Abstract

Background/Objectives; Indiscriminate and brutal crimes have occurred in our recently society. Among the crimes, recidivism of sexual crimes by sex offenders even with their electronic anklets increases, hence an improvement plan is urgently required in such a condition, which the effectiveness of the anklets, in effect, is being questioned and challenged. This study recognizes the severity of the recidivistic and retaliatory crimes and proposes a sexual violence response system, an upgraded variation, via IOT-based smart devices, resolving problems in the existing model and enabling responses against sexual violence.

Methods/Statistical analysis; The proposal model of sexual crime response system with IOT-based smart devices consists of 5 parts – Data collection and comparative analysis module, crime response module-sex offender response module/crime victim response module, Integrated D/B and posterior utility D/B. This system has the phased crime response mode activated to practice sex offender response when a sign of criminal recidivism is captured and a crime sign is detected via attachment of Smart Electronic monitoring Anklets with various IOT-based sensors mounted, on ankles of the sex offenders. Simultaneously, to prevent recidivism by the sex offenders, the sexual violence victims are instructed to wear Smart Electronic Bracelet thereby, the states of the offenders are analyzed, and any recidivistic and criminal injury on the sexual violence victims is minimized via operations of the phased crime victim response module when an injury occurrence is detected.

Findings; While the existing model only collected the sex offender data, the proposal model collects not only the offender data but also the sexual violence victim data through Smart Electronic monitoring Anklet and Smart Electronic Bracelet, thus more accurate prediction against crimes is enabled via the more expanded data collection. The proposal model, involving Smart Electronic monitoring Anklet and Smart Electronic Bracelet, allowed a preventive sexual violence victim response mode, as well as the crime response mode coping with recidivism by sex offenders, by analyzing the data from both the offenders and the victims. In manners of crime response patterns, the existing model only comparatively analyze the collected offender data and gradually operate the phased crime response module against the offender, while the proposed model distinguishes itself by operating response modules of both sex offenders and sexual violence victims, having data of the both collected and analyzed.

Improvements/Applications; Sexual violence response system with IOT-based smart devices, the proposal model, allows more accurate crime prediction via diversified data collection through Smart Electronic monitoring Anklets and Smart Electronic Bracelets, unlike the existing model and the current Electronic Anklet system being run by the Ministry of Justice. Moreover, by operating crime response modes – one allowing rapid response against recidivism to sexual crime victims and the other preventing recidivism based on analysis, the proposal has a difference in the extent of probable crime injury from sexual violence.

[Keywords] IOT, Smart Device, Smart Electronic Monitoring Anklet, Smart Electronic Bracelet, Sexual Violence
1. Introduction

In the recent society, indiscriminate and brutal crimes – violent crimes including murder and robbery – frequently occur. Sexual violence, in particular, has a higher risk of recidivism than other general crimes thus, efficient monitoring and surveillance are necessarily required for the victims. Recognizing the severity of sexual violence, Electronic monitoring Anklets are introduced and have been utilized for over 10 years, yet recidivism rate by sex offenders is keep increasing. The existing Smart Electronic monitoring Anklet model responding by phase to the state of criminals based on the all-in-one Electronic monitoring Anklet and sensors established to collect data from external environment run by the Ministry of Justice has limitation in efficiency of recidivistic and retaliatory crime management and monitoring. Therefore, for efficient management and monitoring of the increasing sexual violence crimes, a preliminarily preventive sexual violence crime response system would be suggested, which utilizes an upgraded IOT-based smart devices from the existing monitoring system via Electronic monitoring Anklets.

Hence, the IOT-based sexual violence crime response system suggested in this study allows various data collection thanks to the uses of Smart Electronic monitoring Anklet and Electronic Bracelets. Such data collection enables more precise crime state and relevant actions, compared to the existing, and even brings preventions of recidivism by sex offenders and retaliatory crimes upon the sexual violence crime victims. As the proposal model brings more rapid and phased response measures, compared to the existing, upon recidivistic and retaliatory crimes by sex offenders, their injuries may be minimized.

2. Related Research

2.1. IOT-based smart devices

IOT is defined as ‘a global infrastructure offering intellectually integrated services on situational recognition and communication capabilities between human and thing, and among things, having intelligent things connected’[1]. Key technologies of IOT are sensing technology, communication and network technology and interface technology. Among them, the most critical technical element for successful IOT services is sensing technology adequately working in different situations and purposes, is composed of input, processing and output devices, and creates new value by organizing a service producing data from the reality via sensors[2].

