FingerPhone: Smart Interphone Integrated with a Fingerprint Sensor

Maho Oki
Future University Hakodate
116-2, Kamedanakano-cho,
Hakodate, Hokkaido, Japan
okimaho@acm.org

Satoshi Nakamatsu
Future University Hakodate
116-2, Kamedanakano-cho,
Hakodate, Hokkaido, Japan
b1012076@fun.ac.jp

Koji Tsukada
Future University Hakodate
116-2, Kamedanakano-cho,
Hakodate, Hokkaido, Japan
tsuka@acm.org

Kazuhiro Kimura
Future University Hakodate
116-2, Kamedanakano-cho,
Hakodate, Hokkaido, Japan
b1011071@fun.ac.jp

Ubicomp/ISWC'15 Adjunct, September 7-11, 2015, Osaka, Japan.

http://dx.doi.org/10.1145/2800835.2800839

Abstract
The biometrics has become popular especially for electronic authentication and payment methods. However, we think biometrics have possibilities for further applications. We focus on casual applications of biometrics, that is, integration of a fingerprint sensor and a home appliance. In this paper, we propose a smart interphone, "FingerPhone", which integrates a fingerprint sensor with a push button of the interphone. The system can automatically collect fingerprint data when someone uses the interphone. Then, the system can support users to judge whether the visitor is welcome or not.

Author Keywords
Interphone; Fingerprint sensor; IoT;

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
The ID systems like RFID and the biometrics authentication [1] have become rapidly popular especially for access control systems and payment methods of electronic money[1]. Moreover, some

[1] Transport for London, OysterCard: http://www.tfl.gov.uk/fares-and-payments/oyster

research projects have been proposed, which tried to integrate with ID systems and various sensors to archive versatile interaction methods [2][3] . We focus on casual applications of biometrics, that is, integration of a fingerprint sensor and a home appliance.

In this paper, we propose a smart interphone, "FingerPhone", which integrates a fingerprint sensor with a push button of the interphone. The system can automatically collect fingerprint data when someone uses the interphone. Then, the system can support users to judge whether the visitor is welcome or not. Although interphones are equipped in most houses, their basic functions have not been changed for decades; that is, most interphones support only temporal communications using sounds and videos. We also discuss the possibility of future interphones.

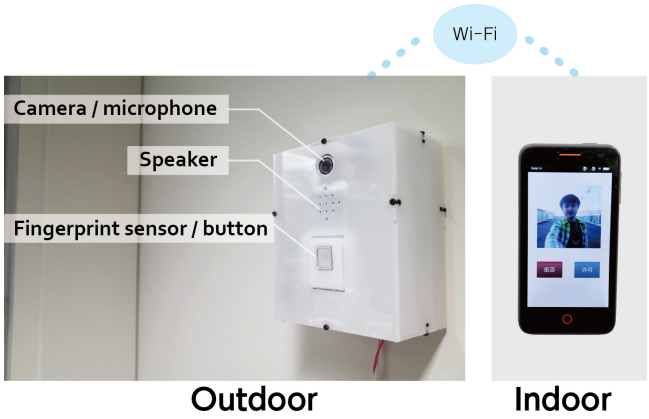

Figure 1: The FingerPhone prototype. Interphone device (left) and indoor device (right).

FingerPhone

The FingerPhone is a smart interphone that integrates a fingerprint sensor with the button of the interphone (Figure 1). The interphone also equips a camera, a mic, and a speaker.

Here, we explain the basic usages of the FingerPhone.

When a visitor pushes the button, he/she unconsciously touches the fingerprint sensor, and the system can automatically collect the fingerprint data along with his/her pictures. Next, when the fingerprint data is not found in the database, the system shows his/her picture on the indoor device (Figure 1 right). Then, a user in the home can easily categorize the visitor as acceptable or not just by touch the button shown in the indoor device. When the visitor comes again, the system changes the behavior depending on the decision of the user. For example, when the “acceptable” visitor (e.g., an acquaintance or postman) pushes the FingerPhone button, the indoor device plays comfortable sound; and the user can quickly open the entrance door to welcome the visitor.

On the other hand, when the “unacceptable” visitor (e.g., salesman) pushes the button, the FingerPhone takes his/her picture and the indoor device plays a uncomfortable chime (e.g., dissonance) , and the user can carefully deal with (or ignore) the visitor.

Since the system can take pictures only when the visitors are categorized as unregisterd or unacceptable, the system helps users avoid troubles with unknown or

unacceptable visitors without invading privacies of acceptable visitors.

Implementation

The FingerPhone prototype mainly consists of the interphone device on the entrance and the indoor device on the room. We explain the implementation of each device.

