Development of the Tool for Artistic Representation of Internal Information of the Body

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ABSTRACT
In this paper, we describe the idea of a new artistic representation tool to project performer's internal state of the body. To solve the problem of complicated wires and for detecting biological signals, the flexible conductive wear for wearable computing named as "TextileNet system" was applied to the system. In this paper, we also describe the experimental results of trial growing of the tool. The advantage of the conductive fabric was not only solving the problem but shielding effect, which could make the amplifier simple. Using the feature of TextileNet, huge number of biological information can be treated at same time, and more complex representation is expected.

Categories and Subject Descriptors
H.5 [**Information Interfaces and Presentation**]: General

General Terms
Measurement, Performance, Design, Experimentation, Human Factors.

Keywords
TextileNet, Wearable Computing, Entertainment Computing, Dance, Biological Signal, EMG,.

1. INTRODUCTION
A dance performer embodies his/her implication with a formation and movement of his/her own body parts, which can be represented by choreology. These external views are easy ways to tell semiotic information. However, a dance is seen as an accumulation of not only a body and its movement but nonverbal information such as atmospheres, aura, breath, fever, excitement, and so on, which are projected by internal state of the performer's body. Here, we thought that a tool to display internal information such as biological signals which are generated as a result of physiological activity of muscles or neurons helps art performer such as dancer who wants to represent his/her enthusiasm and passion generated from inside of his/her body.

Several kinds of research for similar concepts have been done before. Bermudez et al. provided a immersive, interactive virtual environment that is being generated in real time based on physiological data readings of a human body [1]. In the environment, one performer connected to EEG, ECG, EMG, EOG, and PSG detector. The measured data is transmitted to a PC where they are then transformed into a 3D visualization named *cyber***PRINT** which is projected to performer's background in real time. However, many wires connected to sensors to get many signals make system complicated and unstable, and the number of the channel of transmitter has a limit. Therefore, the number of attached sensors was not enough.

On the other hand, we already have developed the flexible network infrastructure system made of conductive fabric, named as TextileNet, for wearable computing systems [2, 3]. We thought that it is possible to make a system which has enough number of sensors using with this system.

In this paper, we propose an idea of representation tool applying TextileNet system for new artistic dance performance. Especially targeting EMG, we tried to develop the wear with a light which gleams depending on the strength of EMG. And we discuss the entertainment feature realized by the advantage of this system.

2. SYSTEM
2.1 TextileNet System
We have developed electric conductive wear named as "TextileNet" as shown in figure 1 [2, 3]. TextileNet provides both the power supply and communication channel for all the devices installed on the wear, as well as the flexibility of installing and arranging layout of devises. The users can install the adequate devices on any places, and the devices can be supplied electric power as well as communication channel. TextileNet is expected to be an infrastructure for all the wearable computing systems.

This system has the following features.

1) Cable-free
2) Comfortable wear with conductive fabric
3) Free installation on the wear by pin

4) High communication ability (Point-to-point, up to 1Mbps)

5) High power supply ability (～1W)

Figure 1. The wear using conductive fabric.

This fabric consists of three layers; two conductive fabric on the both side of insulator fabric. Each device module has power supply unit and communication unit as shown in figure 2. And the module is plugged by pin as shown in figure 3. The system does not require the complicated wires for communication. And the size can be made very small as shown figure 4.

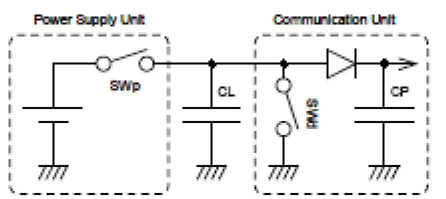

Figure 2. Circuit architecture of data communication and power supply unit of TextileNet.

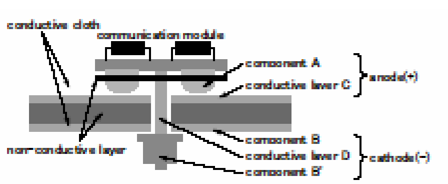

Figure 3. structure of electric contact.

