Bio-Collar: A wearable optic-kinetic display for awareness of bio-status

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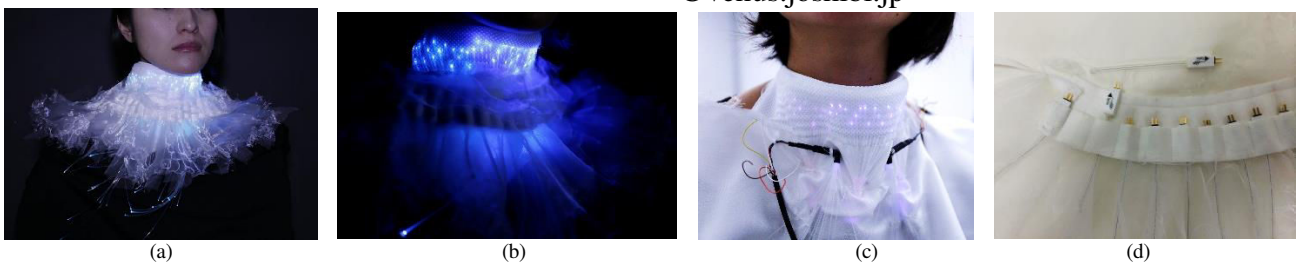

(a) (b) (c) (d)

Figure 1. Bio-Collar: (a) overview, (b) lit-up display, (c) optical display, (d) kinetic display.

ABSTRACT

Advances in sensor technology allow us to wear various sensors that detect bio-signals, such as body posture, body movement, heart rate and respiration rate. Compared with the many options of wearable sensors available, the options of display methods are limited. This paper proposes the Bio-Collar, which is a novel collar-shaped wearable bio-status display. The Bio-Collar indicates the wearer's bio-status through its color and kinetic motion.

Author Keywords

Hairlytop interface; bio feedback; kinetic clothes, wearable.

ACM Classification Keywords

H5.2 [**Information interfaces and presentation**]: User Interfaces – Interaction styles.

INTRODUCTION

Advances in sensor technology have allowed the development of various wearable sensors that can detect bio-signals such as body posture, body movement, heart rate and respiration rate [7]. Wearing such sensors makes it easier to monitor a person's bio-status, and they are thus often used in health care. Despite the variety of sensors available, however, the methods of displaying information are limited.

To display information from wearable sensors, a wearable display that is not limited to visual monitors is needed. Conventionally, visual monitors are often used because they are an appropriate way to indicate sensory information to the wearer of the sensor and others, such as doctors. However, the visual display often draws too much attention to the monitors and is thus not suitable for face-to-face communication. Taking care of one another is a basic feature of interpersonal interaction. In daily life, we are often aware of a person's bio-status on the basis of their complexion and demeanor. In this respect, a bio-status wearable display is needed that allows us to note a person's bio-status in a casual way.

Biophysical data are often assumed as private data that should not be made public. However, opening such data to a certain close group will lead to better communication and appropriate care among members of the group. By displaying and sharing biophysical information among a certain group, members of the group could notice each other's bio-status, allowing the members to provide immediate and appropriate care.

This paper proposes the Bio-Collar, which is a novel collar-shaped wearable bio-status display. The Bio-Collar indicates the wearer's bio-status through its color and kinetic motion. In our previous study, we developed kinetic clothes [6] and a color changing arm cover with optical fibers [1]. Both pieces of clothing respond to bio-signals such as breathing rate or an electromyogram signal. In this study, we focus on motion sickness as a status that could be shared. Previous

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works on motion sickness and simulator sickness [4] suggest that the heart rate and heart period, hypergastric response and skin conductance are sensitive parameters that can be used to detect motion sickness and simulator sickness. As a first step, we construct a Bio-Collar that indicates the heart rate optically and kinetically.

RELATED WORKS

Much research has been conducted on wearable sensors. One major application of the sensors is health monitoring [7]. In this area, visual monitors are often used to display collected information to the wearer or a specialist such as a medical doctor. However, most of the monitors are not intended to share the wearer's bio-status among people in a casual way. In the textile field, there are various clothes embedded with optical display elements [1,3] and with kinetic elements [2,6]. Such technology should have the potential to provide a casual display that shares the bio-status among people.

