A Method for Supporting Medical-interview Training using Smart Devices

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***Abstract*—In the case of medical schools in Japan, clinical training has been focused on lately. Giving such training, the trainer can only take a short time for each trainee. Moreover, the trainer has to provide one-to-one teaching for each trainee, so the number of classes for practical training in conducting medical interviews is not still enough. In addition, the number of physicians who can provide teaching is not enough. Therefore, classes in practical training become a burden on the trainer. In this paper, we proposed a method for supporting medical-interview training, which is one kind of clinical training given in medical schools. The proposed method uses sensors and smart devices such as smart glasses and tablets. Its usefulness was demonstrated in experiments involving students and physicians at a medical school. The proposed method makes medical training more efficient, gives trainees more chances of conducting medical interviews, and alleviates the load on trainers.**

I. Introduction

In the case of medical schools in Japan, clinical training has been focused on lately. One part of clinical training is a practical training in how to ask patients detailed questions about their symptoms. This questioning process is called a “medical interview” hereafter. As for medical care, a medical interview is the first and most-important step in diagnosing symptoms exactly or in determining how to examine them in more detail. Practical training in giving medical interviews, which is an important part of clinical lectures, simulates a real medical examination in an outpatients’ ward. The number of such clinical training sessions has increased year by year from 2010[1], [2]. It is supposed that the required medical-school accreditation for ECFMG certification in the USA has affected the number of clinical training sessions in medical interviews[3]. In the case of practical training in medical interviews, the questions that outpatients are asked have been standardized[4]. That status suggests that the practical training has been established. Moreover, that training has been adopted as one of the most-important curricula in medical schools.

In the medical school where the authors requested cooperation of students in experiments, practical training in medical interviews was performed in the style of role playing. Three or four trainees played the roles of physician and outpatient in turn. A trainer (i.e., a real physician) checked the process of the practical training while sitting by the side of the trainees. At the end of the practical training, the trainees received advice —based on the trainer’s experience—from the trainer about how they gave the medical interviews. That advice was very useful for the trainees. Moreover, to master the technical skill of asking questions, the practical training in medical interviews should be taken repeatedly. However, the trainer didn’t have enough time to give detailed advice to all of the trainees. That is, the trainer could only spend five to ten minutes with each trainee. In addition, the trainer could not give advice about all of the items asked about during the medical interview by all the trainees. Multiple practical training sessions cannot be given at the same time because the trainer cannot check all of the communications in the medical interviews. In Japan, as a result of this situation, the number of classes for practical trainings in medical interviews is not still enough. The trainer is a real physician who works at an outpatients’ ward; therefore, classes in practical training become a burden on the trainer. In addition, the number of physicians who can provide teaching is not enough.

In this paper, we propose a method—using smart devices—for supporting training in giving medical interviews. Applying this method, the trainer monitors the trainees via a network and sends instructions to each trainee. Accordingly, it supports the trainer in a manner that eases their burden. Moreover, the trainees can check their current statuses on the display of the smart glasses and get efficient feedback immediately from the trainer. Finally, the proposed method was experimentally evaluated at a medical school, and the results of the evaluation demonstrate the usefulness of the method.

II. Related works

The effectiveness of a self-directed learning environment for objective structured clinical examination (OSCE) has been demonstrated[5]. That environment provided a tablet for watching video demonstrations, and it was shown to be effective in improving trainee’s skills and reducing the trainer’s burden. However, it would incur extra cost to make a better demonstration video. Moreover, the trainee cannot reflect their own training sessions.

Fig. 1. Google Glass[8]

FIFA used an electronic performance and tracking system (EPTS), which includes wearable technologies, for football games at the 2018 FIFA World Cup in Russia[6]. EPTS primarily tracks player positions by using devices such as accelerometers, gyroscopes, and heart-rate monitors. It is used to control and improve the performance of individual players and the team[7]. Such studies using EPTS have focused on large-scale movements on the football field. They do not need detailed data on movements of arms and legs.

A new generation of wearable technologies, like smart glasses[8], has evolved. A pair of smart glasses is one kind of wearable device. It is a glasses-shaped device composed of a small computer with a display. The person wearing the smart glasses can see a view of the real world with their eyes in the same manner as normal glasses. They can also see a notification message seemingly floating in front of their eyes when the device displays relevant information. A typical example of smart glasses, "Google Glass[8]" by Google, is shown in Fig. 1.

Smart glasses have been systematically evaluated in the healthcare environment[9]. In that evaluation, smart glasses were found to have clear utility in a clinical setting, and they foreseeably have a great potential to favorably impact medical and surgical practitioners in their daily activities.

