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Emotion Recognition Method for Driver Services

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Abstract

Electroencephalographic (EEG) is used to record activities of human brain in the area of psychology for many years. As technology developed, neural basis of functional areas of emotion processing is revealed gradually. So we measure fundamental areas of human brain that controls emotion of human by using EEG. Hands gestures such as shaking and head gesture such as nodding are often used as human body languages for communication with each other, and their recognition is important that it is a useful communication medium between human and computers. Research methods about gesture recognition are used of computer vision. Many researchers study Emotion Recognition method which uses one of EEG signals and Gestures in the existing research. In this paper, we use together EEG signals and Gestures for Emotion Recognition of human. And we select the driver emotion as a specific target. The experimental result shows that using of both EEG signals and gestures gets high recognition rates better than using EEG signals or gestures. Both EEG signals and gestures use Interactive Feature Selection (IFS) for the feature selection whose method is based on the reinforcement learning.

Key words : Evolvable neural networks, Developmental Model, Adaptive learning interval , L-system, DNA coding.

1. Introduction

In human communication, people communicate the exchange of information with each other the by using language. Especially, it is important that people use not only verbal information but also nonverbal information. Nonverbal communication is the basic of human communication. In addition to human to human communication, communication between human and machines or computer agents are becoming more and more common recently [1]. Emotion recognition of human is an interesting but difficult research. People can recognition emotion speeches with about 60% accuracy and emotional facial expressions with about 70~98% [2]. The emotion recognition research has been typically attempted using four kinds of medium. They are speech, image, physiological signal, and gesture. In addition, our IEEE survey papers published from 1990 to 2006 show that papers using the speech medium have been published more often than others have. The reason for this result is probably due to feature set extraction from speech and image being easier than physiological signal or gesture and the possibility of classification is higher [3]. Most researchers have used to one of speech, image, physiological signal, and gesture [4~6, 10]. And a few researchers try to study both facial emotion and gesture, speech and image, etc.

In this paper, we propose emotion recognition method for using Electroencephalogram (EEG) signals and gesture. Bio-potential signals use EEG signals and gestures use moving the wrist and the hand. According to study EEG signals, many researchers know a fundamental function of human brain that control human emotions. And EEG studies are used to detect seizure and epilepsy by them [10]. They use the EEG feature extraction in deception detection [4]. Also gesture recognition is important that it know emotion of human. We study gestures recognition with sensors such as cameras, Data Gloves and Data Suit [7]. This paper use both Gyro (angular speed) sensor and accelerometer sensor as action recognition measurement equipment.

The outline of the paper is as follows, In Section II, it explains the experiment data acquisition and Section III explains the emotion recognition method. The Section IV shows a simulation and result of emotion recognition experiment. Section V concludes and shows future works.

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2. Experimental Data Acquisition

2.1 Experimental equipment

EEG represents electrical activity of human brain as a signal. But EEG signals are often infected with various artifacts caused by electrical phenomena. Due to the artifacts, it is difficult to analyze and decipher EEG signals.

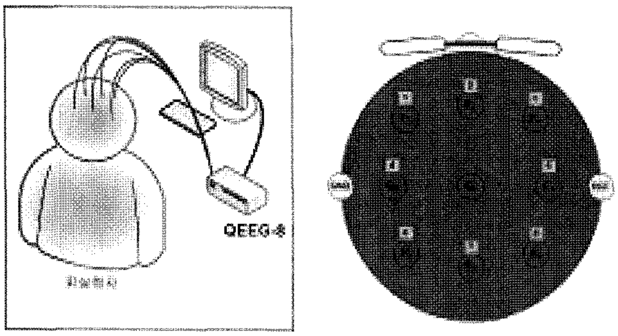
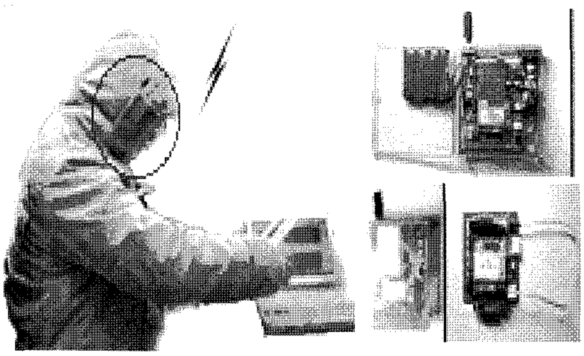
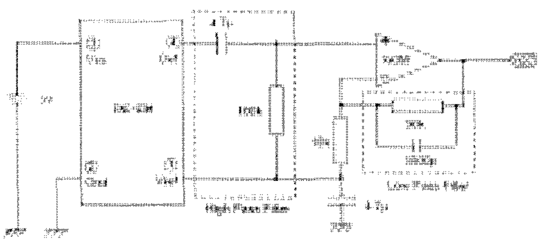


