Touch at a distance: Simple perception aid device with user's explorer action

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Touch at a Distance: Simple Perception Aid Device with User's Explorer Action

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Abstract

Although we obtain a lot of information in our environment via the visual modality, we also obtain rich information via the non-visual modality. In the mechanism how we perceive our environment, we use not only the sensor information, but also "how it changes according to how we act." For example, we obtain the haptic information from the haptic sensor on our finger, and when we move our finger along to the surface of the touching object, the haptic information changes according to the finger motion, and we "perceive" the whole shape of the object by executing the action-and-sensing process. In other words, we have a high ability to "integrate" the relation of our body's action and its related sensing data, so as to improve the accuracy of sensor in our body.

Based on this idea, we developed a simple perception aid device with user's explorer action, to perceive the object at a distance, which has a linked range sensor and haptic actuator, which we name "FutureBody-Finger." The distance sensor measures the distance to the object (20-80[cm]), and it is converted to the angle of lever attached at the servo motor (0-60[deg]). The user holds this device in his hand with attaching his index finger on the device's lever. For the long distance to the object, the lever leans to the front, and the user feels nothing. On the other hand, for the short distance to the object, the lever stands vertically, and the user feels the existence of the object. Although the device simply measures the distance to the single point on the object, as the user "explorers" around him, the user can obtain more rich distance information of the surrounding object, and hence, finally perceive the shape of the whole object.

CR Categories: H.5.2 [User Interfaces]: Haptic I/O— [I.3.6]: Methodology and Techniques—Interaction techniques

Keywords:

Perception Aid Device, Explore Action, Distance Sensor, Lever Actuator

1 Introduction

Although we obtain a lot of information in our environment via the visual modality, we also obtain rich information via the non-visual modality. In the mechanism how we perceive our environment, we use not only the sensor information, but also "how it changes according to how we act." For example, we obtain the haptic information from the haptic sensor on our finger, and when we move our finger along to the surface of the touching object, the haptic information changes according to the finger motion, and we "perceive" the whole shape of the object by executing the action-and-sensing process. In other words, we have a high ability to "integrate" the relation of our body's action and its related sensing data, so as to improve the accuracy of sensor in our body.

Based on the idea described above, we developed a simple perception aid device with user's explorer action, to perceive the object at a distance, which has a linked range sensor and haptic actuator. [Okamoto et al. 2011]

2 Related Works

There are a lot of works on the device that assist the user to find the obstacles with nonvisual modality; most of them are to assist the visually impaired person to walk, so called electronic travel aids (ETA)[B.B.Blasch et al. 1997]. ETAs have incorporated functions that obtain information on orientation. For example, ETA sensors determine a user's location, the direction in which the user moves, and the distance of nearby objects.

ETAs are categorised into two types based on their output modality: auditory and haptic. Devices of the former type transform spatial information into audible sound[C.Carter and K.A.Ferrell 1980]. For example, Tri-sensor[L.Kay 1974] and Miniguide[L.Kay 1984] measure distance via ultrasonic waves, convert the data into sound, and convey information on the distances of objects around a user. These devices emit a low-pitched sound when an object is distant from the user and a higher-pitched sound when the object approaches.

Devices of the latter type, which use haptic output[L.A.Johnson and C.M.Higgins 2006], typically convert spatial information into vibration. The intensity and frequency of the vibration are conveyed as information via the user's skin sense. For example, the vibration frequency of such a device increases when a user approaches an object. Users become accommodated to the skin stimulation provided by this type of haptic output because the threshold of vibration sensitivity becomes increasingly high as users are exposed to the same vibration stimulus for increasingly longer times.

