Transferring Tacit Skills of WADAIKO

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Abstract. The techniques are acquired through repetition of such copying and passed on in this intuitive way. As even the experts acquired them by intuition, the techniques are difficult to put into explicit knowledge, forms of word or value. To solve the problem, recently there are numerous attempts to turn the techniques into explicit knowledge for preservation and transmission thereof. However, current situation is that not all of the knowledge is conveyed by unsuccessfully forcing tacit knowledge (skills) into the disguise of its explicit counterpart. It is necessary to preserve the tacit knowledge learned by experience and intuition and convey it in a way understandable. Techniques refer to postures and motions of experts. Motions of the experts striking a Wadaiko are extracted as data, which is used in developing an instruction system of passing on the techniques of the experts to novices. Finally, it is verified whether the novices have acquired the techniques through the system.

Keywords: Expert-Novice, Tacit skills, Tacit knowledge.

1 Introduction

In recent years, Japan has declining birth rate and a growing proportion of elderly people. At the forefront of traditional entertainment and crafts, number of expert is decreasing each year and there are few successors. As such, it is a concern that techniques of the traditional skills will be lost together with the experts.

The techniques involve tacit knowledge which is learned by experience and intuition. Tacit knowledge refers to that difficult to convey in written form as it cannot be put into words of text or numbers of value. When learning the traditional techniques, novices do not receive some special training from experts (their masters), but rather are instructed to “see, hear and feel”, starting by copying postures and movements of the experts. The traditional techniques are acquired through repetition of such copying and passed on in this intuitive way. Thus, they cannot be conveyed accurately in written form even by the experts, who are well-versed in the practice, and texts in such attempt are vague. As even the experts acquired them by intuition, the techniques are difficult to put into explicit knowledge, format of word or value. As a result, passing them on to successors is also difficult, which may become a reason of the loss of the traditional techniques. Furthermore, it is also a problem that passing on them takes a long time as they have to be learned through repeated copying.

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To solve these problems, recently there are numerous attempts to turn the traditional techniques into explicit knowledge for preservation and transmission thereof. These attempts aim to turn tacit knowledge of individuals into written explicit knowledge so that the techniques can be passed on. However, current situation is that not all of the knowledge is conveyed by unsuccessfully forcing tacit knowledge into the disguise of its explicit counterpart. It is necessary to preserve the tacit knowledge learned by experience and intuition and convey it in a way understandable.

2 Related Work

Research of preservation and passing on of traditional skills in ceramic arts has been conducted by the Fujimoto et al.[1]. In their studies, data of movements of a ceramic artist' wrists and fingers was collected by motion capture sensors and data gloves and input into computer to reproduce the movements in CG. Meanwhile, movements of hands of the ceramic artist were captured by two cameras and reproduced in 3D video. Putting shutter glasses on, users could then view the 3D video and see the movements in 3D. The actual hand movements of the potters and transformation of the clay could be understood through the 3D CG animation. Moreover, by setting the clay semi-transparent, movements of the hand on the side in contact with the clay could be viewed which is impossible from ordinary camera angle. This system enabled the techniques be more accurately passed on. However, a problem was raised that how much strength such as the grip strength was applied in fact could not be understood merely by watching the 3D CG animation.

Teaching materials based on motion capture and virtual spaces have been developed by the Ando et al.[2]. They suggested using a virtual reality by 3D space in "observing performance" and "watching video teaching materials", which were basic in conventional practical teaching. They then developed teaching materials in which movements could be observed from any angle with the aid of motion capture technology. Based on the movements captured by motion capture system and incorporated into the teaching materials, together with coordinates of joints calculated, human models were created, which could show differences between movements of novices and experts from various angles. By such comparison, effectiveness of the motion capture technology as practical teaching materials was proved.

