LETTER Special Section on Log Data Usage Technology and Office Information Systems

A Method for Smartphone Theft Prevention When the Owner Dozes Off

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SUMMARY We propose a method for preventing smartphone theft when the owner dozes off. The owner of the smartphone wears a wristwatch type device that has an acceleration sensor and a vibration mode. This device detects when the owner dozes off. When the acceleration sensor in the smartphone detects an accident while dozing, the device vibrates. We implemented this function and tested its usefulness.

key words: *smartphone theft prevention method, wristwatch type device, acceleration sensor, dozing detection*

1. Introduction

Wristwatch type devices that have an acceleration sensor and a vibrator mode (hereafter, written as a wristwatch) have become especially common. Life logs can be accumulated by routinely wearing these devices. Moreover, utilizing these life logs can improve safety and access control [1].

Smartphones are increasingly important as tools to access cyberspace and as storage tools for personal data like telephone directories and passwords. Therefore, if the owner loses his or her smartphone, the owner will suffer great damage. This paper proposes a method for preventing smartphone theft when the wristwatch is used.

2. Related Research

2.1 Wearable Computing Environment

An access control mechanism that dynamically changes the control of services according to the user's behavior, position, surrounding environment, etc., was proposed [2]. Here, the user wears a computer that is always running. The security in the wearable environment is as follows. 1) the service does not operate in a situation that the user does not desire, 2) the user does not perform undesired processing, and 3) inappropriate services do not cooperate.

2.2 Continuous Authentication Using Wearable Devices

Continuous authentication that guarantees the authenticity of users continuously was proposed to replace the conventional every-time user authentication [3]. For example, it detects that two devices equipped with both an acceleration sensor and Bluetooth are held by the same person. It is as a base of trust. This method is effective when a user wearing a wristwatch has a smartphone in his or her hand.

2.3 Activity Recognition Using Accelerometers

An activity recognition method using accelerometers had difficulty classifying routine activities such as sitting and standing [4]. Classification became more difficult if the wrist was placed on a horizontal surface like a desk, particularly when using a wristwatch. Therefore, misclassification occurred for activities that had little changes on acceleration, such as dozing off.

2.4 Distinction of Other People Using a Smartphone

An anti-theft method using only a smartphone was proposed [5]. An owner and other people were distinguished using inertial sensing data acquired from the acceleration sensor of a smartphone. However, because the detection time needed 6 seconds on average, a thief might escape before an alert is issued.

2.5 Identifying Users Using Wrist Sensors

Wristwatches were used to identify users in a house [6]. The acceleration of the user‘s wrist was measured, and each user was identified at high accuracy for actions using objects. This shows the usefulness of wristwatches that have acceleration sensors.

2.6 Detection of Detachment of Wristwatch

An experiment of detachment detection of a wristwatch was reported [7]. The differences in acceleration changes of the X, Y, and Z axes are summed over a certain time. Detachment from the arm is detected when the summed value is below the threshold value.

2.7 Sleep Detection Using Wrist Sensors

The wearer's sleep and arousal state were detected using 3D inertia data of wrist sensors [8]. Highly accurate detection was possible because the detection was performed at long time intervals. However, because the time intervals were long, real-time detection of dozing is not suitable for our anti-theft scenario.

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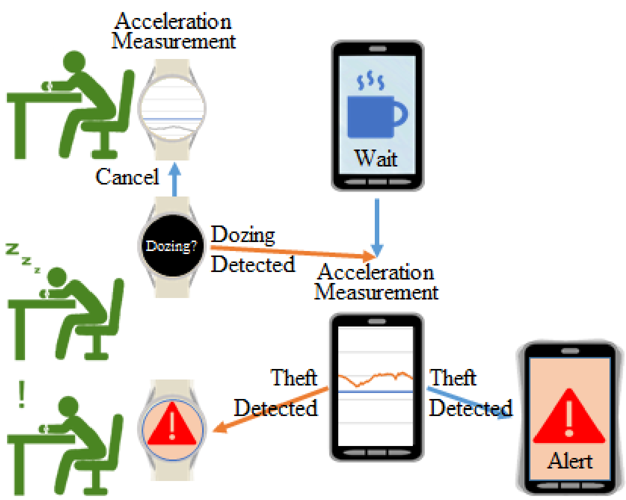

Fig. 1 State transition diagram.

