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Interaction Design for Preventing Child Abuse

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1. Introduction

The chapter aims to share various approaches to prevent crimes against children with students and professionals interested in developing and designing interactions. Accordingly, it is focused on discussing various examples and features of current interaction designs based on a diversified examination of designed products, services, and social systems. It also aims to understand and analyze characteristics of crimes against children from a designer's perspective and suggest a new direction for design while discussing basic suggestions on crimes against children and examining design methods with regard to crimes against children.

1.1. How to study

Firstly, what are the characteristics of children? Secondly, what are the characteristics of crimes against children? Thirdly, what is the current prevention system for against crimes and the advantages and disadvantages of such as system? Fourthly, what technologies could complement the disadvantages? The current study discusses interaction designs aimed to prevent crimes against children based on service designs through resolutions to suggested problems.

Researchers have revealed that more practical preventive measures can be taken when a protector – the government (the police) or private companies (security providers) – communicate with children to prevent crimes. The protector must immediately estimate the situation on behalf of children and a government agency or a private security service provider serves as a linking device and intervenes to protect children.

From examining the current products on the market as available devices, smart phones have been deemed appropriate; however separate development guidelines are needed given that users are children.

2. Theoretical background

This chapter analyzes children's performances and circumstantial judgments through literature and studies on preventing methods through understanding the procedure and characteristics of precedents of crimes against child over the past seven years.

2.1. Characteristics of a child

A child refers to the ages between 6 and 12. During this period, a child learns similar tasks that he or she must perform once they become an adult[1]. Child development is often discussed from the perspective of developmental psychology and paediatrics and is defined from biological and psychological perspectives. Child development is believed to have characteristics of dependency, continuous development, susceptibleness, demand, and adaptability[2]. Table 1 summarizes research conducted Sigmund Freud, Erick Erikson and Jean Piaget with regard to the psychological cognitive development of children.

Psychologists	Development	Stages	Characteristics
Freud	**Psychosexual Development**	Latency Stage 6-11 year old	Libido is repressed and the child develops superego.the child acquires social value through playing with same age group with same sex and adults other than family members.
Erikson	**Psychosocial Development**	Industry vs. Inferiority Latency Stage 6-11 year old	Children develop competence and cooperation skills in school. Complex develop through negative experiences in the family or when experiencing incompetence in school or among same age group.
Piaget	**Stages of Development**	Concrete Operations Stage 7-11 year old	A child can conduct logical reasoning what regard to specific cases and is able to divide objects into different categories (i.e., children can conduct operation). In this stage, the child which performs concrete operational reasoning, but cannot perform reasoning that requires algebraic equations because it require advanced abstract thinking.

Table 1. Characteristics of child by Freud, Erikson, and Piaget

Jean Piaget's "concrete operations stage," which is third of four stages of development applies to 7-11-year-old children. Children in this stage can perform simple operations and logical reasoning replaces intuitive thinking, which means that children can operate a mobile phone. However, how well a child can operate a mobile phone in case of an emergency must be carefully examined.

Therefore, the following needs to be considered when designing a device for kids. Although child in the concrete operations stage can perform operations that requires quite

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[1] Laura E. Berk, translated by Nang Ja Park, Infants & Children.
[2] Sung Sim Han, Joo Mi Song, 'Child Welfare', Chang Ji, 2003, page 12.

complicated and logical thinking, it must be designed so a child can operate quickly in case of emergency. Table 2 shows a list to consider in accordance with the characteristics of children.

Items	Contents
General Characteristics	• should be able to get attention from same age group • should seek for a way to educate children about utilization in case of emergency through game • should prepare for malfunction caused by shock • should educate children to avoid unintended operation out of curiosity • child should be familiarized with operation
Physical Characteristics	• design should consider physical development of childhood • design should consider safety of a child so he/she does not get injured from unintended operation due to physical development
Cognitive Characteristics	• cognition of age of 6, 9, and 12 is different and should have flexible structure or icon design for respective ages. • not only a button but also a variety of methods need to be considered to respond in case of emergency • circumstantial judgment and discernment may insufficient compare to an adult

Table 2. List of considered device designs in accordance with the characteristics of a child

2.2. Characteristics of Child Abuse

Based on the analysis of precedents, what marks the child abuse is that most crimes involve sexual motivation, although some lead to the murder of a child. For the crime from occuring, there must be three prerequisites: (1) crime will, (2) victim, and (3) crime scene.

