Whispering Bubbles: Exploring Anthropomorphism through Shape-Changing Interfaces

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ABSTRACT
In anthropomorphic design, there has been increasing interests in using kinetic motion and shape changing of the physical objects as a medium to communicate with people. In this paper, we introduce an interactive installation named Whispering Bubbles to explore anthropomorphism through shape-changing interfaces embedded in a physical space. It aims to provide a poetic place for people to whisper with the organically shaped objects (bubbles), to help people release mental stress in their modern lives. When a person approaches bubbles within a given distance, slight up-and-down movements of the bubbles will be activated by infrared sensors embedded in the space; when a person stands nearby a bubble and whispers to it, the bubble will "hear" with its sound detector and be triggered to bend towards the person, indicating engagement in listening. A scale model is implemented to explore and demonstrate interactions.

Author Keywords
Anthropomorphism; shape changing; kinetic design

ACM Classification Keywords
H.5.2. Information interfaces and presentation: User Interface.

INTRODUCTION
Anthropomorphism describes the tendency to imbue the real or imagined behavior of nonhuman objects with humanlike characteristics, motivations, intentions, or emotions [1]. "Anthropomorphism" originates from the Greek "*anthropos*" for "human" and "*morphe*" for "shape" or "form" [2]. In the field of Human-Robot Interaction (HRI), one approach to enhance people's acceptance of the robots is the attempt to increase a robot's familiarity by using anthropomorphic (humanlike) design and "human social" characteristics [3]. In the design of socially interactive object, anthropomorphism can be reflected in the object's form, behavior (e.g. motion), and interaction (e.g. modality) [3]. It uses anthropomorphism to increase the acceptance of the socially interactive object and facilitate the interaction. People tend to respond more positively to an object that displayed humanlike behavioral characteristics (emotions, facial expression) in contrast to a purely functional design [4][5][6][7].

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The phenomenon of ascribing intentions and animacy to simple shapes based on motion has been intensively studied in (developmental) psychology [8]. In the field of Human-Computer Interaction (HCI), there has been increasing interests in using shape changing of physical objects as a medium to communicate with people. Parkes et al. addressed it is the innate ability for people to be engaged by the lifelike qualities of motion, allowing them to employ the movement of objects as a tool for communication and engagement, and allowing inanimate objects to become partners in people's interactions [9]. The inanimate objects could become "alive" if they have organic and life-like movements. This approach is commonly used for engendering emotion. Togler et al. proposed a novel type of home appliance: a thrifty water faucet. Through a servo motor construction, it was enabled to move and behave in life-like manners by continuous and small movements. These movements enriched the impression of a living object stepping into a dialogue with the user [10]. Seoktae Kim et al. also designed the Inflatable Mouse that was a volume-adjustable user interface. It simulated breathing to "express the motion of taking a nap when it is not in use." [11]. Attributing familiar humanlike qualities to a less familiar non-humanlike object can serve to make the object more familiar, explainable, or predictable[1].

In this paper, we present an interactive installation named Whispering Bubbles to explore anthropomorphism by merging shape-changing technology, which is widely used in HCI field. It aims to provide a poetic place for people to whisper with organically-shaped objects (bubbles), to help people release their mental stress in the modern lives. The kinetic interactions of the bubble (e.g. breathing and bending postures) are designed to be mimetic of a living organism, aiming provoking emotional responses.

PERSONA & SCENARIOS
Persona and scenarios were developed at early stages of the concept design. Instead of considering human behavior and experience through formal analysis and modeling of well-specified tasks, scenario-based design is a relatively lightweight method for envisioning future use possibilities

[12]. Here we identify two typical scenarios of Whispering Bubbles in our design:

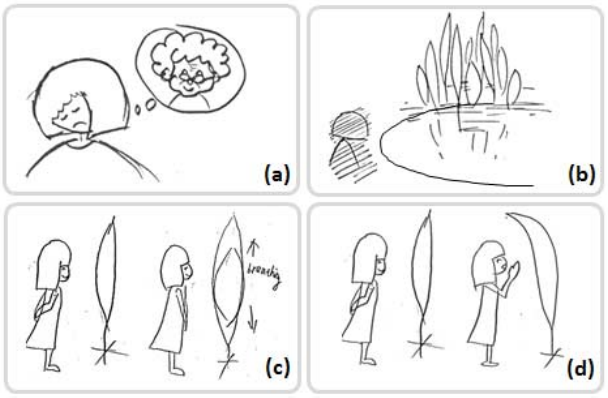

Figure 1.Sketches of the scenarios (sketches provided by Yangzi Li).

Persona

Emily is a student who continues her master study abroad. Being fresh to a new place, she feels lonely and often misses her hometown, especially her grandma who accompanied with her in her childhood. Sometimes, she dreams of talking to her grandma and sharing all her unhappiness. Her grandma is a good listener, who is helpful in releasing her pressure and making her feel better (Figure 1 (a)).

