Crime Prevention Using Individual’s State Estimation

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Abstract. Research on prevention of crime through redesigning of the city environment is actively pursued. In this study, we propose the fact that the state of individuals living in the city space is also related to the crime occurrences as well as the city’s space aspect and propose the method to estimate the state of individuals. Tri axis acceleration sensor is a sensor which is equipped in generally supplied smart phones and by utilizing this, we can estimate the state of an individual in real time. SVM technology translates the input value from tri axis acceleration sensor to the energy value. This study demonstrated that by analyzing the changes in measured value according to the flow of time, it is possible to infer whether the individual having outdoor activities is in normal or abnormal state.

Keywords: Gait Awareness, Crime Prevention Through Environmental Design, Context Inference

1 Introduction

The crime prevention study through redesigning the city environment is gaining spotlight. This reflects the perspective that city’s environment is making crime even easier to execute. Architecture researchers are studying to redesign city’s space to limit the crime occurrence on the foundation that it is related to the occurrence of the crimes. Based on this study, we are introducing a concept that can prevent the occurrence of the crime while designing new city and architecture. However, it costs a lot to change existing environment of city.

As a way to acknowledge the individual’s state, we propose gait awareness which has been used for the individual’s identification. For the ways to identify gait awareness, using visual sensor, inertia sensor, or tri axis acceleration sensor has been studied. In this study, we are to demonstrate ways to estimate state of individual using tri axis acceleration sensor. This is to translate the measured value gained from the tri axis acceleration sensor through SVM technology and to recognize changing pattern; and from this, we would like to propose that it can estimate the health state of the pedestrian and propose detailed utilization. This study is composed of the following. In chapter 2, we will organize related studies and propose to utilize gait awareness to

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prevent crimes using state inference of the individual. We will execute the experiment and analysis on the proposed contents in chapter 4 and conclude in chapter 5.

2 Related Studies

Paul Cozens compares and contrasts the perceptions of rail users and security experts in relation to two railway stations in Perth, Western Australia. This exploratory investigation suggests that the effectiveness of CPTED is mediated by the local environment surrounding each station and its associated image [1].

Hiroaki Sugino and Takaumi Arima revealed the vulnerability and resilience against one specific crime, arson, in Fukuoka and more specifically in Haruyoshi district, through consecutive researches from urban planning and environmental psychological viewpoints. They found that there are temporal and spatial vulnerabilities against arson in Fukuoka and Haruyoshi which remain to be improved intensively. However, at the same time, Haruyoshi has some resilience against arson, and they conclude that the human traffic, observability and anonymity are high in the district[2].

Dong-Wook Sohn assess the relationship between residential crime and the built environment that reflects the principles of crime prevention through environmental design (CPTED) at the neighbourhood level. Using crime data for Seattle, his study investigated the effectiveness of CPTED principles associated with two different space design approaches (i.e., permeable space and defensible space) with respect to reducing residential crime[3].

Sohn, et al. develop evaluation indicators of neighborhood park about CPTED, and verify the weighted value of the evaluation indicator through survey targeting related field experts. The main factors that contributed positively to people’s feelings about the area are the presence of activity, familiarity with the surroundings and maintenance of the area, building, or space[5].

Kamalipour, H., et al. implemented combinational research methods with quantitative and qualitative approach containing descriptive, analytical, simulation, correlation and logical reasoning. The syntactic analysis showed that the ruined districts located near the Arg Square and Grand Bazaar which have a minimum of connectivity and maximum of depth[6].

3 Crime Prevention Using the Estimation of Individual State

Gait awareness is a method to estimate the individual’s state from long distance. Along with fingerprint analysis, iris analysis, and face recognition, gait awareness is used for individual identification and is well known for its security.

We use tri axis acceleration sensor in smart phones for gait awareness. Tri axis acceleration sensor measures the walking patterns of the pedestrian by calculating the momentum in x, y, and z axis and has been used for individual identification. In this study, we propose of using tri axis acceleration sensor to identify whether the pedestrian is in normal/abnormal state.
3.1 Need to Estimate Individual State

In sexual assaults that took place in CheonAn city in Oct. 11, 2014, there is a case of which attacker found that victim is drunk and staggering and assaulted her. In Dec. 26, 2013, victim in her 40s are found drunk and was robbed; in Feb. 26, 2014, there were another case of which drunk victim walking down the street was sexually assaulted; in May 5, 2016, there were a case of which drunk victim staggering were sexually assaulted. Although spatio-temporal environment may propose that it is highly likely for the crime to occur, the victim’s state is also related to the occurrence of the victim. Based on these cases, it is necessary to include the degree of individuals’ state being exposed to the criminal threat while studying ways to evade danger by estimating and calculating the spaio-temporal environmental threat to the user.

3.2 Estimation of Individual State Through Gait Awareness

Gait awareness can be performed by visual analysis by filming the individual’s stride, by inertia sensor, and by tri axis acceleration sensor. Tri axis acceleration sensor is a sensor equipped in general smart phones. Gait awareness using tri axis acceleration sensor is advantageous as it does not need additional terminal or sensor. The ways of gait awareness using tri axis acceleration can be expressed as following expression.

\[ E = \sqrt{x^2 + y^2 + z^2} \]  

This expression is to calculate total energy emerged in x, y, and z axis when the pedestrian walks. As the stride of each individual differs, this is based on the assumption that it has inherent total energy. From these changes in total energy, we are able to identify the inherent pattern of each pedestrian.

For the gait awareness, we need to set the range of normal stride and remember the value of normal range while acknowledging the normal stride patterns.

By combining the result of individual’s state estimate with the risk analysis based on crime occurrence related element, the real world’s crime occurrence rick can be estimated in even higher quality. In next chapter, we will analyze the measured value from the tri axis acceleration sensor in smart phones and perform experiments to identify normal/abnormal and perform analysis on the result and utilization.

4 Experiment and Analysis

This experiment is performed by obtaining the data value of tri axis acceleration sensor built in the Android Smart phones. The following fig.1 shows the measured value of tri axis acceleration sensor in smart phones displayed in graphs.
Although it is hard to find clear regularity of the values in x, y, and z axis, it is happening in limited range.

The following fig.2 is after applying SVM. Although the changing trend of the graph doesn’t show any regularity, the scalar value shows limited trend.

The following is the measured and processed value when pedestrian is walking normally. The following experiment shows how acceleration value of tri axis changes when walked abnormally.
The following graph is the result of processing the abnormal stride through SVM. You can see that the range of the estimated value increased significantly.

From the experiment performed above, we could demonstrate that through gait awareness using tri axis acceleration sensor, it is possible to distinguish between normal/abnormal state of the pedestrian.

5 Conclusion

To prevent crime occurrence, studies to control crime occurrence through redesigning of the city space are in progress; this study proposed the existing incidents showing that personal state is related to the crime occurrence and proposed to use the gait awareness to estimate the state of the individual. We proposed using tri axis acceleration sensor for the gait awareness; by transferring the measured values gained
from tri axis acceleration sensor through SVM technique, we can recognize the changing patterns through time and estimate the physical condition of the pedestrian.

References