

Frisson Waves: Sharing Frisson to Create Collective Empathetic Experiences for Music Performances

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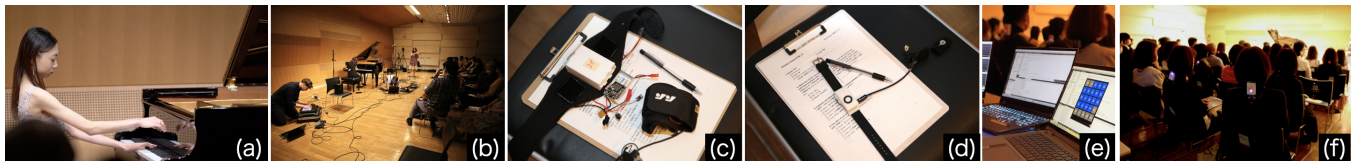


Figure 1: Frisson Waves System Setup and Performances: (a)Classical piano performance by Muyu Liu; (b)Interactive music performance by Danny Hynds, Yuehui Yang, Ragnar Thomsen, Yan He; (c)Thermo-haptic neckband to induce frisson; (d)G-band to detect frisson automatically; (e)frisson waves sharing server; (f)activated neckbands during performance

ABSTRACT

Frisson is a feeling and a mental experience of body reactions such as shivers, tingling skin, and goosebumps. However, this sensation is not shareable naturally with others and is rarely used in live performances. We propose Frisson Waves, a real-time system to detect, trigger and share frisson in a wave-like pattern during music performances. The system consists of a physiological sensing wristband for detecting frisson and a thermo-haptic neckband for inducing frisson. We aim to improve the connectedness of audience members and performers during music performances by sharing frisson.

CCS CONCEPTS

• **Human-centered computing** → **Interface design prototyping**; **Human computer interaction (HCI)**.

*Both authors contributed equally to this research.

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KEYWORDS

frisson haptic, physiological sensing, interactive music performance, interoceptive interaction, empathy

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1 INTRODUCTION

When music deeply resonates with us, we may experience a sudden feeling of excitement. Frisson is a psycho-physiological phenomenon commonly described as having goosebumps, or feeling shivers down one's spine[Schoeller et al. 2019] that can be triggered from external stimuli such as music or intense emotions[Bannister 2019].

Colver et al. [Colver and El-Alayli 2016] find that while most people experience chills when listening to music - the feeling of goosebumps and shivers on the neck, scalp, and spine - some people never seem to experience this sensation. The sensation of frisson is a personal experience and not shareable with others unless with external interventions. Previous works related to frisson sharing exist, such as by Neidlinger et al. [Neidlinger et al. 2017] who explored

externalizing and sharing the feeling of goosebumps with color visualizations and inflatable textiles in their work "AWElectric". Cooper et al.[Cooper et al. 2014] find that people's temperature goes down if they see others shiver.

So far no attempts have been made to induce, detect, and share frisson during music performances. To address this and to connect human emotion and empathy, we introduce Frisson Waves: a system based on physiological sensing that detects, induces, and shares frisson. The Frisson Waves system consists of two devices: 1) a wristband with electrodermal activity sensor and blood volume pulse sensor to detect physiological changes in the skin properties and heart rate variability related to frisson, 2) a neckband with haptic actuators and Peltier thermoelectric modules to induce frisson. Using this setup(see Figure1.(c).(d)), this system enables us to detect and transmit the sensation of feeling frisson to nearby spectators based on a designed macroscopical pattern that imitates the pattern of a wave or ripple. The goals of this research are: 1) to detect and induce frisson in real-time among audience and performers during music performances, and 2) to explore whether frisson sharing can enhance connectedness of the audience and performers.

This work is a continuation of our work in progress effort towards detecting and sharing frisson through a haptic metasomatic interaction system based on physiological sensing and thermal feedback[He et al. 2021].

2 SYSTEM DEVELOPMENT

2.1 Detecting frisson: physiological wristband

Automatic frisson detection is performed using a physiological sensing wristband(see Figure.1.(d)) that measures blood volume pulse and electrodermal activity. The device is based on ESP32 MCU and uses WiFi to stream the data. Heart activity is measured using a reflection-based optic plethysmograph. Electrodermal activity is the change of skin conductance measured with a Wheatstone bridge and a differential ADC. The heart rate variability and electrodermal activity-related features are extracted and are used by a support vector machine classifier. The frisson classification model was trained in a series of pre-studies with 32 participants, approx. 20 min of data from each. On the training set, the model accuracy was 85% with leave-one-out validation. In the final design, the classifier is evoked every 10 seconds for each participant and operates with variable sliding window size, usually around 5-10 minutes of data.

2.2 Triggering frisson: thermal neckband

Based on interoception technology that drives emotion by driving physical sensations[Schoeller et al. 2019], in order to trigger frisson, the thermo-haptic neckband includes two Peltier thermoelectric modules and up to six haptic vibrotactile actuators fixed on a neckband as shown in Fig.2. Each Peltier thermoelectric module is cooled with an exposed to air heatsink. The device is controlled by an ESP32 module and communicates with the software using WiFi. In the event of an activation, each thermal module is turned on for 5 seconds with consecutive 5 seconds of cool-down time, allowing the heatsink to diffuse the accumulated heat, which ensures the constant performance of the thermal actuation. For safety reasons the battery is protected with a 2.5 A PPTC fuse and the board is enclosed.

The neckband is significant to induce frisson($M=.93; p<.00001$) based on the user study.

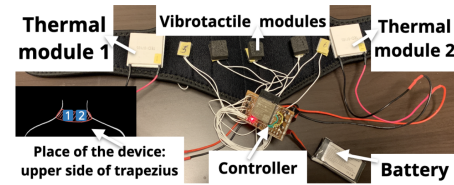


Figure 2: Neckband

2.3 Sharing frisson: network server

The frisson sharing server (see Figure.1.(e)) first processes raw physiological data, extracts certain features related to frisson, and runs the classification. Next, the server activates the neckbands of the people sitting nearby to the spectator whose frisson was detected, thus making them the receivers of the frisson sensation. If the neckband successfully induces frisson, their wristband will then detect it from their physiological response. This will allow the frisson sensation to propagate with each member of the audience both receiving and inducing frisson to other nearby audiences. Therefore, the system technology enables the transmission of frisson in a pattern like a wave or a ripple.

3 USER EXPERIENCE

5 to 25 users can participate simultaneously, where we have each of them put on the devices. We then play different musical scores using headphones for the system to detect, trigger and share their frisson sensation with each other, the experience will last about 10 minutes. If the conference venue allows, we can also schedule a live performance for the audience, and the audience could experience the system, share frisson live.

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