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Editors

Ahmad Fauzi Mohd Ayub

Ben Chang

Krittaya Leelawong

Fu-Yun Yu

Tsukasa Hirashima

Gautam Biswas



Chapter 9

Skill Analysis, Learning or Teaching of Skills, Learning Environments or Training Environments for Skills

Preface

In this workshop, skill means special techniques to do something by interacting with objects, other persons or environments. Creating arts and playing sports are examples of the category of skill. Skill consists of recognition of objects or environments, Selection of appropriate action, and execution of action. A learner repeats these processes when he/she learns skills and trains skills. In this workshop, analyses of such skills are important issues. In addition how to learn skills or how to train skills are also important issues. Moreover, designs or developments of learning environments or training environments for skills are also important topics.

In this workshop, seven interesting papers were accepted and will be presented. Two papers of them are related to sports skill learning support environment. Other two papers are related to nursing skill learning support. Another paper is related to acupuncture. Another paper is related to pronunciation skill training environment, and the other paper is related to presentation skill learning environment. Therefore, the papers are coming from various domains.

The methods how to support skill learning also show wide variety. Some papers use 2D or 3D animations with CG. Another paper uses electroencephalogram for sports training. Another paper uses web technology for presentation skill learning. Another paper shows ontological approach. Other papers use motion capture system for sensing learners' or experts' body motions, and the other paper uses force feedback device.

In this way, participants in this workshop will be able to know various aspects of skills and also various approaches for skill learning research. Fruitful discussions on skill learning and training are expected in this workshop. Hopefully, this workshop will contribute to develop new skill learning studies.

Organizer

Masato Soga, *Wakayama University, Japan*

Development of Motion Visualization System with The Center of Gravity for Novice Learners

Takazumi Kawagoe ^{a*}, Masato Soga ^{b*} & Hirokazu Taki ^b

^a *Graduate School of Systems Engineering, Wakayama University, Japan*

^b *Faculty of Systems Engineering, Wakayama University, Japan*

* {s125014, soga}@center.wakayama-u.ac.jp

Abstract: To control the center of gravity of the body is one of the most important issues in motor skill learning, however, it is difficult for us to imagine the center of gravity, because he/she cannot see it. Furthermore, when he/she learns motor skill by coach or reference book, the center of gravity is often described with ambiguous expression, therefore, he/she find it difficult to know the center of gravity. In this background, we developed a motion visualization system with the center of gravity for novice learners. The learner's motion data is got by wearable motion capture system with gyroscope. By using this system, a learner would be able to visually understand the relationship between his/her body movement and the center of gravity.

Keywords: motor learning, body's center of gravity, motion capture, skill, badminton

1. Introduction

To move a body is to move the center of gravity. Therefore, it is clear that the center of gravity is important in motor skill learning. Thus reference book or coach often gives advice about the center of gravity. However, learners cannot understand the center of gravity very well, because the advice about it is implicit or described with ambiguous expression. Furthermore, it is difficult for us to imagine it, because we cannot see it. Accordingly, invisibility of the center of gravity prevents learners from the mastering motor skill.

In this background, Kubo et al estimated the center of gravity visually [1]. The fitness software :Wii Fit or Wii Fit Plus shows the shift of the center of gravity by the projection on the ground. These researches show the center of gravity from one viewpoint.

For in related research on motor skill learning, Soga, A. et al developed application system[2][3]. This research shows the learning support by using 3D models.

The goal of this study is to design and develop a skill learning support environment for novice learners to improve his/ her arbitrary motion in motor skill learning. We developed a motion visualization system with the center of gravity. This system displays the physical center of gravity and movement with learner's 3DCG born model. The 3DCG models are made by OpenGL. We made the animation from the motion data which we acquired by a motion capture system. By using this system a learner can see his/her movement and the center of gravity from the any view point. Moreover, the learner can easily understand the relationship between body movement and the movement of the center of gravity. Therefore, we think that learning performance would increase.

In addition, we performed an evaluation experiment which decided whether a learner was able to improve his/her motor skill by the visualization of the center of gravity. Moreover, we performed a questionnaire survey after the experiment.

2. The Calculation Method of The Center of Gravity

The position of the center of gravity of human body is calculated as follows.

- (1) Divide human body into 15 parts.
- (2) Calculate the position of the center of the gravity of each part.
- (3) Calculate the integrated center of gravity.

We need to know the length and mass of each part of the body for calculating the partial center of gravity. We can get the length of part of the body by a motion capture system. Ae et al intended for youth athlete for the wide area for build and divided a body into 15 parts: the head, upper trunk, lower trunk, left upper arm, right upper arm, left forearm, right forearm, left hand, right hand, left thigh, right thigh, left leg, right leg, left foot, and right foot. They estimated those mass and a centroid position and the centroid ratio by use of a mathematical model[4]. We used this mathematical model in this study.

For example, when we demand a x value of the head, the partial center of gravity can be calculated by math formula (1). Figure 1 shows endpoints of physical parts. Endpoint a and endpoint b represented each endpoint of each physical part. The position of the endpoint is calculated by the data which we acquired by the motion capture system.

$$\begin{bmatrix} X' \\ Y' \\ Z' \end{bmatrix} = \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix} + r \begin{bmatrix} b_x - a_x \\ b_y - a_y \\ b_z - a_z \end{bmatrix} \quad \dots (1)$$

X' : x value of the partial center of gravity

Y' : y value of the partial center of gravity

Z' : z value of the partial center of gravity

a_x : x value of the endpoint a

a_y : y value of the endpoint a

a_z : z value of the endpoint a

r: the centroid ratio

b_x : x value of the endpoint b

b_y : y value of the endpoint b

b_z : z value of the endpoint b

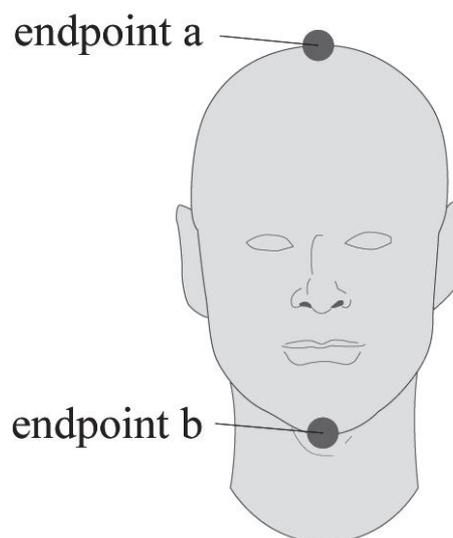


Figure 1 The example of the physical part (The head)

When I demand a x value of the center of gravity, it can be calculated by math formula (2)

$$\begin{cases} X = \sum_{i=1}^{15} (m_i x_i) / \sum_{i=1}^{15} m_i \\ Y = \sum_{i=1}^{15} (m_i y_i) / \sum_{i=1}^{15} m_i \\ Z = \sum_{i=1}^{15} (m_i z_i) / \sum_{i=1}^{15} m_i \end{cases} \quad \dots (2)$$

X: x value of the center of gravity

Y: x value of the center of gravity

Z: x value of the center of gravity

m: the mass of each part of the body

x: x value of the partial center of gravity

y: y value of the partial center of gravity

z: z value of the partial center of gravity

3. Motion Visualization System with Center of Gravity

3.1 System Summary

It is easy for the learner to understand the relationship between movement of his/her body and movement of the center of gravity by making it visible. Therefore, we developed the motion visualization system with the center of gravity for novice learners. We think that it might be helpful for the motor skill learning. This system displays learner's 3D bone animation and the learner's center of gravity. An Expert's motion data is captured by wearable motion capture system(IGS-190) in advance. IGS-190 has directional sensor. In addition, it sends and receives data by wireless thus the learner is able to move wide area.

3.2 The Procedure for Use of The System

Procedure to use the system is as follows.

1. An expert's motion data is measured by the wearable motion capture system in advance, and store the data is stored in the system.
2. The learner measures his/her motion by the wearable motion capture system, and store the data in the system.
3. The system opens two windows. One window shows the expert's motion by bone animation with the center of gravity. The other window shows learner's motion by bone animation with the center of gravity.
4. The learner can find the difference between expert's motion and learner's motion.
5. The learner trains himself/herself to minimize the difference.
6. The learner repeats 2 - 5.

This system displays the bone animation in the three-dimensional space, therefore, the learner can check his/her movement from any viewpoint. The learner can zoom in, zoom out, replay the motion, and change the viewpoint by using a mouse and the keyboard. In addition, the learner can see movement of the center of gravity by displaying trajectory of the center of gravity. Moreover, the learner can know the passage of time intuitively, because the trajectory varies from blue to red as time passages. Figure 2 shows an example of bone animation of learner's movement and trajectory of the center of gravity.

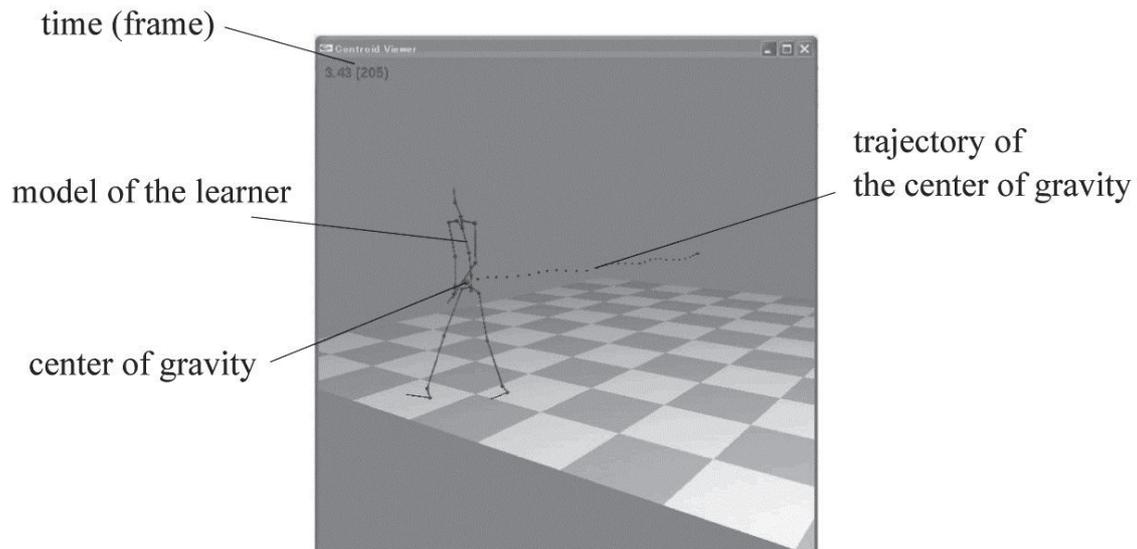


Figure 2 Bone animation of learner's movement and trajectory of the center of gravity

4. Evaluation

4.1 Experimental Methodology

We performed an evaluation experiment to verify effects and the utility of the system. We chose two kinds of forms which are basic shots of badminton: long high serve and high clear as a test domain in this experiment. The reason why I choose these shots are because a learner moves feet a little but moves body much, therefore I think the center of gravity is important in motion of long high serve. In addition, I make sure of the effectiveness of the system by the movement in a wide area in the motion of high clear. This is because there is a reason that movement with a whole body without moving a foot can utilize the characteristic of the system. Subjects are six male students in their 20's. We divided them into two groups. One group is experimental group in which subjects use the system with seeing the center of gravity. The other group is control group in which use the system without seeing the center of gravity. Long-high serve is the shot in badminton by which a player shots a shuttle as highly and far back in the court as possible from the service line to the opponent's court with underhand stroke. High clear is the shot in badminton by which a player shots a shuttle as highly and far back as possible from back in his/her own court to the opponent's court with overhand stroke. In addition, we performed a questionnaire survey after an experiment to evaluate a usability and effectiveness of the system.

4.2 The Flow of Experimentation

The flow of the experiment is as follows.

(1) We told the target point in the opponent's court, and then, we explained how to swing in basic long serve, the trajectory of the shuttle.

(2) Subjects in both group hit five shuttles without any practice by wearing a motion capture system. We measured subjects' motion and flying distances of the shuttles. These data represents subjects' ability before learning. We measured flying distance by measuring the perpendicular lines from the fall spot of the shuttle to a service line. If the shuttle did not go

over the net or a subject hit a wood shot, we didn't count them in the trial. A wood shot is a legal shot in which the frame hits the shuttle of the racket.

(3) After subjects finish hitting five shuttles, they compare their own motion data with expert's motion data by using the system. Subjects in experimental group use the system with seeing the center of gravity. On the other hand, subjects in control group use the system without seeing the center of gravity.

(4) Subjects in both group hit five shuttles by wearing a motion capture system. We measured subjects' motion and flying distances of the shuttles. These data represents subjects' ability after learning.

After finishing the experiment for long high serve, we performed the experiment for high clear by the same procedure as the long high serve. A flying distance by the high clear is length of a perpendicular when hitter dismantled the vector that bound the spot of the hind leg heel when he hits the shuttle and the fall spot of the shuttle together to a horizontal ingredient and a perpendicular ingredient in a net.

4.3 Result of Experimentation

Table 1 and table 2 show pre-learning and post-learning results of flying distance of the shuttle by long high serve. We rounded off flying distances to 10-digit.

Table 1 Pre-learning result by long high serve (cm)

		1	2	3	4	5	average
experimental group	A	760	700	800	800	700	752
	B	780	730	870	770	810	792
	C	580	580	650	680	510	600
control group	D	760	710	740	680	760	730
	E	330	500	590	460	490	474
	F	750	530	600	580	500	592

Table 2 Post-learning result by long high serve (cm)

		1	2	3	4	5	average
experimental group	A	830	800	780	770	820	800
	B	850	950	910	830	780	864
	C	680	820	520	530	730	656
control group	D	730	730	700	720	750	726
	E	590	490	660	380	600	544
	F	690	660	640	650	750	678

We found that the average of flying distance of all the subjects in the experimental group increased by comparing the averages in table1 and table2. We also found that the average of flying distance of all the subjects in the control group also increased except subject D by comparing the averages in table1 and table2. Therefore, it is difficult to show a learning effect by visualization of the center of gravity by the results.

We define maximum difference as the difference between maximum flying distance of pre-learning result and that of post-learning result. Similarly, we define minimum difference as the difference between minimum flying distance of pre-learning result and that of post-learning result. The maximum difference becomes larger in experimental group than control group. In other words, as for the experimental group, the maximum flying distance comparatively increased. On the other hand, we could not find difference for minimum

difference between experimental group and control group. From this result, we understood that the maximum flying distance tended to be easy to come to increase by learning with visualization of the center of gravity indication.

Table 3 and table 4 show pre-learning and post-learning results of flying distance of the shuttle of high clear. We rounded off flying distances to 10-digit

Table 3 Pre-learning result of high clear (cm)

		1	2	3	4	5	average
experimental group	A	910	1020	990	1050	1100	1014
	B	640	560	710	640	680	646
	C	960	970	830	1040	920	944
control group	D	960	1100	960	1170	1140	1066
	E	1010	920	1070	1100	930	1006
	F	860	900	800	850	670	816

Table 4 Post-learning result of high clear (cm)

		1	2	3	4	5	average
experimental group	A	1050	1070	1160	1130	990	1080
	B	670	830	800	850	640	758
	C	920	920	860	1000	1030	946
control group	D	1100	1160	890	1100	1040	1058
	E	920	670	1000	1030	940	912
	F	960	880	830	1000	840	902

By table 3 and table4, subject A and B of experimental group largely increased. Subject C in experimental group and subject D in control group did not show learning effect. Subject E in control group largely decreased. Therefore, there seems to be a tendency to increase flying distance a little in experimental group, however, we didn't find clear conclusion.

4.4 Result of Questionnaire Survey

We performed questionnaire survey about a feeling of use or the effectiveness of the system with six subjects. Subjects answered each question by five point scale. Score 5.0 means most positive score and score 1.0 is most negative score. In addition, subjects described their opinion by free description. Table5 shows questionnaire sentence

Table 5 shows questionnaire and the answer result of the questionnaire. The number in the right column indicates each is average each of rating. Questionnaire number 2 and 3 are questions only to experimental group, and questionnaire number 4 is a question only to control group.

Table 5 Questionnaire results

	question	average
1	Was the operation of the system comfortable?	3.0
2	Do you think it is effective to learn skill by seeing movement of the center of gravity?	3.7
3	Did you know a center of gravity position?	4.0
4	Did you understand how to move your bodies correctly?	3.8
5	Do you want to use a system in the future? (experimental group)	4.0
5	Do you want to use a system in the future? (control group)	3.7

We show some opinions by free description as follows.

Positive opinions:

- I was able to discover defects of my movement.
- I understood well the difference of the center of the gravity between expert's movement and my movement.
- I am glad that I can watch my movement from any view point.

Negative opinions:

- It is difficult for novice learners to improve their form even if they noticed differences.
- An unnecessary trajectory of the center of gravity was displayed and was obstructive.
- It is difficult for me to relate the center of gravity to physical movement

We verified effect of visualization of the center of gravity by positive opinions, because subjects told that they understood deeply their movements and movements of the center of gravity. On the other hand, we also found some disadvantages by negative opinions, because subjects told that they understood the difference between their own movements and expert's movement, however, they also told that they didn't understand how to improve their movements.

5. Conclusions

We developed the system which visualizes body motion with center of gravity in this study. We expected that a learner understood his/her body motion and a relationship between his/her body movement and the movement of center of gravity. To evaluate the system, we chose two kinds of forms in badminton as a test domain. We found that the flying distance of the shuttles tended to increase a little; however, we didn't get a clear conclusion by the experiment results. Since there is an opinion that there may be more important factors than the factor of the center of gravity in badminton, we would like to verify the learning effect of this system by the other sports.

