Interactive Platform of Gesture and Music Based on Myo Armband and Processing

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Abstract. This interactive platform of gesture and music is an interactive product developed with the Myo armband. We conduct EMG gesture recognition research, mainly using the DTW algorithm to calculate the distance between the templates, so we can use the DTW algorithm for real-time gesture recognition. We used p5 and Processing for development, and completed sound recording and sound processing by reading the gestures of Myo. The user can feel the change of music when issuing the action command. At present, we have completed the development of three modes: vibrator, sound changer and audio processor.

1. Introduction
This product is an interactive platform of gesture and music based on Myo armband and Processing. The product is composed of two parts:

The hardware part is Myo armband which provides the function of gesture customization. Users only need to wear the armband and learn the recognition operation to use it. We can also use our own design, development of software to create a variety of custom gestures, to achieve more possibilities.

The software part is Processing music interactive platform with various interactive modes. After connecting the armband to the computer, the user only needs to open different modes on the interactive platform and can understand its operation method through a simple attempt.

Table 1. The three application modes.

| Mode name     | Mode content                                           |
|---------------|--------------------------------------------------------|
| Vibrator      | Gesture control modulator handles music and trill      |
| Sound changer | Gesture control recording and sound changing effect    |
| Audio processor | Christmas-style music interactive website             |

2. DTW Algorithm
Since the Myo armband itself only comes with 5 gestures, we need to redevelop it on the basis of the Myo armband's own gestures, so that Myo can recognize more gestures. Eight groups of EMG signal values were read through Myo Connect.
Figure 1. Myo signal value.

The waveform of the EMG [1] signal showed a high degree of similarity when the same gesture was made continuously. And there is a sequence of waveform changes, which correspondingly reflects the sequence of muscle activities when people make the same gesture. This includes the unique characteristics of different gestures. The features of EMG signal waveform of 8 groups of different gestures were used for gesture recognition.

We collect a lot of data of single gesture, segment the gesture part according to the collected data, extract the wave feature of this gesture and normalize it. The "template" of gesture signal waveform obtained by processing is the normalized gesture waveform obtained by summarizing a lot of data and organizing. We can assume that the standard gesture waveform is not too different from the template we made. We read some gesture data into our template for comparison during recognition. If the deviation is within the range we allow, we can consider the current gesture as a template corresponding to the gesture.

3. Gesture reading and recognition

3.1. Date Collection
The first thing to do gesture recognition is to collect data, because data is needed for both template and test. After connecting the armband with Myo Connect, we used Python to read the 8-dimensional EMG signal of Myo and stored it in 8 columns in excel format for subsequent processing.

After the armband is connected, we open up the Python file that can graphically show the real-time EMG signal changes. We judge which EMG signal of gestures is more obvious, and judge the difference between EMG signals of different gestures, in order to choose friendly gestures with obvious differences. According to the change of EMG signal, we selected 6 gestures in figure 2.

Figure 2. Six different gestures.
3.2. Data Segmentation

Data segmentation is also known as active segment detection of data. We need to distinguish between the gesture signal segment and the silent signal segment. By detecting the starting and ending positions of the actions, the effective actions of the signal segment are extracted for the convenience of identifying the effective actions later. The EMG signals varied slightly between subjects who were inactive. This means that the energy without motion cannot be exactly the same, and there will be a small range of fluctuations in the energy. Nevertheless, the average energy value of the inactive state can completely reflect the inactive state. The energy values vary widely when there is movement, so the energy can be used to find out the movement stage of each subject. The moving average energy method is used for data segmentation and sliding window segmentation is used to facilitate the analysis of signals with high frequency.

In the real-time experiment, for the value of sliding window size, the sum of window size and processing time should not be too long, which is about 0.3s. At the same time, the length of the window should not be too short. As the length of window segmentation decreases, the synthesis of surrounding features will decrease. When feature points contain less information, the deviation and variance will increase, which will reduce the availability of the system.

![Figure 3. Fist gestures of moving average energy and segmentation.](image-url)
3.3. Feature Extraction

Since the input sequence of EMG signal is large and random, the sequence needs to be mapped to vectors with smaller dimensions for analysis, which can also save the operation cost. This vector is called the eigenvector, which represents the information of the original EMG signal [2]. Feature extraction is the key to successful recognition. Through experimental comparison, we adopt the method of sliding mean absolute value in the time domain. The principle of the sliding mean absolute value is similar to that of the moving average energy. Therefore, the window length was set to 40 points (200ms), the sliding increment was set to 10 points (50ms), and then the average absolute value of the signal value of the segmented window was calculated.

For each movement, the DTW algorithm is used to select samples with close average length to match the remaining training samples, so as to obtain samples with small sum of distances. At the same time, the path finding method is used to find the sequence points corresponding to the training samples with the minimum matching distance. Then the average value of the data corresponding to these time points is calculated, and the template of each action is obtained for the recognition of the action.

![Figure 4. Finger spread template and wave in template.](image)

![Figure 5. Distance between different templates.](image)

3.4. Gesture Recognition

In the recognition function, we first read EMG data in real time and save it in DataFrame format. When the number of rows of data reaches 40, calculate the energy average, and then read the data after subtracting 10 from the count, which is equivalent to the step operation of sliding average energy. Then, the starting point and ending point functions are used for data segmentation, and gesture features are extracted with mean absolute value. The DTW algorithm [3] is used to match the obtained sequence points with the template to return the deviation value. When the deviation is small enough, we are sure to detect the gesture, otherwise we ignore and continue to read the data.
4. Audio processing
Our interactive platform reads any audio and video files on the server and sets up a frequency-controlled modulator that processes the audio to create a vibrato/reverb/acoustic effect. Myo armband could control the modulator parameter size in real time for audio process.

The essence of sound processing in different modes is to call a modulator with adjustable amplitude and frequency. By changing the frequency of the input sound, the voice’s tone and pitch are changed. This is achieved by using a modulator in Processing and reading data changes in Myo in real time to change its parameters.

![Image](image_url)

**Figure 6.** Different mode interfaces.

5. Conclusion
This interactive platform of gesture and music is an interactive product developed with the Myo wristband. Currently we concentrate on the music. Getting the data returned from the Myo gesture action. Then we use the JavaScript to redevelop. After receiving the data, the sound will be processed in real time on the http server. In the meantime, the output effect is intuitively perceived by means of a picture or the like.

At present, three modes of development have been completed: vibrator, sound changer and audio processor. We could try this product in a very simple way, but the output effects vary in different ways. This product is suitable for use in the science and technology museum, and its main audience is teenagers and people who are interested in wearable devices. By reading the gestures of Myo, sound recording and sound processing are completed. The user can feel the change of music and realize sound visualization while sending out action instructions.

6. References
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