
Pygmy: A Ring-like Anthropomorphic Device That Animates The Human Hand

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Figure 1. Pygmy worn on the hand

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Abstract

Pygmy is an anthropomorphic device that magnifies finger expressions. It is based on the concept of hand anthropomorphism and it uses finger movements to create the anthropomorphic effect. Wearing the device is similar to having eyes and a mouth on the hand; the wearer's hand spontaneously expresses their emotions. Interactive manipulation by controllers and sensors make the hand look animated.

Keywords

Wearable Robot; Finger Expression; Ubiquitous Computing; Anthropomorphism;

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design, Performance

Introduction

In human history, hands have not only expressed emotion with their gestures, but also have been used in performance, communication and art [1,2]. Shadow puppetry, sign language [3] and hand paintings [4] prove that human hands are highly expressive. This

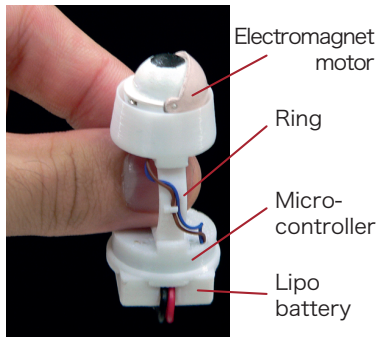


Figure 2. Device detail

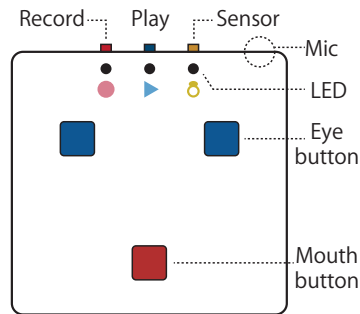


Figure 3. Controller

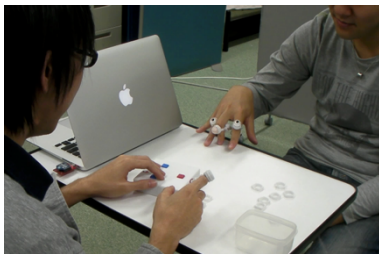


Figure 4. Usability study

could be because of their flexibility and reflexivity. This high flexibility of the human hand can be attributed to the fact that it has many joints. Reflexibility refers to the ability of the hand to reflect a human's intentions and to easily operate interface devices such as keyboards and touchpads. We invented Pygmy to function as an easy-to-wear device for performances, communication, and storytelling. It is a ring-like anthropomorphic device that complements hand gestures. Pygmy is a ring embedded with parts of the face such as the eyes and the mouth. We can generate various facial expressions by configuring devices worn on the fingers.

Related Work

Research pertaining to wearable robots, interfaces the use of hand metaphors, and anthropomorphization have much in common. To begin with, in wearable robots, there are some agent and avatar robots. These include (a) the accessory-type robot [5], which is worn as a necklace and (b) the shoulder-mounted robot known as Telecommunicator [6]. These robots have a body and help reduce the physical distance involved in human-robot interaction. Pygmy is robotic, but it directly collaborates with the human body by exploiting human expressions and flexibility in a novel manner.

Hand expressions are attractive because of their use in the entertainment industry. They also provide intuitive input methods for robot and computer graphics (CG) characters. Whadget [7] makes it possible for users to control CG character motion on a tabletop computer by using only two fingers. This is achieved by mimicking bipedal walking. Walky [8] is a robot that can walk and play soccer based on instructions given to it from a touchpad mobile device. Trials are being conducted for

anthropomorphizing day-to-day objects. DisplayRobot [9] is an attachable robotic device with minimal facial features. It works as an agent describing the object to which it is attached. Nikodama [10] is also an anthropomorphizing object; it has only two eyes. However, Pygmy focuses on enhancing body performance by attaching devices on the human body.

Design

We have designed Pygmy in the shape of a ring to make it a standalone device. Our design policy is given below.