Once these are satisfied, there are five phases to commit a crime; crime prerequisite → approaching → luring and kidnapping → movement → committing the crime.

Step 1		Step 2	Step 3	Step 4
Crime prerequisite	Approaching	Luring and Kidnapping	Movement	Committing the crime

Table 3. Process of Crime

The intention of classification of a crime is to extract the Design Specification of the device for children to respond to each phase of the crime and prevent it the crime from occuring.

First the prevention of the first phase, crime prerequisite, has been conducted in the West in various ways.

Nevertheless, criminals continue to approach victims, wearing electronic Tagging. Criminals lure victims using feigned identity or by asking for directions. Criminals may also capture victims by force and move to a certain spot to commit the crime.

In the Kim Kil-Tae case, the preschool, the crime scene, and the criminal's house were located within 300m. This shows that many crimes are committed within the child's home

environment. On study showed that the luring point and crime scene are only 30 min. away (i.e. within 2km).

Phase	Counter Measures
Crime prerequisite	Need for systematic measures to block any attempts for crime will, victim, crime scene.
Approaching	Alert the child's parent by receiving signals from the Electronic Tagging of recidivism through a device for children.
Luring	Educating the child about the action guide and letting them avoid the crime scene.
Kidnapping	Informing the third party about the danger using an emergency button or strap when captured by force.
Movement	Collecting all data about a child's routine pattern and alerting the parents when their child strays from the routine.

Table 4. Counter measures for each crime phases

According to a survey, cases where the victim's house, crime scene, lure place, victim's school and perpetrator's house were located within 2 km and accounted for 50% or more of crimes. Findings also revealed that a perpetrator searched for the subject of the crime in surrounding areas and the crime scene was a familiar environment. In addition, the lure place was not the same as the crime scene, and a perpetrator lured the child to another place to commit the crime. In these cases, it is the only time when a child can be rescued. Of note, 2 km takes up to 30 minutes to traverse on foot.
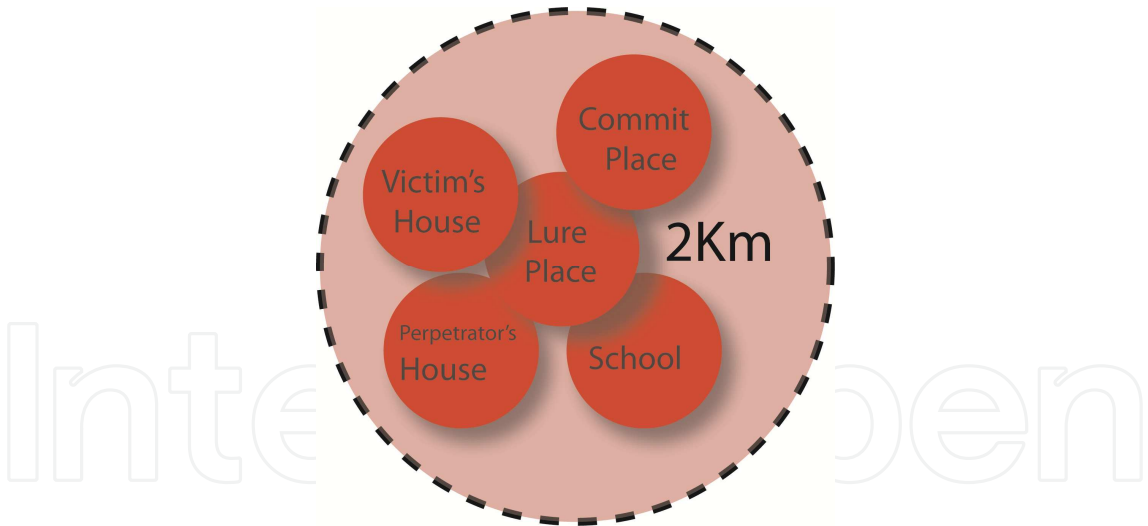

Figure 1. Distance from victim's house, crime scene, lure place, victim's school, and perpetrator's house.

