AccelTag: A Passive Smart ID Tag With an Acceleration Sensor for Interactive Applications

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ABSTRACT

There are many everyday situations in which users need to enter their user identification (user ID), such as logging in to computer systems and entering secure offices. In such situations, contactless passive IC cards are convenient because users can input their user ID simply by passing the card over a reader. However, these cards cannot be used for successive interactions. To address this issue, we propose AccelTag, a contactless IC card equipped with an acceleration sensor and a liquid crystal display (LCD). AccelTag utilizes high-function RFID technology so that the acceleration sensor and the LCD can also be driven by a wireless power supply. With its built-in acceleration sensor, AccelTag can acquire its direction and movement when it is waved over the reader. We demonstrate several applications using AccelTag, such as displaying several types of information in the card depending on the user's requirements.

Author Keywords

RFID; High-function RFID; contactless IC card; battery free; gesture.

ACM Classification Keywords

H.5.2. Information Interfaces and Presentation (e.g. HCI): User Interfaces–Input devices and strategy, Interaction styles.

INTRODUCTION

Entering user IDs and passwords when logging in to websites and home entry control systems has become commonplace. In such situations, contactless passive IC cards are often used because they allow for easy identification. The cards transmit and receive ID and other information simply by being passed over a card reader. However, this is the only operation they support, and they cannot be used for other gestural operations, such as swipe and flip. Therefore, passive IC cards cannot be used for successive interaction after identification.

To address this issue, we propose AccelTag, a contactless IC card equipped with an acceleration sensor and a liquid crystal display (LCD). AccelTag uses high-function RFID technology to drive the acceleration sensor and LCD without any battery, enabled by a wireless power supply. With the help of its acceleration sensor, AccelTag supports gestural operations, such as slide and flip operations. In addition, it is possible to recognize the orientation of an AccelTag card, and the card can also be used for successive interactions.

Shu et al. [1] demonstrated individual authentication using the movement of contactless IC cards. NFC-WISP [2] described the wide use of NFC for contactless IC cards and electronic paper and a temperature sensor driven by a wireless power supply.

We developed two applications using AccelTag: an attendance management system that supports gestural input of arriving and leaving and a balance display system that shows the balance and other information on the card depending on gesture.

ACCELTAG

Overview

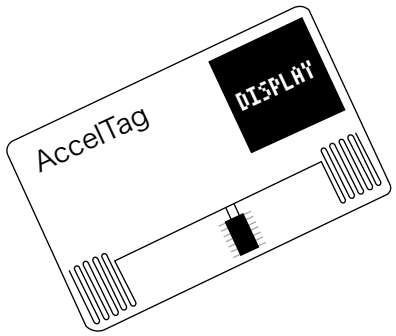

Figure 1. AccelTag. It is a card-like device equipped with an acceleration sensor and LCD.

AccelTag is a card-type RFID tag with an acceleration sensor and an LCD, as shown in Figure 1. AccelTag utilizes high-function RFID technology. Normally the driver IC of RFID is driven by a wireless power supply of radio waves. High-function RFID technology enables the powering of sensors and other microcomputers. With this technology, the acceleration sensor and the LCD mounted in AccelTag do not require a battery because they are driven by RFID radio waves.

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Interaction

With the help of the built-in acceleration sensor, AccelTag can sense its movement when it is passed over a card reader. The current implementation of AccelTag supports two types of gestures over the card reader: *slide* and *flip*. The *slide* operation is a horizontal straight movement of the card over the reader. The direction of the slide operation is also used for interactions. The *flip* operation is a twisting or rotating operation over the card reader. In addition to these operations, static orientations of the card can be used as input vocabulary.

AccelTag has an LCD screen to display text and graphics. It can also be powered simply by being passed over the card reader. Thus, the LCD screen can be utilized during AccelTag's interactions. For example, if AccelTag is used as an employee ID card, the user's face can be displayed on the LCD screen. If the card is a prepaid card, the balance and other information can be displayed on the screen.