Research of comparison between Wadaiko (Japanese drums) experts and novices in terms of techniques was conducted by the Yamaguchi et al.[3], in which movements of upper limbs of experts in striking a Wadaiko and those of novices were compared. The movements, including those of the right side of the head, shoulder, elbow, wrist and waist, and movements of drumsticks were recorded into videos and analyzed through image processing. Also, muscle activities of right anterior part of deltoid, biceps, triceps, musculus extensor carpi radialis and musculus flexor carpi ulnaris were measured by surface electromyography. Results of the analysis showed that change in angle of joints from shoulder toward wrist was to a larger degree in experts and less in novices; drumsticks of experts struck downwards with higher speed; and the two groups also differed in their striking motion. It was found that the

experts moved all the muscles monitored while novices moved only those of the upper arms. By their difference in striking motion, it proved that they have different techniques.

3 Proposal

This study aims to extract techniques of experts, including tacit knowledge, for the passing on thereof. If the techniques can be extracted, novices may acquire the techniques quickly even without direct instruction from the experts.

Problems of the related works are that they cannot not show the strength applied by the experts. In this study, in addition to actual motion of the experts, their strength applied and speed of movements are also obtained and extracted. Aiming to extract and pass on techniques of experts, the study is conducted on Wadaiko, one of traditional skills. As the techniques, extracted in the form of data, contain tacit knowledge, they are not handled as explicit knowledge such as text and value, but are passed on by the method of intuition, which is a conventional learning method of "learn by observing".

Techniques refer to postures and motions of experts. Motions of the experts striking a Wadaiko are extracted as data, which is used in developing an instruction system of passing on the techniques of the experts to novices. Finally, it is verified whether the novices have acquired the techniques through the system.

4 Overview of Recording and Playback System

Motions of experts in striking a Wadaiko are extracted by using acceleration sensors, pressure sensors, motion capture sensors and other appliance. By referring to techniques extracting studies of the Ando et al and Fujimoto et al. using motion capture technology; these sensors can extract the motion accurately.

The instruction system avoids as much as possible passing on the techniques to novices in the form of explicit knowledge, in order to prevent the problem of individual differences in interpreting textual information. Instead of value and text, change in colors and shapes are used for instruction.

The studies of the Ando et al. and the Fujimoto et al. created models of human and motions. Merely by watching playbacks of models, one may learn little more than learning by watching video and cannot acquire tacit knowledge behind the motions. Thus, it is important to enable the techniques in the motions be passed on to novices in real time.

A system to pass on techniques extracted from experts to novice is developed (fig.1). The figure 1 shows the whole screen display of the system. Motions of novices are superimposed on motion data of experts saved. When the motions of novices deviated from those of experts, novices are instructed to make adjustments. It is the same for deviations in downward striking speed of and grip strength on drumsticks. When experts and novice take same motion, the novices are considered to have acquired the techniques including tacit knowledge.

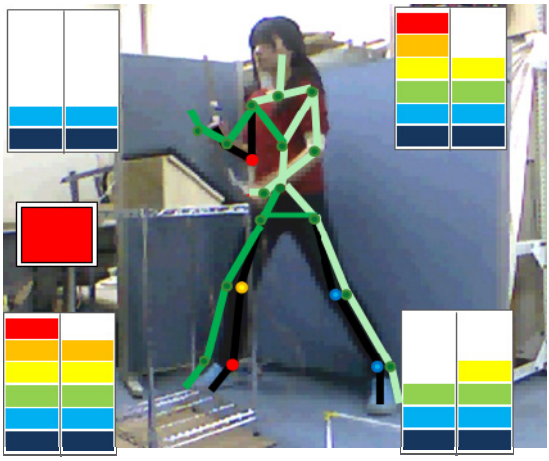

Fig. 1. Screen display of recording and playback system

4.1 Measuring Method and Parameters

Data of motions of the experts striking a Wadaiko extracted includes up-bending angle of arms and wrist indirect and elbow joints movements, as well as speed of downward striking drumsticks. These parameters are determined by referring to the study of the Yamaguchi et al.

3D data of motions are obtained through Kinect, a motion capture sensor of Microsoft Corporation. This sensor calculates depth information by near infrared camera and estimates 3D coordinates of joints of human body. By using Kinect, skeleton data of motions of experts striking a Wadaiko is compiled, and the data of novices is similarly obtained.