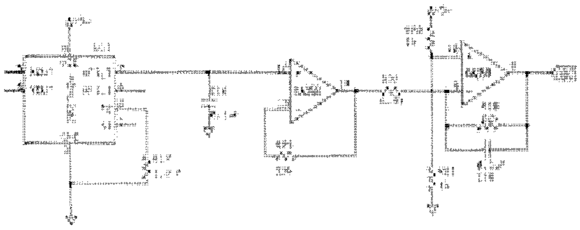
Fig. 1. EEG Signal Extraction Experiment: QEEG-8 experiment equipment (left), experiment head coordinates (right)



(a) Action Recognition measurement Experiment and equipments



(b) Gyro sensor circuit



(c) Accelerometer circuit

Fig. 2. Action Recognition measurement Experiment and Equipment circuit diagram

But it is necessary and indispensable to measure EEG signals when we know a fundamental function of human brain[6]. EEG measure equipment is QEEG-8 by LAXTHA in Fig. 1(left) and sensors, experiment equipment, are adhered the head coordinates in Fig. 1(right) for measuring signals of human brain. And they have eight channels. Action recognition experiment is used 3 coordinate gyro (angular speed) sensor, 3 coordinate accelerometer sensor and a system, which use ATMEGA 16 controller. This experiment equipment is adhered the wrist, neck, part of body and sense a motion. So it recognizes the human active. Measure data are sent to PC by wireless. It uses blue-tooth communication.

2.2 Psychological Emotion Experimental

For inquiring out mental condition of human, researchers approach a dimension model and a foundation emotion model. Wundt classifies three dimensions that are pleasant/unpleasant feeling, excitement/calmness and tension/relaxation. Russell combines the existing researches and divides two dimensions that are pleasant/unpleasant feeling and awakening/sleeping [8]. Fig. 2 shows various emotions classification by dimension model. In contrast, Ekman who leads the foundation emotion theory asserts six foundation emotions which are happy, surprise, fear, anger, disgust and sad [9].

This paper selects feeling emotions when people drive. They are happy, anger, normal and sleepiness. Sleepiness is the important recognition part specially and is similar to tired condition. We cause emotion through stimulus of pictures and films in experiment. And we use both EEG equipment and action recognition equipment for measuring bio-potential signals. A testing ground is set up driving simulation in small laboratory.

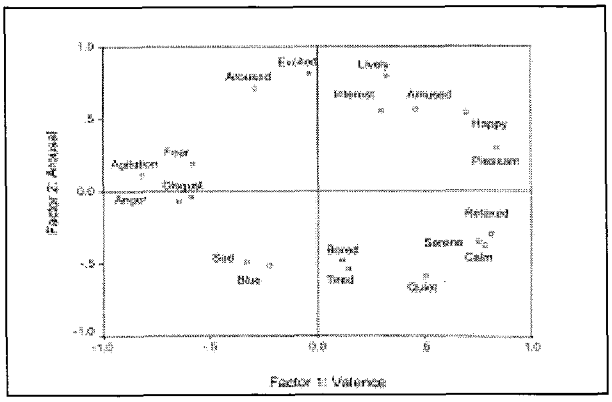


Fig. 3. Emotion Classification by Dimension Model

To make many emotion situations, we use pictures of International Affective Picture System (IAPS), standardized sensitive stimulus system, which are made by the professor Peter Lang, the University of Florida. Fig 4 shows the stimulus picture for inducing emotions.

We select four emotions for driver services. According to selecting emotion, actions are defined and defined actions are measured. Table.1 shows defined actions as selecting emotions.

