

***Applying Wearable Technology to Facilitate the Transmission of Tacit Knowledge
for practice-based learning***

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Abstract

The 10,000-Hour Rule, the key to success in any field, is simply a matter of practicing a specific task for more than 10 thousand hours (Gladwell, 2008). The ability to speak a language or knead dough requires to a lot of hours practice to accumulate tacit knowledge. Whether the wearable technology can facilitate the transmission of tacit knowledge in specific skill learning remains an interesting and critical research question.

The objective of this paper is to apply a wearable technology with Electromyography (EMG) and Electroencephalography (EEG) to detect body information and examine how wearable technology facilitates the transmission of masters' tacit knowledge in the knead dough skills learning process. This paper designed a practice-based learning system with EMG and EEG to record hand movements and the change of brain wave when the bread apprentices make breads. The findings of this paper contribute to the practice of wearable technology applications and tacit knowledge transmission in learning.

Keywords: Electroencephalography (EEG), Electromyography (EMG), Practice-based learning, Skill learning, Tacit knowledge, Wearable technology

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Introduction

It's necessary to learn hard no matter which fields you work on. Gladwell said that the average learning time to become an expert is about ten thousands hours, likewise, to be a bread baker, one has to practice again and again to acquire dough making process and to make a perfect bread. However, the traditional way to teach dough making is often based on the oral transmission of the Master, and is too abstract to completely deliver dough making knowledge to learners, so learners have to spend much more time to practice. If people can use the current technology to record the various hand postures of the master and display the implicit knowledge to make learners understand the difference between them and the master, it may reduce training time and be more efficient for dough making learning process. This research uses wearable technology devices like MYO and Neurosky mindwave to enhance the learning accuracy, decrease the training time, and helps learners immediately fix their learning problems.

Literature

Tacit Knowledge

A concept proposed by Michael Polanyi in 1958, he regarded knowledge as two sections, one includes information such as words, graphics, and mathematics that can be described, and the other one consists of information that can't be measured. The implicit knowledge is concerned with individual intuition, imagination, innovation and knowledge of skills. However, implicit knowledge is difficult to be recorded and transferred, so this research aims to display the implicit knowledge of bread master, to reduce the learning time and to help learners acquire professional skills through the current technology.

Electromyography (EMG)

The Electromyography means the slight electric current when body's muscle exercises or happens on people's skin, or the graphic that records the signal through electronic machine. Most time applied on medical or related fields.

Electroencephalography (EEG)

The Electroencephalography recording the voltage fluctuations that released by people's brain in any situations, then transform the continued voltage fluctuations signal to icons. The fluctuations often seen are Delta, Theta, Alpha, Beta, Gamma, Lambda and so on. EEG also used in medical fields.

NeuroSky

Founded in 2004, NeuroSky is a privately held, Silicon Valley-based company with offices throughout Asia and Europe. Through their brainwave device, we can get the data and information in brain by non-invasive method, and use bluetooth sending to cellphone. Developer can observe the brain types and transfer them to attention and mediation and analyze to develop different fields.

Table 1: Brainwave types.

Types	Frequent	Situation
δ	1Hz ~ 3Hz	Unconscious state, Deeper Sleep
θ	4Hz ~ 7Hz	Subconscious state, dreaming state
Low α	8Hz ~ 9Hz	Calm
High α	10Hz ~ 12Hz	High alert
Low β	13Hz ~ 17Hz	Relaxation and focus
High β	18Hz ~ 30Hz	Anxiety and agitation
γ	31Hz ~ 50Hz	Well-being and calm



Figure 1: Neurosky.

MYO

MYO, a kind of Gesture Control Armband device in wearable technology fields, developed by Thalmic Labs in Canada. This is a device that can detect the slight change on electric current on skin, also can reload the eight sensors' EMG to phone, compare the data and observe. The product specification is listed below (Figure 2).