3. System Configuration

We assume the following scene. A smartphone is left on a desk, and the owner dozes off in a classroom. The owner of the smartphone is wearing a wristwatch. The wristwatch detects the owner's dozing and reduces the theft risk of the smartphone. The state transition of the system is shown in Fig. 1. When the wristwatch detects the owner dozing off, the smartphone starts an acceleration measurement. When the acceleration sensor in the smartphone detects an accident, the wristwatch and the smartphone both show alerts and vibrate.

4. Target Issues

The proposed method detects the movement of the smartphone when the owner dozes off. We focused on detection sensitivity and detection time for the evaluation.

4.1 Detection Sensitivity

We used an acceleration sensor to detect dozing and theft. Dozing is detected by the wristwatch and movement is detected by the smartphone as follows. The differences in acceleration changes of the X, Y, and Z axes are summed for a certain time. Dozing is detected when the summed value is below the threshold value. Movement of the smartphone is detected when the summed value is over the threshold value. The detection algorithm is shown in Fig. 2.

The detection sensitivity can be optimized by changing the threshold. In addition, the owner can cancel erroneous detection. Figure 3 shows the cancel screen and the alert screen displayed on the wristwatch.

4.2 Detection Time

The method detects and notices loss just after it happens.

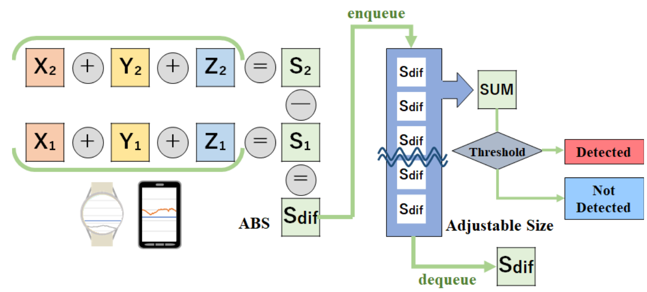

Fig. 2 Detect algorithm.

Fig. 3 Cancel screen and alert screen.

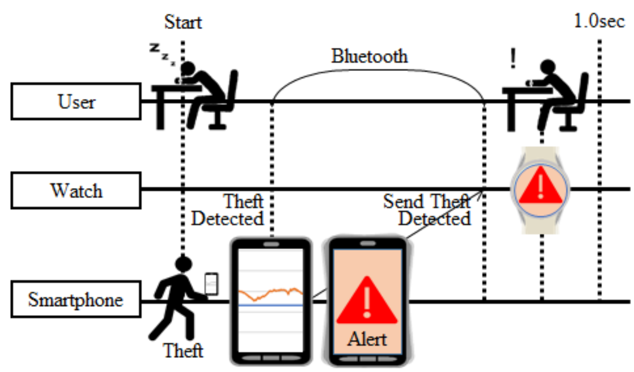

Fig. 4 Detection time.

Therefore, the time from detection to actual theft should be made as short as possible.

We installed the method on the wristwatch ASUS ZenWatch3 (WI503Q) and the smartphone Xperia Z5 (SO-01H). When the wristwatch detects the owner is dozing off, the smartphone starts measuring the acceleration. In this state, we measured the time from the movement of the smartphone to the display of an alert on the wristwatch. We obtained from 498 to 763 ms with 30 measurements. The average was 610 ms.

5. Discussion and Conclusion

We compared our method with related research. In wearable computing environments [2], the method satisfies 1) situation-dependent safety and 2) automatic execution safety. The method does not need to have the smartphone in the owner's hand, different from continuous authentication [3] and distinction of other people [5]. Using acceleration data obtained from wristwatches enables high accuracy for the user identification [6] and the wearer's activity recognition [4]. However, dozing detection is more erroneous than detachment detection [7] and sleep detection [8]. As a solution to that, we implemented a function enabling the owner to cancel erroneous detection.

The novelty of this paper is that the owner can prevent losing his or her smartphone and will not need to search after losing it. We focused on theft that could not be handled with the function of preventing misplacements using Bluetooth radio wave strength.

The usefulness of the outcome is that the method can be optimized by the owner with variable detection sensitivity and detection time. The limit is that erroneous detection occurs when the smartphone is in a pocket or a bag because the method specializes in having a smartphone on the desk of a classroom. Further study is needed for automation to optimize the detection sensitivity and time.

Acknowledgments

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