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Feature Extraction of the Nursing Techniques from Hand Motion Data

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Abstract: It is not easy to acquire nursing techniques from lectures only, but research on transforming a tacit knowledge of nursing techniques into a formal knowledge has started recently. In this paper, we analyze the coordinate information of hand motion data in an intravenous injection, and discuss on the possibility of formulating information.

Keywords: Nursing techniques, Hand Motion Data, Tacit knowledge, Formal knowledge and Correlation matrix

1. Introduction

The knowledge which is hard to express by words is called as a tacit knowledge. On the other hand, the knowledge that can be expressed by text, mathematical expression and figure is called a formal knowledge. In the SECI model of knowledge creation theories (Ikujiro Nonaka & Hirotaka Takeuchi 1995), it is claimed that a tacit knowledge is transformed into a formal knowledge by discussion in an organization. In nursing techniques, tacit knowledge appears in various contexts such as intravenous injection and excretion care (Bowtell, L., Moloney, C., Kist, A.A., Parker, V., Maxwell, A., Reedy, N. 2012). As the study on the inheritance of nursing techniques, for example, the method of using a meta-synthesis of practical examples from prior reports had been proposed (Aya Ueta, et.al 2009).

Recently, the knowledge share system using video data based on SECI model had been innovated in the education of nursing techniques, and it is utilized to transform nursing techniques from a tacit knowledge to a formal knowledge. Moreover, the study to visualize the movement of hand motion during the running of nursing techniques has been starting, and it provides useful information to learner (Majima. Y., Maekawa, Y., Soga, M. 2012). By these recent studies, it can be said that the data including a tacit knowledge concerning nursing techniques are becoming computable by computer.

In this study, we investigated whether the hand motion data includes some tacit knowledge of experts by comparing with the data of learner. In the prosecution of this consideration, we analyzed the hand motion data of two experts and four learners (i.e. 6 testers) by computing correlation matrix of hand motion data. The hand motion data are obtained from 16 location sensors attached at their hand, and one sensor obtains three-dimensional coordinate. To extract the information of experts, we focused attention on the correlation of 16 sensors for each coordinate (i.e. x, y and z coordinate). From the result of data analysis, we could see that there exists important sensor to extract the feature of expert nursing techniques although the number of data is not enough. Furthermore, we proposed the evaluation function to measure the difference between two testers, and showed that the evaluation function could detect the difference between an expert and a learner in the data of this study.

2. Data Acquisition System and Hand Motion Data

2.1 Method of Data Acquisition

The system to get hand motion data had been developed and is using for the education of nursing techniques (Majima. Y., Maekawa, Y., Soga, M. 2012). In this study, we will analyze the data whose are obtained from this system. The system is LIBERITY 240/16 (POLHEMUS), and it has 16 location sensors. By using this system, we can obtain 240 three dimension coordinate data per second. We fixed 15 (3 sensors * 5 fingers) sensors at the central outside of a phalange and 1 sensor for measuring the reference position.

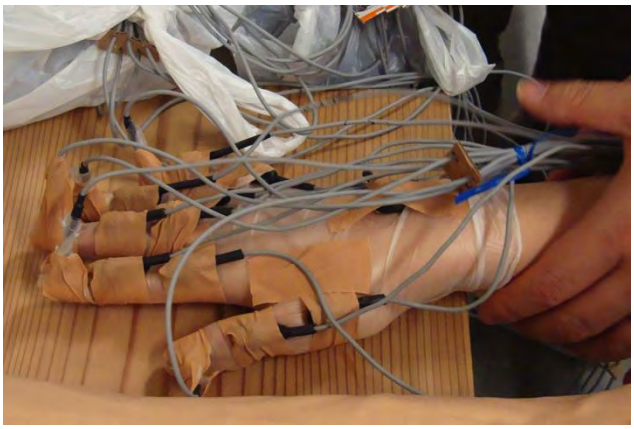

Figure 1. The scene of sensor wearing.

In this study, we analyze the hand motion data performing intravenous injections.

2.2 Pretreatment of Hand Motion Data

Since the time of intravenous injections differs by tester, the size of hand motion data is unequal. Therefore, we quantized data in the following way. Let (x_i, y_i, z_i) be the coordinate data of some sensor of the tester T_k for $i = 1,2,\cdots,I_k$ and $k = 1,2,\cdots,6$, where I_k is the number of data, T_1, T_2 are experts and T_3, T_4, T_5, T_6 are learners. Since the data size is different in each tester, we transformed I_k into 70 and redefined three dimensions coordinate as $(\hat{x}_j, \hat{y}_j, \hat{z}_j)$ in the following way.

$$\hat{x}_j = \frac{1}{I'} \sum_{i=I'(j-1)+1}^{I'j} x_i \,, \hat{y}_j = \frac{1}{I'} \sum_{i=I'(j-1)+1}^{I'j} y_i \,, \hat{z}_j = \frac{1}{I'} \sum_{i=I'(j-1)+1}^{I'j} z_i \,,$$

where $I' = [I_k / 70] + 1$ and $[x]$ denotes the largest integer not greater than x.

