PINOKY: A Ring That Animates Your Plush Toys

Yuta Sugiura, Calista Lee, Anusha Withana, Yasutoshi Makino, Daisuke Sakamoto, Masahiko Inami, and Takeo Igarashi
Keio University, The University of Tokyo, and JST ERATO IGARASHI Design Interface Project

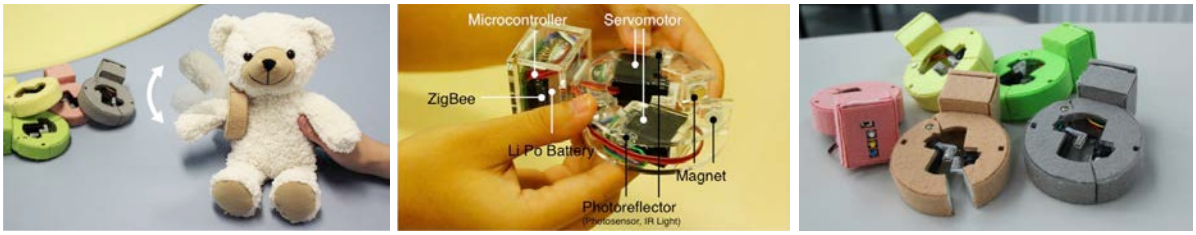

Figure 1. *Left: PINOKY attached to right arm of a plush toy, Center: Hardware components, Right: Overview of ring.*

1. Introduction

PINOKY is a wireless ring-like device that can be externally attached to any plush toy as an accessory that animates the toy, such as by moving its limbs. A user is thus able to instantly convert any plush toy into a soft robot. The user can control the toy remotely or input the movement desired by moving the plush toy and having the data recorded and played back. Unlike other methods for animating plush toys, PINOKY is non-intrusive, so alterations to the toy are not required.

2. The PINOKY System

The PINOKY system (Figure 2) consists of a microcontroller (Arduino Pro Mini), a pair of DC servomotors, a pair of photoreflectors (photosensor, IR LED), a wireless module (XBee Series 1), and a Li-Po battery. Each servomotor is in contact with the surface of the plush toy through an arm, and causes the area in contact to bend by pushing on the covering. The photoreflectors are used to measure the angle at which the joint is bent. A pair of strong magnets holds PINOKY in position, enabling the user to attach and remove it without using special tools. The user is also able to synchronize the motors of multiple PINOKYs using ZigBee communication. The case is made of laser-cut acrylic and covered with felt to give it a look and feel similar to that of a plush toy (Figure 1 center).

Actuation. The ring-type actuator we developed can be attached and removed from any plush toy. Our prototype actuator creates joint movement using two servomotors. Each is fitted with an arm that displaces the surface of the toy. The joint is bent by pushing on the cover (Figure 2). By changing the servomotor speed and rotation angle, we can dynamically control the speed and joint angle of the plush toy. The arms are positioned so that they do not extend beyond the device. For an 8.5 cm plush toy limb, the joint angle range is $-50° < \theta < 50°$.

Sensing. To measure the joint angle, we use a pair of photoreflectors, which are generally used to measure the distance to objects. As shown in Figure 4, they are embedded in the device at either end of the ring, and measure the distance to the surface of the toy. When the joint bends, one of the sensors becomes closer to the surface. We conducted an experiment to investigate the relationship between the change in the joint angle and the photoreflective properties of the sensors (Figure 3). The limb length was 8.5 cm, and the limb was bent from −50 degrees to 50° by hand at intervals of 2°. The results are shown in Figure 3; the red line shows the photovoltaic voltage when a hand was covering the sensor. As shown in the figure, the range of joint angle that the system can measure is $\theta < -31.2°$, $34.2° < \theta$.

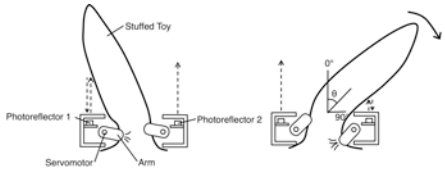

Figure 2. *Actuation principle: a pair of DC servomotors push on the toy's cover; two photoreflectors sense joint angle θ by measuring the distance between the sensor and the cover.*

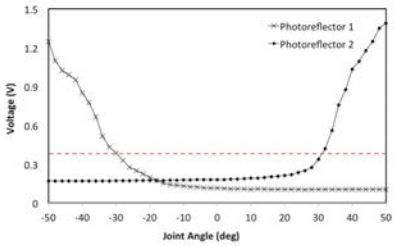

Figure 3. *Measurable joint angle range.*

Communication. A wireless communication device (ZigBee) is embedded in PINOKY. It is energy efficient and has a self-organization network function. The ZigBee module is able to communicate not only with PCs but also with other ZigBee modules directly without using a server on a PC. In this research, it was used as a standalone module without PC support. However, the device is also designed to support other configurations. The use of ZigBee enables the number of devices to be flexibly increased.

3. Basic Interaction

We created two basic interaction modes for PINOKY on the basis of those of Topobo [1]. The user can switch between them by pushing one of the three colored buttons on the side of the device (see Figure 1 center).

Record and play mode. In record and play mode, the user can record the desired behavior by directly moving the joint to which the device is attached. The microcontroller memory is sufficient to record behavior for up to 1 minute. The plush toy can then execute the recorded movements.

Synchronize mode. Through the ZigBee network, multiple PINOKYs can be synchronized with each other.

References

RAFFLE, H., PARKES, A. AND ISHII, H. Topobo: A Constructive Assembly System with Kinetic Memory, In *Proc. CHI '04*, ACM (2004), pp. 869–877.