Chapter 16

Analyzing Coordinate Relations in Handwriting Activity: Tacit Skill and Individuality

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1. INTRODUCTION

Handwriting activity is one of the intelligent and dexterous movements produced by human. The research on the relation between the movements or character shape in handwriting and writer’s personality or individuality has been challenged for a long time. Especially, there is a lot of contribution to person authentication (signature verification) by handwriting features (Nalwa 1997) (Komiya et al. 2001) (Jain et al. 2002) (Li et al. 2006).

Meanwhile the concern with embodied (physical) skill, which is the implicit knowledge the body memorizes, has been growing for the last several years. Such skill is a kind of tacit knowledge, which is presented by Michael Polanyi.

Generally, tacit knowledge is an intelligence that we cannot clearly explain by ourselves in spite of being acquired or learnt. In the light of the concept of tacit skill analysis, conventional studies on handwriting activity and individuality include two problems as follows;

Problem 1: In the conventional studies, handwriting activity is not handled as one of the complicated movements of the whole body. Nicholai A. Bernstein pointed out that human’s activity forms a hierarchy and it is based on various coordinations between small activities in various levels. According to Bernstein’s hierarchical model, handwriting activity is a kind of aimed and transferring movements. It leads the pen-tips from somewhere to somewhere on the two dimensional space such as paper. Generally, you may consider that controlling a dominant hand mainly supports handwriting.
activity. However, not only controlling a hand, but also keeping posture is the most fundamental function in handwriting activity. If we do not keep posture, we could not move our hand and lead the pen-tips with sensibility. Therefore, handwriting activity should be analyzed as a movement of the whole body from the multiple viewpoints such as motor skill, how to use the muscle of the neck or the back, how to keep posture as well as pen-tips movement, pen pressure etc..

Problem 2: In the conventional studies, several handwriting features such as character shape, pen pressure, pen-tips coordination, pen azimuth, pen altitude etc., are evaluated independently. Although there is a lot of contribution to use or analyze various features, there are little contribution to analyze the correlations between various features. Recently the coordination between various physical parts or synergy of muscles are treated as important factors in the fields of physical or embodied skill analysis or skill science. Moreover, in Japanese calligraphy “Sho,” Syouichirou Otaki pointed out the importance of handwriting activity as the movement of the whole body and coordination of different parts in the physical skill. Therefore, handwriting activity should be analyzed as coordination between various features such as pen-tips movement, pen pressure, pen-incline and motor skill.

These two concepts have brought substantial changes into the idea of human’s dexterous activity analysis. It can be possible to find a novel fact or knowledge if the relation between tacit coordination and individuality are revealed in handwriting activity. However, it is difficult to address the handwriting tacit skill because we cannot understand our embedded knowledge by ourselves. Naturally, we cannot express the tacit knowledge as linguistic (symbolic) knowledge.

One of the methods in order to solve the problem is data mining approach. Various human’s activities are observed by specific devices and then the observed data should be analyzed. In this approach, tacit knowledge processing is to discover the implicit knowledge from multivariable and nonlinear time series.

Needless to say, soft computing technologies are very suitable tools in finding the knowledge from ambiguous and complex data. Some clustering or self-organizing algorithms can convert nonlinear time series data into symbolic data as well as visualize features. Some learning algorithms or chaotic time series analysis technologies can find causal relation as input-output system. By using soft computing technologies, we can mine and symbolize complex raw signal data as well as we can understand tacit knowledge in activity.

Thus, we propose a framework of tacit skill analysis by soft computing technologies; especially we show the method of handwriting skill analysis. Moreover, a brief experiment of handwriting skill analysis has been done by structural learning of neural network.

2. DEFINITION OF HANDWRITING SKILL AS TACIT KNOWLEDGE

In this section, we discuss about the definition of handwriting skill. First of all, we describe about a concept of “levels of construction of movements” proposed by Bernstein and a concept of tacit knowledge proposed by Polanyi. Based on the relation between tacit knowledge and “levels of construction of movements,” we propose that the handwriting skill is a kind of tacit knowledge.

Levels of Construction of Movements and Tacit Knowledge

Dexterous and flexible human’s activities are achieved by controlling joints based on muscle coordination. Figure 1 shows the relation between muscles and joint. Most important thing is that the muscle can generate the force not by its stretch but by its contraction, which is represented as outgoing arrows in Figure 1. It needs a couple of flexor and extensor muscle, which is called antagonist.
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