The use of smart glasses in otolaryngology surgery has been demonstrated[10]. It was found that smart glasses have a beneficial educational effect and allow for remote intraoperative consultation. Improved communication using them would allow improved flow of information between members of the surgical team inside and outside of the operating room.

III. A Method for Supporting Medical-Interview Training using Smart Devices

We propose a method—using smart devices—for supporting trainings in conducting medical interview of interviews with patients.

A. Overview

The system analyzes the behavior of a trainee, who plays the role of a physician, and their questions during a medical interview. The results of the analysis are summarized on a monitor viewed by the trainer. An alert notification is shown on the display of the smart glasses, which are worn by the trainee puts on, when the system detects a problem during the interview, which the trainee should be notified of immediately. The trainee can check the summary of their own interview immediately after the interview is over.

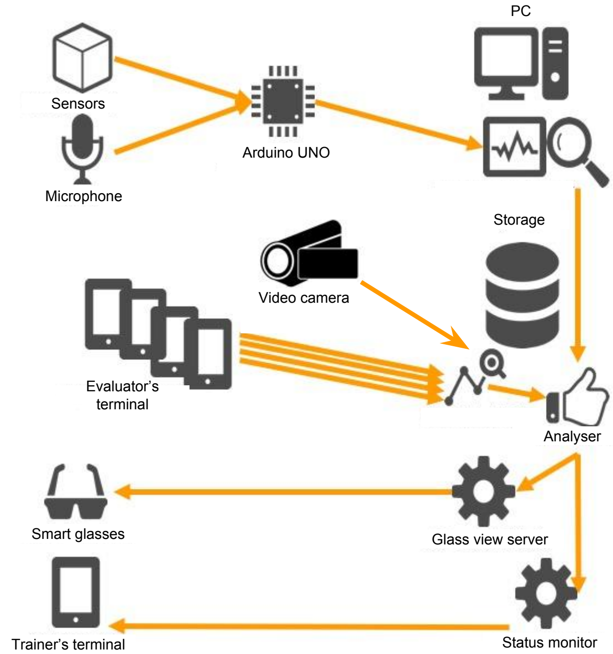

Fig. 2. Overview of proposed method

The configuration of the proposed system is overviewed in Fig. 2. To understand the behavior of the trainee, the system acquires data from sensors like accelerometers and microphones. When the system detects a problem, such as the trainee loses focus on the patient for a short while, the system displays an alert on the monitor of the trainer. Simultaneously, it sends the alert to the display of the smart glasses of the trainee so that they can be notified of the problem and take corrective action themselves.

Other students play the role of evaluators to check the questions asked by the trainee during the interview (shown at the lower left of Fig 3). The evaluators have a standardized list of questions (displayed on a tablet) covering all of topics that the physician should ask the patient about. They mark the topic that the trainee has asked the patient about on the screen of the tablet. The trainer can check all of topics the trainee asked about and understand the flow of questions.

B. Group Training

In the medical school where the authors requested cooperation of students in experiments, practical training in conducting medical interviews was performed in the style of role playing. A training group consists of around four trainees. Each trainee takes a turn to play the role of physician. The other trainees play the role of evaluators. The role of the patient is sometimes played by pseudo patients.

The evaluators listen to the questions asked by the trainee during the medical interview. They check the trainee's questions against the standard questions on their lit. The checking