Smart devices refers to products which their functions are not restricted, but considerably changeable or expandable by using application programs[3]. Such smart devices are being more widely applied in various areas such as health, education, beauty, social welfare and disaster management, as many sensor network technology has been developed with IOT-basis. Particularly, in recent, application of IOT-based smart devices is widely increasing to establish safe society from crimes.

2.2. Sexual violence crime

Sexual violence crime comprehensively refers to physical, verbal and emotional violence in-fringing on one’s sexual self-determination[4]. As sex offenders have higher recidivism risk, hence are required to wear Electronic monitoring Anklets since September 2008. The anklets are required to be worn when the target has committed 2 or more imprisonments due to sexual violence crimes and the total prison term prior to the second conviction is within 5 years, and a criminal with a past conviction of an Electronic monitoring Anklet commits a sexual violence again or recidivism and intentionality in sexual violence are recognized[5]. According to the investigation by Ministry of Justice, as shown in following <Figure 1>, the number of sex offenders with Electronic monitoring Anklets has increased as 874 in 2012, 2,370 in 2014, 2,894 in 2016
and 2,911 in 2018, and if second offenders of sexual violence has increased as 21 in 2012, 48 in 2014, 58 in 2016 and 67 in 2018 – hence a constant increases[6].

**Figure 1.** Status of second conviction of sexual offenders with smart electronic monitoring anklet.

2.3. Applications

Kwack & Kim & Cha & Hong(2014) suggested a necessity of an intellectual Electronic monitoring Anklet that allows prediction of criminal actions held by criminals, via installing sensors, collecting data from external environments, including degrees of pulse, temperature, drunk driving, acceleration and impact[7].

Kim & Yoon(2015) suggests the public restrooms in crime-ridden districts such as parks as highly probable places where fire and crimes may occur due to improper management due to limitations in human resource and costs. To resolve such issues, commercial sensor is connected to wireless sensor node in the middle of each public restroom or toilet, thus enabling monitoring the restroom conditions and appropriate and rapid responses in different situations by sending signals to an integrated management server[8][9].

Lee et al.(2017) insists the existing CCTV system, monitoring CCTV videos from a fixed position, has blind spots, hence faces difficulties in detecting and arresting intruders. Establishing an IOT-based security CCTV system with smart devices allows flexible responses to different crime situations by ensuring more reliable monitoring[10].

To improve the problem in all-in-one Electronic monitoring Anklets, merely offering simple location information, currently being provided – limitations in precautionary crime prevention - Oh & Lee(2018) suggested a precautionary crime prevention model by detecting crime signs from sex offenders in advance through Smart Electronic monitoring Anklets with various sensors[11]. Furthermore, Oh(2018) suggested a preventive system model against retaliatory crimes by using IOT-based smart watches to easily identify the preliminary risk and cope with situations to minimize criminal injuries to retaliatory crime victims[12].

3. Proposal of Sexual Violence Response System Using IOT-Based Smart Devices

3.1. System design

3.1.1. System configuration
(1) Data Collection

: Via the smart devices attached, data about victims and assailants, police record, history of mental illness, recidivism risk assessment of criminals is collected. The smart device with various sensors attached is Smart Electronic monitoring Anklet and Smart Electronic Bracelet. Smart Electronic monitoring Anklet is attached to ankles of sex offenders to prevent their second conviction and is Smart Electronic Bracelet is to be attached to wrists to prevent any secondary damage from retaliatory crimes by criminals.

(2) Data Comparative Analysis Modules

: Comparatively analyzing data transmitted from various sensors, data comparative analysis modules operate situationally adequate crime response modules in different conditions. That is, based on the data analyzed through Smart Electronic monitoring Anklet, a smart device, crime response modules are operated against sex offenders to prevent their recidivism and, by using Smart Electronic Bracelet, victim response modules to prevent retaliatory crimes of sexual violence with high second conviction risk are operated.

(3) Crime Response Module

: Crime Response Module is a phased crime response module to rapidly and precisely deal with sex offenders by allowing prediction of crimes – recidivism by sex offenders and retaliatory crimes by them with high recidivistic risk – based on comparatively analyzed data from Data comparative analysis Modules.

(4) Posterior Utility D/B

: Posterior utility D/B is a D/B for the uses to prevent second conviction of sex offenders by storing processed data from crime response module and to minimize crime injuries by preventing any future retaliatory crimes of sex offenders.

(5) Integrated D/B

: Integrated D/B is a storage of comprehensive data including judgment records, crime methods, current addresses, mental illness and retaliatory risk on criminals by official judicial authorities such as the prosecution, the police and the Commissioner of the Bureau of Reclamation, and allows comparative analysis with data generated from Smart Electronic monitoring Anklet and Smart Electronic Bracelet, and hence, more accurate prediction and responses against crimes.