Unfortunately, the aforementioned ready-made devices are difficult to handle skillfully. For example, the blind need to develop higher cognitive abilities to comprehend the information conveyed by sound or vibration, i.e., they must interpret the sound and vibration signals by learning to associate a sound of a certain pitch or arbitrary vibration frequency with the distance to an object. Otherwise, they will fail to infer the locations of objects. In this sense, blind children will have difficulty managing these devices because their abilities in higher-order cognitive processing are not fully developed. Furthermore, adventitiously blind persons may have to make greater efforts to use ETAs because they have difficulty in discriminating sound pitch as well as the intensity and frequency of vibration compared with congenitally blind persons.

3 Operation Principles

Based on the previous works on ETA for visually impaired person, we have designed a perception aid device that assists the users to "touch" the object at a distance.

Figure 1 shows the developed perception aid device, a kind of ETA which we name "FutureBody-Finger (F.B.Finger)." The infrared distance sensor (PSD sensor) measures the distance to the object

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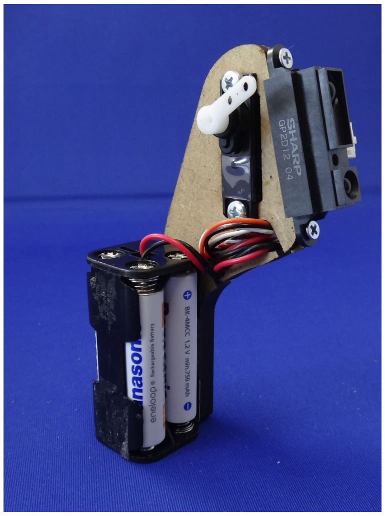

Figure 1: *Developed "F.B.Finger."*

in front of the sensor (20-80[cm]), and it is converted to the angle of lever attached at the servo motor (0-60[deg]). The user holds this device in his hand, and attaches his index finger on the device's lever. For the long distance to the object, the lever leans to the front, and the user feels nothing. On the other hand, for the short distance to the object, the lever stands vertically, and the user feels the existence of the object. (Fig.2)

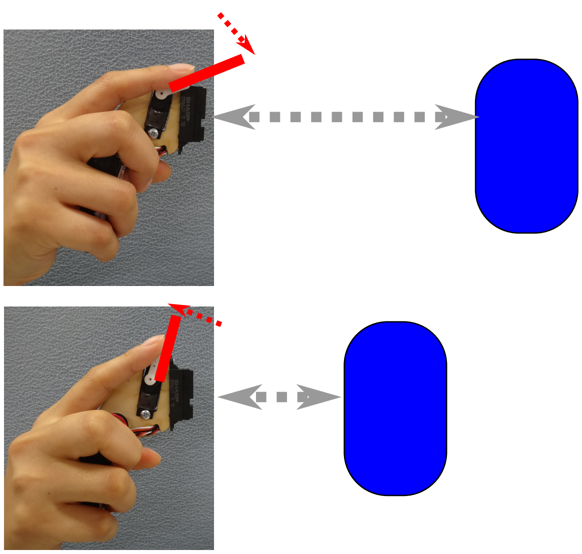

Figure 2: *Basic operation of "F.B.Finger."*

Although the device simply measures the distance to the single point on the object, as the user "explorers" around him, the user can obtain more rich distance information of the surrounding object, and hence, finally perceive the shape of the whole object, as shown in Fig.3.

We confirmed that the user can perceive the distance to the object with using F.B.Finger correctly from the experiments[K.Ito et al. 2012].

Note that the range of measuring the distance to the object can be extended with long-range distance sensor, and the other types of distance sensors can be applied for their characteristics, such as ultrasonic distance sensor, or laser range finder.

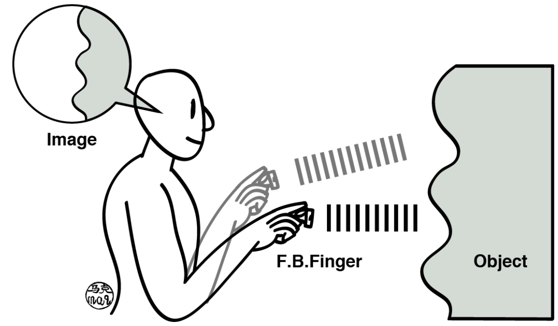

Figure 3: *How the user "perceive" the object with "F.B.Finger."*

4 Applications

Here we show some applications of F.B.Finger, which we will demonstrate at Emerging Technologies..