Scenario 1: Up-and-Down Movements

One day, she walks to a repulse bay and many translucent bubbles are located there. She is attracted by their elegant appearances. She walks towards them (Figure 1 (b)). When she is approaching, one cluster of bubbles softly moves up and down. The shape changing of the bubbles looks like "breathing". In her eyes, they are no longer inanimate bubbles and they become "alive" now. When she passes by, the bubbles move up and down one after the other to send "greetings" to her (Figure 1 (c)).

As illustrated in this scenario, when a person approaches bubbles within a given distance, slightly up-and-down movements of bubbles will be activated by infrared sensors embedded in the physical environment.

Scenario 2: the Bending Posture

Emily walks along with the path and after a while she stops walking and stands near a bubble. She cannot help murmuring: "I feel so tired now and I could not handle all the things well …" At that time, the nearby bubble gently bends to her as a posture for offering comfort (Figure 1 (d)). "Thank you, bubble. You seem willing to listen to me, which reminds me of my grandma. She always has patience to listen to me when I feel sad." She says.

In this scenario, when a person stands nearby a bubble and whispers to it, the bubble will "hear" by its sound detector and be triggered to bend to the person, which indicates engagement in listening. The bending posture of the bubble also creates close and private space for the person to whisper.

WHISPERING BUBBLES SYSTEM

We design our Whispering Bubbles system from two aspects: 1) kinetic and shape-changing design; 2) circuit and system design.

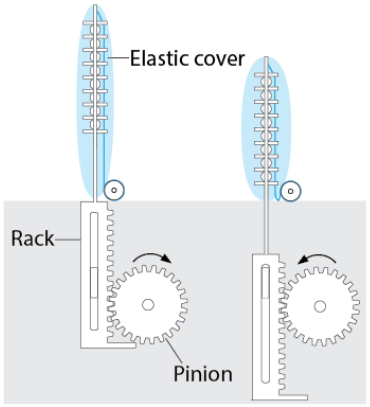

Figure 2.Mechanism of the up-and-down movement.

Kinetic and Shape-Changing Design

In the kinetic design, bubbles have two primary postures as described in the scenarios: up-and-down movements and the bending posture. To enable the bubble to move up and down, a rack-and-pinion system is proposed as the working mechanism. It is made of a pair of gears that can convert rotary motion to linear motion. As shown in Figure 2, the pinion is driven by a servo motor to rotate clockwise or counterclockwise. It drives the nearby rack to move up or down correspondingly. A thin rod follows the rack to go up and down to trigger the shape change of the elastic cover outside.

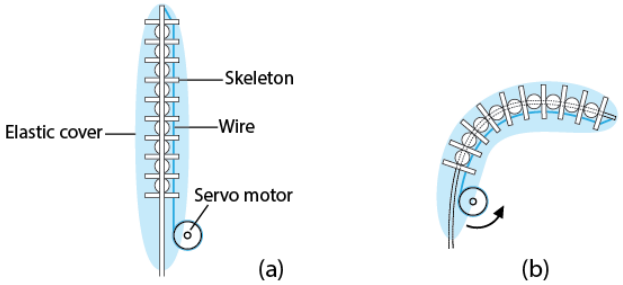

Figure 3.Mechanism of the bending posture.

A bending skeleton consists of plastic rings, plastic beads and a thin elastic rod. The thin elastic rod passes through rings and beads and both of them are arranged at intervals. They are used to guide a wire that, when exerted a force on, bend the skeleton (Figure 3). Allocating the force by many hinges achieves an organic bending movement. When the wire is pulled by the servo motor, it causes the skeleton with the elastic cover to bend towards that direction.

System Design

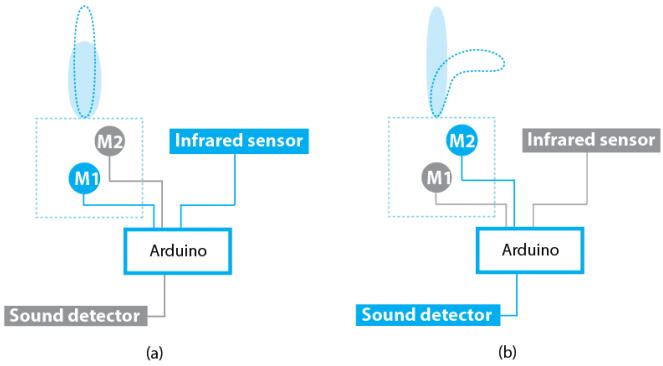

Figure 4.The system overview of the bubble.

Each of the bubbles is controlled by an Arduino microcontroller connected with a sound detector and an infrared sensor (Figure 4). The distance that the infrared sensor can detect is up to 80cm.The detection distance between the human and the bubble is adjustable as long as it is within the range of 10 cm to 80 cm. The sound detector is used to detect presence of voice coming from the human. This sensor will convert sound into analog voltage. It is possible to read the amplitude of sound coming from the human's voice by programming the Arduino to convert the analog voltage into digital representation. Based on this reading, the Arduino will compare and make sure that it is the amplitude of sound coming from the human and not from the surroundings.