A main characteristic of crimes against children is that it is impossible for children to protect themselves or ask for help when they perceive a crime because of physical differences between the child and perpetrator. Accordingly, it has been perceived that the intervention of a third party, who can immediately extend a helping hand to children, is desperately needed. Therefore, this study focuses on determining measures to achieve such an intervention.
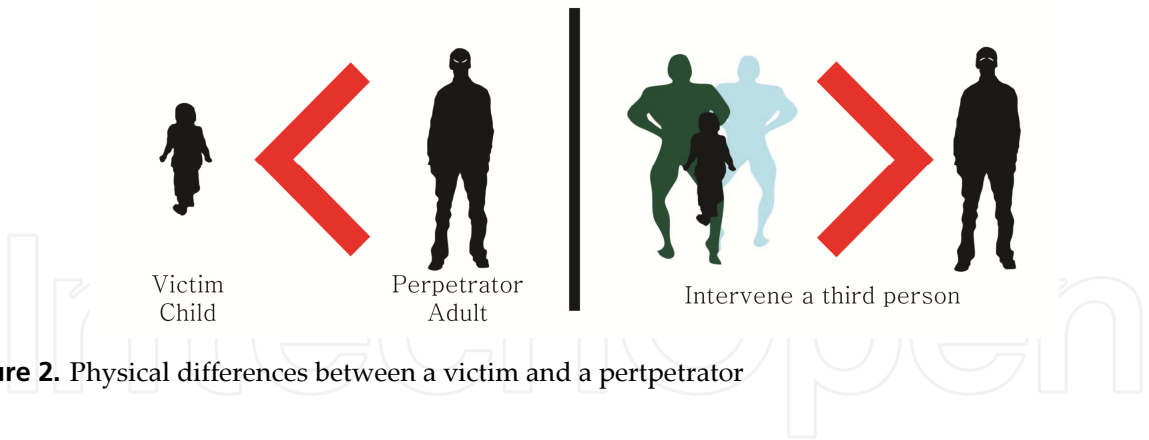
Figure 2. Physical differences between a victim and a pertpetrator

2.3. Prevention system and current technologies

Preventive means can be divided into individual and social means. As seen in the Figure 3, the social means are characterized by handling a situation after the fact. As it is difficult to protect many and unspecified persons, an emphasis is placed on preventing the recurrence of crimes that center on ex-cons. However, it is difficult to protect victims prior to a crime. Individual means are characterized by prevention that is focused on self-protective instincts aimed to protect oneself and one's family from many and unspecified persons.
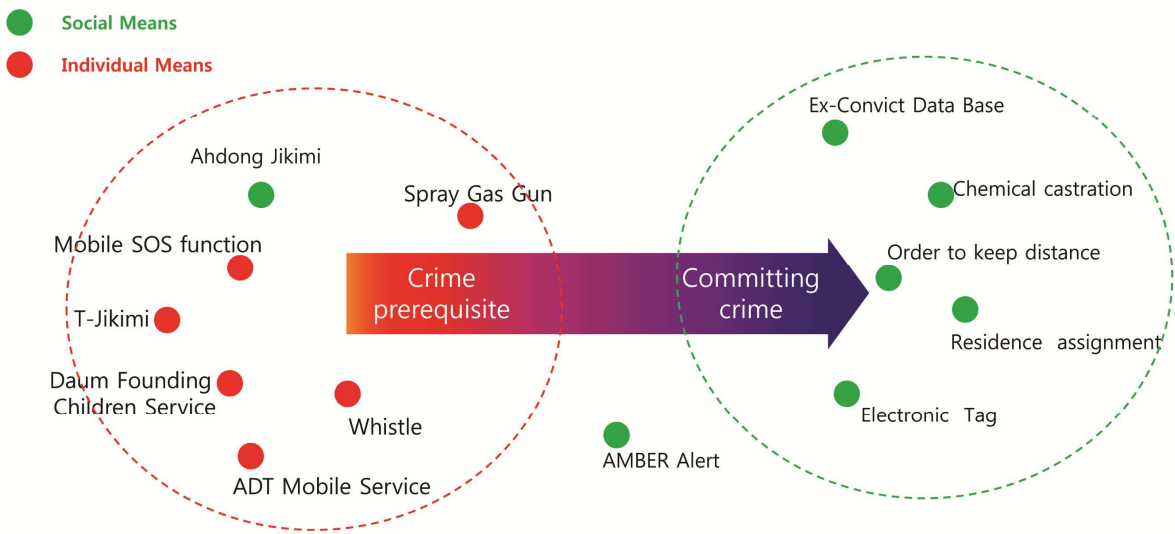