This system was effective for learner to understand his/her movement and movement of the center of the gravity. The learner was able to notice the difference between expert's movement and his/her movement and also difference between expert's trajectory and learner's trajectory of center of gravity. However, the problem is that the learners cannot find the method how to improve his/her movement. To solve this problem, we have to develop a new function which advises the difference between learner's movement and expert's movement and also advises how to improve learner's movement.

References

- [1] Kubo, Y., Yamaguchi, M., Ono, N., & Fukui, T. (2006). Investigation of the Validity of Visual Assessment of Center of Gravity in the Analysis of Posture and Movement. *Japanese Physical Therapy Association*, 33(3), 112-117.
- [2] Soga, A., & Myojin, Y. (2008). Educational Applications for Learning Rhythmic Gymnastics Rules Using Motion Data, *The Journal of The Institute of Image Information and Television Engineers*, 62(2), 222-226.
- [3] Soga, A., Umino, B., & Yasuda, T. (2006). A Web-based Motion Archive and 3DCG Simulation System to Support Classical Ballet Choreography (Database Systems). *Information Processing Society of Japan*, 44(2), 227-234
- [4] Ae, M., Tou, K., & Yokoi, T. (1992). Estimation of Inertia Properties of the Body Segments in Japanese Athletes. *Society of Biomechanisms Japan* (11), 23-33.

Integrating Electroencephalogram Analysis for Improving Mental Condition in Physical Skill Learning

Soichiro Takaiwa^{a*}, Kenji Matsuura^{b*}, Naka Gotoda^{c*}, Hiroaki Ogata^{d*},
Kazuhide Kanenishi^{e*}, Hiroki Moriguchi^f & Yoneo Yano^f

^a Graduate School of Advanced Technology and Science, The University of Tokushima,
Japan

^b Center for Administration of Information Technology, The University of Tokushima,
Japan

^c Kochi University of Technology, Japan

^d Institute of Technology and Science, The University of Tokushima, Japan

^e Center for University Extension, The University of Tokushima, Japan

^f Center for Administration of Information Technology, The University of Tokushima,
Japan

^{a*} takaiwa-soichiro@iss.tokushima-u.ac.jp

^{b*} matsuura@ait.tokushima-u.ac.jp

^{c*} gotoda.naka@kochi-tech.ac.jp

^{d*} ogata@is.tokushima-u.ac.jp

^{e*} marukin@cue.tokushima-u.ac.jp

Abstract: In this paper, we propose a supporting system for a learner to develop a motor-skill. This study focuses on an electroencephalograph during physical skill performance. There are close relations between brain wave and psychological condition. It is our beliefs that identifying the strong relation between brain waves and the physical motion leads new approach to support learning motor-skill. The purpose of this study is to make the ideal psychological condition by the mental support according to runner's psychological condition

Keywords: Motor skill, skill development, running support, mental support, brain wave.

1. Introduction

1.1 Background

We focus on running as a primary target of developing motor-skill by this study. A lot of people currently pay attention to running because it is an easy exercise that can be carried out alone [1]. The population of both regularly and temporal runners are increasing. It is because the advantage of running are eliminating lack of exercise and avoiding metabolic syndrome. Further, it is easy, low cost and having a lot of race-events. However, many runners sometimes tend to dropout. The expected reasons why to dropout are injury, seasonal estrangement and decreased motivation.

The people who are civil runners seldom take professional lectures on running. Therefore, educational support for such runners is important. In considering the approach, we take into account of the different approaches of supporting type. There are two major types; physical support and mental support. Both supports are important for runners [2]. Many previous studies are based on the physical support for sports at real time. However, real-time mental support is rarely seen. We believe the mental training in sports is important. Running

performance and mental state are closely related. In other words, running of high performance is created ideal mental state [3].

1.2 Purpose

The purpose of this study is to support runners who want to improve their running conditions efficiency and continuousness. One of the methods for detecting mental state is to monitor brain wave. Several tools to capture the brain wave are published. We adopt “*BrainAthlete*” to measure the brain state. With this device, the system is able to monitor the information of brain at real-time. The brain state of a runner is estimated for 15 seconds in every 5 minutes. With psychological design of a runner after the measurement, the system provides the feedback of the mental information. The feedback can cause with early-expression, maintain, re-expression of the runner’s-high that is favorable psychological state.

2. Integrating Brain Wave

2.1 Brain wave

Brain wave shows potential change from electrode on the scalp. Those data are shown by line-chart. Horizontal-axis of the chart is time line. Vertical-axis indicates the potential change. Brain wave is detected potential change from cortex to extensive cortex. Brain wave takes the integral from cortex and distant point (e.g. Ear)

Brain wave is classified into Alpha wave, Beta wave, Theta wave, and so on (see Table 1). These waves can be divided and captured at the same time because of the different frequency. Cerebrum is always processing much information intricately. When the brain is working normally, potential of neuron is scattering. Thus, the brain shows beta wave. The potential of neuron is synchronized with other one in rough when the brain is non-active. Thus, the brain shows Alpha wave [4]. Activity of brain is understood by watching brain wave. Additionally, psychological state is estimated from activities of the brain.

Table1 The brain wave states

Brain wave	Frequency	Feature
Delta	0.5~4Hz	Deep sleep
Theta	4~8Hz	Shallow sleep
Alpha	8~13Hz	Memory, Learning, Stress reduction
Beta	13~40Hz	Focus, Concentration, Energy, Excitement, Attention
Gamma	30Hz	Angry State

2.2 The relationship between sports and psychology

To keep high state in mental condition is important for high performance of running. As mentioned before, the physical state and psychological one in sports are closely related [5][6]. The types of mental training for athlete are attention and meditation.

There are many kinds of mental training that is reported and regarded as an effective method for performance. However, most of the evaluation of effect of mental training is subjectivity. The problem is that evaluation always performed with less objectivity [4]. Therefore, it is important to integrate brain wave for the detection so as to evaluate the mental state objectively.

2.3 Runner's High

Repetitive motion like running will cause pleasant emotional states when a runner runs more than a certain time. A publicized effect of endorphin production is so-called "runner's high". This phenomenon is occurred by excreting a lot of endorphin in the brain. The endorphin cause analgesic effect and enhanced mood. Hence, a runner can train without emotional distress. If a runner can control the condition, it may lead to the better performance.

3. Tool

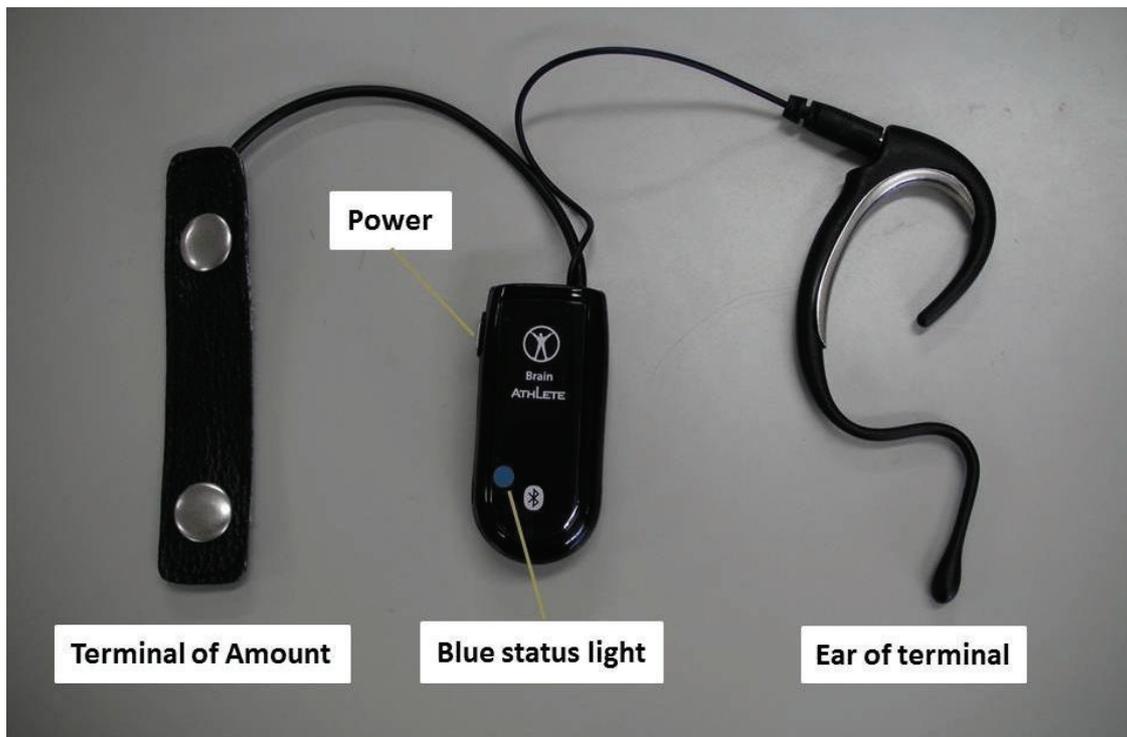


Figure 1 Sensing device in BrainAthlete

3.1 Module

3.1.1 BrainAthlete

BrainAthlete is the device that measures the brain wave (see Figure 1). This computes and determine attention and mediation from the brain wave based on the unique algorithm (this is called eSense). These values show the psychological state. It can be measured without obstruction of running. We can wear at a sun visor because this device is very small and lightweight.

3.1.2 Noise Filtering

Brain wave is very faint signal that is normally microvolt. Therefore, measurement result is sometimes affected by noise. Electroencephalogram is needed noise filtering to eliminate the interfere noise.

BrainAthlete eliminates the noise by using hardware and software filtering. The system removes bio-signal that is non-brain wave. The software on the device is able to output the wave in graphic representation at real-time during these process.

The device sends data on Bluetooth communication. If the distance between the sender and the receiver is less than guaranteed distance, Bluetooth can send data without being affected by angle. Therefore, it is easily measured in indoors and outdoors.

3.1.3 Conversion

BrainAthlete analyzes the brain wave by using unique algorithm called eSense. The brain wave is a complex data that is understood by only specialist. Therefore, eSense can convert from the raw data into two aspects as attention and mediation in order to be understood by non-specialist. These data is given from 0 to 100 of relative values. It shows relax and concentrating status that are important index values for sports. Besides, these values can be monitored without regarding the scene. Accordingly, this device is fitted one for our system. The device consists of smart shape because the process and analysis of the brain wave is mounted on only one module.

3.1.4 Appearance

The body of the sensing device is set on a sun visor and the relative-grand position is located at ear. The measurement of the brain wave and the sending of the data are realized by only these devices. Therefore, the runner does not mind deeply about wearing it. It is a basic advantage of this device.

3.2 Output Attention and Meditation

The device outputs the attention and meditation from measurement data. These data are output from 0 to 100 in real-time. Figure 1, 2 show the experimental result of output pattern. Red line shows attention, green line shows mediation. The horizontal line shows time. The vertical line shows the score of each data.

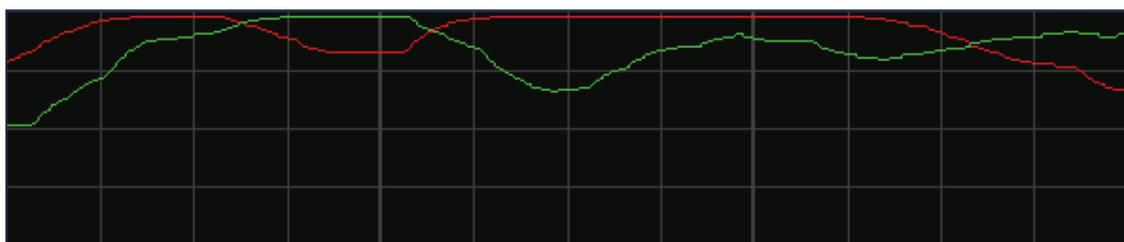


Figure 2 Sample of concentration

When the examinee is concentrating, the attention always shows high values such as from 70 to 90. The mediation also shows high value. Judging from the data, it can be confirmed that the examinee is concentrating (See Figure 2).

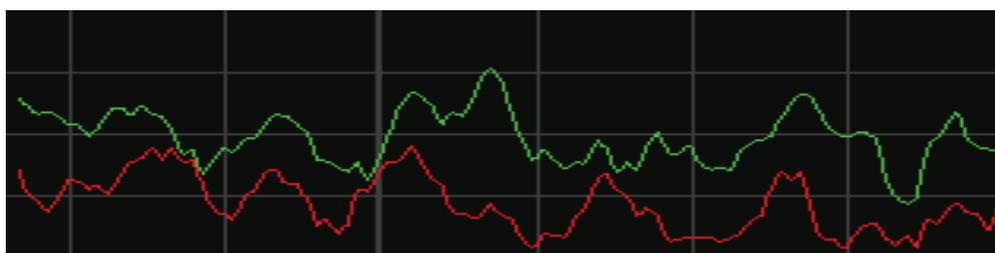


Figure 3 Sample in reading a book

When the examinee is reading (See Figure 3), the attention and the mediation oscillate in a chaotic pattern for instance. The average of the mediation is about 50. It is monitored that the attention is lowered at the same time as flipping the page. It is assumed that the examinee have a lapse of concentration when one flip the page.

3.3 Usefulness

Electroencephalogram measurement experiment uses flash mental arithmetic. Because, we want to demonstrate the usefulness as an index of BrainAthlete. From this experiment, measured characteristic data were similar between subjects in flash mental arithmetic. Thus, we demonstrated the usefulness as an index of BrainAthlete.

3.3.1 Flow

The number of subjects is four at this time. Subjects solve flash mental arithmetic on PC during measuring the brain waves. Subjects wait 5 seconds until the next issue after the answer. The flash mental arithmetic is going up difficulty according to solving the question. Subjects will end the measurement, when they mistake.

3.3.2 Experimental result

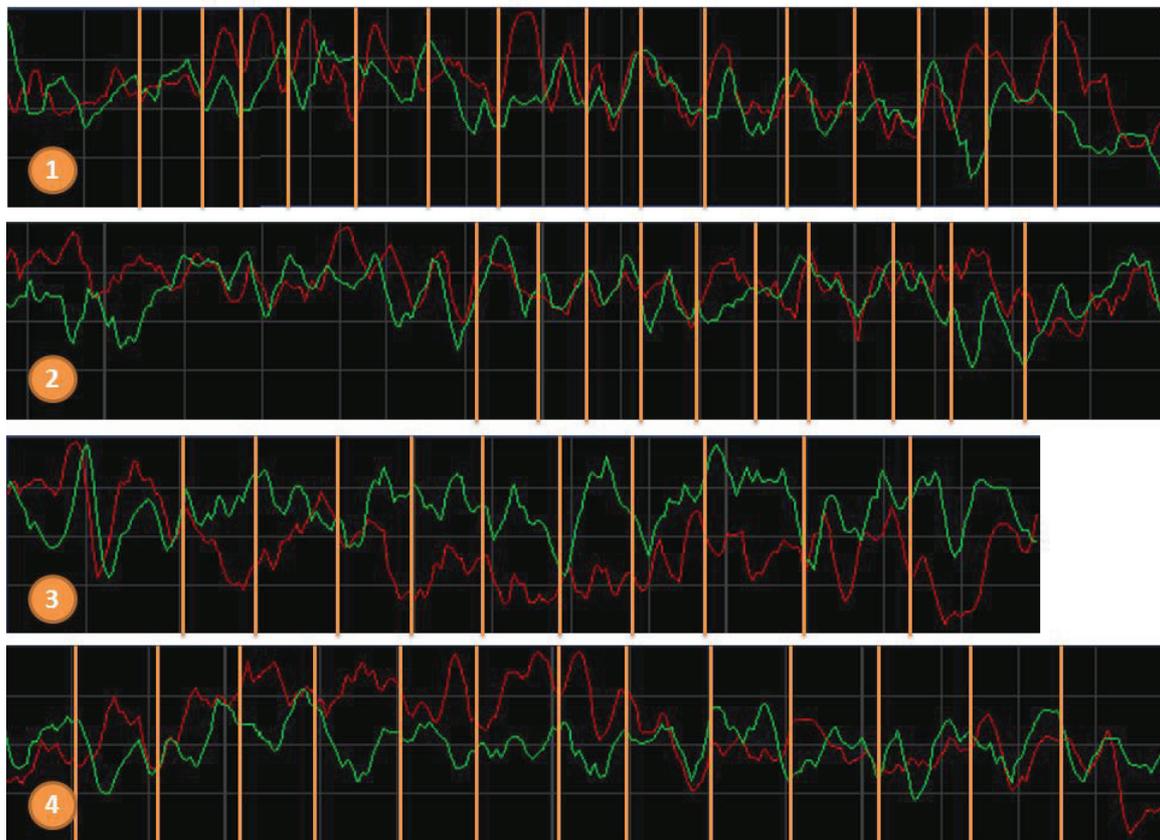


Figure 4 An experimental graph

The red line indicates *Attention*. The green line is for *Meditation*. Both lines are represented in a same graph (Figure 4). The vertical bar is the time that started to solve the question. When subjects start to solve the question, Attention raises sharply, then descent after the

answer. This pattern appeared frequently. At first, Attention had to rise from begin the question. However, when the difficulty in question goes up, just before beginning the question, the rise of Attention appears notably.

4. Implementation

4.1 Flow

In this study, our purpose is to support to the runner by using electroencephalogram and feedback on time. At first, the runner runs 30 minutes by using treadmill. The runner using BrainAthelete for electroencephalogram. Next, the runner slows down speed of running equally walking speed when after the 5 minutes. The runner kept shaking head as much as possible. The measurer measure the electroencephalogram while 15 seconds. If the measurer finishes measurement, the runner begins running. The measurer feed back to the runner by using electroencephalogram. These repeat every 5 minutes that are running, slowdown, measurement, acceleration, feedback.