PROTOTYPE SYSTEM

Figure 1 (a) is an overview of the prototype system. Figure 1 (b) shows that the color of the Bio-Collar changes and the bottom of the Bio-Collar moves according to the wearer's heart rate. This Bio-Collar consists of an optical display (Figure 1 (c)) and a kinetic display (Figure 1 (d)) that indicate the wearer's heart rate. Figure 2 left shows that the top and bottom of the Bio-Collar light up according to the sensory information. Meanwhile, the bottom of the Bio-Collar moves according to the same information (Figure 3, right).

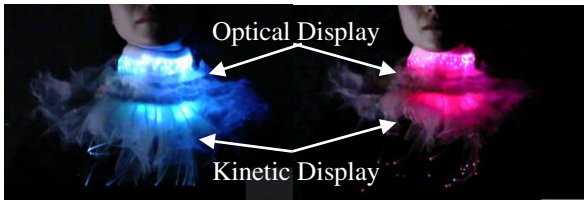

Figure 2. Left: Slow heart rate mode (60 bpm), Right: Rapid heart rate mode (140 bpm).

Sensors

The system uses a pulse sensor (SEN-11574, SparkFun Electronics, CO, USA) to detect the wearer's heart rate. The data are transmitted to a personal computer via Arduino Duemilanove hardware through a serial interface.

Kinetic display

For the actuator of the kinetic display, we use Smart Hair (Symphodia Phil Inc.), which is the commercialized version of the Hairlytop Interface [5]. Smart Hair is an actuator composed of shape memory alloy and bends according to its temperature. Each Smart Hair is lightweight and produces no sound as it moves. These characteristics are suitable for use in various textiles. In the display part of the Bio-Collar, we used 19 Smart Hairs to move the bottom of the collar. All Smart Hairs move simultaneously with a certain period, according to the measured heart rate (2056 ms @ 60 bpm–904 ms @ 140 bpm).

Optical display part

The color of the Bio-Collar can be changed using full-color LEDs and side-emitting optical fibers (PF-1.0S,ϕ1.0 mm, Saiden Corp.). The color of the LEDs is controlled from blue to red according to the wearer's heart rate by using Arduino UNO, Maxuino and Max/MSP6 (Figure 3.)

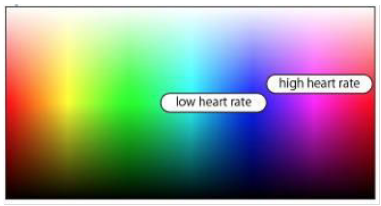

Figure 3. The correspondence between heart rate and the color of the LED.

CONCLUSION

This paper proposed the Bio-Collar, which can display the wearer's biological information optically and kinetically. In future work, we will integrate additional sensors such as breathing sensors and skin conductance sensors to detect the wearer's status related to motion and simulator sickness [4]. This integration is also aimed to detect the wearer's status in specific relation to space sickness. Space travel will be common in the future. Wearing such sensor systems should help many numbers of future space travelers who suffers from space sickness.

REFERENCES

1. Cochrane, C., Meunier, L., Kell, F.M., and Koncar, V. Flexible displays for smart clothing: Part I-overview. Indian Journal of Fibre and Textile Research, 36, (2011), 422–428.
2. Coelho, M. and Maes, P. Sprout I/O: A Texturally Rich Interface. International conference on Tangible and embedded interaction (TEI), (2008), 221–222.
3. Kanebako, J., Oishi, H., Ishigami, L., and Uchiyama, H. myo-skin: Clothing which makes myogenic potential visible. In Proc. of the SIGGRAPH Asia Emerging Technologies, ACM Press (2013), Article No.12.
4. Miller, J.C., Sharkey, T.J., Graham, G.A., and McCauley, M.E. Autonomic Physiological Data Associated with Simulator Discomfort. (1993), NASA-CR-177609.
5. Nojima, T., Ooide, Y., and Kawaguchi, H. Hairlytop interface: An interactive surface display comprised of hair-like soft actuators. World Haptics Conference (WHC), (2013), 431–435.
6. Ohkubo, M., Nojima, T., Yamamura, M. and Uchiyama, H. Breathing Clothes: Artworks with the Hairlytop Interface. In Proc. ACE2014, ACM Press (2014).
7. Pantelopoulos, A. and Bourbakis, N.G. A Survey on Wearable Sensor-Based Systems for Health Monitoring and Prognosis. IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews) 40, 1 (2010), 1–12.