Development of Software for Chemical Education
Using Multimedia Techniques

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There are many software in the field of chemical education. However, it was found, via student questionnaires, that these software have some defects, for example students like to see more realistic graphics rather than the computer graphics, and teachers also like to have a more intractive approach in their classes. We have developed new type CAI software to solve these difficulties by using a new technique which enables us to use different multimedia sources as part of original CAI programs.

These multimedia software will hopefully improve the use of CAI programs in chemical education. In particular, we edited the video movie into a short interval (a few minutes) file and used it in CAI programs as an original and novel method.

Key words: Chemical Education, CAI, Multimedia, Video Operation System

1. The uses of CAI programs in chemical education in Japan

The proposal to stimulate the use of CAI techniques in chemical education in Japan was made in 1980 [1, 2]. Over the years, many articles on this topic have appeared. The chemical software research group (Japanese Association of Personal Computer for Chemists) was established in 1982, and consisted of 300 members. More recently, the number of the members has increased with many reports on the uses of CAI programs for chemical education and research using computers in chemistry. Due to this change of situation, the research group reformed its organization in 1992 and became "The Chemical Software Society of Japan". Since then, the Society has started to
publish a scientific journal (The Journal of Chemical Software) and Software Catalogues (Annually). The Society has international communication with the USA and UK, as well.

The CAI technique is used in real classroom activity for the teaching chemistry in some schools where active teachers use computers in their lectures, but it is not popular in the classes in general, according to the statistical reports. It was reported that the reasons why most teachers do not introduce CAI method into their classes were as follows:

(1) Teachers like to teach chemistry the same as before (traditional way of teaching).
(2) It is very difficult to develop software that teachers wish to use to their satisfactions.
(3) The software commercially available was not sufficient for use in classes, because the supplemental information could not be added along with that provided by the teacher.
(4) The experiments have to be more emphasized but the computer graphics in the CAI are merely animation and far removed from the real experiments.

The authors have used CAI programs in the teaching of chemistry, and tried to summarize the reactions of students via a questionnaire. Fig. 1 shows the result for the question "How long can you concentrate your attention in viewing video movies?". As seen in Fig. 1, it is found that most of students feel tired if the presentation period is longer than 5 minutes. Video movies are not flexible in presenting teaching materials because of their sequential nature.

2. Trials in the development of new type CAI programs

We can now make use of video animation with PICS format, which is an animation file format in the software Director (Proforce Systems, Inc.) for Macintosh. However, there is one weak point when we make a video movie file with this format. The synchronizing system of sound and movie does not work well with a different type of computer, as shown in Fig. 2. PICS format file is not suitable for CAI materials [3, 4]. Fortunately, the video OS (QuickTime in Macintosh) became available in 1993. With the advantage of QuickTime OS, all video animations are synchronized with movie and sound perfectly. It is very important to synchronize movie and sound in the CAI system. QuickTime OS has made it possible to make the best use of video movies for chemical education. A software Video for Microsoft-Windows is also available.

It is expected that multimedia schooling will become compulsory, not only for chemical education, but also for all school education. Multimedia computer will encourage school education for students.
As we write on a blackboard and in a textbook, we want to make chemistry objectives handy in a computer [1]. In order to make the CAI software procedure simple and easy, we have developed a CAI building shell system, which we call "Chemical Dry Lab" shell [1]. We have prepared three different types of software; word processor, graphic processor, and Chemical Dry Lab shell system. The two processors are available on the market. The Chemical Dry Lab shell system was handmade by us [1].

Chemistry teacher has his courseware for chemistry teaching at school. The materials of chemistry teaching are divided into two types of information; (1) letter information and (2) graphic information. By the use of a word processor, we put letters into the shell system, whose contents are sentences and technical keywords, etc. By the use of a graphic processor, we draw figures into the shell system, whose contents are pictures, tables and modelling, etc. The result can be a chemical dry lab system that is completed for the purpose of a desirable chemistry courseware. If somebody can operate a computer, he/she can put three types of courseware information in the shell and complete the software easily.

Using this method, we have developed many CAI materials [1]. For example, (1) Chemical Dry Lab System, (2) Computer-Aided Learning of Instrumental Analysis software, (3) CAI material for Chemical Experiments, (4) Chemical Calculations, and so on. There are some textbooks in Japanese with such CAI software [1].

We can make Chemical Dry Lab software easily by the use of the CAI building shell system, word processor and graphic processor. In this method, we cannot treat a video.
movie file in CAI software, because the animation and sound of a movie are not synchronized at the same period with different types of machine.

Now a video OS is available, which has enabled us to use the movie with a personal computer. We have tried to utilize it with our system. Fig. 3 illustrates that the basic philosophy of the development of the CAI program, however, there are limitations in the development of the shell unless a convenient tool for the development is available. It can be said that most of the CAI programs were designed as linear program flexibilities in the modifications of the shell. That is, in addition to letter and graphic information, video information is entered by the use of a video processor with a video capture board and the software.