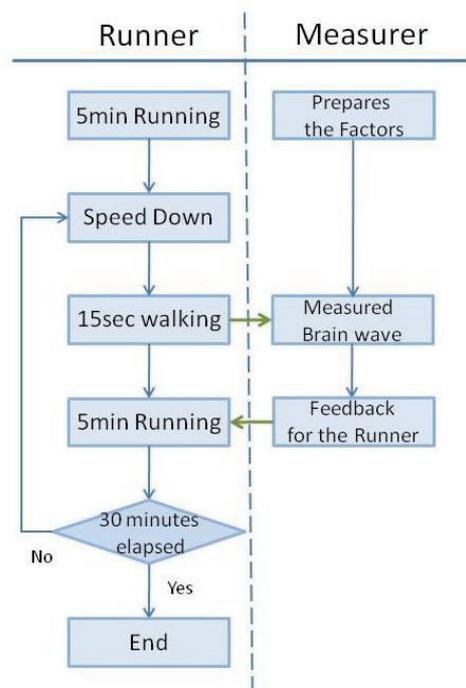


Figure 5 The process of supporting skill-development

To measure brain waves may then runner is stop. But, it is difficult, the runner stops to take brain wave like the running. Because, runner was calm heartbeat and respiration. If the measurer measure the electroencephalogram, the runner walk while keep shaking head as much as possible. There by, measurer can get low-noise electroencephalogram and similar to the electroencephalogram during running.

The measurer provides feedback for the runner by using electroencephalogram that was measured. The runner can get continue and re-emergence of runner's high. Thereby, the runner was sported of mental.

4.2 3×3 Thresholding

The measured brain waves are output as attention and meditation. These are represented by the value from 0 to 100. In this study, we define the 3 scope of attention and meditation.

Thereby, psychology is estimated of runner. Attention and meditation done in this area divided. Then, psychological state of the runner is divided into 9 states. The measurer provides feedback for the runner by using them.

4.3 Feedback

The measurer provides feedback for the runner by using the measured brain wave. Thereby, the runner was inspired to appear, continue and re-emergence of runner's high. The feedback approach is to encourage 5 sensory. There, the measurer prepares the factors to encourage for 5 sensory in advance (Table 2). These are factors that runner can relax or exit. Therefore, the runner is changed to ideal psychology by using them.

Table 2 Sensory organ and approach

Sensory organ	Approach
Vision	Projector, Monitor, etc...
Hearing	BGM, Natural sound, etc...
Smell	Perfume, Aroma, Incense, etc...
Taste	Candy, Drinking water, Cigarette, etc...
Touch	Temperature adjustment, Air Conditioning, etc...

5. Summary

This paper provided problems in running and the importance of mental support. we proposed solution of them.

Section 2 explained the relationship between brain wave and mental status. It explained the suitability of the brain wave in mental support.

Section 3 explained BrainATHLETE that is electroencephalogram measurement.

Section 4 explained this support system's flow, threshold value and feedback.

Acknowledgements

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References

- [1] Gotoda, N., Matsuura, K., Hirano, T., Tanaka, T. & Yano, Y. (2010) : Supporting real-time awareness for the community of runners, International Journal of Knowledge and Web Intelligence, Vol.1, No.3/4, 289-303.
- [2] Tokunaga, M. (1998) "A Study on Mental Conditioning for Athletes :Development of Diagnostic Inventory of Psychological State Before Competition", Institute of Health Science, Kyushu University, Journal of health science 20, 21-30
- [3] Tokunaga, M. & Hashimoto, K. (1986) "A Study on the Training of Psychological-Competitive Ability for Athletes (2) -On Relaxation Training by Skin Temperature Biofeedback-", Journal of health science 8, 65-77
- [4] Medical Systems Research, What is brain wave
http://www.kenn.co.jp/text/eeg_text.pdf
- [5] Yamanishi, T. & Matsumoto, H. (2005) "The Relationship between Mood Change and Exercise Intensity following Running in POMS : about Athlete and non-Athlete", Department of Health and Physical Education, Faculty Education, Gunma University (Accepted September 14)
- [6] Fujita, T. & Sugihara, T. (2007) "Prediction of exercise participation of university students based on intrinsic motivation in physical education while at high school", Japan J. Phys. Educ. Hlth. Sport Sci. 52: 19-28, January

Evaluation of An E-learning System to Support Self-Learning of Nursing Skills

Yukie MAJIMA^{a*}, Masayuki SAKODA^b, Yasuko MAEKAWA^c & Masato SOGA^d

^a*Faculty of Liberal Arts and Sciences, Osaka Prefecture University, Japan*

^b*Graduate School of Engineering, Osaka Prefecture University, Japan*

^c*Research Organization for the 21st Century, Osaka Prefecture University, Japan*

^d*Faculty of Systems Engineering, Wakayama University, Japan*

*majima@las.osakafu-u.ac.jp

Abstract: Learning-support using video teaching materials is known to be effective in nursing education. In recent years, as video equipment or computer technology have advanced, learning systems providing nursing skill video images on the web have been investigated. However, because they are only shown the teaching materials, students cannot review their own skills using such materials. Therefore, we verify the effectiveness of reflective learning by comparison between the video of a nursing student's skill recorded while training and the video of skilled nurse's skill model, using the self-learning support system. We report the analysis of the nursing students' skill acquisition process was phased in their self-learning situation.

Keywords: Nursing Skill Learning, Learning Model, Self-learning Support System, Nursing Student, Reflective Learning

Introduction

In nursing education, it is necessary to acquire not only specialized knowledge but also appropriate nursing skills. Furthermore, because nursing evaluation is often judged by whether the nursing skill is good or not, learning support necessary for a nurse to become familiar with nursing skills is required. In recent years, although the study of learning support of the specialized knowledge using ICT in the field of education is well practiced, the study of the learning support system requiring skills (series of techniques related to physicality) has been underway.

Intravenous injection, which draws much attention among nursing skills, is a skill that is related to body invasiveness by inserting a needle and infusing medicine into a blood vessel. In recent years, after the change of new administrative interpretation to "intravenous injection conducted by a nurse is treated as the category of auxiliary action of medical treatment" in Japan (Health, Labour and Welfare Ministry, 2003), it has been noted that education related to intravenous injection must be improved (Japanese Nursing Association, 2003). Consequently, nursing students are now required to master the skills to administer intravenous injection safely. Nevertheless it has been found that "self-learning of intravenous injection" and "technical training in college" are less useful for skill acquisition of intravenous interjection of new nurses, presumably because many students do not feel that learning at college is useful in a field or because new nurses tend to be passive in skill acquisition. Moreover, "reviewing one's own failure" and "knowing one's own tendency by personal experience" are described as highly valued for skill acquisition. Therefore, it is regarded as important to encourage the support system to allow a nurse to review their own failures and know their own tendencies.

Consequently, the author holds that it is necessary to encourage students to think subjectively and find important points for themselves to improve the circumstances described above, including self-learning in skill education at college. Moreover, it is necessary to support their effective nursing skill acquisition. In this study, for supporting nursing skill acquisition for nursing students, we put forward the three-level skill-learning-support models of (1) practice, (2) comparison, and (3) reflection. Then we verified the models using intravenous injection skill as one example. Focusing attention on the difference in the thinking mode of “knack” of intravenous injection skill between nurses and nursing students, we developed a learning support system to allow nursing students, as beginners, to self-learn nursing skills. In this study, we verified that capability.

1. Present situation of nursing skill education

In conventional classes designed to teach nursing skills, first instructors explain the purpose, necessity, and procedures of nursing skills in lectures and then demonstrate them in technical seminars. Thereafter, nursing students gain skill training individually or in a group in a series of learning processes. In skill training, even if the students sometimes teach each other in a group, they often put questions directly to the instructor. In other words, they tend not to think well about their questions by themselves in many cases. There are not many teachers who can answer their questions sufficiently on the scene. Therefore, students might be unable to gain nursing skills sufficiently within college classes, given present conditions. Although some skills can be learned with knowledge that is prescribed in a manual, it is difficult to learn nursing skills, which include implicit knowledge, as physical knowledge, according to a manual. Knowledge acquired from experience or practice could be called experiential knowledge, or deep knowledge (meaning the expertise or special skills which proficient engineers or managers accumulate from their various experiences). For learners to obtain that kind of knowledge, they must acquire experience and reinforce that knowledge through additional learning including practice, observation, problem resolution, and experiments, especially under the guidance of instructors [1].

In the field of nursing education, the chances for learners to gain skills through on-the-job training (OJT) in the clinical training are offered. In the field of college education under the pressures of number of instructors or time, however, it is not easy to use the form of OJT for learning various skills. In addition, because nursing students have many skills to learn, it is difficult for them to take much time to master any one of them. Consequently, to support them in acquiring nursing skills, we shed light on what is an effective learning-support method and examine the skill-learning support model.

To produce a learning-support model, it is noteworthy that we must consider two kinds of cognition that are used by human beings: experimental cognition and reflective cognition [2]. The former includes reactive understanding of an overall situation without deep thinking and acting just then. The latter involves making decisions through consideration and comparison. Furthermore, it is noteworthy that learning with reflective cognition should be required at an early stage, suggesting that it is important for a learner to learn by careful independent reflection to promote more effective skill learning.

Moreover, new nurses learn practicing intravenous injections through first “following the instructors’ model,” “benefiting by their experience,” and “repetitive practice” [3].

Additionally, in a traditional learning method, at first, it is common that the nursing student imitates the technique of the expert nurse [4]. In the another point of our previous study, we found that linguistic expressions differed among nurses in terms of the sensation of fingers that nurses recognize at perceiving blood vessels by touch or inserting an injection needle.

This suggests that formal knowledge by visualization would be better than that by verbalization to share and use know-how of nursing skills which cannot be verbalized [5]. For that reason, seeing video images from the viewpoint of skilled persons (nurses) and learning by following their model or by comparing one's own skills to theirs, a new nurse can promote reflective thinking, leading to the acquisition of effective skills. Consequently, in this study, using the learning-support system [6] developed for comparison between the video of a nursing student's nursing skill recorded while training and the video of skilled nurse's skill model, we first verify the effectiveness of reflective learning of nursing students' skill acquisition by making a comparison between both video images.

2. General outline of the learning-support system

Learning-support using video teaching materials is known to be effective in nursing education. In recent years, as video equipment or computer technology have advanced, learning systems providing nursing skill video images on the web have been investigated. However, because they are only shown the teaching materials, students cannot review their own skills using such materials. Therefore, we verify the effectiveness of reflective learning by comparison of how nursing students acquire their skills, using the following learning-support system [6].

The developed e-learning system described assigns importance to handling images to enable visual learning. In addition, because many nursing students consider precise implementation of procedures as technical "knacks", the instructional design consists of the following four phases:

- 1) Identification of one's own technical procedures;
- 2) Comparison of model images with one's own technical images;
- 3) Comparison of each image in one's own practice progressions; and
- 4) Output and identification of learning results.

The system comprises four functions. In the following, we explain the functions sequentially.

2.1 Procedure-learning function

It enables nursing students to learn technical procedures. Nursing students understand that the knack of skills should be to conduct the procedures precisely, suggesting that learning methods allowing learners to remember the procedures among others are good for them. The illustration of Figure 1 below shows that this function is a type by which a user can confirm procedures by checking a radio button.

2.2 Image-comparing function

This is a function by which a user can play two video images simultaneously or alternately to compare them (Figure 2). If the learners use this function, then they are helped by comparison to experience and think about the difference of time between that required by a skilled nurse and by themselves.

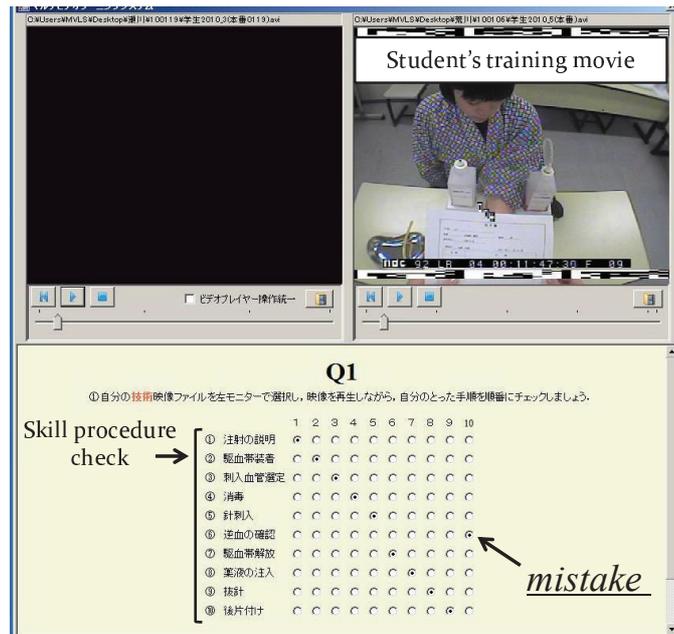


Figure 1. The screen of technical procedures check

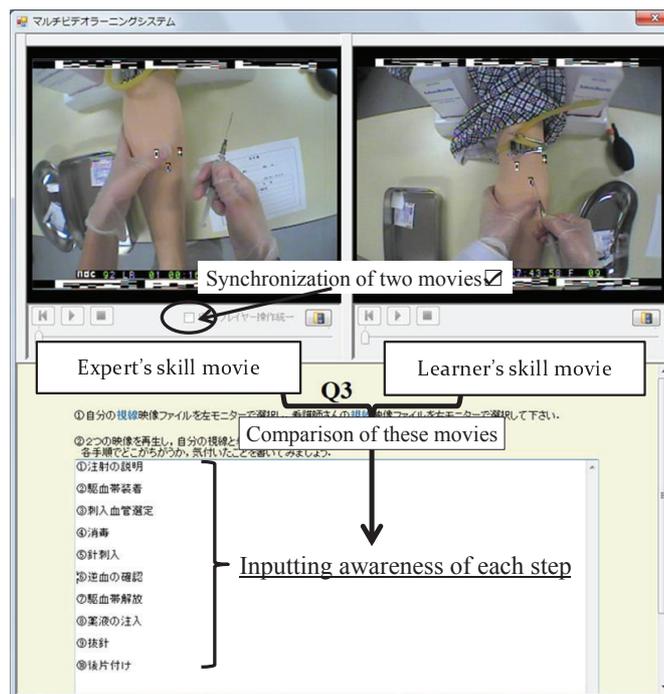


Figure 2. The screen of comparing images and inputting awareness

2.3 Text-entry function

With this function, nursing students can enter text through answering questions (see the lower illustration in Figure 2). Learners can think by themselves through comparison and freely describe what they have found. It helps learners to promote their reflection and think by writing using the system. The questions are set so that learners can make a comparison in every procedure of intravenous injection.

2.4 Text-output function

With it, users output the procedures that they have input by themselves or describe what they have found. It is also used as a portfolio of the process of skill acquisition, by which the learners can be conscious of their own findings and advance their own learning.

3. Research method

3.1 Experimental method

To verify reflective learning by video comparison on nursing students' skill acquisition, the experiment was conducted using the system described above. The experimental procedures are shown as follows. The experiment was conducted in January 2010.

- 1) A student wears a camera and conducts intravenous injection according to the simulation model of intravenous injection (Fig. 3), shooting a video (video A before training) from his perspective. The video images are portrayed in Figure 4.
- 2) After the student conducts training, the student shoots a video (video B after training).
- 3) Using the system, the student confirms the procedure and then describes findings after comparing video A (taken personally before training) with a skilled nurse's model.
- 4) Using each function of the system, the students confirm the procedure, comparing their own video images before and after training (video A and B) and theirs after training (video B) with the skilled nurse's video. Then they input their own findings.
- 5) Finally, they conduct intravenous injection again to shoot a video (video C after learning by the learning-support system).



Figure 3. An experimental picture



Figure 4. A nursing skill image

3.2 Subjects

The experimental subjects are five senior students who received credit in nursing technique training, including intravenous injection skills, and whose consent to participate in this experiment has been obtained.

4. Results

We analyzed (1) the procedure video shot by the nursing students, (2) the confirmation of whether they succeeded in inserting the needle into a vein precisely, and (3) the content of the interview which we conducted with them. The obtained results are presented as follows.

4.1 Procedures conducted by the nursing students

The numbers of students who made mistakes in the intravenous injection skills are shown in Table 1. The column of items in Table 1 represents the precise procedures used to conduct intravenous injection. The numbers in Table 1 presents the numbers of students who made mistakes while conducting respective procedures (say, skipped it or conducted in reverse order). The result of each situation is explained step-by-step in the following:

1) Before self-training

Before the students conducted self-training, many procedural mistakes were found overall.

2) After self-training

Taken altogether, the numbers of mistakes even after training were not so different from those before training.

3) After experiencing the self-learning support system developed

After comparing video images and learning by the self-learning support system that we have developed, no students exhibited mistakes overall from explanation of injection in procedure (1) to cleanup in procedure (10).

Table 1: Number of nursing students who made mistakes during procedures

proc.	items	before skill training	after skill training	after learning support system
(1)	explanation of injection	1	1	0
(2)	wearing tourniquet	0	1	0
(3)	selection of a vein to insert a needle	1	2	0
(4)	sterilization	1	1	0
(5)	insert of a needle	0	0	0
(6)	check of reversed blood	0	0	0
(7)	undoing tourniquet	3	2	0
(8)	infusion of medical solution	3	2	0
(9)	removal of a needle	2	1	0
(10)	cleanup	0	0	0

4.2 Check whether the needle is precisely inserted into a vein

The students who were confirmed to have succeeded in inserting a needle into a vein precisely were 0 before training, 4 after training, and 5 after comparing video images using the learning-support system.

