A Proposal for a Simultaneous Biometric Measurement System for Multiple People using a Cloud Server

NARUMON JADRAM[†1] YANZHI LI[†1]
YURI NAKAGAWA[†1] MIDORI SUGAYA[†1]

Abstract: Due to the spread of COVID-19, telework and online classes take more important roles, making online communication more common. However, online communication may cause mental problems such as increased anxiety and stress. Therefore, it is necessary to understand mental states and take countermeasures against those problems. So far, there have been studies that objectively assess mental states using biometric data. However, it is not easy to obtain biometric data of many people simultaneously and analyze them in real-time during online communication. Therefore, this study aims to develop a system that can obtain biometric data simultaneously to support the research in estimating mental states in online communication. We proposed a system that uses a cloud server to obtain biometric data of multiple people simultaneously and visualize data in real-time. As a result of this system's evaluation, we succeed to collect biometric data of multiple people simultaneously from a distributed environment into a database, though the number of connections is still limited. Also, we succeed to use the system to provide data confirmation by visualizing it in real-time.

Keywords: Cloud computing, Biometric measurement systems, Online communication

1. Introduction

Due to the recent spread of COVID-19, telework and online classes take more important roles, and thus, people have more opportunities to communicate using “online tools”. Using online tools for classes and works saves travel time and provides a more flexible way to use individual time. Therefore, living with online tools is convenient and is expected to be utilized even after the convergence of COVID-19.

However, spending time online for classes and works face some problems such as decrease in student’s motivation to learn, increase in loneliness, anxiety and stress [1]. To cope with these problems, several recent studies have been conducted. For example, Nakagawa et al. used biometric information such as brainwave and heart rate variability (HRV) to evaluate the concentration and relaxation changes in different communication levels during online classes [2]. Shimamura et al. evaluated the empathy during online conversations using brainwave and HRV indexes [3]. Both studies focused on online communication problems and used biometric data to evaluate mental states objectively. The biometric-based method that they used enable an evaluation of mental states in real-time, unlike questionnaire which is used to evaluate mental states by subjectively asking some questions.

The above two research suggested that if the evaluation of mental states during online communication among different people is needed, biometric data from different people must be obtained simultaneously. However, biometric measurement system to collect biometric data from the different people simultaneously are still lacking.

To solve the problem, this study develops a system that collect biometric data from the different people simultaneously. We aim at providing this system to support the evaluation of mental states by collecting the data simultaneously from multiple people in online communication. To achieve such requirement, we developed a cloud server to collect the data and visualize data in real-time. We then evaluated the proposed system from two perspectives: simultaneous measurement evaluation and data visualization. This paper presents the design of our proposed system and its evaluation results.

The paper is organized as follows: Section 2 presents the architecture of the system. Section 3 presents the system evaluation. Finally, Section 4 concludes the paper.

2. Proposal

2.1 Overview

In this research, we propose a system using cloud server to collect and visualize the biometric data from multiple people simultaneously. This system is designed to enable the biometric data collection from distributed environments, and allow experimenters to check multiple people's data from one location in real-time. The system overview is shown in Fig. 1.

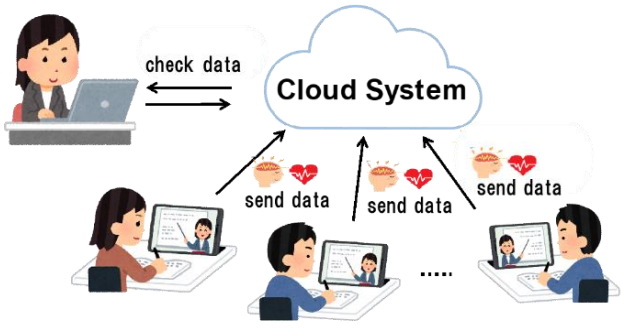

Fig. 1 System overview

2.2 Design of a cloud-based biometric measurement system

The structure of the proposed system is as shown in Fig.2. It consists of a measurement node and a cloud server. The detail of

†1 Shibaura Institute of Technology

each part is described as follows:

The measurement node collects the brainwave data from the Electroencelphalograh (EEG) sensor and the HRV data from the pulse sensor, worn by multiple people. The system accepts the data sent from the EEG sensor (MindWave Mobile2; NeuroSky) and the HRV data from the wearable pulse sensor (Switch Science). Then, the system converts those obtained data into JSON text format and transmits to a cloud server via HTTP communication every second. To store data in the database immediately, we use the JSON keys as the database attributes.