Figure 4(a) shows the situation that the user are "touching" the object inside the clear box. Since F.B.Finger measures the distance to the object by infrared, the user can "touch" the object beyond the clear wall.

Figure 4(b) shows the situation that the user are "touching" the moving pendulum, which the user will find the cyclic change of the distance to the object.

Figure 4(c) shows the situation that the user are trying to "touch" and perceive the shape of the objects at a distance. From our experiments, the user can perceive the shape of the objects with using the similar perception aid device[R.Mizuno et al. 2008].

5 Conclusions

In this paper, we described the developed simple perception aid device with user's explorer action, to perceive the object at a distance, which has a linked range sensor and haptic actuator, which we name "FutureBody-Finger (F.B.Finger)." Although the device simply measures the distance to the single point on the object, as the user "explorers" around him, the user can obtain more rich distance information of the surrounding object, and hence, finally perceive the shape of the whole object. The user can have the experience to "touch" the objects at a distance with using F.B.Finger.

Acknowledgements

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References

B.B.Blasch, W.R.Wiener, and R.L.Welsh. 1997. *Foundations of Orientation and Mobility*. AFB Press.

C.Carter, and K.A.Ferrell. 1980. The implementation of sonicguide with visually impaired infants and school children. Sensory Aids Corporation.

K.Ito, Y.Fujimoto, J.Akita, R.Otsuki, A.Masatani, T.Komatsu, M.Okamoto, and T.Ono. 2012. Development of the future body-finger: A novel travel aid for the blind. In *Proceedings of 2nd International Conference on Ambient Computing, Applications, Services and Technologies*, 60–63.

L.A.JOHNSON, AND C.M.HIGGINS. 2006. A navigation aid for the blind using tactile-visual sensory substitution. In *Proceedings of Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, vol. 6, 6289–6292.

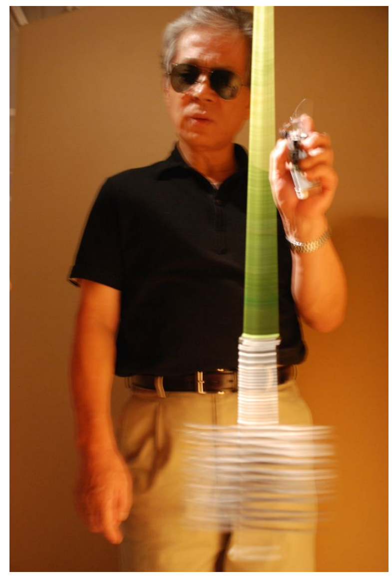
L.KAY. 1974. A sonar aid to enhance spatial perception of the blind: engineering design and evaluation. *Radio and Electronic Engineer 44*, 11, 605–627.

L.KAY. 1984. Acoustic coupling to the ears in binaural sensory aids. *Journal of Visual Impairment & Blindness 78*, 1, 12–16.

OKAMOTO, M., KOMATSU, T., ITO, K., AND ONO, T. 2011. Futurebody: Design of perception using the human body. In *Proceedings of the 2nd Augmented Human International Conference (AH 2011)*, Association for Computing Machinery, article No.a–35.

R.MIZUNO, K.ITO, J.AKITA, T.ONO, T.KOMATSU, AND M.OKAMOTO. 2008. Shape perception using cyarm – active sensing device. In *Proceedings of the 6th International Conference of Cognitive Science (ICCS2008)*, 182–185.

(a)



(b)

(c)

Figure 4: *Example of "F.B.Finger" usage, "touching" (a)a object beyond clear wall, (b)a moving object, (c)objects with various shapes.*