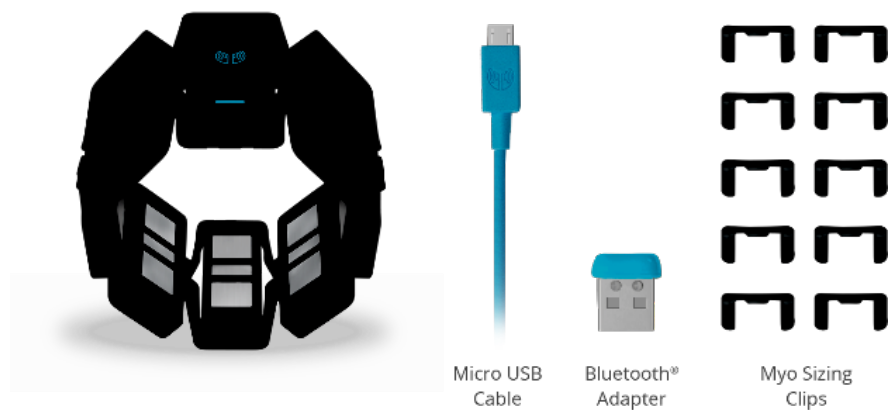


Figure 2: Myo device.

Table 2.

Sensors	Medical Grade Stainless Steel EMG sensors, highly sensitive nine-axis IMU containing three-axis gyroscope, three-axis accelerometer, three-axis magnetometer
LEDs	Dual Indicator LEDs
Processor	ARM Cortex M4 Processor
Bluetooth	4.0v

Result & Conclusion

This research developed a system to analyze the learning difficulty through gathering learners' physical information. A wearable technology was used to record and collect the data from the varied physical changing degrees of the master's hand muscle during exercising and dough making period (Figure 3). This paper used the correlation algorithm (formula one and two) to calculate the related coefficient from the eight channels' data of MYO in master's and the learner's hands, and observe the similarity between these two persons (Figure 4). Finally, this paper finds the posture difference, muscle grade, and attention values of learners and master, and offers a model that can be used and train repeatedly.

$$R_n = \frac{n \sum xy - \sum x - \sum y}{\sqrt{n \sum x^2 - (\sum x)^2} \sqrt{n \sum y^2 - (\sum y)^2}}$$

Formula 1.

$$\frac{(R_{r1} + \dots + R_{rn})/n + (R_{l1} + \dots + R_{ln})/n}{2}$$

Formula 2.

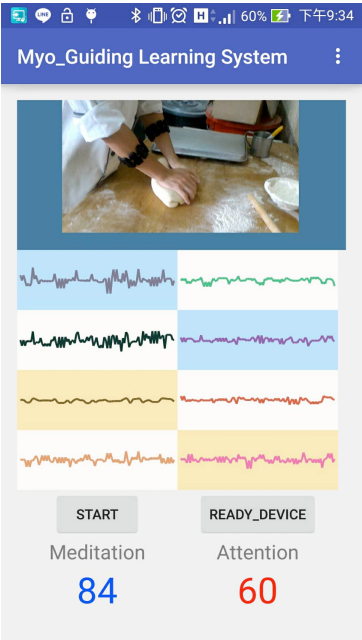


Figure 3: System Demo 1

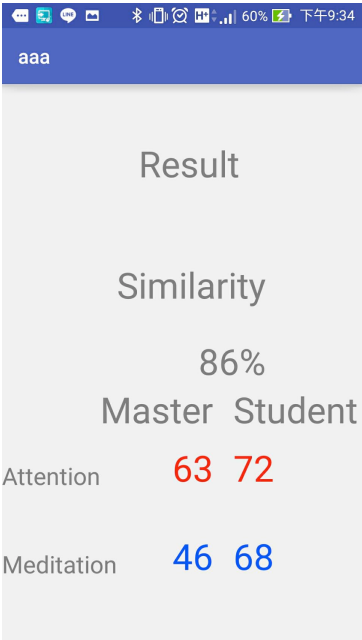


Figure 4: System Demo 2

Contribution

In the past, implicit knowledge was hard to be recorded by a scientific method. This study completed a model system to accelerate the training of learners in the baking industry by recording and transferring the master's implicit knowledge to be explicit. If this model system is used on different fields, it will help to understand the implicit knowledge of many traditional skills.

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