The cloud server uses HTTP server and CGI script to process multiple people's requests simultaneously, and then writes each data to the database. For the database, we use PostgreSQL with Master/Slave model. We also employ a web-based UI for visualizing and checking the data in real-time.

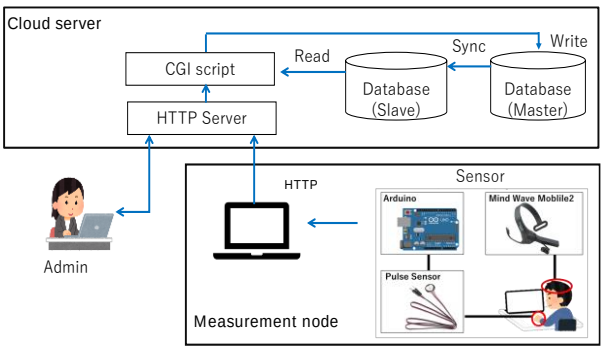

Fig. 2 System design

3. System Evaluation

We evaluated the proposed system from two perspectives: simultaneous measurement evaluation and data visualization from a single location.

3.1 Evaluation of simultaneous measurement

To investigate the capability to collect the data from multiple people simultaneously, we measured the CPU utilization while increasing the number of client connections. We used fork on a 40-core x86_64 machine to increase the number of connections as a process to generate pseudo-clients for sending data. The server and clients are connected via 1000Mbps ethernet.

The evaluation results are shown in Fig. 3. The CPU utilization increased as the number of simultaneous measurements increased. When the connection of clients reached 9, the CPU utilization reached 100%. The results indicate that it is possible to obtain the data of multiple people at the same time using our proposed system. However, the number of connections that can be connected at the same time is limited. The CPU usage reached 100% because our system used CGI script, which created many processes that lowered the server performance. To further solve this problem, FastCGI, event loops, coroutines may be used in order to reduce the CPU utilization.

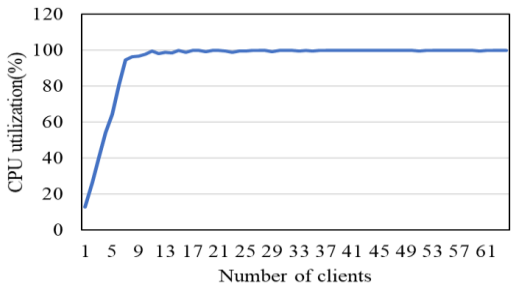

Fig. 3 Number of clients and CPU utilization

3.2 Evaluation of data visualization

This system can obtain brainwave and HRV data, and send them to a cloud server to store in a database. At the same time, web-based UI displays the client's ID who is sending data to the cloud server. By selecting the specific ID, we can visualize data in real-time. Figure 4 shows that we succeeded to used our proposed system to visualize the data in web-based UI.

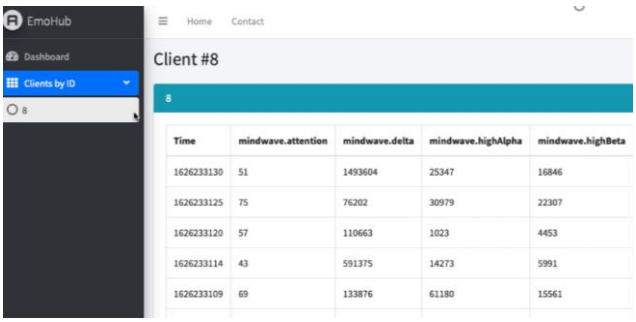

Fig. 4 Web-based UI to visualize data

4. Conclusion

In this research, we propose a system using cloud server to collect and visualize the biometric data from multiple people simultaneously. We evaluated the proposed system from simultaneous measurement and data visualization perspectives. The evaluation results show that this system enables the biometric data collection from multiple connections simultaneously and provides data visualization in real-time on web-based UI. These results show the possibility of supporting the investigation of mental states of multiple people in online communication.

For future work, we will use this system in online classes to evaluate students' concentration and stress states, which contribute to a more effective education system. Moreover, we will continue to improve the system to solve the limited number of simultaneous connections.

References

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