3.1.2. System proposal

This system based on IOT utilizes Smart Electronic monitoring Anklet and Smart Electronic Bracelet to collect crime related data from sex offenders and victims, to transmit the collected data to data comparative analysis module for an analysis, and then to operate crime response modules depending on the data comparatively analyzed. Thus, sexual violence crime response system with IOT-based Smart Device as following <Figure 2>.
**Step 1:** Through Smart Electronic monitoring Anklet on ankles of sex offenders and Smart Electronic Bracelet on wrists of sexual crime victims, location data and body condition of both offenders and victims as well as data regarding criminal records, addresses and mental illnesses stored in judicial authorities, including the prosecution and the police.

**Step 2:** Various data collected from Smart Electronic monitoring Anklet, Smart Electronic Bracelet and Integrated D/B is sent to Data Comparative Analysis Module.

**Step 3:** In the data comparative analysis module, data sent from Smart Electronic monitoring Anklet and Smart Electronic Bracelet is comparatively analyzed to prevent any recidivistic and retaliatory crimes by sex offenders and to operate response modules for both offenders and victims.

The data comparative analysis module comparatively analyze data transferred from Smart Electronic Bracelet attached on wrists of crime victims for initiation of response module for victims, and the operation sequence as followings.

1. Identify the current location of sex offenders.
2. If the current position of sex offenders is out of designated area or is close to the preliminarily registered addresses of sexual violence victims, the victim response mode A is initiated. If the current location of sex offenders is not in pre-registered position, victim response mode is not operated, but only the location of the offender is saved.
3. Comparatively analyzing the data transmitted from Smart Electronic Bracelet equipped with a body information detection sensor for sexual violence victims, status of the victims is identified, and victim response mode A is initiated when a crime risk is detected from body information such as pulse, temperature and body movements.

Data comparative analysis module for sex offenders comparatively analyze data collected from Smart Anklet monitor attached on ankles of sex offenders to prevent any second convictions by the offenders and initiate response module against sex offenders, and the operation sequence as followings.
① When cutting sensor on Smart Electronic monitoring Anklet on sex offenders, their locations are identified.

② If Smart Electronic monitoring Anklet is cut, the current location of the sex offender is confirmed and crime response mode B against the offender is initiated.

③ If Smart Electronic monitoring Anklet is not cut, the current location of the sex offender is confirmed and if the offender is not in designated area of pre-registered address, crime response mode B against the offender is immediately initiated. However, if the location is identified and the offender is located in designated area, the status of the sex offender is analyzed via body information detection sensor attached on the offender, then if any risk of crime sign is detected crime response mode B is operated and if no risk of crime sign is detected, the analyzed data is saved and the crime response mode B against the offender is not initiated.

Step 4: Crime response module is operated based on transferred analysis data from data comparative analysis module as crime victim response module and sex offender response module simultaneously by phase.

Crime victim response mode A is initiated and the operation sequence as followings.

① Generate a warning message and an alarm sound to crime victims

② Notification of Real-time location of sex offenders

③ Mobilize the police

Crime response mode B against sex offenders is operated and the operation sequence as followings.

① Generate a warning alarm to surrounding people within 1km from the Smart Electronic monitoring Anklet position of the sex offender

② Induce the surrounding people who produced an alarm to disclose personal information of and to report the sex offender via SNS

③ Expand the warning alarm range if no significant SNS results are notified in 30 minutes

④ Mobilize the police

Step 5: Transmit the process data from sexual violence crime response module and crime victim response module to D/B for storage, hence utilize the data for responses and prediction of future probable sexual violence crimes.

4. Evaluation of the Proposed Model

In this chapter, as shown via <Table 1>, the existing model, A Study of Prevention System against Second-Convictions of Sexual Violence Offenders by Using Smart Electronic Monitoring[12] and the proposal in this study, Response System against Sexual Violence via Smart Devices are examined in efficiencies and differences in operational functions compared to the existing model.

First, the existing model only collected data relevant to sex offenders through Smart Electronic monitoring Anklets, Integrated D/B and Body Information Detection Sensor. However, such a model is insufficient in its effectiveness to prevent crimes for victims who suffer from retaliatory crimes by the offenders who are likely to commit second convictions, as only data focused on recidivism prevention is collected. Hence, while the existing model only collects data
related to sex offenders and focused on a system for second conviction prevention, the proposal model in this study allowed simultaneous data collection through Smart Electronic monitoring Anklet to prevent second conviction by sex offenders and Smart Electronic Bracelet being attached to wrists of sexual violence victims, and hence injuries from retaliatory crimes by sex offenders may be minimized.