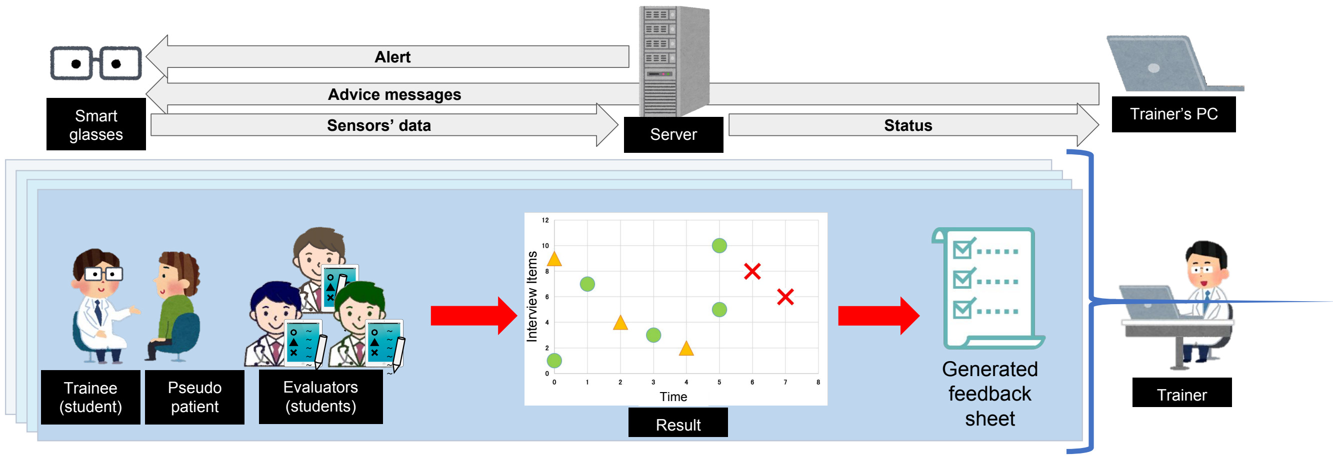

Fig. 3. A training by the proposed method

process is also effective for assisting their own learning. Though they used a paper form based on the standardization to check the questions, they use an application on their terminal that each evaluator has at hand. Immediately after the trainee asks the patient a question, they push a button on the screen according to their evaluation of that question. The system records the evaluation and the time it was input.

After the medical interview, the system provides a feedback sheet containing all of results of all the evaluators. The input times of the evaluations are also printed on the sheet. By reviewing the feedback sheet, the trainee can understand the flow of questions that they made.

The medical interview is recorded by video camera, and each trainee watches their own video for reflective learning after the training. It is not easy to find a scene that the trainee wants to confirm. Fast-forward is not an efficient way because all of scenes are almost the same visually. In the medical school where the experiments were carried out, all the training sessions were recorded. However, the whole video of a session was not played back because it takes too long and the time available to the trainer to give advice is limited. Accordingly, as for the proposed method, the system roughly grasps the time each question was asked on the basis of the input time of the evaluations. By choosing a certain question, the trainee can play the video from near the scene in which the question was asked. They can thus learn reflectively by video efficiently.

C. Training with Smart Glasses

The proposed method is shown schematically in Fig. 3.

Acceleration sensors and a microphone are attached to the trainee has. They detect whether the trainee is facing the patient and whether the trainee is talking[11]. The trainee sees a warning on the smart glasses when their behavior is deemed unsuitable by the trainer. In particular, the trainer sends a message to advise the trainee when the trainer thinks that it is necessary in the current situation.

D. A Prototype System

A prototype system for evaluating the effectiveness of the proposed method was implemented by using Arduino UNO for the sensor controller.

Fig. 4. EPSON BT-200[12]

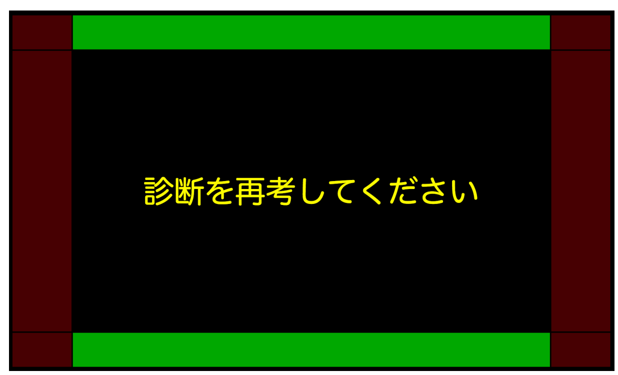

Fig. 5. Red signs and an alert message on smart glasses

Two models of smart glasses, namely, Moverio BT-200 and BT-300[12] by EPSON, were used. These models have a stereographic display for each eye. The user can thus see a floating display in the center of their field of view. BT-200 is shown in Fig. 4.

An example of the view seen in the smart-glasses display by the trainee ("awareness view" hereafter) is shown in Fig. 5. Although the background color of the awareness view is black in the figure, it is transparent in the smart-glasses display. The trainee can always see the patient through the view. Dark red bars appearing on both sides of the view indicate a warning