4.3 Content of the interview which we conducted on the subjects

Regarding the question of what were the key points of intravenous injection skills or what they were careful of while conducting it, all five participants answered, “to confirm the procedure” before training. In contrast, after the video comparison, all participants described not only the procedure but also the content about “selection of blood vessel and support to a patient.” Regarding the question as to what they found when comparing their own video and a skilled nurse’s, we obtained the comment “I was able to find my mistake clearly. I understood the process of procedures. I was able to see my video objectively.” Regarding the comparison between self-videos before and after training, a student answered, “There was almost no change. I know well on what points I failed, even if I tried after self-training. I can understand what I did not do well.”

Asked whether they feel their skill was improved through comparing video images, all five participants answered that they think so. In addition to the question about whether they want to learn in the future, we obtained the request “I’d like to use the system that I used this time. After practicing the intravenous injection skill, I’d like to learn from listening to the opinions of the professor and my friends; I want concrete advice from them.”

5. Discussion

Regarding procedures, results show almost no improvement after self-training. In contrast, after learning by comparison of the self-video and the model video produced by a skilled nurse, improvement was shown by all participants. They became able to do intravenous injection precisely according to the procedure. It might be that seeing the self-video and then comparing it and the nurse’s encouraged participants to have a clear image of the whole process of procedure and to understand it better. Regarding confirmation of whether they succeeded in inserting a needle into a vein precisely, after self-training, four participants were able to do it but they did not improve their procedures. After comparing the video images, however, all five participants succeeded in inserting a needle into a vein according to the precise procedure, suggesting that their skills of intravenous injection were improved. Results of interviews of participants as to what they kept in mind while doing intravenous injection revealed an important change: they have become conscious not only of procedures but also more practical and concrete contents (how to select a blood vessel or support for patients). That might be true because the learners were able to learn by seeing their own skill objectively and by being mindful of their own mistakes or what they had failed by describing their findings and recognizing it formally through video comparison. In other words, video comparisons and finding descriptions, which promoted the nursing students’ reflective learning, were found to be effective for skill acquisition support in intravenous injection.

From the explanation presented above, even if self-training exerts some effect on improvement of the skill of “inserting a needle into a vein precisely,” it was found to be less effective for improvement of procedures. Furthermore, learning through video comparison had effects not only on knowledge-level improvement such as procedures but also on skill-level improvements such as “selection of a blood vessel and support for patients.” Therefore, results suggest that conventional learning using only training can only insufficiently facilitate learners to acquire the procedures of intravenous injection and more practical skills.

Moreover, based on results of the interview after comparing video images, we came to learn that the participants want to know peer nursing students’ opinions and thoughts. They examined themselves through video comparison and their questions therefore became

clarified. Consequently, they might have come to know of other people's opinions and learned about them more deeply. Furthermore, they might have come to want to know about their friends with skills of the same level as their own.

6. Conclusion

Results of this study confirmed that conducting a "procedure check, video comparison, and finding description" using the system enabled nursing students to obtain new findings and that it has effects on improvement of intravenous injection skill acquisition. Future tasks are to investigate the effectiveness of the system on more nursing students, evaluate the efficiency of the system in skills other than the intravenous injection, and to facilitate skill learning support for nurses using the system. From these experimentally obtained results, we also know that the nursing students who examined themselves by comparing video images have come to accept better listening to people around them. That is true probably because learners who were more conscious of their questions through introspection, might have wanted to know others' opinion and learn the subject more deeply. Therefore, we must investigate whether it is necessary that learners should share in others' findings after they obtain experience and findings through comparison and subsequent reflection.

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References

- [1] Dorothy, L., & Walter, S. (2004). Deep Smarts. *Harvard Business Review*, 82(9), 88-97.
- [2] Norman, D. A. (1993). Things That Make Us Smart: Defending Human Attributes in the Age of the Machine. *Addison-Wesley*.
- [3] Kikuoka, S., Honjo, K., Sugita, H., Nakaki, T., Kawashima, M., & Kawaguchi, T. (2005). Qualitative Analysis of Practicing Intravenous Injection Skills by Graduates of A College of Nursing : Learning despite Difficult Situations. *Journal of the Japanese Red Cross College of Nursing*, 19, 11-19. (in Japanese)
- [4] Majima, Y., & Maekawa, Y. (2009). Comparative Analysis of Vein Injection Skill Difference Between Skilled Nurses and Nursing Students: Focus to Radial Motion and Skill Procedures. *Proceedings of the 33rd Annual Conference of Japanese Society for Information and System in Education, JSiSE2008* (pp. 28-29). (in Japanese)
- [5] Majima, Y., Soga, M., & Maekawa, Y. (2010). Development of an E-learning System to Support Reflectional Nursing Skills Training, *Japan Journal of Medical Informatics Supplement*, 30 (pp.256-259). (in Japanese)
- [6] Majima, Y., Soga, M., & Maekawa, Y. (2010). Development of an E-learning System to Support Self-learning of Nursing Skills, *Proceedings of the IADIS International Conference, WWW/INTERNET 2010* (pp. 400-402).

Articulation Animation Generated from Speech for Pronunciation Training

Yurie Iribe^{a*}, Silasak Manosavanh^b, Kouichi Katsurada^b, Ryoko Hayashi^c,
Chunyue Zhu^d & Tsuneo Nitta^b

^a *Information and Media Center, Toyohashi University of Technology, Japan*

^b *Graduate School of Engineering, Toyohashi University of Technology, Japan*

^c *Graduate School of Intercultural Studies, Kobe University, Japan*

^d *School of Language and Communication, Kobe University, Japan*

*iriibe@imc.tut.ac.jp

Abstract: We automatically generate CG animations to express the pronunciation movement of speech through articulatory feature (AF) extraction to help learn a pronunciation. The proposed system uses MRI data to map AFs to coordinate values that are needed to generate the animations. By using magnetic resonance imaging (MRI) data, we can observe the movements of the tongue, palate, and pharynx in detail while a person utters words. AFs and coordinate values are extracted by multi-layer neural networks (MLN). Specifically, the system displays animations of the pronunciation movements of both the learner and teacher from their speech in order to show in what way the learner's pronunciation is wrong. Learners can thus understand their wrong pronunciation and the correct pronunciation method through specific animated pronunciations. Experiments to compare MRI data with the generated animations confirmed the accuracy of articulatory features. Additionally, we verified the effectiveness of using AF to generate animation.

Keywords: Animated pronunciation, Pronunciation learning, Articulatory feature

Introduction

Computer Assisted Language Learning (CALL) systems have been introduced for language education in recent years [1][2]. CALL systems typically analyze a learner's speech by using speech recognition technology, and point out pronunciation problems with specific phonemes in words and automatically score the pronunciation quality [3][4][5]. However, although the learner can thus realize that his/her speech is different from the teacher's, the learner cannot understand how to correctly move the appropriate articulation organ. The system should show how to do this when the learner makes a wrong pronunciation, in the same way that teachers teach. On the other hand, although other studies have examined making correct pronunciation animations and video in advance [6][7][8], they do not automatically produce animations of the learner's wrong pronunciation. The proposed system visually represents the teacher's and the learner's articulatory movements (movement of the tongue, palate, and lips) by using CG animations. As a result, the learner can study how to move an articulatory organ while visually comparing their mispronunciation animation with the correct pronunciation animations. To represent the teacher's and the learner's articulatory movements, the proposed system extracts the articulatory features (AFs) from the learner and teacher speeches automatically. Next, the system converts speech from articulatory features into

coordinate distances based on MRI data by two MLN. This paper describes the method of automatically generating animated pronunciations from speech. In section 2 we describe the method of articulatory feature extraction, coordinate distance extraction and CG animation generation. Section 3 discusses the experimental evaluation to confirm the accuracy of the generated animated pronunciation. The last section summarizes this paper.

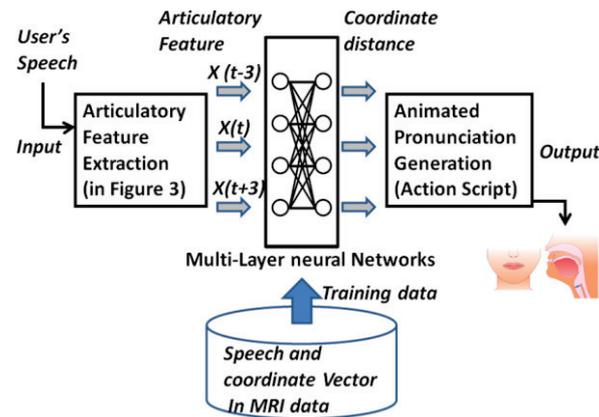


Fig.1: System outline.

1. CG Animation Generation System

1.1 System outline

Figure 1 shows an outline of the system. The system consists mainly of articulatory feature extraction by first multi-layer neural networks (MLN), coordinate distance extraction by second MLN, and CG animation generation programs.

We use the articulatory features composed of place of articulation and manner of articulation extracted from the speech, and use them to generate highly accurate CG animations. Concretely, the articulatory features are extracted from the speech input to first MLN, and the articulatory features and the coordinate distances of the MRI data are trained by second MLN. As for articulatory extraction, we use existing developed technologies as described in the next paragraph. The CG animation is generated based on the y-coordinate distances (Δy) extracted from trained MLN. As a result, the user's speech is input in our system, and a CG animation that visualizes the pronunciation movement is automatically generated.

1.2 Articulatory Feature Extraction

In order to vocalize, human beings change the shape of the vocal tract and move articulatory organs such as the lips, alveolar arch, palate, tongue and pharynx. This is called articulatory movement. Each attribute of the place of articulation (back vowel, front vowel, palate, etc.) and manner of articulation (fricative, plosive, nasal, etc.) in the

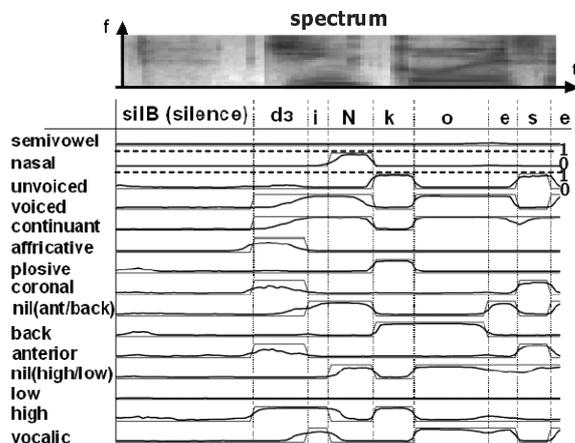


Fig.2: Articulatory feature sequence: /jiNkoese (artificial satellite)/.

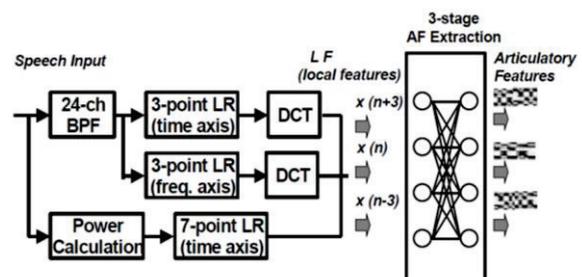


Fig.3: Articulatory feature extraction.

articulatory movement is called an articulatory feature. In short, articulatory features are information (for instance, closing the lips to pronounce "m") about the movement of the articulatory organ that contributes to the articulatory movement. In this paper, articulatory features are expressed by assigning +/- as the feature of each articulation in a phoneme. For example, the articulatory feature sequence of "/jiNkoese/ (space satellite)" in Japanese is shown in Figure 2. Because phoneme N is a voiced sound, "voiced" in Figure 2 is given [+] (Actually, [+] is given a value of "1" (right side of Figure 2)) as the teacher signal. Because phoneme k is a voiceless sound, "voiced" in Figure 2 is given [-]. Actually, [-] is given a value of "0" (right side of Figure 2) as the teacher signal and "unvoiced" in Figure 2 is given [+]. We generated an articulatory feature table of 15 dimensions corresponding to 25 Japanese phonemes. We defined the articulatory features based on distinctive phonetic features (DPF) involved in Japanese phonemes in international phonetic symbols (International Phonetic Alphabet; IPA) [10].

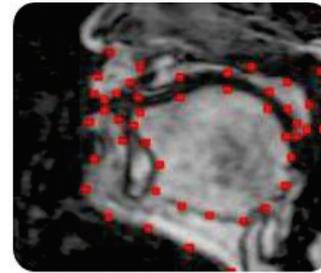


Fig.4: Feature points on MRI data.

We also used our previously developed articulatory feature (AF) extraction technology [11]. The extraction accuracy is about 95 %. Figure 3 shows the AF extractor. An input speech is sampled at 16 kHz and a 512-point FFT of the 25 ms Hamming-windowed speech segment is applied every 10 ms. The resultant FFT power spectrum is then integrated into a 24-ch BPFs output with mel-scaled center frequencies. At the acoustic feature extraction stage, the BPF outputs are first converted to local features (LFs) by applying three-point linear regression (LR) along the time and frequency axes. LFs represent variation in a spectrum pattern along two axes. After compressing these two LFs with 24 dimensions into LFs with 12 dimensions using a discrete cosine transform (DCT), a 25-dimensional (12 Δt , 12 Δf , and ΔP , where P stands for the log power of a raw speech signal) feature vector called LF is extracted. Our previous work showed that LF is superior to MFCC as the input to MLNs for the extraction of AFs. LFs then enter a three-stage AF extractor. The first stage extracts 45-dimensional AF vectors from the LFs of input speech using two MLNs, where the first MLN maps acoustic features, or LFs, onto discrete AFs and the second MLN reduces misclassification at phoneme boundaries by constraining the AF context. The second stage incorporates inhibition/enhancement (In/En) functionalities to obtain modified AF patterns. The third stage decorrelates three context vectors of AFs.

1.3 Coordinate Distance Extraction

We use the magnetic resonance imaging (MRI) data to map AFs to coordinate values that are necessary to generate CG animations. MRI captures images within the body by using magnetic fields and electric waves. We used MRI data captured in three dimensions, which shows in detail the movements of the person's tongue, larynx, and palate while making an utterance. CG animations are generated based on coordinate distances. Concretely, MLN inputs AFs extracted from speeches included in the MRI data and outputs coordinate distances. As a result, after the user's voice is input, the coordinate vectors adjusted to the speech are extracted, and a CG animation is generated based on them. This section describes the extraction of the feature points on the MRI data and the method of calculating the y-coordinate distance from them.

We assigned feature points to the mouth shape on the MRI data (tongue, palate, lips, and lower jaw) beforehand. To generate CG animations automatically, the proposed system uses the distance of the y coordinate of each feature point. We assigned 15 tongue points, 2 lip points, and 18 palate points as the initial feature points in view of the frequency of movement of the articulatory organs. Figure 4 shows these feature points.

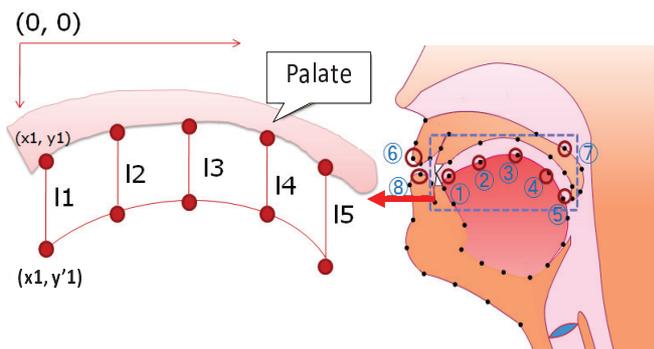


Fig.5: Feature point used in MLN training.

The relative, not absolute, coordinate distance is used for CG animations because the feature points of each articulatory organ in the MRI data vary among individuals.

The coordinate distances are extracted as follows. Firstly, we imported 10-ms speech and image segment in the MRI data because speech segment is 10 ms. The coordinate value of each feature point is extracted by the optical flow calculation program for each frame.

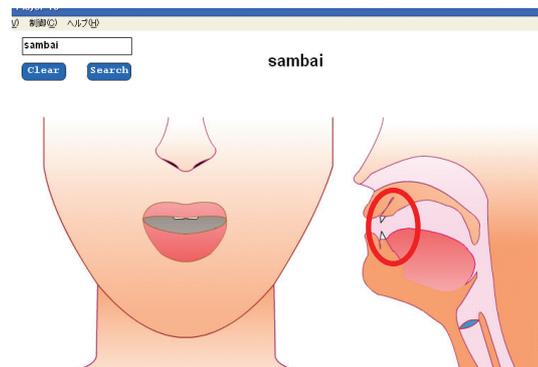


Fig.6: CG animation of pronunciation

The input data for the program is the MRI images and coordinate vectors of the initial feature points. Next Acquisition of many MRI data costs time and money, so we decreased the number of dimensions of MLN training data in order to train MLN effectively by even a small amount of MRI data. Therefore, only eight feature points having large changes in movement are trained in MLN (Figure 5). Moreover, the proposed system calculates only the y-coordinate distance of each feature point used as MLN training data to decrease the number of dimensions. The y-coordinate distance is calculated by subtracting y from y'. The x-coordinate value is the same as x-coordinate of the initial feature point (Figure 5). That is, the distance is calculated only the y-axis.

Specifically, to fix the palate with a little movement and to acquire the change of the uvula, we set feature point ⑦. Moreover, to express the movement of the tongue, the system determines the distance of the y coordinate (Δy) from feature point ① to feature point ⑤. To acquire the movement of the lips, the change in y-coordinate distance (Δy) between feature point ⑥ and feature point ⑧ was calculated. The spline curve mainly supplements the y-coordinate distance (Δy) of other initial feature points based on the above-mentioned eight points. On the other hand, to consider co-articulation, the system calculates the y-coordinate distance of the preceding and subsequent frames (t-3, t+3) in each frame (t), and trains these data in MLN. That is, the output of MLN is 8×3 dimensions.