3. Data Analysis and Result

We can express data as three 70×16 matrices whose are related to x, y and z coordinate in each tester. From these data, we analyzed the correlation of 16 sensors in each coordinate x, y and z by computing 18=(3 sensors × 6 testers) correlation matrices (16×16 matrix). Then, we obtained the result that only y coordinate of experts has not correlation with each 16 sensors. Figure 2 is comparison of an expert's correlation matrix and a learner's one. It can be said that this is a big feature of expert's data. Therefore, we may measure the level of nursing techniques by using this feature.

We propose the evaluation function of the level of nursing techniques in the following way. From the above discussion, we had three correlation matrices R_{xk}, R_{yk} and R_{zk}. Here, R_{xk}, R_{yk} and R_{zk} are correlation matrices of x coordinate of tester T_k, y coordinate of tester T_k and z coordinate of tester T_k, respectively. Let r_{ij}^k be (i, j) element of correlation matrix R of tester T_k. We define the count function

$$d\left(k=k_1,k=k_2\right)=\frac{1}{16}\sum_{j=1}^{16}\sum_{i=j+1}^{16}\left|r_{ij}^{k_1}-r_{ij}^{k_2}\right|$$

Then, we got $d\left(k=1,k=2\right)<0.08$. This means that there is not so much difference between expert's matrices. On the other hand, for $l=3,4,5,6$, we had

$$0.20\le d\left(k=1,k=k_l\right),d\left(k=2,k=k_l\right)\le 0.32.$$

Hence, it may be said that the correlation matrix of hand motion data includes the expert's tacit knowledge, and have possibility that this information can be embedded into the learning system of (Majima. Y., Maekawa, Y., Soga, M. 2012).

	1−y	2−y	3−y	4−y	5−y	6−y	7−y	8−y	9−y	10−y	11−y	12−y	13−y	14−y	15−y	16−y
1−y	1															
2−y	0.4	1														
3−y	0	0.9	1													
4−y	0	0.9	1	1												
5−y	0.2	0.9	0.9	0.9	1											
6−y	0.9	0.2	−0	−0	0	1										
7−y	0.9	0.3	−0	−0	0.1	1	1									
8−y	1	0.3	−0	−0	0.2	1	1	1								
9−y	1	0.4	−0	−0	0.2	1	1	1	1							
10−y	0.7	0.9	0.7	0.6	0.8	0.6	0.6	0.7	0.7	1						
11−y	0.9	0.6	0.2	0.2	0.5	0.8	0.9	0.9	0.9	0.9	1					
12−y	0.3	1	0.9	0.9	1	0.1	0.1	0.2	0.3	0.8	0.5	1				
13−y	0.8	0.7	0.4	0.4	0.6	0.7	0.7	0.8	0.8	0.9	1	0.7	1			
14−y	0.2	0.9	1	1	1	−0	0	0.1	0.1	0.8	0.4	1	0.6	1		
15−y	0.8	0.6	0.3	0.3	0.6	0.7	0.8	0.8	0.9	0.9	1	0.6	1	0.5	1	
16−y	0.5	0.9	0.8	0.8	0.9	0.3	0.3	0.4	0.4	0.9	0.7	0.9	0.8	0.9	0.8	1

	1−y	2−y	3−y	4−y	5−y	6−y	7−y	8−y	9−y	10−y	11−y	12−y	13−y	14−y	15−y	16−y
1−y	1															
2−y	0.5	1														
3−y	0.3	1	1													
4−y	0.6	0.9	0.9	1												
5−y	0.8	0.6	0.6	0.9	1											
6−y	0.9	0.6	0.4	0.8	0.9	1										
7−y	0.9	0.6	0.4	0.8	0.9	1	1									
8−y	1	0.6	0.4	0.7	0.9	1	1	1								
9−y	0.9	0.6	0.5	0.8	0.9	1	1	1	1							
10−y	0.7	1	0.9	0.9	0.8	0.8	0.8	0.8	0.8	1						
11−y	0.9	0.6	0.6	0.8	0.9	0.9	0.9	0.9	1	0.8	1					
12−y	0.7	0.9	0.8	1	0.9	0.8	0.8	0.8	0.9	1	0.9	1				
13−y	0.9	0.6	0.5	0.8	0.9	0.9	0.9	0.9	1	0.8	1	0.9	1			
14−y	0.7	0.8	0.7	0.9	1	0.9	0.8	0.8	0.9	0.9	1	1	0.9	1		
15−y	0.9	0.5	0.4	0.7	0.9	0.9	0.9	0.9	0.9	0.7	1	0.8	1	0.9	1	
16−y	0.8	0.6	0.5	0.8	1	0.9	0.9	0.9	0.9	0.8	1	0.9	1	0.9	1	1

Figure 2. Correlation matrices of an expert's y coordinate (left) and a leaner's one (right).

4. Conclusion

In this paper, we analyze the hand motion data during intravenous injections, we clarified that the correlation matrix of some location data may includes a tacit knowledge of nursing techniques. Our future works are the following two things. The one is to collect more data and verify the discussion of this paper, and the other is to develop the learning system based on the result of this paper.

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