Fig. 6. Screenshot of evaluator's view

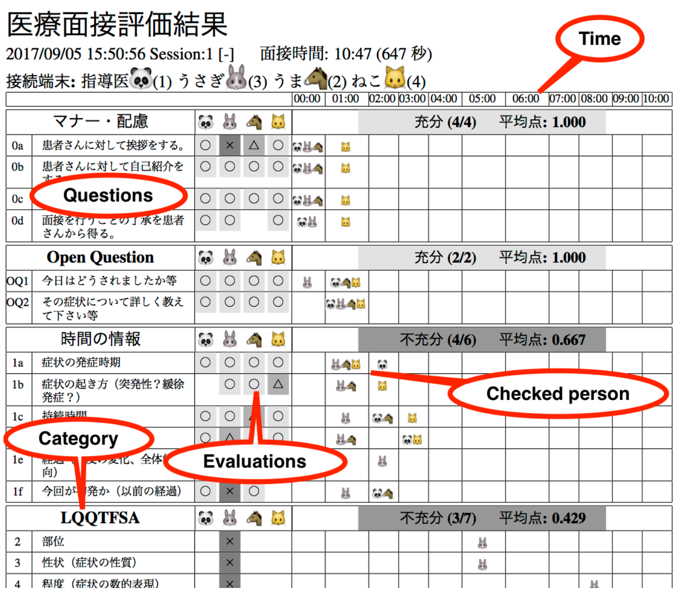

Fig. 7. A part of the feedback sheet about questions asked in a medical interview

concerning the facing action of the trainee. That is, the bars become brighter if the trainee stops facing the patient or does not talk to them for a certain time.

The trainer sends the warning to the view of the smart glasses when the trainee needs to be alerted. For example, the message in the center of Fig. 5 says (in Japanese) "Reconsider your diagnosis." The message appears over the face of the patient to make sure the trainee is aware of the problem. This feature is only used in the case of a serious problem.

A view of the evaluators ' check-sheet page concerning the questions asked is shown in Fig. 6. To access the page, the evaluator uses an iPad and Apple Pencil (which are just as convenient as a paper form and a pencil). The system combines all the checked results and generates one feedback sheet immediately after the interview. An example of a feedback sheet is shown in Fig. 7. The trainee can review the evaluation for each item and gets a summary of their interview in the form of sequenced questions.

Fig. 8. A view of the video player

TABLE I. RESULTS OF QUESTIONNAIRE ON GROUP LEARNING BY EVALUATORS

	Question	Average
SC1	Checking is effective	4.3
SC2	Sharing results is effective	4.1

The trainee watches their video to reflect on their performance (i.e., reflective learning). The system records all the times when the evaluators inputted their evaluations of each item. When the trainee clicks an item in the video player, shown in Fig. 8, video streaming starts from 10 seconds before the average checked time. In that way, the trainee can learn reflectively and efficiently from only the required scenes.

IV. EXPERIMENTS

In this section, we describe three experiments that were performed in a medical school to evaluate the proposed method. We also present the results of the experiments.

A. *Experiment on group learning*

To evaluate the usefulness of group training with the proposed system, tablet terminals were introduced into actual training sessions of medical interviews at a medical school. All the examinees were students (numbering 15), who learned the standard questions for the medical interview. Each training session consisted of a 10-minute interview and around 10-minute "advice time" with the trainer. During the advice

TABLE II. RESULTS OF QUESTIONNAIRE ON GROUP LEARNING BY TRAINEES

	Question	Average
SS1	Evaluation is useful	3.9
SS2	Evaluation is correct	4.1

TABLE III. RESULTS OF QUESTIONNAIRE ON VIDEO REFLECTION BY TRAINEES

	Question	Average
VS1	Reflection with video is effective	3.9
VS2	Ratio of scenes you want to see (1: 10%, 2: 30%, 3: 50%, 4: 70%, 5: 90%)	3.0

TABLE IV. RESULTS OF QUESTIONNAIRE ON VIDEO REFLECTION BY TRAINERS

	Question	Average
VT1	Reflection with video is effective	5.0
VT2	Result of pre-training is useful	4.7
VT3	Ratio of scenes you want to see (1: 10%, 2: 30%, 3: 50%, 4: 70%, 5: 90%)	2.3
VT4	Video reflection reduces burden	4.0

time, the system generates the feedback sheet. All examinees answered a questionnaire after the training.

The results of the questionnaire given after the interviews are listed in Tables I and II. All answers were measured according to the five-level Likert scale. An answer of "3" means a neutral value. According to these results, the trainee thinks that the evaluations by other students are correct and useful. The evaluations by the students and those by the trainer were compared. The comparison results indicated that 74% of the results matched. Given that the trainer could not check more than 10% of the questions because due to limited time during the interviews, more than 80% of the evaluations by students are considered correct.

B. *Experiment on reflective learning with video*

Reflective-learning support through the prototype system was demonstrated with eight students and three trainers at the medical school. Each participant in the demonstration was given a questionnaire after their participation. The questions and respective results are listed in Tables III and IV.

C. *Experiment with smart glasses*

The usefulness of the smart glasses used in the proposed method was evaluated by an experiment with eight students at the medical school. Each student was given a questionnaire after their participation. The questions and respective results are listed in Table V. All answers were measured according to the five-level Likert scale. An answer of "3" means a neutral value. The results of the experiment are discussed in the next section.