PROTOTYPE IMPLEMENTATION

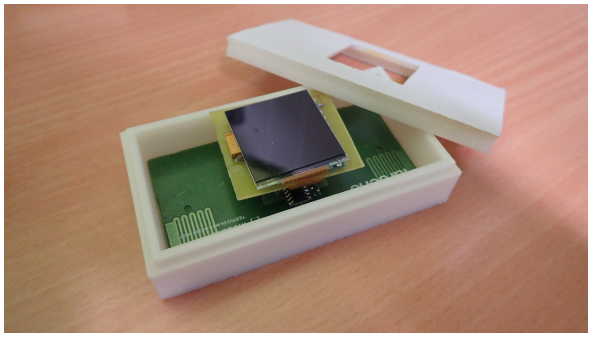

Figure 2. Prototype of AccelTag. The evaluation board of the RFID IC, the acceleration sensor, and the LCD are contained in the case.

We prototyped an AccelTag device, as shown in Figure 2. The RFID used in AccelTag has a frequency band in the UHF range. It is possible for a user to operate AccelTag about 30 cm away from the reader. A reflective memory liquid crystal display is used whose power consumption is extremely low; thus, AccelTag's LCD screen can display information for a maximum of 1 min. Farsens Inc.'s Medusa-M2233 is used for the evaluation board of the RFID IC. The STMicroelectronics Co., Ltd., LIS3DH is used for the acceleration sensor, and Japan Display Inc.'s LPM013M126A is used for the LCD. The LCD is mounted in the center, and the acceleration sensor is mounted on the back side of the LCD.

Figure 3 shows the architecture of the system. When RFID radio waves are received, electric power is generated and drives the RFID IC, the microcomputer, the acceleration sensor, and the LCD. The microcomputer controls the acceleration sensor and the LCD screen via the SPI bus, obtains acceleration values from the acceleration sensor, and transmits the screen content to the LCD.

The reader continuously requests an acceleration value from AccelTag. Upon receiving a request for an acceleration value from the reader, the microcomputer in AccelTag relays the acceleration values (x, y, z axis) to the reader via the RFID IC. The acceleration values received by the reader are then transmitted to a PC or smartphone connected to the reader. An application in the PC or smartphone analyzes and recognizes the values as gestures such as slide and flip.

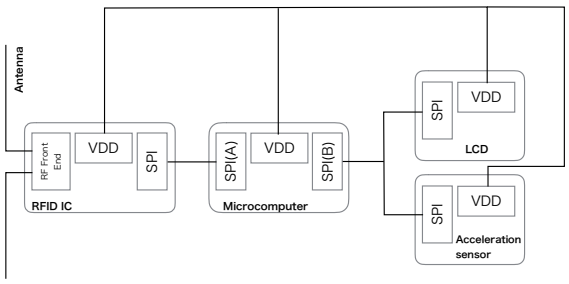

Figure 3. System Configuration. Electric power obtained from the antenna is supplied to the microcomputer, the acceleration sensor, and the LCD. The acceleration sensor and the LCD are controlled by the microcomputer.

APPLICATIONS

Attendance management system

With this system, users can input information on their presence simply by holding and sliding AccelTag over the card reader. First the user holds AccelTag over the reader for a second. Then the user slides it left or right or in other directions. For example, sliding right means "arriving," and sliding left means "leaving work."

ID and balance confirmation

Just recognizing the orientation of the ID card can enrich the interaction space of AccelTag. For example, in this application, the LCD screen shows the ID (name) information of the card when it is held horizontally over the reader. When the card is held vertically, the LCD screen shows its balance.

CONCLUSION AND FUTURE WORK

We have presented AccelTag, a contactless IC card equipped with an acceleration sensor and LCD. AccelTag utilizes high-function RFID technology to drive an acceleration sensor and LCD without a battery. With the help of the acceleration sensor, AccelTag supports gestural interactions such as slide and flip.

In future work, we are planning to develop smaller prototype devices. The current prototype is thicker than standard IC cards. We also plan to design and implement more complex gestures so that AccelTag can be used for more general and useful interactions.

REFERENCES

1. Shu, Y., Chen, J., Jiang, F., Gu, Y., Dai, Z., and He, T. Demo: WISP-based Access Control Combining Electronic and Mechanical Authentication. In *Proceedings of the 9th ACM Conference on Embedded Networked Sensor Systems*, SenSys '11, ACM (New York, NY, USA, 2011), 433–434.
2. Zhao, Y., Smith, J. R., and Sample, A. NFC-WISP: A sensing and computationally enhanced near-field RFID platform. In *2015 IEEE International Conference on RFID (RFID)*, IEEE (New York, NY, USA, 2015), 174–181.