Table 1. Evaluation of the difference between two models.

<table>
<thead>
<tr>
<th>Category</th>
<th>Existing system</th>
<th>Proposed system</th>
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<tbody>
<tr>
<td>Data collection</td>
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<tr>
<td>Smart electronic monitoring anklet</td>
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<td>Smart electronic bracelet</td>
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<td>Integrated D/B</td>
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<td>Smart electronic bracelet</td>
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<td>Status analysis</td>
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<td>Dual crime response module</td>
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<tr>
<td>Electronic shock machine</td>
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Second, in terms of data analysis methods, the existing model only performed data analysis to prevent second conviction by sex offenders through Smart Electronic monitoring Anklets, Integrated D/B and Body Information Detection Sensor. Such an existing model has limitations in preventing secondary damages on sexual violence victims from retaliatory crimes by sex offenders with high recidivistic risks as it only entails data analysis upon the offenders. Therefore, to resolve the limitations, the proposal model brings analysis of data not only of sex offenders but also from Smart Electronic monitoring Anklet on sexual violence victims and Body Information Detection Sensor, hence dual data comparative analysis to cope with both recidivistic and retaliatory crimes by sex offenders has become available.

Third, in terms of D/B, the existing model only utilized Integrated D/B to collect data of sex offenders. As the model did not store and analyze the result data from crime response module, hence a definite time was required to analyze data and respond when every sexual violence crime occurs thus, faces difficulties in rapid responses. However, the proposal model additionally used Posterior Utility D/B as well as Integrated D/B to collect data of sex offenders. Such a Posterior Utility D/B may lead to more rapid and accurate response against future emergent sexual violence crimes by storing and analyzing result data from crime response module activated to cope with crimes via data analysis of both sex offenders and victims.

Fourth, while the existing model comparatively analyze the data collected from sex offenders to proceed the phased crime response module, the proposal model involves analysis of data gathered from sexual violence victims and sex offenders, hence allows operation methods to deal with not only second conviction, but also retaliatory crimes to victims by sex offenders. Moreover, the dual crime response mode operations in proposal model, employing SNS, inducing citizens to respond to and report the crimes and using cutting detection sensor has differences from the existing crime response methods against sexual violence crimes.
5. Conclusion

The number of domestic sexual violence crimes for the previous year, according to National Statistical Office, has been over 32,800 cases. Even with Electronic monitoring Anklets, number of sex offenders committing a second conviction has constantly increased from 21 in 2012 to 67 in 2018. Such an above investigation result suggests a question upon the effectiveness of the currently introduced Electronic monitoring Anklets to prevent recidivism by sex offenders. Hence, in a circumstance, suffering from increasing recidivism by sex offenders with Electronic monitoring Anklets, efficient and practical measures to prevent sexual violence crimes are more required than ever. Accordingly, this study suggested a system model to deal with sexual violence crimes by phase, supplementing the limitations in the existing model, the preventive system against second conviction by sex offenders through using Smart Electronic monitoring Anklets, in order to prevent retaliatory crimes to the victims by the offenders, particularly who are likely to commit a second conviction.

This system consists of 5 components – Data Collection, Data comparative analysis Modules, Crime Response Module and Posterior Utility D/B to deal with sexual violence crimes. Various data is collected from Smart Electronic monitoring Anklets on sex offenders, Smart Watches on sexual violence victims and Integrated D/B, and the collected data is sent to Data comparative analysis Modules. Then, the transmitted data of the offenders and the victims is analyzed, and is used to simultaneously operate response modules on both, hence probable injuries from sexual violence crimes are minimized. In particular, the proposal model in this study, having Smart Devices – Electronic monitoring Anklets and Electronic Bracelets – can collect more diverse data than the currently operating model with Electronic monitoring Anklet system, and can prevent not only second convictions by sex offenders, but also retaliatory crimes to the victims. Therefore, proposing such a response system has a significance in its utility as a basic material for future crime response system models against sexual crimes.

6. References

6.1. Journal articles

6.2. Additional references


6.3. Conference proceedings


7. Contribution

7.1. Authors contribution

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<th>Initial name</th>
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<td>- Significant contributions to concepts, designs, practices, analysis and interpretation of data ✔</td>
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<td>- Participants in Drafting and Revising Papers ✔</td>
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<td>- Someone who can explain all aspects of the paper ✔</td>
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</table>

7.2. Authors profile

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