Figure 3. Characteristics of individual and social means

According to Table 5, which compares the domestic and foreign prevention system, the domestic system shows more favor to the rights of the criminal than those of the victims or the many and unspecified possible victims. Under certain circumstances, prevention becomes essential.

type	Measures	Comparison
Domestic System	• Child safety guards • Amber alert • Electronic Tagging • Posting identities of sexual offenders	Victim's human right < perpetrator's human right
Foreign System	• Isolation policy of the sexual offenders (U.S) • Amber alert • Posting sexual abuse record/ identities(U.S.) • Surgical or drug castration of sexual offenders(U.S.) • Genetic database (U.K.)	Victim's human right > perpetrator's human right

Table 5. Comparison of domestic and foreign systems and victims' and perpetrators' human rights

The followings are current technologies used for crime prevention.

1. SOS feature on mobile phones: Transmits the signal to five or six people who are registered by users in case of emergency and are available for only limited mobile phones.
2. LBS (Location Based Service): Electronic Tagging of ex-convicts; this has been adopted in many different fields. The security company ADT uses LBS-based mobile service for crime prevention. Users can set up an ETA (Estimated Time of Arrival) and if the users do not arrive on time, the company dispatched their men. If users enter the plate number of a taxi, the company will do the background check. However, as seen from the Fig. 2, this is problematic because it is not a kid friendly interface.
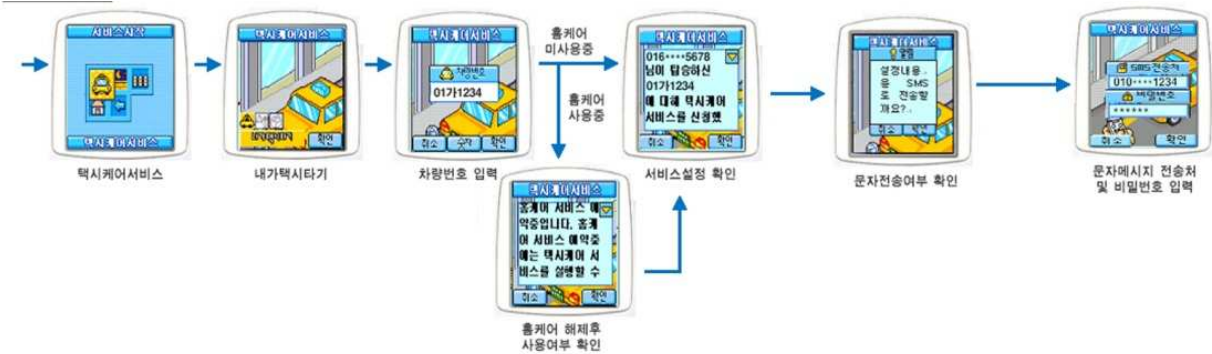

Figure 4. Example of setting up an ADT mobile phone - service name : Taxi care

3. Electronic Tagging: Domestically, electronic tagging of ex-convicts uses an LBS system. Legislation regarding adherence to Electronic Tagging for specific sexual offenders was enacted in April, 2007. After its revision in May 2008, electronic tagging was effective starting September 1st, which is an another use of LBS. Thus, if inspectors and mobile phones for children can detect the signal of the Electronic Tagging, it would provide a significant solution for preventing crimes against child.

Table 6. summarizes the results of the analysis of utilization of applicable systems and technologies through an assessment of effectiveness of each crime phase.

Phases	SOS feature of Mobile phone	LBS	Electronic positioning system /Electronic Tagging
Phase 1 : approaching	-	-	-
Phase 2 : luring and kidnapping	○ (when kidnapped)	○ (when kidnapped)	○ (when kidnapped)
Phase 3: movement	○	○	○
Post crime phase	○	○	○
Characteristics	Informs guardians in case of an emergency. Frequently unintended operation causes loss of reliability	Not a user friendly interface when using the service through a mobile phone; requires frequently resetting the settings. High cost for extra device and fees can be a burden on users when using a satellite-based system	It is a current measure that is systematically utilized. There is limits to prevention of crimes against people with no criminal records. May not expect any prevention when intentionally detached and committing a crime

Table 6. Assessment of effectiveness of prevention technologies regarding each crime phase.