Interphone Device

The Figure 1 shows the appearance of the interphone prototype. The interphone device mainly consists of a Raspberry Pi, an Arduino Pro Mini, a push switch (MX1A-G1NN), a fingerprint sensor (GT-511C1), a small camera, a speaker, and a microphone (Figure 2). The fingerprint sensor (GT-511C1) equips an internal database for fingerprint data, and matches a new fingerprint with the registered data. The result can be easily obtained using a library written for the Arduino. The Arduino transmits the result of fingerprint recognition to the Raspberry Pi through RS232C. The push switch is connected to the GPIO port of the Raspberry Pi and used for the trigger of fingerprint recognition. The web camera is connected to an USB port of the Raspberry Pi, and used for taking a picture of a visitor. The microphone and the speaker are connected to the audio port of the Raspberry Pi, and used for recording/generating sounds. The Raspberry Pi equips an USB Wi-Fi adapter and can communicate with the indoor device via Wi-Fi network.

We also developed an original case with acrylic boards to store these devices.

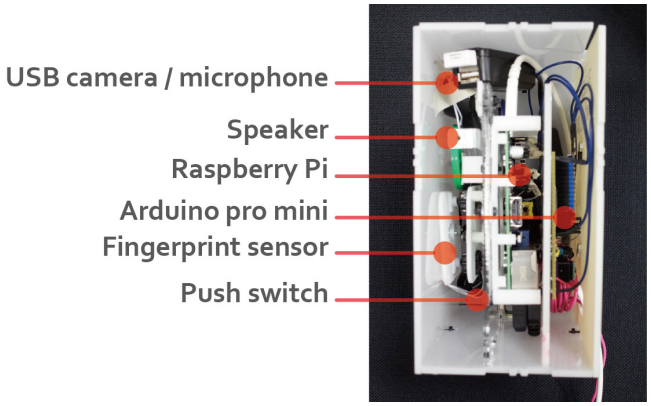

Figure 2: Implementation of the interphone device.

3.2 Indoor Device

We developed the indoor device based on a smartphone in consideration of versatility.

We used a Firefox OS smartphone called “Flame” and developed the software using HTML5. The indoor device provides several functions using a touch display and a speaker: a notification of visitors using chimes and pictures; the categorization of visitors as “acceptable” or not to change the system behavior in the next visit. We show the basic procedures of the system in Figure 3.

Discussion

Here, we discuss three issues related to the FingerPhone: “accuracy of fingerprint recognition”, “automatic categorization of visitors”, and “applications for local community.”

First, the he FingerPhone has only limited time for the fingerprint recognition since the recognition should be

finished before a visitor releases the switch. In the current prototype, although the system can found the registered fingerprint data in such short term, it requires much time to register new fingerprint data. Moreover, there recognition rate sometimes decreases depending on persons. To solve these problems, we plan to apply following methods: (1) applying a high-end fingerprint sensor like "GT-511C3" to reduce errors caused by the slight difference of fingerprint angles; (2) integrating a touch sensor on the frame of the fingerprint sensor like iPhone 5S [1] to start fingerprint recognition/registration more earlier.

Next, we discuss the categorization of visitors. The current categorization is performed manually using the indoor device. Although the manual categorization is not so troublesome since numbers of visitors are often limited, we also explore the possibility of automatic categorization methods using past patterns of visitors.

Finally, we discuss the possibility of a useful application for the local community. The system might share the fingerprint data of unacceptable persons in local community (e.g., a same apartment). When a visitor is categorized as unacceptable by some users in the community, he/she is automatically categorized in the black list of the local community. Of course, we need to also consider the privacy issues; however, we believe such application possibly enhance safety in the local community.

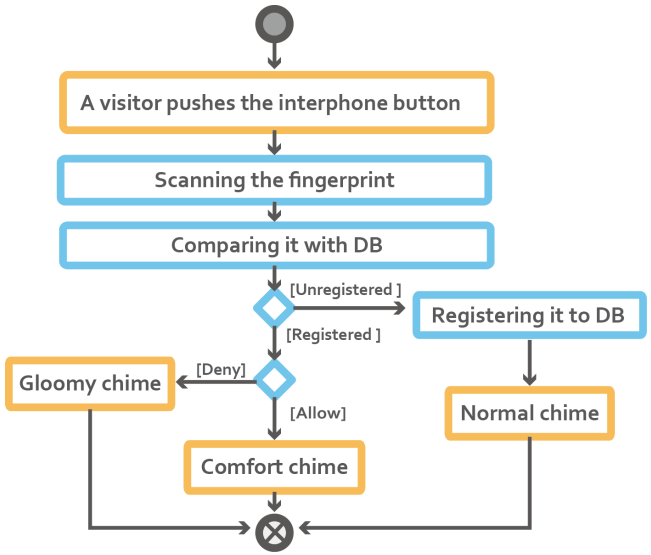

Figure 3: The System flow chart of the FingerPhone.

Acknowledgements

This research was partly supported by CREST, JST.

References

[1] Apple Inc. Touch ID on iPhone and iPad (2015/5/29), https://support.apple.com/en-us/HT201371

[2] Matsushita, N., Tajima, S., Ayatsuka, Y., & Rekimoto, J., Wearable Key: Device for Personalizing nearby Environment, Proceedings of ISWC2000, p. 119 (2000).

[3] Masui, T., Tsukada, K., & Siio, I., MouseField: A Simple and Versatile Input Device for Ubiquitous Computing, Proceedings of UbiComp2004, 319–328 (2004).