Speed of downward striking drumsticks is obtained by using 3-axis acceleration sensors (KXM52-1050), which allow measurement of acceleration and tilt in directions of x, y and z. The sensors can detect acceleration from -2G to +2G.

Grip strength is obtained by pressure sensors (FSR406), which measure 43.69mm and are rectangular in shape. The sensors are installed at where the drumsticks are gripped to detect grip strength. They are controlled by Arduino.

4.2 Motion Based Instruction System

The figure 1 shows the recording and playback system. Colors of the left side of body in the skeleton data of experts are in deeper shades than those of the right to show depth. Where there are deviations of skeleton data of novices from that of experts, such deviations are indicated by a change of colors.

The graph shows joints on the left, indicated in red, yellow and blue. While looking at the colored joints, novices can rectify their deviations of joint positions. When the deviations are reduced, the indication turns blue, which is showed in the graph. Without any indication on direction of the deviations, the novices have to move their joints up and down, back and forth and left and right, through such efforts it is easier for them to remember where the right position is.

Grip strength and speed of drumsticks are showed by meters. The meters of grip strength are placed at the upper left and right of the screen, and those of speed are placed at bottom left and right. Pressure and speed are showed by colors.

Tempo of strikes of experts is displayed at the middle left of the screen. When left and right drumsticks are in contact with the Wadaiko, their respective indicators turn blue and red, this enables novices to understand the tempo.

5 Evaluation

5.1 Experts Data

Experts, from whom data is obtained, are members of Wadaiko groups which have activities worldwide. They consist of 4 males and females, who have 8 to 27 years of experience. Data was extracted through four one-minute continuous striking, two consist of quarter notes and two of eighth notes.

5.2 Method of Experiment

The figure 2 shows locations of all appliances. Kinect was placed in the front of and 45° right to Wadaiko performers, 0.8m from the ground. Video cameras used for capturing striking motions of the performers were next to Kinect.

The performers struck the Wadaiko with drumsticks equipped with acceleration sensors and pressure sensors, who were instructed to face the acceleration sensors upwards. The screen of the instruction system was set up in the front of and left to the performers.

Effectiveness of the instruction system suggested in the study was subject to verification, in which novices were tested on whether they have acquired techniques of experts and the results were compared with those of conventional instruction methods, where novices are instructed verbally.

The novices consisted of 10 ordinary university undergraduates with no experience of Wadaiko. Five of them received verbal instruction and five used the instruction system in the experiment. After this, they were subject to a test without using both kinds of the instruction to examine to what degree they have acquired the techniques.

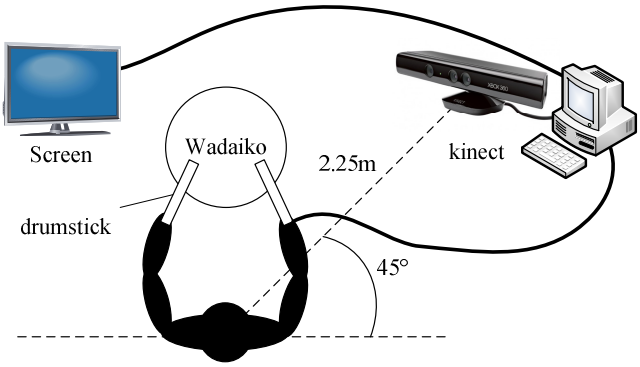

Fig. 2. Experiment environment

5.3 Method of Evaluation

Whether the novices have acquired the techniques is evaluated by comparison of skeleton data. The comparison was on motions in the 0.26 seconds (8 frames) before and after impact of drumsticks striking downwards. Where there were joint deviations from skeleton data of experts over 10cm, the novices were considered not having acquired the techniques.

Subsequent to the instructions, opinion of novices was collected through questionnaire. The performance proceeded and the experts gave subjective assessment on degree of techniques acquired.