It is concluded that mobile phone SOS features, LBS, Electronic Tagging are ineffective for luring and kidnapping because a child is not aware of it; however, it is effective for movement after kidnapping. In addition, to find a solution for preventing crimes against children, it is necessary to integrate mobile phone ubiquitous and LBS.

2.4. The current design of mobile phones for kids

The evaluation of precedents of existing mobile phones for kids was conducted to analyze features that are needed for this population of users.

Company model	Image	Characteristics
Verizon Migo		-emergency use for kids/elders, -minimum capacity that allows only five limited numbers be saved including emergency number (911) -no texting
Kyocera Mamorino cell phone for kids		-only available in Japan, can locate child's position and sounds alarm in emergency to inform -limited texting available through preregistered texts -there is a strap besides an emergency button and when pulled, it sounds an alarm and transmits signal to security company -when there is no light based on the setting, the lights will be turned on

Cingular Firefly		-private button for mom and dad -can save up to 20 numbers -emergency call button and designed to prevent mal-manipulation -suggests that child can be protected from harmful materials becuace there is no internet or email connection
Willcom Nico		-arrangement of large buttons/buttons with enlarged dome design -positioning system that can inform parents of child's location -parents can learn child's location by calling or through a computer at any time -high quality audio with low electromagnetic waves, which ensures safe use for kids
Gigabyte Sergeant Keroro, Doraemon		-Keroro and Doraemon version released by Taiwanese company Gigabyte -no specific features for child safety
au A5520SA		-provides location of child in real-time using GPS and informs when a child approaches specific location -pressing # for several seconds sounds an alarm and transmits current location through GPS mail to registered number and simultaneously informs the security company -can contact fire department or hospital in emergency of fire or illness -informs the child's location in time intervals, even if the power is off -wireless internet NTT Tokomo arranged 'Kids I menu' and prevents child from harmful internet content
Hop-on chitterchatter		-mobile phone that can frequently connect family with child under 10 or person with disability -comprises five (mom, dad, home, 911, Track Me) buttons with total of seven emergency numbers -child can inform parents of their location -can be put in backpack, wallet, pocket, etc, or can hang on neck or worn on the wrist

Willcom Papipo		-Papipo, released by Willcom, is manufactured by plastic model company Bandai -produced in Blue, Damogochi, Chao version and has meticulous UI design -once connected to kids studio, a database for children, a child can download wallpaper, games, ring tones and even raising Damagochi (function of fun) -provides positioning system using PHS base station, and emergency button
Dmodo M900		-manufactured by Hong Kong mobile phone handsets company -uses Walt Disney's Mickey-Mouse design -popular among kids and young women, also uses Disney characters for integrated programs such as wall papers, animation, icon, button sound.

Table 7. Precedents of existing mobile phone for kids

The precedent analysis showed that it is not easy for a child to control the device in an emergency and protecting a child through third party involvement seems an easy task. However, some features of these devices were useful such as A5520SA from AU, which informs parents when a child is approaching a specific location and informs the child's location at specific time intervals, even if the power is off. Additionally, Chitterchatter's wearing method was found useful. Table 8 summarizes useful features for preventing crimes against children.

Categories	Functions	Contents
Button	Specified Key	Easy operation for various ages and children with disabilities. Can maximize battery by allowing limited number of phone numbers to be saved and prevent unnecessary calls and harmful content.
	Emergency Button	Informs the current situation and self location to the preregistered person in case of an emergency
	Notifying Self Location Button	Can inform self location at any time
Power	Battery Cover	When the battery cover is forcibly removed, a warning sign will be sent out to preregistered numbers
	Powerless Positioning Signal	Can notify one's location without any power in certain time intervals
Lamp	Lamp	When a child is trapped in dark area, the lights will be turned on based on the settings
Emergency	Strap	If a situation doesn't allow a child to a press button, he/she can pull the strap, which will sound the alarm and send out a text message to the preregistered numbers
App.	GPS	Parents can confirm their child's location any time and will be notified when the child approaches a specific location
	DB	Parents can protect their child from harmful content and decorate the mobile phone using DB for kids.