Figure 4. Actual communication unit.

2.2 Development of a Small EMG Amplifier Module for TextileNet System

We developed a small EMG amplifier for TextileNet system as shown figure 5. This amplifier was designed as small as we can. It consists of differential amplifier, high pass filter and low pass filter as shown figure 6.

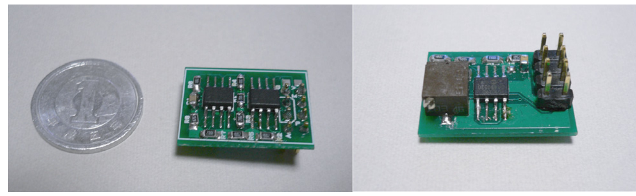

Figure 5. The developed small EMG amplifier.

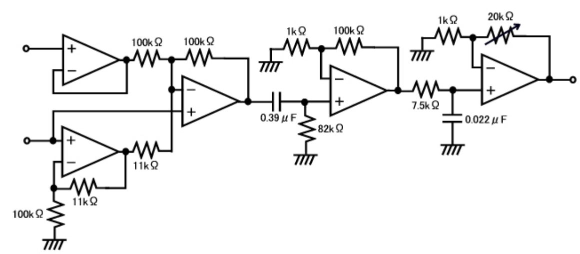

Figure 6. The diagram of the electro circuit of the developed amplifier.

2.3 Experiments and Results

We tried to apply the amplifier developed here to the medial forearm as an example. The elasticated conductive fabric was experimentally manufactured here. It was cut and sewed up to make a sleeve which tightly fit to subject's forearm, looks like elbow supports. Two electrodes made of Ag/AgCl (Nihon-Koden, Tokyo) attached to the medial forearm with conductive paste for EEG measurement (Nihon-Koden, Tokyo) with the 1 cm spacing at the inside of TextileNet. Those electrodes were connected to the small amplifier pinned inside of the sleeve with minimum leads up to 2 cm long. The amplifier could be supplied electric power from the TextileNet system at the every pinned point on the fabric. The amplified analog EMG signal was converted into digital signal, which could be transmitted everywhere we want to use the signal on the fabric by serial communication function of TextileNet system.

Here, we experimentally made device to convert force of muscle contraction into intensity of LED using the transmitted EMG signal right opposite side of the amplifier through the fabric as shown figure 7. The device receive EMG signal, make full-wave rectification, accumulate rectified wave while constant duration and lighted LED at a intensity depending on the accumulated signal, which represents power of EMG.

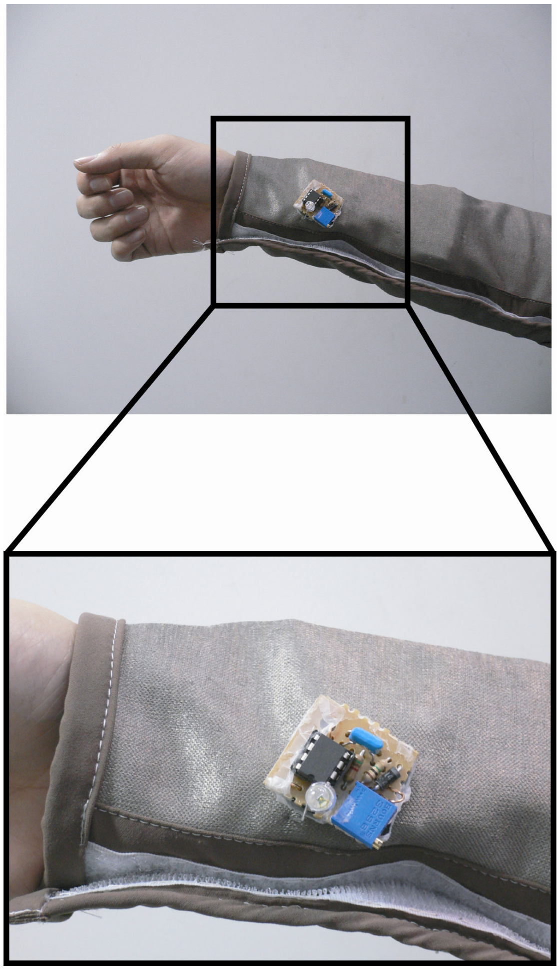

Figure 7. Actual attachment of device module to light LED depending on the power of EMG.

