguous evaluation criteria such as gestures are mainly performed by machine learning. We call such education promoted by AI technology "AI-Powered Education."

6 CONCLUSIONS

I explained the new facilities of Nagoya University, smart learning environment and digital poster panels. Digital posters are used for student presentation training. In addition to the information on the digital poster, the acoustic and linguistic features of the presenter's speech are analyzed for automatic evaluation of the presentation and discussion. In particular, a machine learning technique is used to analyze linguistic features. In the future, the digital poster panels and the automatic evaluation system will be made publicly available.

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