Table 8. Useful current technologies to prevent crimes against children

The users have a need for normalization and avoiding admitting that they are special[3]. Thus, mobile phones for kids that are currently available have very small LCDs or none at all; nevertheless, designs for both specified-key mode and 10-key mode would be viable by parents setting up the key-type screens based on the Full Touch Technology and adjusted for their children's age-specific cognition levels.

2.5. Summary

- Children aged 7 to 11 experience concrete operational stage as mentioned by Piaget with regard to characteristics of children who can deal with simplified manipulation and logical inference, which suggests that children have no problem manipulating a device.

- With regard to characteristics of crimes against children, a perpetrator commits a crime if three conditions, crime will, victim, and crime scene are met and the crime goes through the stages Approaching→ Luring and Kidnapping →Movement→ Committing Crime.

- Cases where victim's house, commit place, lure place, victim's school, and perpetrator's house are located within 2 km account for 50% or more; therefore, crimes are committed near routing of children.

- As it is deemed impossible for children to protect themselves due to physical differences between the child and perpetrator, it is perceived that intervention by a third party is essential and many thoughts have been given to intervention by a third party.

- There are various methods to prevent crimes, which are divided into individual and social means. Individual means are preventive measures to protect oneself and family from many and unspecified perpetrators; however, few methods have been found to enable children to protect themselves. On the other hand, social means are related to ex-cons and are characterized by prevention after the fact; therefore, they are less often characterized by prevention prior to a crime.

According to an inquiry into preventive technologies, many useful technologies and functions have been found with mobile phones and include such diversified technologies as LBS and SOS functions. However, they may have problems because children are unable to perceive situations where they are exposed to crimes or there are difficulties in helping them directly or indirectly when they ask for help even thought they have perceived a crime.

3. Design concept of device for preventing child crime

As the study aims to prevent crimes, it is focused on suggesting the direction of design so that children can be protected from a crime through a device one way or another. Accordingly, it has designated a scenario to extract factors according to situations while suggesting guidelines needed for a device from the extracted factors.

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[3] Shin Ah Jo, 'Research on Designing Customized Menu for Users in Mobile Phone', Dept. of Digital Design, Kyung Sung Univ.

3.1. Categories of scenario for child crimes

The following scenario was written based on crime categorization of Table 9 and was used to support reasons for necessary device features.

Criminal records	Methods	Cognition	Categories
Less than two previous conviction	Luring	does not perceive danger	category 1
	Kidnapping	recognize danger	category 2
More than two previous conviction	Luring	does not perceive danger	category 3
	Kidnapping	recognize danger	category 4

Table 9. Setting up four categories

This scenario was established based on a previous research and has the following conditions. It has been sub-divided into the following crime stages: crime prerequisite → approaching → luring and kidnapping → movement → committing crime before suggestion.

First, perpetrators are divided into ex-cons and first offenders and this scenario is related to the application of electric tagging. Some criminals attempt to commit a crime after removing electronic tagging; these are regarded as first offenders. These criminals are divided into luring and kidnapping and luring refers to as a situation where a child is unable to be exposed to a crime; kidnapping refers to as a circumstance where a child perceives that he or she is in danger.

Category 1 : Without Electronic Tagging and Luring

Category 1 of Table 10 describes the role of mobile phone for each phase under the premises that a 40-year-old man with less than two previous convictions targets a 12-year-old female victim.

Category 1	Setting	Phase 1	Phase 2	Phase 3	Phase 4
Perpetrator	40 year old, less than two previous convictions	Approaching	Luring	Movement	Commit a crime
Victim	6-12 year old girl / playground	Does not Perceive /wariness	Does not perceive	Does not perceive	Recognize
Function of mobile phone	Detecting any abnormal activities (route, speed, etc.)	-	-	Detecting any abnormal activities (route, speed, etc.)	Emergency button / Alarm/ lighting

Table 10. Category 1: Criminal without Electronic Tagging and Luring

The worst case is Category 1 because the perpetrator can hide intention and the child may never recognize the danger until right before the crime. In such a case, parents can be informed about abnormal activity of their child such as different routine pattern or sudden acceleration of speed and detect changes in mode of transportation; they can also confirm

the situation of their child. In many cases, the child does not recognize danger until right before a crime, thus, active involvement of third party is necessary.