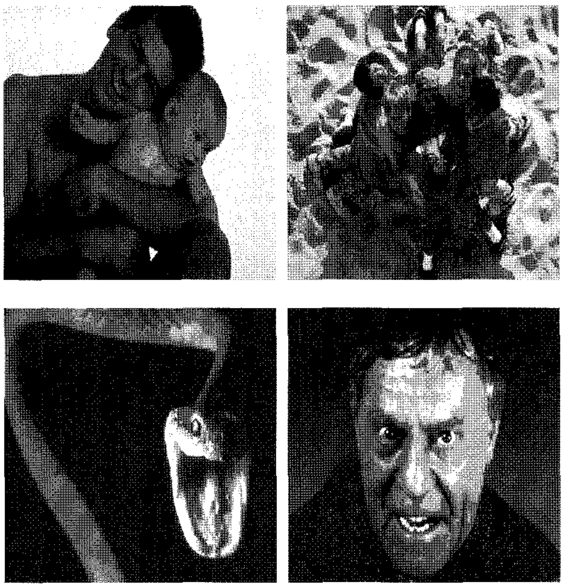


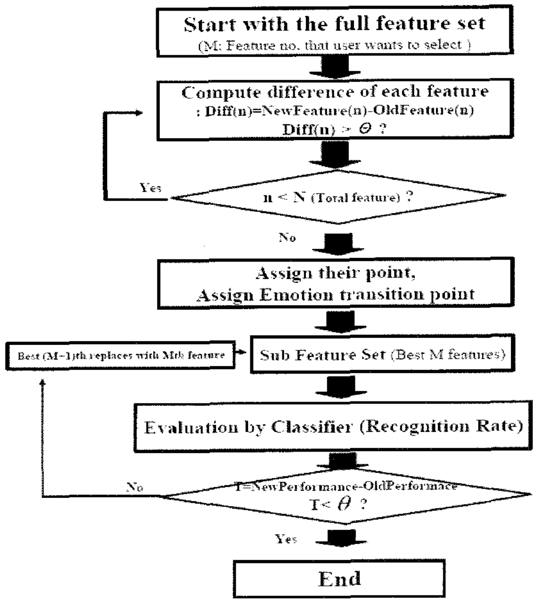
Fig. 4. Stimulus picture

Table 1. Actions of Emotion

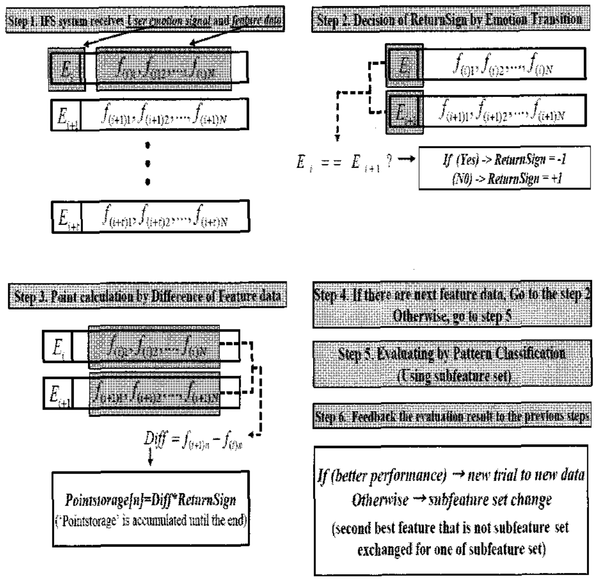
Emotion	Action
Normal	A little tension condition, small gestures
Anger	Large gestures of hand and foot more than normal, increase in power (power of turning the steering wheel, power of stepping the acceleration)
Sleepiness	Nod the head by periods
Happy	Wriggle one's body by small gestures

3. Emotion recognition method

The Interactive Feature Selection algorithm we are proposing is an algorithm based on reinforcement learning. Also, these feature selection algorithms are based on the rationale of correlation and information-theoretic measures. Reinforcement learning consists of an agent and environment and is a learning method that leads the agent to perform a target action for a user. The process of learning is as follows, given an environment, an agent firstly performs an action and the agent receives a reward for the action from the environment. At that time, each time step is denoted as t, an environment state which the agent may be include is denoted as $s_t \in S$ (S is a set of possible environments) and an action is denoted as $a_t \in A(s_t)(A(s_t)$ is a set of possible actions in a state). A reward for an action is denoted as r_t and when an episode has been completed, the r_t is expressed as the following equation:



(a) IFS Algorithm



(b) IFS example

Fig. 5. IFS Algorithm and an example

$$R_t = \sum_{k=0}^{T} \gamma^k r_t + k + 1 \qquad (1)$$

Where γ is a discount coefficient in the above equation and does not make the sum of rewards an infinity in the case of being defined as $t = \infty$. In addition, if the discount coefficient is zero, it means that only the current reward value is admitted. That is, we can give the weight to a future value differently according to the discount coefficient. Finally, reinforcement learning is a method that determines a policy to maximize the equation 1[3, 11]. The IFS focuses on both the search strategy and evaluation by objective function. Fig. 5(a) shows The IFS process. We assume that an emotion recognition system that includes this algorithm will be applied to a home robot or appliance. If such a situation is considered, users may be comfortable inputting emotional speech and a user's emotional state at that time (as a supervisor value). Due to this characteristic, this algorithm is a user adaptive system that can efficiently solve a problem and the more a user is in contact with this system, the better it will perform.

4. Experiment results

4.2 Experimental Environment & Results

First, experimenters are measured EEG signals in normal and they tall their condition. We tell the contents of experiment, show the stimulus images, and measure EEG signals and gesture. Fig. 6 shows to measure EEG signals.

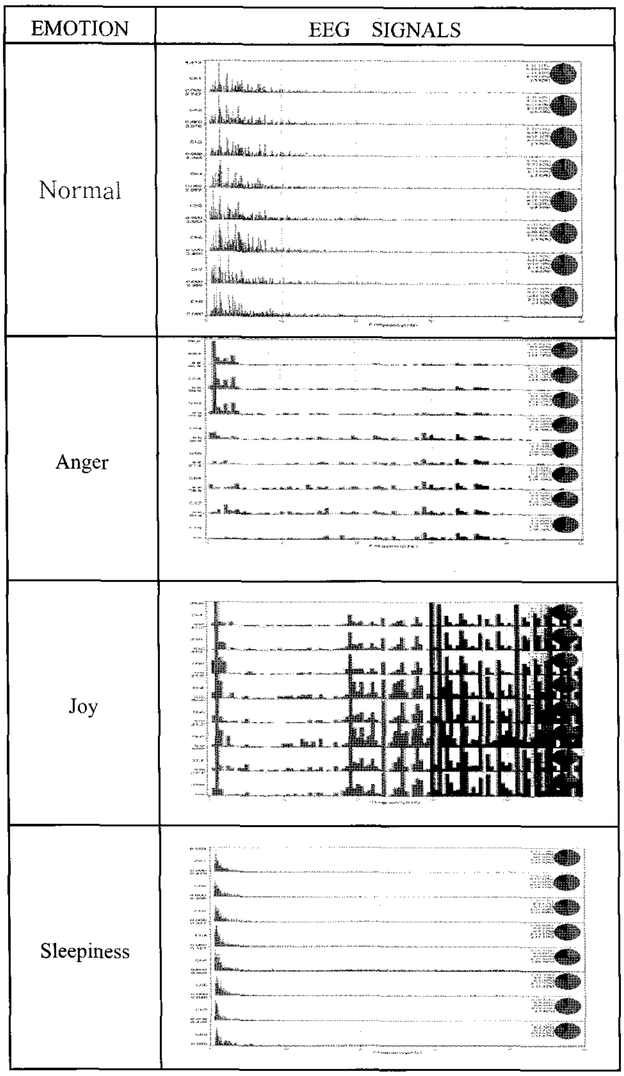


Fig. 6. EEG Signals

Active recognition sensors were attached part of the wrist and the head. According to emotions in driving, experimenters was measured their gestures. Fig. 7 shows gesture signals as emotions.

If we measure only EEG signals, we know 'Happy' emotion because brain signals of 'Happy' emotion shows a remarkable contrast more than other emotion. They are similar to each other. So, we are a difficult correct measurement. To a correct measurement, we use both EEG signal ad gesture data. According to emotions, recognition rates show some differences. And people show some differences, too. When people recognize emotions of other people, they show 60% recognition rate. This experiment almost show 60% recognition rate, too. The experiment rate is similar to the recognition rate of human. As using both EEG signals and gestures, we can get the correct emotion recognition.