V. DISCUSSION

A. *Self-learning trainings*

A medical interview is one of the most-important techniques used by a doctor. Students in current medical schools, however, have few chances of trainings in giving medical interviews. A trainer can only take from five to ten minutes for each trainee. They do not have enough time to give detailed advice to all of trainees. The trainer advises each trainee in one-to-one training. It is thus impossible to have multiple sessions in parallel because the trainer would have to listen to all trainees at once.

TABLE V. RESULTS OF QUESTIONNAIRE FOR SMART GLASSES

	Question	Average
G1	Usefulness of notification for no-facing	4.0
G2	Usefulness of notification for no-talking	4.1
G3	Usefulness of trainer's advise	4.4
G4	Obstructiveness for interview (1: obstructed, 5: no-obstruction)	2.9

Although a trainee only has one training sessions per year, they can receive more training without a trainer. In that case, the other students in a group of trainees can be evaluators. We found that more than 80% of the evaluations generated by the system based on students' evaluations are correct. Thus, the students can have more chances of training before the training with the trainer.

Trainers think that checking the results of pre-training is useful ("VT2" in Table IV). They also think that watching trainees' videos before training is useful. However, they think they need to watch only less than half of the scenes in each video (VT3).

The above-described experiment is based on an actual one-to-one training. The proposed method makes it possible for the trainer to be at a remote location and communicate via the internet and to conduct multiple training sessions in parallel. The number of training sessions could be increased if such parallel training was possible. As a result, repeated training sessions would be possible and lead to better medical education.

B. *Training in time*

1) Efficiency of training sessions: When a trainee makes an incorrect diagnosis, most of the questions asked become inadequate. That is, the training is not effective for that trainee. In that case, some trainers would prefer to stop the interview. However, that would waste time. Most trainers therefore wait for the trainee to realize by themselves that they asked an inadequate question.

Using the proposed method, the trainer adds a small alert on the display of the smart glasses to draw the trainee's attention to the misunderstanding. In this way, the training is not interrupted and is made more efficient. Result "G3" in the questionnaire means the trainees think that the advice displayed in the smart glasses is very useful.

The time taken giving advice to the trainee is short and limited. It is thus not sufficient for providing efficient education. Most trainers cannot point out small mistakes made by the trainees. Even so, the proposed system can alert trainees to some simple mistakes automatically while making training sessions more efficient. Results "G1" and "G2" in the questionnaire show the trainees think that automatic alerts are also useful.

2) Efforts of trainers: Medical-interview training is one curriculum that requires a great effort from trainers, and the insufficient number of trainers in Japan is a serious issue. Utilizing the proposed system, however, the trainee can check their evaluation results and quickly identify simple mistakes by themselves. That feature supports trainers' tasks from the viewpoint that trainers can focus on important problems only. Moreover, it might be possible to hold several training sessions in parallel and thereby lower the burden on trainers.

C. Reflective learning

All the experimental training sessions at the medical school were recorded. However, each trainee usually does not have enough time to play the whole video and the time the trainer has to give advice is restricted. Although trainees and trainers think that reflective learning with their own video is effective (answers "VS1" and "VT1"), they do not think they need to watch the entire video ("VS2").

In general, it is costly to make effective video contents for education. The proposed system generates all pages for each trainee automatically and immediately after the training.

VI. Conclusion

In this paper, we proposed a method for supporting medical-interview training, which is one kind of clinical training given in medical schools. The proposed method uses sensors and smart devices such as smart glasses and tablets.

In the case of medical schools in Japan, clinical training has been focused on lately. The trainer could only spare a short time for each trainee. Since the trainer has to provide one-to-one teaching for each trainee, the number of classes for practical training sessions in conducting medical interviews is not still enough. In addition, the number of physicians who can provide teaching is not enough. Therefore, classes in practical training become a burden on the trainer.

Using the proposed method, the trainee receives self-learning training in a group. The trainer understands the skills of each trainee before the clinical training sessions. During a clinical training session, the trainer does not need to focus on trainee's behavior; instead, they provide advice based on their experience. After the clinical training session, the trainee learns reflectively and efficiently by watching their own video.

The usefulness of the proposed method was confirmed by the experiments involving students and physicians at a medical school. The proposed method makes medical training more efficient, gives trainees more chances of conducting medical interviews, and alleviates the load on trainers. It is thus concluded that the proposed method will a suitable solution for the current issue—namely, insufficient medical-interview training—facing medical education in Japan.

It is also planned to extend the proposed method for other kinds of clinical training in medical schools and nursing schools.

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