Next, we explain the training method of MLN. AF is obtained by converting the speeches that accompany the MRI data. MLN projects the extracted AF to the y-coordinate distance. The number of dimensions of MLN is articulatory features (15×3 dimensions) as inputs and y-coordinate distances (8×3 dimensions) as outputs.

1.4 CG Animation Generation Programs

We used the moving average method, spline curve, and median filter to construct smooth CG animations by using the y-coordinate distance extracted from MLN.

Firstly, the system smoothes the movement of the tongue, palate, upper lip, and lower jaw by the moving average method to average the coordinate vectors of each frame. Moreover, the spline curve is used to complement between 8 feature points (training by MLN) and other feature points. This generates a CG animation having a smooth curve and movement. The movement is drawn based on the y-coordinate distance, but it moved twitchily, so we used a median filter to smooth the movement. The median value means the intermediate value when it is arranged finite data in descending order. The present study outputs as the median value the intermediate value of five data: the y-coordinate value of the third frame is used as the median value when the coordinate values of five frames are sorted in ascending order.

The pronunciation learning system is designed to play CG animations on a web browser so that various users can use it.

The CG animation program was implemented with Actionscript3.0 to operate on a Web browser with a Flash Player plug-in installed. Figure 6 shows a screen shot of a CG animation developed in the present study. The animation can be played slowly at half speed. Users can see the pronunciation in slow-motion by adjusting the play speed

Table 1. Words and syllables included in MRI data

Japanese vowels and consonants	/i/ /u/ /e/ /o/ /ka/ /ki/ /ku/ /ke/ /ko/ /sa/ /si/ /su/ /se/ /so/ /ta/ /ti/ /tu/ /te/ /to/ /na/ /ni/ /nu/ /ne/ /no/ /ha/ /hi/ /hu/ /he/ /ho/ /ma/ /mi/ /mu/ /me/ /mo/ /ya/ /yi/ /yu/ /ye/ /yo/ /ra/ /ri/ /ru/ /re/ /ro/ /wa/ /ga/ /gi/ /gu/ /ge/ /go/ /za/ /zi/ /zu/ /ze/ /zo/ /da/ /di/ /du/ /de/ /do/ /ba/ /bi/ /bu/ /be/ /bo/ /pa/ /pi/ /pu/ /pe/ /po/
Contracted sounds	/k ya/ /kyu/ /kyo/ /sya/ /syu/ /syo/ /cya/ /cyu/ /cyo/ /nya/ /nyu/ /nyo/ /hya/ /hyu/ /hyo/ /mya/ /my/ /myo/ /rya/ /ryu/ /ryo/ /gya/ /gyu/ /gyo/ /zya/ /zyu/ /zyo/ /bya/ /byu/ /byo/ /pya/ /pyu/ /pyo/
Sound of the kana /N/	/saNbai/, /saNdai/, /saNnin/, /saNko/, /saNen/, /saNwari/, /saNsai/
Double consonant /Q/	/iQpai/, /iQtai/, /iQko/, /iQsai/, /iQsyo/, /iQtu/, /iQcho/

2. Evaluation

We calculated the correlation coefficient between the coordinate values of generated CG animations and MRI data to confirm the accuracy of the animations. Moreover, to show the effectiveness of using articulatory features to extract coordinate distances, we compared the correlation coefficients of the case of AF with the case of LF as MLN inputs.

2.1 Experimental Setup and Method

We used MRI data pronounced by a 39-year-old Japanese male who specializes in Japanese-language education and who has received phonology training. The data is consisted of pictures and Japanese speeches when the subject pronounced in an MRI machine.

We used 5 vowels and 99 syllables, 11 words as MLN training data and 3 words ("sandai," "sanbai," "sanko") as test data among 41 Japanese words included in the MRI data. Table 1 shows the Japanese MRI data used by MLN.

Each MLN has three layers. The number of input layer is 75, hidden layer is 150, and output layer is 45 in the first MLN to extract AF. The number of input layer is 45, hidden layer is 90, and output layer is 24 in the second MLN to extract coordinate distances.

2.2 Experimental Results

Here, we discuss mainly the results of three words with the kana /N/ because the pronunciation movement of this sound differs according to the back phoneme. As a typical example, /N/ in "sanbai" is the same as the nasal sound of the English /m/ with both lips shut. As for /N/ of "sandai," it is the nasal sound when uttering with the tongue tip touching the

alveolar ridge behind the anterior teeth as in the English /n/. The /N/ of "sanko" is created without the tongue tip touching the alveolar ridge behind the anterior teeth unlike /N/ of "sandai". It is the nasal sound that is made by stopping the flow of air to the mouth and breathing out from the nose. When uttered, the back of the tongue rises just a little. We evaluated whether the animated pronunciation including /N/ was accurately generated according to the different back phoneme. Thus, the experimental method compared the correlation coefficient of the coordinate value of CG animation automatically generated from the speech and the coordinate value of the MRI data for each frame for three words. The key point is that these three words are not trained in MLN.

Firstly we calculated the correct rate of AF that is important to generate CG animation (Figure 7). Although the overall average was about 82%, it is necessary to improve AF extraction because the correct rate of /d/ was low. Next we also compared LF with AF as the input of the second MLN to

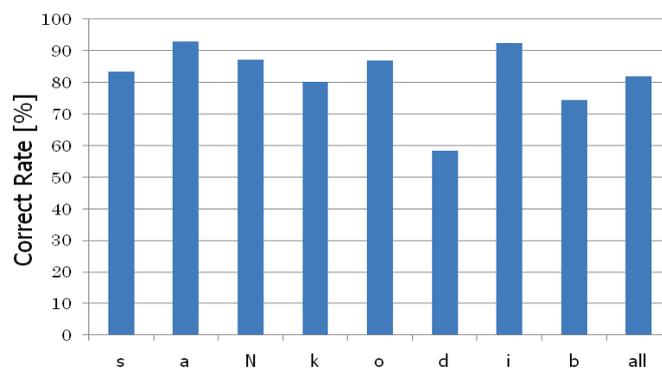


Fig.7: AF correct rate for each phoneme.

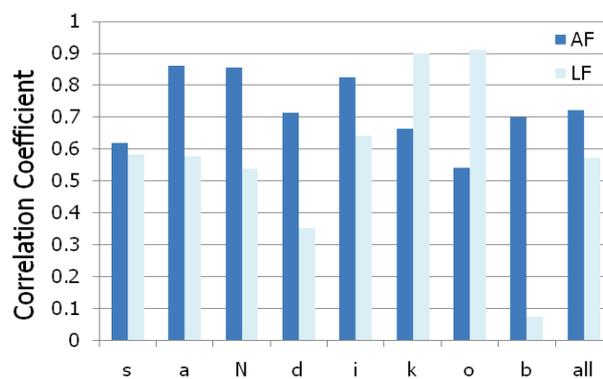


Fig.8: Correlation coefficient for each phoneme.

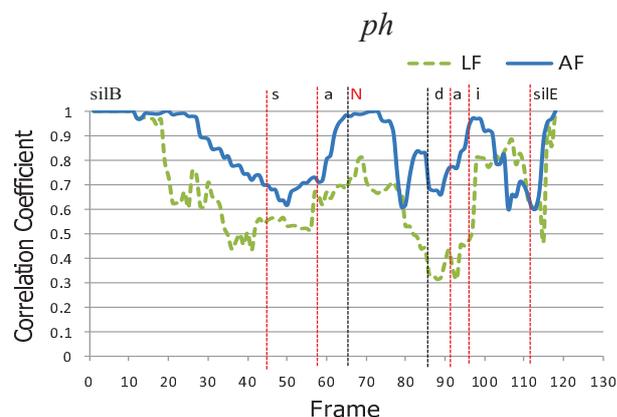


Fig.9: Correlation coefficient of "sandai".

show the effectiveness of using AF extracted from speech. Figure 8 also shows the results of them. The all in Figure 8 is average correlation coefficient of target phonemes. AF shows a higher correlation coefficient than LF overall. The results showed the pronunciation movement was expressed more accurately by mapping the speech to the articulatory feature. Although the pronunciation movement of /N/ differs according to the back phoneme (that is coarticulation), the result of /N/ is about 0.85 which is high. The results showed that the proposed system can accurately generate CG animations while considering coarticulation. Although the AF correct rate of /o/ in Figure 7 was high, its correlation coefficient in Figure 8 was not good. Therefore, it is important to improve second MLN. Figure 9 shows the correlation coefficient per frame. The change rate of the correlation coefficient in a phoneme boundary is large depending on phoneme (Figure 9) · As for /N/, the correlation coefficient decreases rapidly from around 80ms. The small amount of MRI data was used in this experiment. To generate more accurate animation, we intend to use more MRI data in future. Moreover, we will generate not only Japanese animation but also English animation by using English MRI data.

3. Conclusions

We developed a system to automatically generate CG animations to express pronunciation movement through articulatory features extracted from speech. The pronunciation mistakes of the user can be pointed out by expressing the pronunciation movements of the user's tongue, palate, lips, and lower jaw as animated pronunciations. We conducted experiments which confirmed the accuracy of the generated CG animations. The correlation coefficient was more than about 0.7, and we confirmed that smooth animations were generated from speech automatically. We will also improve the system to make the animation motions more natural, and build a pronunciation instructor system including the CG animation program. In the future, we will conduct experiments to compare AF and MFCC as the inputs of MLN.

Acknowledgements

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References

- [1] Delmonte, R. (2000). "SLIM prosodic automatic tools for self-learning instruction," *Speech Communication*, 30(2-3):145–166.
- [2] Gamper, J. & Knapp, J. (2002). "A Review of Intelligent CALL Systems," *Computer Assisted Language Learning*, 15(4): 329–342.
- [3] Neumeyer, L., Franco, H., Digalakis, V. & Weintraub, M. (2000). "Automatic scoring of pronunciation quality," *Speech Communication*, 30(2-3), 83–93.
- [4] Witt, S. M. & Young, S. J. (1995). "Phone-level pronunciation scoring and assessment for interactive language learning," *Speech Communication*, 30(2-3), 95–108.
- [5] Deroo, O., Ris, C., Gielen, S. & Vanparrys, J. (2000). "Automatic detection of mispronounced phonemes for language learning tools," *Proceedings of ICSLP-2000*, vol. 1, 681–684.
- [6] Wang, S., Higgins, M. & Shima, Y. (2005). "Training English pronunciation for Japanese learners of English online," *The JALT Call Journal*, 1(1), 39–47.

- [7] Phonetics Flash Animation Project: <http://www.uiowa.edu/~acadtech/phonetics/>
- [8] Wong, K.H., Lo, W.K. & Meng, H. (2011). "Allophonic variations in visual speech synthesis for corrective feedback in capt," *Proc. ICASSP 2011*, pp. 5708-5711.
- [9] TIMIT Acoustic-Phonetic Continuous Speech Corpus
<http://www ldc.upenn.edu/Catalog/CatalogEntry.jsp?catalogId=LDC93S1>
- [10] Halle, M. (1983). "On distinctive features and their articulatory implementation," *Natural Language & Linguistic Theory*, 1(1), 91–105.
- [11] Huda, M. N., Katsurada, K. & Nitta, T. (2008). "Phoneme recognition based on hybrid neural networks with inhibition/enhancement of Distinctive Phonetic Feature (DPF) trajectories," *Proc. Interspeech '08*, pp. 1529–1532.

Trial Development of A Peer Evaluation System of Presentation Skills Using Web

Kazuki HARADA^a, Miki IWA^a & Miho WADAMORI^{a*}

^a*Dept. of Information Engineering, Matsue College of Technology, Japan*

*miho@matsue-ct.jp

Abstract: Presentation skills have recently become essential in many business situations, and a number of tertiary educational institutes have introduced presentation activities into classes. Feedback from the audience is very important in the development of individual presentation skills, but a speaker and an audience do not always have enough time available to watch and evaluate the presentation. Consequently, we have developed a system to improve presentation skills by using the Web. Presentation videos uploaded to the Web site enable peer evaluation, and analysis of video sound can evaluate speech rate and pause information. In this system, a user can not only see the evaluation or the reviews of his/her presentation by other users and features of his/her speech, but can also realize the process of improvement of his/her presentation skills by repeated practice or modification. Enhanced presentation skills are developed because the learner can practice through understanding the variations in the evaluation of his/her presentation in graphic form. We have assumed that the learner is a student who is practicing for a presentation of his/her study, and the reviewers are peers or his/her adviser.

Keywords: Presentation skill, Web, Video, Peer evaluation, Speech analysis

Introduction

Recently, presentation skills have become essential in various business situations, and a number of tertiary educational institutes have introduced presentation activities into classes. Feedback from the audience about content, visual aids such as slides, voice, and other aspects of performance is very important for developing presentation skills. Furthermore, a presenter must rehearse repeatedly in response to the feedback, if his/her presentation is to be improved. Repeated rehearsal and review from advisers or peers is particularly important for students or beginners. However, it is often difficult for students and reviewers to find enough time to watch and critically evaluate the presentation.

As a result, several systems that provide feedback efficiently from audiences have been introduced to assist in the development of presentation skills e.g. [1]-[4]. The systems developed by Yamashita et al. [1] and De Grez et al. [2] enable presenters to view audience evaluation immediately, in some graphic form of data sent by response devices. Miyawaki et al. [3] and Shibasaki[4] developed systems that can distribute presentation videos and can send reviews of presentations, to make the review process more efficient. However, although learners can get feedback from audiences in these systems, it is not easy for them to recognize how much their presentations have been improved by repeated practice. Conversely, according to Yamashita et al. [5], using good presentations as models helps learners become aware of improvement in their skills by self-learning.

As described above, the goal of this study is to develop an e-learning system with four presentation-training functions, as follows:

- 1) Watch presentation movies, input reviews from peer evaluation and display evaluation results in a graphic form.
- 2) Automatic evaluation of presentation speech by sound analysis.
- 3) Display presentation history as thumbnails and show variations in evaluation using graphics.
- 4) Search for good presentations and watch them.

The aims of the above functions are: 1) improving efficiency; 3) identifying and understanding learning effects; and 2) and 4) supporting independent learning. Functions 2) and 3) are particular features of this system. Function 2) evaluates vocal performance from different perspectives. A presentation is not valuable if it doesn't interest the audience, even if its content may be important [6], so we have also given priority to improvement of speech. In addition, a higher learning effect can be expected by using functions 3) or 4). In this paper, we describe a prototype system in which functions 1) to 3) have been implemented and tested.

1. System Outline

1.1 System Configuration

The system configuration (Figure 1) consists of a Web server and several client PCs. Apache, PHP and MySQL are installed on the Web server, and the MySQL database is used to manage user information, video files, and evaluation data. In addition, the server uses FFmpeg [7] for video conversion or extraction of speech sound from the video, and uses Julius [8] as a speech recognition (SR) engine for automatic evaluation of speech. The client PC for the learner or reviewer requires a web browser with a Flash player. The learner also needs a video camera or software that can convert his/her presentation into a video file such as Microsoft PowerPoint 2010. We assumed that this trial system would be used within a limited network such as an intra-school LAN.

1.2 Using the System

The top page of this system (Figure 2) displays thumbnails linked to video files uploaded by users. The sequence of usage for a learner and a reviewer are described below.

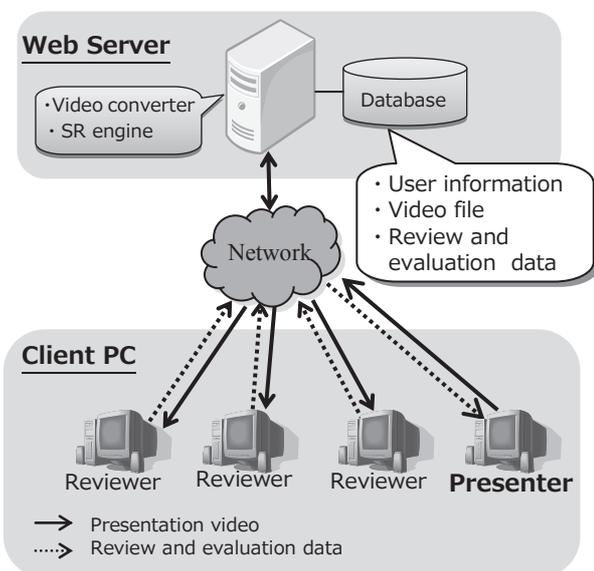


Figure 1: System Configuration

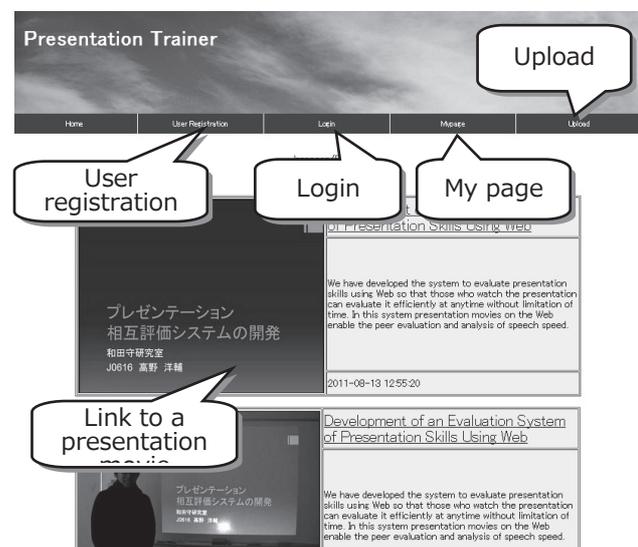


Figure 2: Top Page

After login, a learner selects "Upload" on the top page, and the upload page shown in Figure 3 is displayed. The learner selects a video file, inputs the information required, and uploads it by clicking the "upload" button. The learner then accesses "MyPage" to see the evaluation of his/her presentation. Since we assumed that there will be multiple rehearsals for a presentation event, video thumbnails are displayed separately for each event. For example, when four presentation videos for the interim report on his/her graduate study are uploaded, the four videos are displayed with dates, as shown in Figure 4. The evaluation of these videos is also displayed in graphic form on the left of Figure 4, in time order. This enables the learner to recognize how repeated practice or modification has improved his or her presentation. In addition, by clicking on the presentation image on the right of Figure 4, the learner can understand the detailed evaluation of his/her presentation, by access to the page to watch the video and to see the evaluation. It is assumed that the learners are college students or beginners.