We examine the work of the device measuring the grip force gripping a grip dynamometer. The result of the examination is shown as figure 8. When the subject increased the grip force gradually, the LED on the module lighted depending on the indication of the grip dynamometer as shown at the right side of an each photograph.

3. DISCUSSION

3.1 Advantage of the Proposed System

In this development, we could find that the system proposed here has not only features listed in 2.2 but also electro-magnetic shield effect.

Usually, when we measure biological signals, many kinds of noises strongly interfere the measurement. Therefore, many kinds of filters are employed into the system. However, the body enclosed by conductive fabric were shielded enough to detect weak biological signals. This made the amplifier simple drastically.

And also, eliminating many wires is very efficient for eliminating electrostatic instability due to body movement. This feature is strong advantage for dance performer's application.

3.2 Expected Usages

TextileNet can provide quite large number of communication channel. Proposed system can adopt large number of EMG sensor. Therefore, it is thought that the dance performer's body can be surrounded by thousand of LED which light depending on muscle force, and pattern formation such as wave propagations on surface of performer's body can be created by inter communication among the modules depending on the EMG signals as a possible application. It is thought that this tool can be very powerful for dance performers who want to represent their enthusiasm and passion generated from inside of their body.

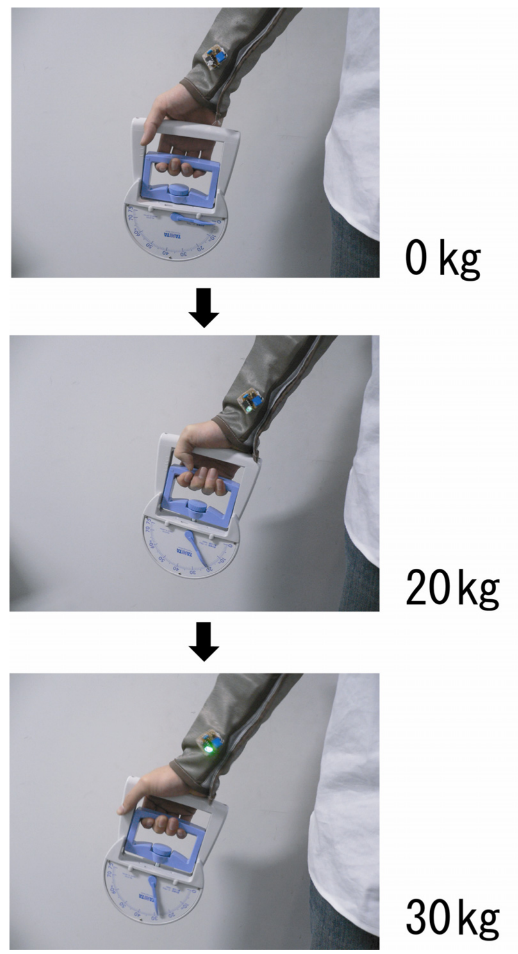

Figure 8. Actual attachment of device module to light LED depending on the power of EMG.

4. CONCLUSION

To solve the problem of complicated wires and for detecting biological signals, TextileNet was applied to the measuring system. We could make the tool to represent muscle activity by LED for the performers such as dancers who want to project internal state of their body. The advantage of the conductive fabric was not only solving the wire problem but shielding effect, which could make the amplifier simple. Using the feature of TextileNet, huge number of biological information can be treated at same time, and more complex representation is expected.

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