As the human passes by one of the bubble, the infrared sensor will detect his/her presence and it will give signal to Arduino. Arduino will send a message to Motor 1 (M1) that triggers the bubble to move up and down as the indication that the bubble acknowledges the human is passing by (Figure 4 (a)). If the human approaches the bubble and starts to communicate verbally to the bubble, the sound detector will detect the voice and transmit the signal to Arduino so that it can process the signal (based on the amplitude of the sound) and control Motor 2 (M2) that drives bubble to bend towards the human (Figure 4 (b)).

SCALE MODEL

An interactive scaled model was exhibited at Hong Kong Polytechnic University with the dimensions of approximately 800 mm x 1000 mm x 500 mm (Figure 5). The mechanic parts were fabricated of acrylic sheets with 2 mm thick (Figure 6). Adobe Illustrator and a laser cutter were used to design and fabricate gears and supporting parts. We used a white net fabric tube with high elasticity to make the physical appearance of the bubble. This particular material could make a big shape change when it was stretched.

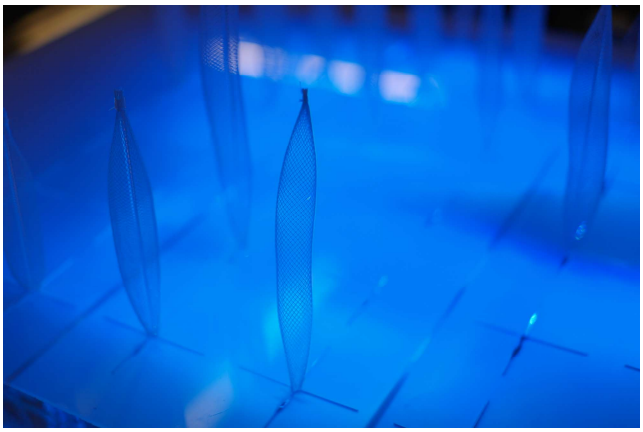

Figure 5.The scale model of Whispering Bubbles.

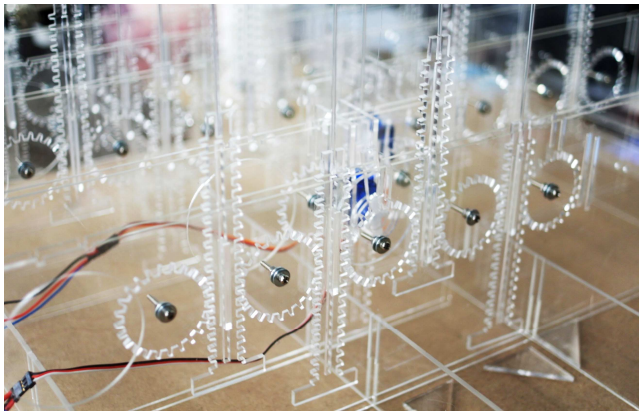

Figure 6.The mechanic parts of the scale model were fabricated with acrylic sheets.

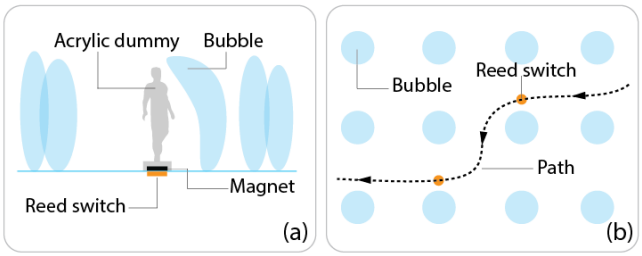

Figure 7.An example of the acrylic dummy interacted with the bubble in the scale model.

The scale model consisted of five servo motors, five reed switches, one Arduino Mega 2560 development board and one LED strip. We used reed switches as a replacement for infrared sensors and sound detectors in the scale model. The reed switch is operated by applying magnetic field. When a magnet is near to the reed switch, it will be actuated. An acrylic dummy with the magnet was used to interact with the bubble in the scale model (Figure 7 (a)). A path was embedded three reed switches (Figure 7(b)). When the dummy was moving along the path approaching one of the reed switches, it was actuated to trigger the nearby servo motor to cause bubble to change its shape. The LED strip was located on the bottom of the scale model to display different colors of light. The LED lights through the

transparent acrylic materials created a dreamlike atmosphere of the Whispering Bubbles.

CONCLUSION

A growing number of the research has been carried out to investigate the human-shaped objects and objects using humanlike behavior in the interaction with people. In this paper, we presented the concept of Whispering Bubbles: an interactive installation to explore anthropomorphism through shape-changing interfaces in the environment. It aims to provide a poetic place for people to whisper to the organically shaped objects. We also emphasized the aesthetic feeling of material and lighting in prototyping to provide a better user experience. The scale model was implemented and exhibited at Hong Kong Polytechnic University. In our future work, we will implement the full-size installation of Whispering Bubbles. After that, we will plan a user experiment to measure the user experience when the people interact with Whispering Bubbles.

VIDEO

The link to the Whispering Bubbles video:
https://vimeo.com/142078880

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