After login, a reviewer clicks on the selected video from the thumbnails of presentation videos on the top page, and accesses the "Watch and Review" page as shown in Figure 5. Before watching the video selected as described above, the reviewer must click the "Create your review" button to display the page for input of comments and rating as shown in Figure 6. After the window appears as a separate display, the reviewer can watch the video, and

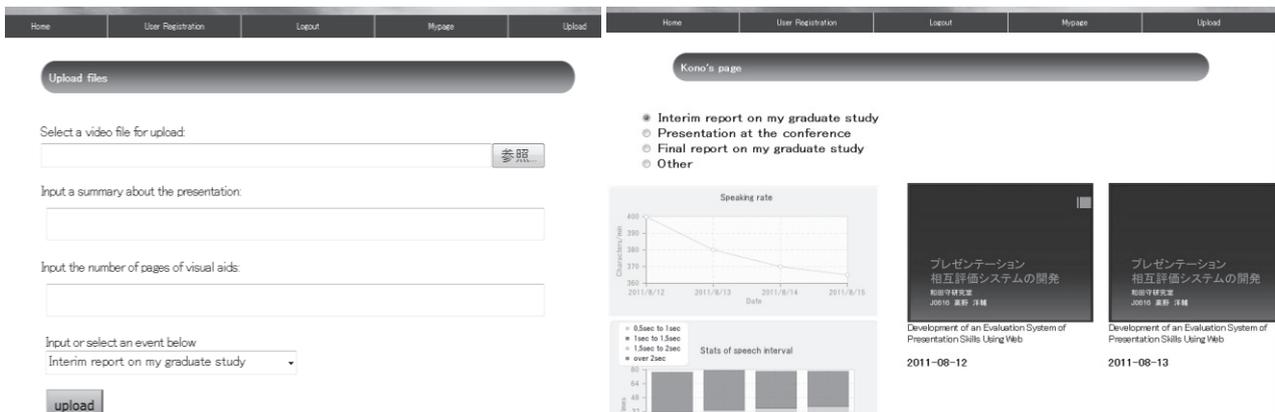


Figure 3: Page for uploading a Video File

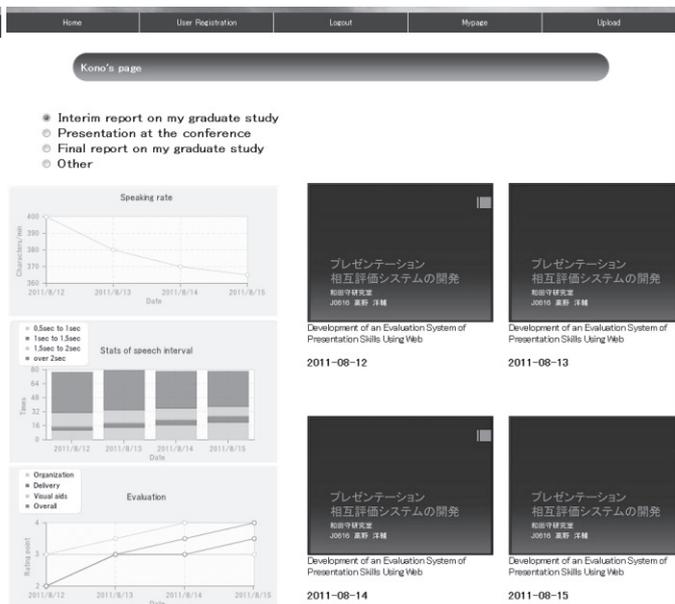
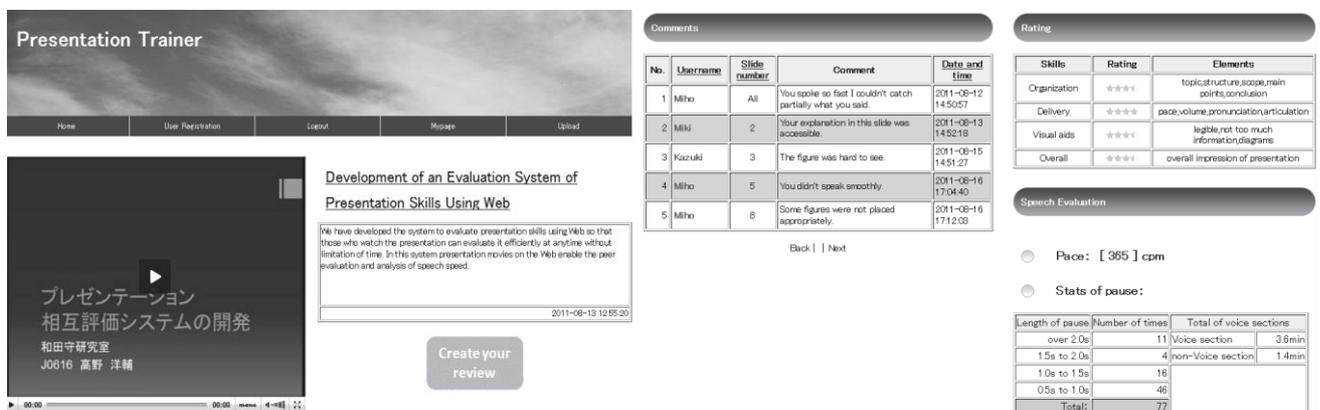


Figure 4: My Page



(a) Upper part of the page

(b) Lower part of the page

Figure 5: Page for watching and reviewing a video file

input comments in parallel. He/she should input the comments about the presentation slide or speech and use the five-grade rating of the evaluation items, as described in the next section. The evaluation results are saved to the database and the presenter's "MyPage" is updated. It is assumed that the reviewers are peers or advisers of the learner.

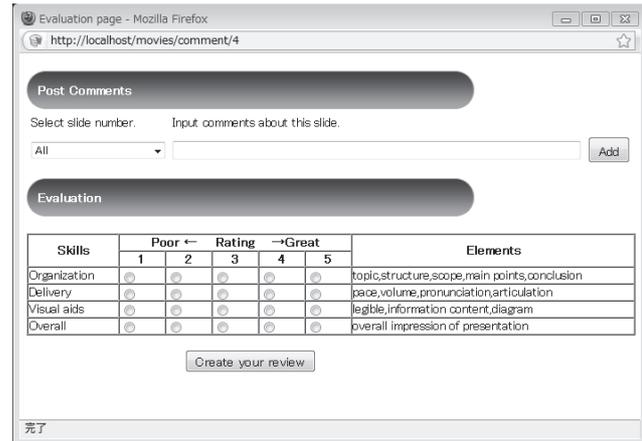


Figure 6: Page for inputting comment and rating

2. Evaluation of Presentation

2.1 Peer Evaluation by users

Reviewers can evaluate the presentation slides or speech by inputting comments for a specific slide number, as shown in Figure 6. Overall evaluation or advice for a presentation is input when "All" is selected. In addition, reviewers should give a rating of their impression of the presentation, using the 5 tier rankings as at the bottom of Figure 6.

In this system, four elements of presentation have been selected for rating: organization, delivery, visual aids and overall impression. A feature of the system is that a learner can understand the effect of his/her own learning efforts by seeing the variation of evaluation. In the future we will consider additional evaluation elements to increase the learning effect or motivation of learners, and will add or modify these elements within the system. Although reviewers can make evaluations at a time convenient to themselves, the input is time consuming. Consequently, improvement of user interfaces will be needed to make them as efficient as possible.

2.2 Evaluation by Speech Analysis

One of the main features of this system is that it can analyze speech sound and calculate speech evaluation data automatically. This enables the learner to gain not only a subjective evaluation from reviewers, but also objective data. Although there are many potential elements to speech evaluation, for this system only simplified methods of speech rate and pause information were adopted.

First, we will explain the speech rate calculation method. Speech rate is an important element affecting comprehension of the audience. In this system, we use a calculation method in which we suppose the number of characters (average) in Japanese per minute, as speech rate by SR using Julius. Slow speaking rates do not necessarily result in good audience comprehension. However, by comparing their performance with other presenters or by understanding the variation in their speaking speed after practice, creates learner awareness. Furthermore, when speaking speed is extremely slow, speakers should question their articulation, because the number of characters by SR is much reduced below the actual rate if articulation is indistinct. While it is difficult to calculate speech rate correctly, it has potential in evaluation of articulation. It should be noted that, at present, the evaluated speech rate cannot be displayed for each slide, as it is calculated as an average value over an entire presentation. Therefore, we will implement some functions such as synchronization between evaluation and a presentation video in the future system. This will provide more detailed information.

Second, we will explain the method of calculating pause information. Pausing is an important element if the audience is to understand the presentation, and presenters sometimes use pauses intentionally, to attract the attention of the audience. Therefore, it is important to understand how pauses are made in a presentation whether they are for comprehension or to gain attention. In this system, pause information has been classified into four intervals: 1) 0.5 - 1.0s, 2) 1.0 - 1.5s, 3) 1.5 - 2.0s and 4) over 2.0s, and the statistics of non-voice sections throughout the presentation are displayed. This does not provide direct clarification of whether the speech is good or bad but a learner can understand the variations in their pause patterns during repeated practices for an individual presentation event. This means that a learner can understand from his/her point of view whether they speak fluently or not, and whether they are using pauses effectively. We will improve the system to create synchronization between pause information and slides or speech sound. Additional improvements will include incorporating evaluation criteria such as volume and intonation to increase the learning effect, since at present only speech rate and pause information are available.

3. Training Methods of Presentation Skills

We will describe the presentation skills training methods to be realized.

3.1 Being Aware of Learner's Own Ability

First, after uploading his/her presentation video to this system, a learner becomes aware of his/her presentation ability by seeing the reviews from other users, and the objective speech analysis of his/her presentation. Although interactive discussions between a presenter and the audience are more effective than one-way evaluations by the audience, in this system we have adopted the method of comment input regarding presentation or slides on the Web, to reduce the burden. Reviewers can add comments piece by piece at their convenience, and may input only the five-grade rating if they do not have enough time to complete the entire evaluation. This should result in a presenter getting more reviews or ratings, but it is still difficult to review sufficiently. Furthermore, although it takes considerable time to re-evaluate whenever presentation videos are uploaded, a learner can see only evaluation by speech analysis when uploads are repeated.

As described above, the learner should become aware of their individual presentation ability and understand the points to be improved.

3.2 Repeated Rehearsal and Improvement

After the learner has recognized the areas for improvement, they should practice or modify their presentations based on those points. Specifically, the content or organization, modification of slides, and speaking practice should be reconsidered. Following that, the learner should rehearse again, record his/her presentation and upload it to the system. It is then re-evaluated, and the evaluations are added to the graphs on his/her "MyPage". After practice or modification, the learner can then understand what has improved compared with their previous presentation, so that they can make use of that during the next rehearsal. The system thus increases not only effective learning, but also motivation.

3.3 Following Model of Presentation

Comparison with good presentations is useful in that a learner has a model to follow. In this system, a user can view videos of other users and can see their evaluations. The user can also follow the history of a presentation, which has gained a good evaluation on features such as the design of slides, use of diagrams and speech. This helps him/her to consider the points for improvement after understanding the evaluation of his/her presentation. However, a search function for uploaded presentations needs to be added to the system in the future.

4. Conclusions

We described the trial system in which a user can develop his/her presentation skills efficiently by peer evaluation of presentation video and by speech analysis on the Web. This system helps a learner to practice and modify repeatedly seeing the effect of his/her own efforts. Furthermore, a learner can also refer to other users' presentation to improve his/her presentation. We will improve the system to be more useful for such aspects as speech evaluation, how to input reviews or evaluations and a search function for good presentations. In the future, we will conduct experiments to evaluate this system and improve its usability.

Acknowledgements

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References

- [1] Yamashita, Y. & Nakajima, T. (2010). Using Clickers with Video Recording for Presentation Skill Training. *Japan Society for Educational Technology*, 33(6), 401-410.
- [2] De Grez, L., Valcke, M. & Berings, D. (2010). Student response system and learning oral presentation skills. *Procedia - Social and Behavioral Sciences*, 2(2), 1786-1789.
- [3] Miyawaki, T., Okamoto, R. & Kashiwara, H. (2009). Development of Presentation Rehearsal Review Support System: Supporting of Presentation Refinement by Review Results with Visual Representation. IEICE Technical Report, ET2008-103, 59-64.
- [4] Shibasaki, J. (2008). Development of Online Video System with Support Function of Presentation, Learning, and Evaluation. *Japan Society for Educational Technology*, 32(Suppl), 65-68.
- [5] Yamashita, Y. & Nakajima, T. (2011). Developing electronic learning material which supports learning presentations for self education. *Educational Informatics Research*, 10, 25-30.
- [6] Taniguchi, Y. & Hayashi, T. (2002). Practice and Evaluation of the Training Program for Improving Presentation Skills: Based on the Teaching Practice in the Department of Teacher Training at School of Oriental Medicine. *Japan Society of Educational Information* (in Japanese), 18, 282-285.
- [7] FFmpeg, <http://ffmpeg.org/>.
- [8] Julius, <http://julius.sourceforge.jp/>.

Learning and Training with Force Feedback for an Acupuncture Education System

Ren Kanehira ^{a*}, Weiping Yang ^b, Hirohisa Narita ^a & Hideo Fujimoto ^c

^a *FUJITA Health University, Japan*

^b *Aichi Shukutoku University, Japan*

^c *Nagoya Institute of Technology, Japan*

*kanehira@fujita-hu.ac.jp

Abstract: It is mostly important in acupuncture to become highly skilled by training with repeated practice. However, such practice can hardly be done on a real human body, which may always be accompanied with pain and misery. In this study, a computer training system with force feedback for acupuncture was proposed. A human acu-points model with acu-point name, position, meridians, stinging techniques and healing functions was created within the computer, and devices with force feedback functions for skill training were used in the system. A trainee gets acupuncture experience not only by visual information, but also from sensing the force information with a true-false judgment of his movement being real-timely given during the exercise.

Keywords: Acupuncture, Computer Learning and Training System, Force-feedback, Training Environments for Skills, Quantification of Technique

Introduction

Acupuncture is an ancient Chinese healing method in which stimulations are applied to the acupoints (defined position on the human body), leading to an increase of the healing power of the human himself and the recovery of the sickness ^[1]. Recently, acupuncture has been paid more attention worldwide, so the Acupuncture of Chinese Medicine has been registered in the humanity national intangible cultural heritage list by UNESCO in November 2010. Although the miraculous ancient Chinese healing method has still some parts not yet being explained scientifically, it is used with increased worldwide interests, and even an Acupuncture Universities has been established in Japan ^[2].

It is important in acupuncture, similar as most of the oriental medical treatments, to use fully the human 5 senses, and to become skillful mainly by repeated exercises ^{[3]-[5]}. However, there are problems in learning and training for acupuncture, such as the lack of clarity in the textbook, the difficulties for a judgment of the accuracy when stinging an acu-point, and so on. Thus, the development of an acupuncture training system using the advanced computer technology can be of great help ^[6].

We have been doing researches on the development of a computer-assisted acupuncture training system for quite a long time. In this study, we reported an improvement on such system. An acu-point human body model was created within a computer, with which the study of recognition of correct 3D acu-point position, and the sting action on them was done with a true-false judgment. When building up the system, we paid more attention to the representation, teaching and training of the tiny operation force applied in the sting action.

The teaching of the insertion angle and insertion speed for a sting operation on an acu-point using a mechanical force feedback system was proposed^{[7]-[11]}. As one of the series researches for the training system, this study reported an improvement on the system by introducing a haptic device PHANTOM. The teaching of the tiny force adjustment in sting was studied with the system, and the results were tested by repeated exercises of trainees with real-timely true- false judgments.

1. Learning and Training of Acupuncture Skills

1.1 Needle Therapy

Acupuncture therapy is a medical treatment using acupuncture needle or moxibustion to stimulate the acu-points of body according to the symptoms. An acu-point is the defined point on the human body, going to receive the needle with proper stimulus. There are hundreds of such acu-points located on the important positions over the human body on the meridian. And the meridian is such an imaged flow (you may not see them) connecting the acu-points to the internal organs. Therefore, it is very important to find the correct position of the acu-points, and the proper stimulus for the highest healing effect.

That is, the acupuncture education requires both a textbook for memorizing, and repeated practice/exercises to master the skill. With the help of advanced computer technology, a better training effect can be expected using the textbook with the series of processes of basic theory, case prehension, treatment policy, acu-points combination and handling, which are systematically combined with a computer.

Acupuncture has techniques of not only holding and insertion, but also those of stinging, trail, whirl, according to different symptoms (Fig. 1). It is further required for good healing to use different techniques such as the stinging angle, the speed, and the depth upon different acu-points for each symptom. Therefore, it is especially important to be trained by repeated practice.