The data values of EEG signals and action sensors input a simulator and the simulator shows the emotion result. Fig. 8 shows experiment simulator.

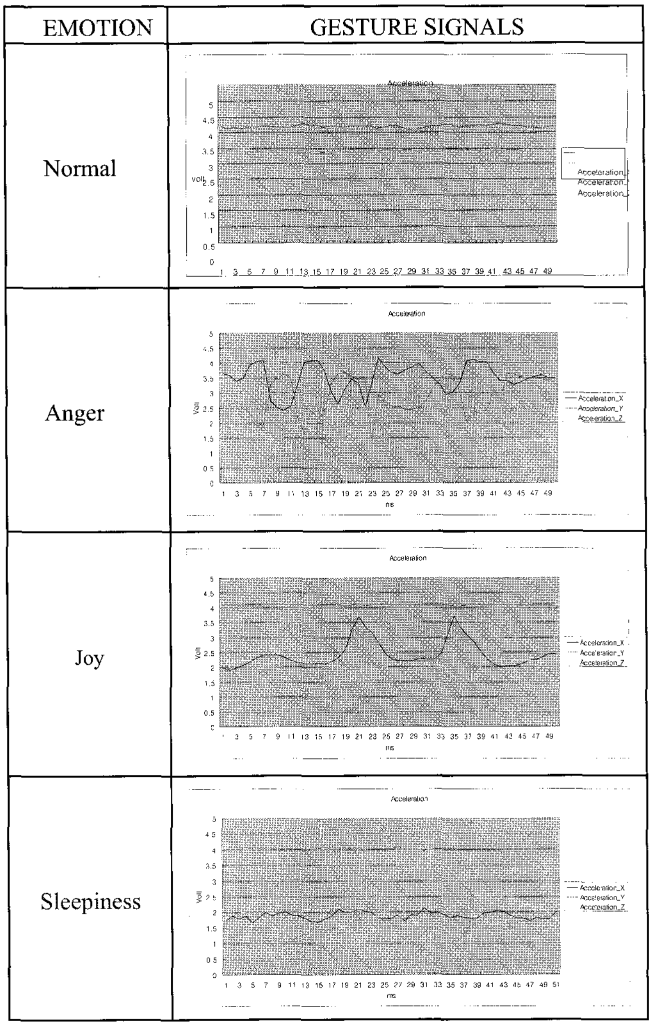


Fig. 7. Gesture Signals

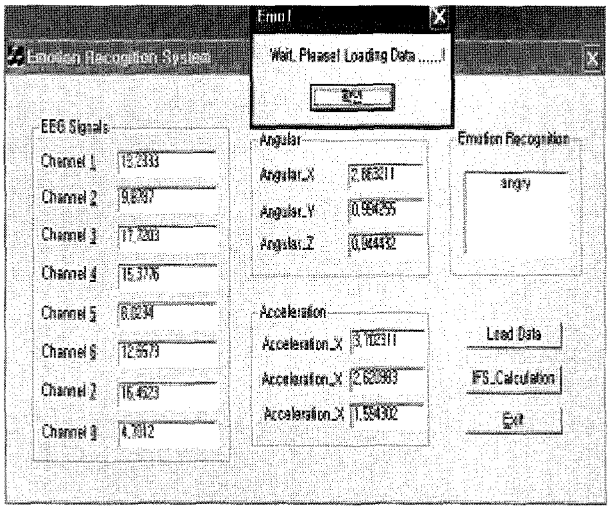


Fig. 8. Experiment Simulator

6. Conclusions

In this paper, we propose the emotion recognition method not using one of speech, image, physiological signal, and gesture but using both Electroencephalogram (EEG) signals and gesture. Bio-potential signals use EEG signals and gestures use moving the wrist and the hand I driving. For emotion recognition, we use both Gyro (angular speed) sensor and accelerometer sensor as action recognition measurement equipment. As we use both EEG signals and gestures, we can get the correct emotion data.

In the future, this experiment result will be used to many service fields that need the emotion recognition of agents. And it will need studies that different algorithms are used to correct emotion recognition more than existent methods.

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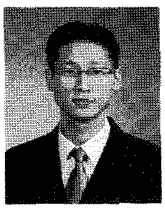

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