In this case, we have used ExpandBook Tool Kit [5] as CAI building shell system, which is available on the market (Voyager Japan, Inc.). With a word processor, we put letters into the shell system. With a graphic processor, we draw figures into the shell system. In addition, by the use of a video processor, we can introduce a video movie into the shell system. The result is a multimedia type chemical dry lab system.

As we have already mentioned, the long time spent in video movie watching is not suitable for some students, as shown in Fig. 1. Sequential watching of a video movie is not flexible enough for the teaching of a chemistry experimental operation.

Therefore, we should cut a video movie at intervals of a few minutes to each section of experimental operation. We are able to treat a video movie flexibly on the short cutting of operation sections for a few minutes. We can make QuickTime files of a video movie, whose memory is about ten mega bytes. Short video presentation has a great advantage in chemistry teaching.
We would like to show five points about the characteristics of video learning, as follows:

(1) The viewing time for video movie is too long for students.
(2) It is easy to treat a video movie flexibly on the short cutting of operation sections for a few minutes.
(3) QuickTime file of video movie is suitable for multimedia type CAI software.
(4) Presentation of video animation can be flexible in chemistry teaching.
(5) Multimedia type CAI material allows students to visualize chemistry operations in practical experiments.

Now, we have a good computer system with multimedia devices. The CD drive is equipped with a standard computer, which is an AV machine. We can use QuickTime OS practically. The QuickTime file set is still low resolution, and its screen size (48 x 62mm) is small. In the near future, however, a high-resolution, full-screen video size animation will be available. We hope that a high-speed cpu personal computer will be developed soon.

3. Examples developed

We are going to show some of our products, as follows. We have filmed the manipulation of chemical experiments. We have selected Infrared Spectrophotometer Analysis and Gas Chromatography as multimedia type CAI subjects. A software treating physical chemistry experiments is now being developed.

Fig. 4 ScreenPlay software for the obtaining of the filmed video movie for a short-cut time.
We get the filmed video movie by the use of video capture board and ScreenPlay software, and then change it into a QuickTime file. Fig. 4 shows ScreenPlay software and the obtaining of the filmed video movie for a short-cut time. Film-like icons are all QuickTime video movie files. The memory size of one QuickTime file is about ten mega bytes. Therefore, we need a hard disk with a large memory and MO (magneto-optical) disk as an assistance memory device.

Fig. 5 Script program for defining the movie output place with freeware QTMoonRod.

Fig. 6 Display of content page with four chapters on Infrared Spectrophotometer Analysis. This box is for controlling the pages of the HyperCard book.
We prepare QuickTime video files on the above and figures and pictures, and then make a document on the desired courseware with a word processor, which is useful for QuickTime. We use Word Write II version 2 (Claris Co.) as a word processor. The figure is drawn by a graphic processor.

We have developed multimedia type CAI software by the use of ExpandBook Tool Kit [5] and HyperCard version 2.1J (Apple Computer, Inc.). This version is not able to
operate QuickTime video files perfectly, because it needs movie operation software. We can use freeware QTMoonRod version 1.61 (Nifty-serve). The movie button in HyperCard is defined in the dialogue box. A script program is written as shown in Fig. 5. We define movie output place in this script program. This weak point was improved in a new version of HyperCard version 2.2. It contains QuickTime Tools. We do not need now the above script program. As user, we can make multimedia type CAI software easily.

These systems are all Japanese for use to students in Japan. Fig. 6 shows a content page, which consists of four chapters on the Infrared Spectrophotometer Analysis. This box is for controlling the page of the HyperCard book. Fig. 7 shows the page, which contains a diagram figure of Infrared Spectrophotometer Analysis apparatus, movie button and text letters. When we push this movie button, movie animation starts. There are three movie buttons (see Fig. 8). We can operate three movie animations simultaneously.

4. Conclusion

Multimedia technology will greatly change the current of developing CAI software in the field of chemical education. Multimedia type CAI software has been greatly needed for chemistry teaching. Multimedia computer will encourage school education for students.

We tried to make a multimedia type CAI software easily. QuickTime has enabled us to use the video movie with a personal computer. Short video presentation has a great advantage in chemistry teaching. Multimedia type CAI material really helps students to visualize chemistry operations in practical experiments.

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化学教育におけるマルチメディアの利用と教材作成

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コンピュータ制御のレーザーディスクやビデオディスクによりビデオ動画が利用されている中で、マックマシンのQuickTime OSの登場により、テキストファイルのように手軽にビデオ動画を利用できるようになった。このマルチメディア技術は、化学CAIソフトウェアの開発を力付けるものである。特に、数分の短い間隔でのビデオ動画の編集は極めて効果的で独創的な手法である。

マルチメディア技術が発展していく中で、化学教育でのCAIソフトウェアの開発が大きい変化していくものと思われる。化学実験用としてQuickTime対応のビデオ教材を開発している。