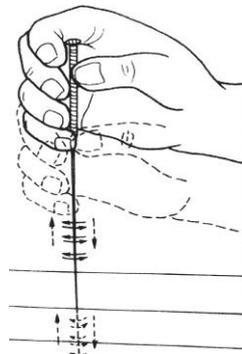


Fig. 1 Normalized of vertical needle speed

1.2 Training with Force Feedback

The proposed system can be roughly divided into two parts. One is the software for teaching and explanation of the sequence of basic theory, case prehension, treatment policy, acu-points combination and handling. The software contains detailed description on the names, position, depths of meridian and meridian point, and its flow or moving, some are demonstrated by 3D expressions for a better understanding. Another, and one of the most important things in the acupuncture training, is the development of a training system with force feedback function with a precise correspondence to the acu-point model. For such a system with force feedback function, firstly, information of operation forces from well-experienced doctors are measured and stored in the computer as a training index. Then,

training functions are input to the computer based on the human model and basic techniques of acupuncture.

A trainee is trained, using the system with force feedback, to master the basic techniques such as the methods of holding, stinging, and so on (Fig.1). He gets the correct feeling by repeated practice referring the standard from well-experienced doctors. The system has the character of real-timely response, giving a true-false judgment during the practice. The results are evaluated by the computer.

As stated above, while the former part can be found a lot in the E-learning or database fields, the latter part is quite few because of being a kind of practice training accompanied by technical difficulties. This study has paid attention to the latter, and experiment was done for a development of a computer training system for acupuncture. In this paper, the construction of a training system using force feedback device PHANTON was done, and the problems and perspectives were addressed.

2. The Acupuncture Training System

2.1 System Construction

A 3D human acu-point model was created on a computer. A training system was constructed upon the 3D model. The schematic of the system composed of a computer (XPS6, 30Dell) for simulation, a monitor to show the information, and a haptic device (PHANTOM Omni®, SensAble Technologies, Inc.), and the software of OpenHaptic toolkit, is shown in Figure 2.

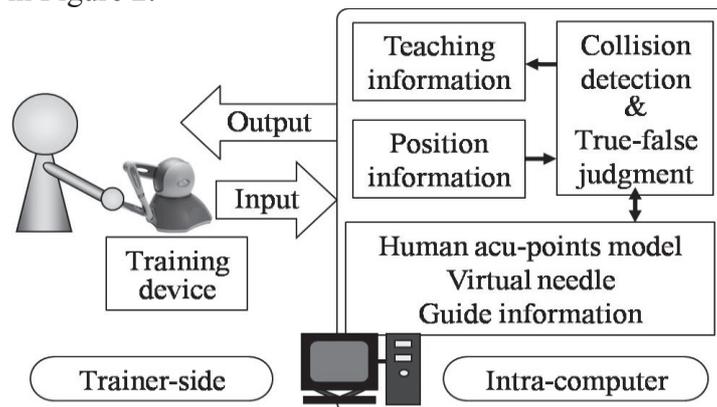


Fig.2 The construction of the training system

Computer system development environment is shown in Table 1.

Table 1 System development environment

OS	Window XP
CPU	Pentium4 2.8G
Memory	480MB
Video card	OpenGL compatible video card
Interface	IEEE1394 Board
Haptic devices	PHANTOM Omni
Software	Microsoft Visual Studio 6.0 OpenHaptics Toolkit version 2.0

2.2 Haptic Devices- PHANTOM-

The PHANTOM is a 3D input-output haptic device capable of force interaction with high precision. The interaction between a 3D object and the operator makes it possible to present not only visual but also force information. The reaction force from the hand when touching an object, therefore, can be real-timely represented, to achieve a high operational effect with real-time response.

The PHANTOM Omni model (Fig.3) is one of the most high cost-effective haptic devices available today. Portable design, compact footprint, and IEEE-1394a FireWire® port interface ensure quick installation and ease-of-use performance. The PHANTOM Omni specification is shown in Table 2.



Fig.3 PHANTOM Omni haptic device

Table 2 PHANTOM Omni specification

Model	Model The PHANTOM Omni Device
Force feedback workspace	~6.4 W x 4.8 H x 2.8 D in > 160 W x 120 H x 70 D mm
Footprint Physical area the base of device occupies on the desk	6 5/8 W x 8 D in ~168 W x 203 D mm
Weight (device only)	3 lb 15 oz
Range of motion	Hand movement pivoting at wrist
Nominal position resolution	> 450 dpi ~ 0.055 mm
Backdrive friction	<1 oz (0.26 N)
Maximum exertable force at nominal (orthogonal arms) position	0.75 lbf. (3.3 N)
Continuous exertable force (24 hrs.)	> 0.2 lbf. (0.88 N)
Stiffness	X axis > 7.3 lb/in (1.26 N/mm) Y axis > 13.4 lb/in (2.31 N/mm) Z axis > 5.9 lb/in (1.02 N/mm)
Inertia (apparent mass at tip)	~0.101 lbm. (45 g)
Force feedback	x, y, z
Position sensing [Stylus gimbal]	x, y, z (digital encoders) [Pitch, roll, yaw (\pm 5% linearity potentiometers)]
Interface	IEEE-1394 FireWire® port: 6-pin to 6-pin*
Supported platforms	Intel or AMD-based PCs
OpenHaptics® SDK compatibility	Yes

The PHANTOM is equipped with position sensors capable of doing precise force operations. A reactive force corresponding to the hand movement is produced by reverse rotating of inner motors to wind the wires. A 3D force vector is output on the tip of the stylus by controlling the torque of the DC motor. The maximum force output is 3.5N. A high rate of input-output change is achieved by 1 kHz high speed processing. The PHANTOM was then introduced into the system considering such characteristics. Acupuncture training with high reality, most near the practical sting, is expected with the system.

3. System Functions

The functions of the system can be that to provide information on both visual and operational (force) at the same time, satisfying the skill training with presence.

3.1 *Presentation of the Information not Visible in the Real World*

The precise positions of the acu-points, which are usually invisible on the human body with the human eyes, can be easily displayed on the 3D model on a computer. The acu-points of a human body in the ordinary textbook are described in a 2D form so it is difficult to identify the 3D information (such as the depth of the acu-points). The developed system, however, is with the ability to demonstrate 3D information because of the use of a 3D human body model, resulting in a highly improved understanding of the 3D position of acu-point including the depth and the relationship with the surrounding organs, which has not been possible in the conventional training.

3.2 *Repetitive Training with Force Feedback*

It is easy to use the system to carry out exercises repeatedly almost without limitation, which is very important for learning and training skills of acupuncture in contrast to the conventional training using human body. In conventional training process, a trainee usually learn technique by sting the points of himself or between the trainees each other and this may lead to a resistance or fear to continue further the acupuncture practice.

A trainee is trained, using the system with force feedback, to master the basic techniques with tiny force operations such as the methods of stinging, insertion, holding, and so on. He gets the correct feeling by repeated practice referring the standard from well-experienced doctors. The system has the character of real-timely response during the practice. The results are evaluated by the computer.

3.3 *True-False Judgment in Real Time*

A precise judgment of a correct stinging to the proper acu-point position with the proper force has been difficult in the conventional training method, while it can be easily and real-timely done with the developed computer system. Using the device with force feedback on hand movement promotes the training towards the most practical one. It is also possible to do reliable true-false judgment on a sting using the computer system, because a beginner is difficult to judge the correct force used to sting into an acu-point. A trainee gets acupuncture experience not only by visual information, but also from sensing the force information with a true-false judgment of his movement being real-timely given during the exercise. The teaching of the tiny force adjustment in sting was studied with the system, and the results were tested by repeated exercises of trainees.

4. Conclusions and Future Work

In summary of this research, a computer training system for acupuncture with force feedback functions was proposed. An acu-point model with precise name, position, flow, sting techniques and healing function, was created on a computer. The information on each operation, especially the tiny force adjustment was obtained and made visualized on the computer. A trainee gets experience not only by visual information, but also senses the force information with a true or false judgment of his movement being real-timely given during the exercise. The system has the character of doing exercise repeatedly without pain, and the ability of reducing operation mistakes at low cost, even with more information not yet possible in reality. The system is expected to contribute to a successful training of acupuncture doctors through the realization of the series processes of study of the basic theory, case prehension, decision of the treatment policy, acu-points combine and technique training on computer.

One of the research subjects for the next step is the enrichment of the acupuncture data base and training-related environment. The quantification of operation force has to be done in more detail using the system by more experiments and analysis. For this purpose, more operation data from the experienced doctors are to be introduced as the standard for training. Further, evaluation and score-taken of the trainees are to be added. Continued studies are carried on towards the realization of a simulation system capable of quantitative study, training, evaluation etc.

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References

- [1] The Japan Society of Acupuncture and Moxibustion, <http://www.jsam.jp/>
- [2] Meiji University of Oriental Medicine, <http://www.meiji-u.ac.jp/>
- [3] H. Mori, (1971). Initiation of acupuncture, IDO-NO-NIPPON SHA INC., pp.8-14, (in Japanese)
- [4] Sugiyama, I. (2003). Manual of acupuncture *Gensosha, Inc.* (pp.13-21) (in Japanese).
- [5] Oriental Medicine College Association, Textbook writing subcommittee, (1992). Outline of meridian and acu-points, IDO-NO-NIPPON SHA INC (pp. 4-12) (in Japanese).
- [6] Chen, L.Y., et al. (2005). A computer training system for acupuncture with force feedback, *Proceedings of CME2005*, (pp. 245-248). IEEE Press.
- [7] Kanehira, R., et al. (2008). Development of an acupuncture training system using virtual reality technology, *Proceedings of 5th FSKD*, (pp. 665-668). IEEE press.
- [8] Kanehira, R., et al. (2009). Insertion angle teaching for an acupuncture training system, *Proceedings of CSEDU2009*, (pp. 281-284). IEEE press.
- [9] Chen, L.Y., et al. (2007). Basic experiment for analysis of acupuncture technique, *Proceedings of 6th EUROSIM* (pp. 1-6) ELES Press.
- [10] Kanehira, R., et al. (2009). Indexing of insertion speed for acupuncture training system, *Human-Computer Interaction, LNCS 5610, Springer*, 692-696.
- [11] Kanehira, R., et al. (2010). Insertion Force of Acupuncture for a Computer Training System, Lecture Note in Computer Science, LNCS 6320, *Springer*, 64-70.

Sizhi: Self-Dialogue Training through Reflective Case-Writing for Medical Service Education

Wei CHEN^{a*}, Masaki FUJII^a, Liang CUI^a, Mitsuru IKEDA^a, Kazuhisa SETA^b & Noriyuki MATSUDA^c

^a*School of Knowledge Science, JAIST, Japan*

^b*Graduate School of Science, Osaka Prefecture University, Japan*

^c*Department of Computer and Communication Sciences, Faculty of Systems Engineering, Wakayama University, Japan*

*wei.chen@jaist.ac.jp

Abstract: In this research, by developing the learning support system for medical services, we will establish an approach that supports the medical profession novices to improve the proficiency of view of patient-centered medical services. In this paper, as a first step of the project, we organized a learning model which promotes reflective learning the case-method for medical service education. As an implementation of the learning model, a learning environment that support learners to reflect on their thinking process in their experiences by a learning strategy which consists of three case-writing phases: the description phase, the cognitive conflict phase, the knowledge building phase.

Keywords: Case-Method, Ontology, Medical Service Education

Introduction

There are always many difficult problems continually appearing in various viewpoints in medical practice. Actually, the medical staffs always feel a vague anxiety that their dedicated efforts could not catch up with the increasing amount of the problems. Moreover, to provide the high quality medical services that can respond to the various and high-degree increasing patients' demand is becoming an important and urgent issue in medical service practice. The subjects in medical service education in a broad sense include both the medical knowledge/skills for the medical diagnosis or the treatment and one for the interpersonal skill to facilitate the prompt and smooth implementation of medical services. In this research, we focus on the latter as the matter of medical service sciences in a narrow sense, while we address the former as the matter of "medical education" and will not be deeply involved in it.

We believe that the service science approaches can make a contribution to establishing a methodology to improve the quality of Medical Services in a narrow sense. The one of the pioneers in the field of Service Science, Yoshikawa has proposed that the model for service improvement is that the knowledge circulation of intellectual collaboration by the persons concerned in the service promotes to create and refine the service knowledge. Moreover, he implies that the knowledge circulation will cause the ideal of society innovation [1]. In the medical viewpoint, we think it is necessary to refine the education approaches for supporting the medical knowledge circulation by improving the medical practitioners' thinking ability to collaboratively create and refine the medical service knowledge.

In this research, by developing the learning support system for medical services, we will establish an approach that supports the medical profession novices to improve the proficiency of view of patient-centered medical services. The current goal of this research is to make a rational learning model for medical service education and try to establish a methodology to conduct the design loop for the medical service educational program development but not to make strong contributions to technological medical service education.

1. The Difficulties in Medical Service Education

In the recent medical practice, the traditional apprenticeship-style on-the-job training system, so-called, “seniors train novices strictly on the job” is vanishing gradually because of the mental resistance for novices to accept the evidence-lacked, experience-based guidance of implicit medical service knowledge from seniors. Moreover, the newcomers who have poor insight and sensitivity to people are increasing and there appears the increasing pronounced tendency for the medical staff to unable to learn the medical service knowledge or skills to understand patients’ mind through the communication with other medical staff.

For example, when a novice nurse takes charge of pediatrics, he may puzzled by the complexity of emotional engagement among the child patients who are weaker than himself, their parents who are exceptionally anxious about their children’s health and the doctors who conducts a medical treatment. In order to have an acute insight into the complex structure of emotional engagement, it is necessary to have a rich sensitivity for understanding the others’ mind, a rational attitude of the acceptance of and respect to the immature hearts of the pediatric patients. That is a typical tacit knowledge which is not easy to acquire for novice medical staff.

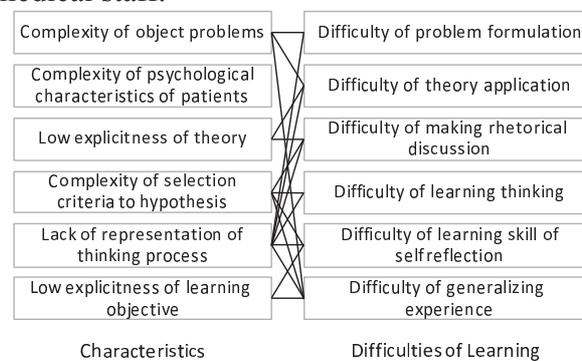


Figure 1. The characteristics of medical service and difficulties of learning the knowledge required for it

For the purpose of developing medical human resources with higher cognitive ability as shown in Figure 1, a variety of educational methods to foster the tacit knowledge or tacit skill by coaching the thinking process has been offered to the medical staff. For example, in the field of nursing education, the teaching approaches such as clinical conferences, reflective journals, narrative methods, case-method, etc. are conducted on a routine basis at many hospitals. However, in such a practical learning environment, it is said that the major difference between the learners who can learn what should be learned and the learners who cannot learn very well comes from differences of learners' sensibility or insight to others' mind. Moreover, even though learners has been successfully learned tacit knowledge in the practical learning environment, most of them face with more serious difficulties to assimilate the knowledge to their own existing knowledge and organize it as general

knowledge to be applicable to the future similar situations. The difficulties caused by lack of the experience of making “thinking about others’ mind” as a subject to meta-level logical thinking, while most people guess others’ mind only by intuition. Therefore, to foster the ability of meta-level logical thinking seems to be accompanied by an essential difficulty caused by the essential nature of human. In addition, the complexity of the matters of mind, the low explicitness of theory, the complexity of selection criteria to hypothesis, a lack of representation of thinking process, etc. make it difficult for novices to learn the knowledge required for medical services(Figure 2).

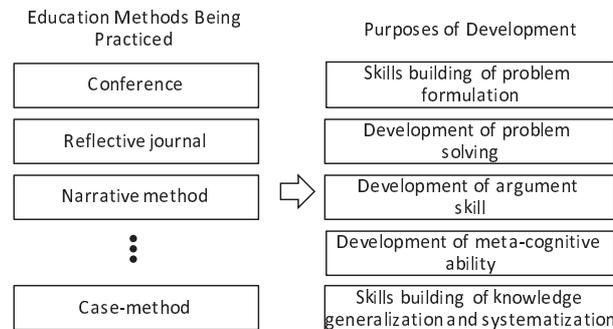


Figure 2. Fostering tacit knowledge/skills by coaching thinking process

In this research, we focus on the case-method as an approach to Medical Service Education. One of the educational principles behind the case-method in business management education is “if you want to teach how to deal with a new problem that you have not yet experienced, we should teach them how to think. In fact, the ability of thinking about thinking and the ability of dealing with new problems can be regarded as the different issues in principle but they are completely the same issue in practice.” [2]

2. The Overview of Case-Method

In the case-method, in order to acquire “skills to deal with new problem that have not been experienced yet”, the learners are assigned the task to think how to deal with the “real” problems that have occurred in their own practices and write their thought and behavior to cope with the problems as “cases”. And then, they join the group discussion on the case with other learners to investigate the validity of their own thinking process from various viewpoints and co-create new solution to the “real” problem. Through these learning experiences, they could learn the learning ability to deal with the highly-non-deterministic and highly-complex practical problems [2].

The actual flows of the case-method in business management education are as follows: (1) the instructor distributes the prepared case materials to the learners in advance. (2) The learners organize the contents of the case to analyze and identify the core issues. The analysis should be made based on the facts in the case, the assertion inferred from the facts the insight into the thinking processes of the agents in the case and the learners’ own knowledge. (3) According to the analysis, they think out their own solutions to the problem. After that, (4) the learners join the discussion on the validity of each learner’s solution where the instructor will not join the discussion actively but just rise the topic to be discussed and lead the flow of the discussion [3].

When designing the learning materials for the case-method, it is necessary to (1) write down the events that actually occurred, (2) to consider how the learners think about the case and how they will discuss about it. Therefore, it is essentially how required for a case-writer to be able to estimate how learners think or how their discussion goes on from the deep understanding of written issues on the case [4].