- **Flexibility.** Each finger remains in contact with the device when it is worn. We designed the structure so that it does not interfere with up-and-down finger movements. In addition, because the finger size is different in each person, we designed the ring so that it can be removed for size adjustments.
- **Scalability.** To diversify the pattern, the arrangement can be changed freely according to the finger posture. The device can be added dynamically by the user. It can be extended using Bluetooth modules for wireless communication.
- **Human likeness.** The eyes and mouth were chosen as the minimal parts forming the human face. Although we also considered the design of a realistic eyeball and a mouth, these features were only painted on the device to avoid giving it a weird appearance. The eyelids of the eye module were painted in light orange; the eyeballs were painted in two colors, black and white. The mouth was also painted in light orange, and the inside was red.
- **Safety.** We needed to design the device so that it could be used by children also. Because of the need to attach it to the body, we ensured that the



Figure 5. Collaboration and trial for making facial expressions

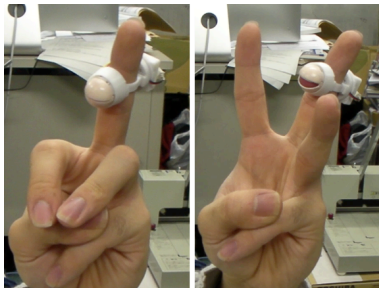


Figure 6. Human expressions

microcontroller board and the battery were fixed inside a plastic case. The motor portion was connected with a vinyl lead so that it could not be touched, and it could not fall out of the device.

- **Responsiveness.** This is an important factor for interactions. The device guarantees fast response.

Technical Implementation

Miniature Implementation

Miniaturization was indispensable in designing Pygmy. The ring device consists of face parts using a motor, microcontroller, and battery made from polycarbonate. A motor driver IC on the circuit board controls the motor in pulse-width modulation (PWM). The face parts can be moved at a great speed. We designed a circuit board to embed the small motor and battery within the device. The device is controlled by Bluetooth (Fig. 2).

Interaction

We developed a ring-like sensor containing an accelerometer so that its movements could be passed to the open level of the eye ring. In the same way, the microphone passes its volume level to the mouth ring. The user can control face parts by moving the finger with the accelerometer or by talking to it. We prepared one more controller for intuitive operations, which contained buttons that resembled the eyes and a mouth (Fig. 3). Three buttons were arranged at the top of the controller for functions such as record, play, and input sensor change. By changing the input, it is possible to select operations (from the controller) and input (from the sensor).

Usability Study

In order to evaluate the device, we observed spontaneous interactions between users. The subjects

were acquainted in two-person pairs. Each subject had majored in computer science; we investigated ten persons. Instructions were provided by controllers and sensors, and the motions were recorded. At the end of the experiment, the subjects completed a questionnaire. They were also interviewed about their experience with the device (Fig. 4).

Character generation

Users enjoyed making faces and characters using their hands. We found that users could generate several expressions by attaching the device on the palm and the back of the hand. For example, they showed a face looking down by bending their whole hand forward. To show an angry or a troubled face, the degree of the eyelid was changed by turning the fingers wearing the face parts (Fig. 5). Some users changed the arrangement of the face parts freely to display a human face or an animal. By interviewing the subjects, we were able to list the different kinds of gestures observed in the usability study (Fig. 7). For one gesture, only the index finger was equipped with the mouth ring; the rest of the expressions were provided by the other fingers that were not wearing any rings (Fig. 6).

Collaboration

It was observed that users used facial expressions to query one another when they gestured in cooperation (Fig. 5). When controlling face parts on the other person's fingers, users coordinated the timing of pushing the button with the motion of the other person's fingers. The users were also instructed to speak along with the operation; we watched the users talk to other persons while controlling the device of that person.



Figure 7. Different gestures for animals: a face, an elephant, a bird, a crab, a fox, a butterfly, an octopus, and a giraffe

User experience

The users evaluated the experience positively based on factors such as: availability of arranging face parts; ease of expressing a wink and surprise; ability to communicate in ways other than a conversation; making various facial expressions using a combination of devices; minimal changes in arrangement; and a feeling that the face is one's own hand. The negative feedback was based on a number of factors such as: difficulty in making characters because of few previous experiences of displaying expressions using hands; inability to imagine a performing character; and boredom created because of the monotonous motion.

Discussion

It is clear that a user's imagination is crucial to exploit hand expressions. Certain users could not create certain forms without instructions because their understanding and methodology was different. However, user trials, which included different finger positions, helped achieve various types of expressions. Certain specific emotions seemed impossible to express because of the size limitation in embedding one more motor. Therefore, it is also important to design systems and devices that can incorporate results from user trials.

Conclusion

By using a ring-like anthropomorphic device that enhances hand expressions by incorporating posture and motion, it was possible to produce a character, a facial expression, an emotion, and the sense of an animal. In the usability study, the users understood the concept of hand anthropomorphism and performed with the device; they were able to converse while using the

device. We also found that the user could resolve device limitations by collaboration.

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