6 Result

The table 1 shows percentage of alignment where skeleton data of novices is within 10cm from that of experts.

Table 1. Concordance rate of skeleton data

Verbal instruction		Proposal instruction system	
Subject	Concordance rate	Subject	Concordance rate
Novice A	34.6%	Novice F	59.5%
Novice B	77.4%	Novice G	70.6%
Novice C	36.0%	Novice H	59.5%
Novice D	46.9%	Novice I	43.5%
Novice E	59.7%	Novice J	51.2%
Average	50.9%	Average	56.9%

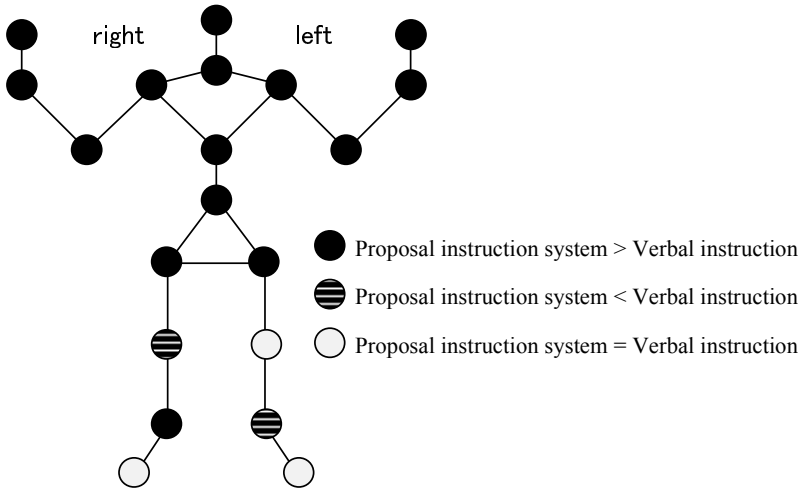

Fig. 3. Higher rate of concordance by joint

The figure 3 shows which method, verbal instruction or the instruction system, resulted in higher percentage of alignment by joint.

7 Discussion

Percentages of alignment were 50.9% and 56.9% for verbal instruction and the instruction system respectively. After calculating the average deviation, there was a significant difference with significance level of 5%. As skeleton data of experts may be compared with constantly, it is considered that its higher percentage of alignment was due to constant modification. Based on the results, it can be said that the techniques of Wadaiko experts which cannot be taught through verbal instruction can be taught by the instruction system.

In grip strength of novices, which was 1631g for verbal instruction and 1371g for the instruction system, there was a significant difference with significance level of 5%. Based on this, the instruction system is better than verbal instruction, as it constantly shows grip strength by colors and is easier for novices to learn as they understand timing and grip strength of strikes of experts. Verbal instruction instructed the novices by utterances of "grip at the instant of strike and loosen the grip when raising the drumsticks", which was not concrete at which instant and how much strength should be applied and led to the bad results.

Novices using the instruction system concentrated on rectifying deviations from motions of the experts in their own motions. As a result, even when they struck, they were not conscious that they struck to make sound. Results of the test showed that sound made by novices receiving verbal instruction was louder.

8 Conclusion

In order to extract and pass on Wadaiko techniques, techniques were extracted from the experts for development of an instruction system, which was then evaluated, with the results that the system can better teach the techniques then verbal instruction does. The results proved the effectiveness of the instruction system suggested. However, problems arose in the experiment that subtle joint bending in skeleton data was indiscernible and too much attention was paid to motions of experts resulting in lower "loudness of sound". Results of the experiment and questionnaire indicated that improvements in accuracy, such as better display of indications, are necessary in the instruction system.

9 Future Work

It is necessary to improve the instruction system by, among other things, better display of joint indications and indicating tempo by sound.

Techniques are not necessarily the same even if extracted from the same person. Also, gender and physique of individuals have effects on the techniques. It is

necessary to extract the essence of the techniques by multiple extractions of physical positions of the same person. At present, the data extracted is used for data mining for works of extracting such essence.

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