2.1 The Learning in Case-Method

In the survey paper on the argument study, Maruno and Tomita [5] claims that most researchers focus on the argumentative skills to examine the rationality or validity of information or knowledge used in the discussion. On the other hand, the skills to produce or externalize the ideas in the discussion have not been studied in the research field. However, based on the empirical and the theoretical research so far, the former skills cannot be acquired without the latter ability. It implies that by participating in activities in which the latter skill is required repeatedly, the former skills can be acquired.”

Moreover, they support the Kuhn(1991)’s model of internal thinking process as a dynamic internal dialogue base on the Billig’s idea that “people engaged in problem solving or decisions making, try to make the best judgment of selecting one from the some possible options by justifying each of them from many different viewpoints and comparing the justifications to the options” [6] [7]. The reason why they strongly rely on Kuhn’s model is that the model shows clear socio-cultural explanation on how the argument guides the thinking process, which is, it regards the thinking developing process as a more dynamic and clarify the tight relationship between individual internal process of thinking and social process of thinking such as exchanging the position with others and the individual process. Standing on this viewpoint, the case-method can be used as a concrete educational approach for learning the internal dialogue. However, on the other hand, it is difficult to learn the dynamic internal dialogue associated with social interaction for the reason (shown in Figure 1) the particularly higher cognitive ability is required. In our research project, in parallel, we have been developing an educational program that can reduce the learner’s load in learning the association between internal dialogue [8] and social interaction [9].

2.2 The Learning by Designing Case Learning Materials

Ito proposed, by analyzing of the effect of the verbalization as a learning strategy, a model of the learning goals achievement by verbalization as an integrated model of three learning mechanisms, that is, the tutoring that focuses on the learning effect of the teaching activities, the self-explanatory of learning activities, and collaborative learning among learners [10]. We believe that the learners can be active entities who can find a meaningful entity for the goal of knowledge acquisition by themselves, and they can achieve the goal by externalizing their self-explanatory of their thinking process to other learners. The externalization processes consist of the two phases of the knowledge description phase and knowledge building phase and the cognitive conflict can be bridging activities of the two phases as shown in Figure 3. We will discuss the three phases in detail below.

The description phase is an iteration of the internal learning activities to achieve the goal of verbalization by externalizing one’s thought in his own experiences. The cognitive conflict is a trigger cognitive process for learners to go into knowledge building phase by facing the conflict states (realization of cognitive gap among learners’ mental models, cognitive differences with other learners, or errors in their knowledge) through the verbalization of their thought and the interaction with others. And then, in the knowledge building phase the learners aim at achieving the goal of resolving those conflict states. The goal of verbalization in the knowledge building phase is to resolve the conflicts and is essentially different from the goal of verbalization in the knowledge description phase. This goal achievement model can be regarded as a learning model that includes the model of thought for dynamic internal dialogue mentioned above.

As it mentioned at the beginning of this chapter, the design of the case materials requires: (1) writing case, (2) the content what should be thought and the set of branch points to discussion. In this research, we aim at developing learners’ meta-cognitive skills by

imposing the design tasks of case-method learning materials on the learners and promoting the cognitive interaction with others.

In particular, as an educational program for the medical professions (the nurses in this paper), we developed a learning environment for realizing a model of the learning goals achievement by verbalization. Using the environment, the nurses write down (the description) their own thinking process in his experience as cases, guess others' different thoughts, find a cognitive conflict among the thoughts and try to resolve the conflicts by building new knowledge [11] [12].

3. The Environment Supporting Learning in Design Learning Materials

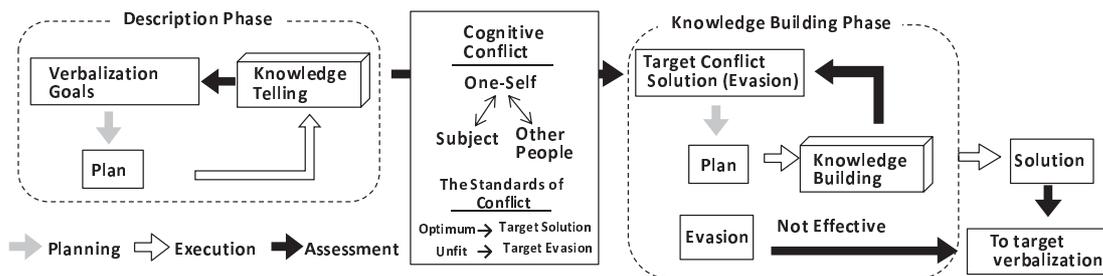


Figure 3. A goal-attainment model of verbalization as a learning strategy

In Figure 3, in the learning strategy, learners engage with verbalization activities in the description phase and the knowledge building phase and the activities are externally observable at behavioral level. Meanwhile, the activities of making goal, plan, cognitive conflict, resolving conflicts etc., are not externally observable internal cognitive activities. Since those activities are relatively abstract and ambiguous, it is difficult for the learners to achieve the learning goals. The difficulties of learning shown as Figure 1 can also be considered as the reason to this ambiguity and abstraction. Our idea of a learning model to reduce the cognitive load for the learners to achieve the learning goal is to provide a easy-to-use environment to support learners to reflect his thinking process in his medical services practices. The ontology for patient psychology, medical services, thinking activities and learning activities are incorporated in the environment. And a user-friendly interface for writing case learning materials is provided [13].

4. The Thinking Representation in Case Design

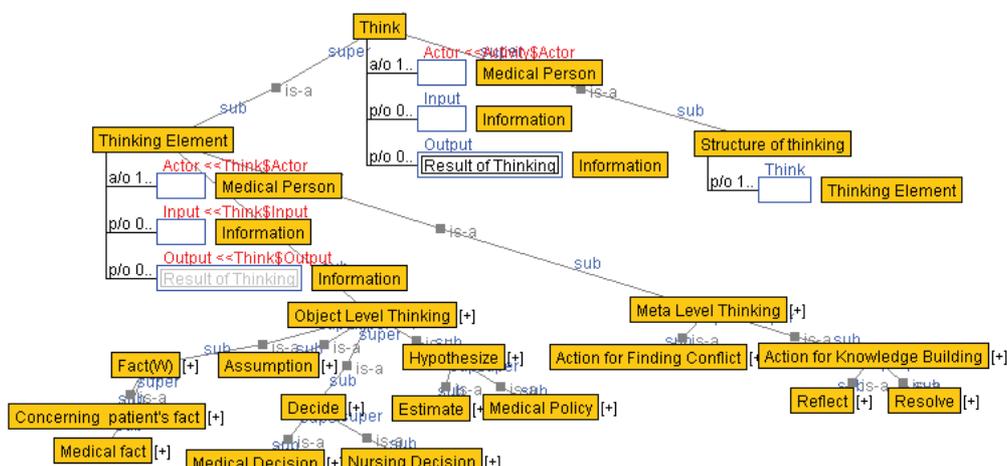


Figure 4. Thinking skill ontology (partially)

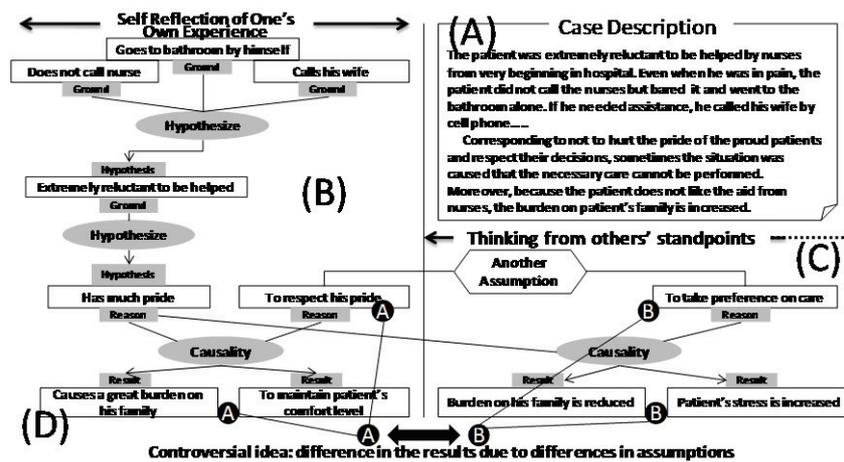


Figure 5. An example of thinking representation in case learning material designing

Figure 4 shows an overview of a part of the ontology for thinking process in medical services [8]. Using the concepts in the ontology, the learners externalize the reflection of their thinking process in their experiences in the graphic representation as shown in Figure 5.

Figure 5(A) shows the reflection description of thinking in one's own experience and Figure 5(B) shows its graphic representation. The square nodes represent the assertions and the elliptic nodes represent thinking activities such as "hypothesizing", "finding cause and effect" and so on. Figure 5(C) shows the guessed thinking process of another nurse with different stance from the learner. Figure 5(D) shows the intended issues (cognitive conflict) to be discussed in the case materials, thought that she should not care the patient too much and respects the patients feeling because the patient does not want it because of his too much pride, even though it is unavoidable to increase the load of the family to take care of the patient. Meanwhile, she guesses that there may be a nurse who thinks, on the assumption of "care priority", that she should provide the enough care to the patients even though it may cause the strong stress on the patient's mind. And then the learner investigated the advantages and disadvantages of the results of different assumptions.

Associating with the discussion in the previous chapter, (B) the visualization of one's own self-reflection can correspond to the description phase. And (C) according to the assumptions at different standpoint, (D) the discussion setting up can correspond to the evocation of knowledge building by cognitive conflicts.

5. Sizhi: A Learning Environment for Externalizing the Reflection on Thinking Processes for Internal Dialogue

Combining the learning strategies based on the goal-attainment model of verbalization (Chapter 3) and the thinking representation in case design (Chapter 4), we developed a learning environment named Sizhi. The Sizhi is designed for developing the learner's ability to conduct logical thinking for internal dialogue and to appropriately reflect on ones' thinking process by one's own. In order to improve the quality of discussions, we designed a model of thinking process for self-dialogue consists of three phases, where the learners are required to be able to conduct high quality thinking for self-dialogue, to describe high quality of reflection on ones' own thinking, to find meaningful conflicts, to create high quality knowledge in order to overcome the conflicts, by continuously developing their ability using the Sizhi tags.

Figure 6 shows an example of a case written by a nurse with Sizhi. As shown in the figure, there are three tabs that correspond to the description phase, the cognitive conflict and the

knowledge building phase in learning strategies. Each line consists of a statement ID (number), a Sizhi tag, and statement, and may have an additional tag and ID's that refer the logical foundation of the statement in the line.

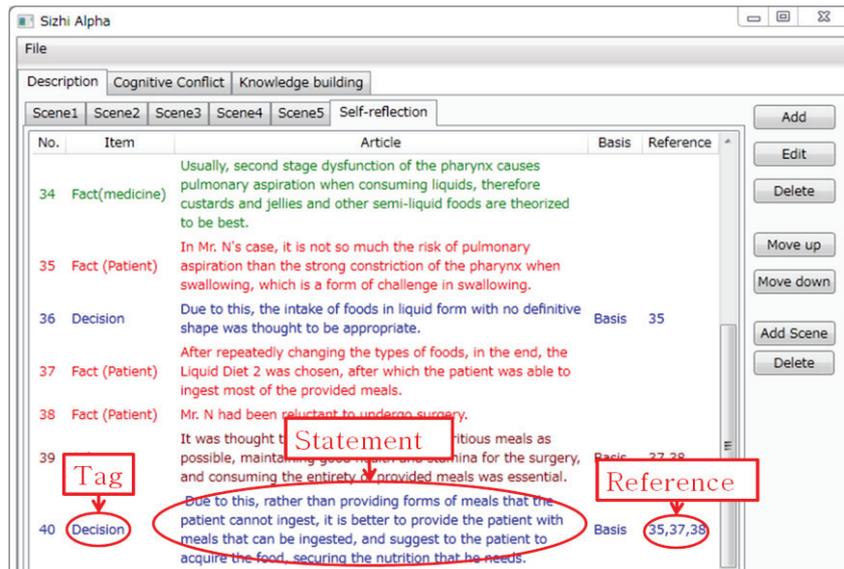


Figure 6. The description phase

Sizhi refers the thinking ontology mentioned in the above section to clarify the logical structure of learners' thoughts by Sizhi tags, and the learners is required to express the thinking processes using a set of Sizhi tags. The set of Sizhi tags is designed for nurses to reflect on their thinking process for internal dialogue and consists of nine tags: fact (patient), fact (medical), policy/principle, assumption, decision, medical decision, conflicts, reflect and resolve. The nurses' learning task in the case writing is to reflect on their own thinking process and clarify the structure of the thinking process using the Sizhi tags.

The most important aspect in designing Sizhi is for learners to clearly write ones' own case by reflecting on their thinking process using Sizhi tags, and reflect on the thinking process to find meaningful conflicts. To promote learners to gain deep insight into conflicts, for instance, Sizhi encourages learners to find conflicts between the statements with policy/principle tag, because the policy/principle tag implies the statement is one of logical foundation of the thinking process.

A preliminary experiment was conducted with the help of medical specialists from Faculty of Medicine, Miyazaki University and Juntendo University Hospital Group. In order to investigate the participants' motivation and their self-evaluation, we conducted two questionnaires, before and after using Sizhi. The Figure 7 (left) describes the mean difference in the target (related with self-dialogue process) column and the distractor (not related with self-dialogue process) column before and after using Sizhi. As a result, we found that as the preliminary experiment progressed, the target became higher and the distractor became lower. This result suggests that the understanding of the importance of thinking skills increased by using Sizhi. Moreover, we asked the learners for a self-evaluation of their thinking ability. And we split the learners into 3 groups according to the magnitude of the change in cognition of importance when analyzing the results and found that the self-evaluation of medium and small growth groups improved after using Sizhi (Figure 7 right).

In summary, for visualizing the invisible, shapeless, complex structure of thinking process to support knowledge creation, Sizhi provides learners with the Sizhi tags which clarify various thinking processes, and the Sizhi tab which encourages the awareness of the three thinking phases of knowledge building process, and is designed with the intent to encourage externalization and careful investigation of ideas that follow those processes.

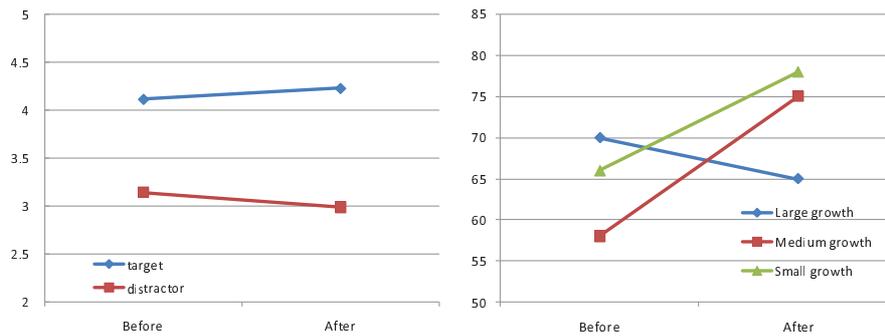


Figure 7. Changes in cognition of the importance of thinking skills (left) and changes in self-evaluation for each growing (right) before and after using Sizhi

6. Conclusion

In this paper, we organized a learning model which promotes reflective learning the case-method for medical service education. As an implementation of the learning model, a learning environment that support learners to reflect on their thinking process in their experiences by a learning strategy which consists of three case-writing phases: the description phase, the cognitive conflict phase, the knowledge building phase. The final goal of this research is not to make contributions to technological improvement in medical service education but to conduct a proposal of a rational learning model for medical service education. In the future, we will establish a methodology to the educational program that contains the scientific rationale for the continuous program procedures included the designing, executing, analyzing and revising for service education.

References

- [1] Yoshikawa, H. (2008). Introduction to Service Science. *Journal of the Japanese Society for Artificial Intelligence*, 23(6), 714-720. (In Japanese)
- [2] Keio Business School. (1977). *Theory and Practice of Case Method*. Tokyo: Toyo Keizai Inc. (In Japanese)
- [3] Hyakkai, S. (2009). *Learning by Case Method*. Tokyo: Gakubunsha Inc. (In Japanese)
- [4] Ishida, H., Hoshino, H., & Okubo, T. (2007). *Case Book 1: Introduction to Case-Method*. Tokyo: Keio University Press (In Japanese)
- [5] Tomida, E., & Maruno, J. (2004). Theoretical Background and Empirical Findings of Argument as Thinking. *Japanese Psychological Review*, 24(2), 187-209. (In Japanese)
- [6] Billig, M. (1987). *Arguing and thinking: A rhetorical approach to social psychology*. Cambridge, UK: Cambridge University Press
- [7] Kuhn, D. (1991). *The skills of argument*. Cambridge, UK: Cambridge University Press
- [8] Cui, L. et al. (2011). Thinking Skill Development Program To Support Co-Creation Of Knowledge For Improving The Quality Of Medical Services. *Proceedings of Conference on Education and Education Management 2011*
- [9] Morita, Y., Cui, L., & Kamiyama, M. (2011). Learning program that makes thinking the outside and presses knowledge collaboration skill development. *The Institute of Electronics, Information and Communication Engineers Technology Research Report*. 111(98), 7-12. (In Japanese)
- [10] Ito, T. (2009). Effects of Verbalization as Learning Strategy: A Review. *Japanese Journal of Educational Psychology*, 57, 237-251. (In Japanese)
- [11] Argyris, C. & Schön, D. (1974). *Theory in Practice: Increasing Professional Effectiveness*. San Francisco: Jossey-Bass.
- [12] Argyris, C. & Schön, D. (1978). *Organizational Learning*. Massachusetts: Addison-Wesley.
- [13] Boud, D. & Walker, D. (1991). *Experiencing and Learning: Reflection at Work*. Geelong: Deakin University Press.



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