Category 2 : Without Electronic Tagging and Kidnapping

Category 2, seen in Table 11, shows a case of threatening and forcible kidnapping by a criminal with a similar previous conviction. Here, the child does not recognize danger until the criminal approaches; however, is aware of that the situation is threatening

Category 2	Setting	Phase 1	Phase 2	Phase 3	Phase 4
Perpetrator	40 year old, less than two previous convictions	Approaching	Kidnapping (threatening)	Movement	Commit a crime
Victim	6-12 year old girl / playground	Does not recognize/ wariness	Recognize	Recognize danger	Recognize danger
Function of mobile phone	Detecting any abnormal activities (route, speed, etc.)	-	Emergency button / Alarm/ lighting	Emergency button / Alarm/ lighting	Emergency button / Alarm/ lighting

Table 11. Category 2: Criminal without Electronic Tagging and Kidnapping

While the mobile phone detects routine pattern and speed, it can also alert a nearby third party by sounding an alarm or informing the child's parents and police when he or she presses the emergency button. However, when the child is being kidnapped forcibly or too nervous to control the device, the mobile phone's secondary function activates through LBS and informs guardians of abnormal activities.

Category 3 : With Electronic Tagging and Luring

Category 3, seen in Table 12, shows crimes committed by 40-year-old man with more than one previous conviction, wearing Electronic Tagging. Proposed mobile phone receives signals from Electronic Tagging; however, does not inform the child to avoid the human rights violation of the ex-convict.

Category 3	Setting	Phase 1	Phase 2	Phase 3	Phase 4
Perpetrator	40 year old, more than one previous conviction	Approaching	Luring	Movement	Commit a crime
Victim	6-12 year old girl / road	Does not recognize/ wariness	Does not recognize	Does not recognize	Does not recognize
Function of mobile phone	Detecting any abnormal activities (route, speed, etc.)	receives signals from Electronic Tagging, transmits warning message to guardians	check with guardian's remote camera, sound the emergency alarm, report to the police	Emergency button / Alarm/ Lighting	Emergency button / Alarm/ Lighting

Table 12. Category 3: Criminal with Electronic Tagging and Luring

The signal received from the Electronic Tagging transmits a warning message, such as "exposed to possible threat," to the child's guardian so they can determine whether their child is exposed to the actual threat or not. Additionally, if the guardian believes there is an actual threat, they can remotely sound the alarm on the child's mobile phone regardless of the child's will.

Category 4 : With Electronic Tagging and Kidnapping

Category 4, as seen in Table 13, is criminal wearing Electronic Tagging and kidnapping a child by threatening. In such a case, the child recognizes a danger and may take immediate action to notify a third party by pressing the emergency button. Even if the child fails to press button, he or she still can get help because the guardians are being notified by signals from Electronic Tagging device.

Category 4	Setting	Phase 1	Phase 2	Phase 3	Phase 4
Perpetrator	40 year old, more than one previous conviction	Approaching	Kidnapping (threatening)	Movement	Commit a crime
Victim	6-12 year old girl / Apartment entrance	Does not recognize/ wariness	Recognize	Recognize	Recognize
Function of mobile phone	Detecting any abnormal activities (route, speed, etc.)	receives signals from Electronic Tagging, transmits warning message to guardians	check with guardian's remote camera, sound the emergency alarm, report to the police	Emergency button / Alarm/ Lighting	Emergency button / Alarm/ Lighting

Table 13. Category 4: Criminal with Electronic Tagging and Kidnapping

Although it was impossible to consider every circumstance, this chapter has discussed the most common circumstances to conduct a study on children's perceptions of crimes and devices that can be helpful in such situations. This discussion has led to the understanding that devices require the LBS function to locate a child, a child's action radius and progress needed to be recorded and designated and a remotely controlled camera and microphone are required to help a protector judge the situation. It has also helped better understand that it is necessary to be able to communicate with parents or a guard.

3.2. Model for device system

Research was conducted to determine how devices sense abnormal movement by situation and how to deliver the information to a third party via logical operational device systems.

For the purpose of the operational system, routing, the rate of movement and location of a child, needs to be collected as data in advance for a certain period to be patternized. If the patternization is completed, the movement deviating from it, which is abnormal speed or change in rout, is considered abnormal movement of a child and is primarily reported to a protector. The following figure provides a detailed explanation.

As seen in Figure 5, a model for device function has been proposed based on the analysis of the above stated categories.
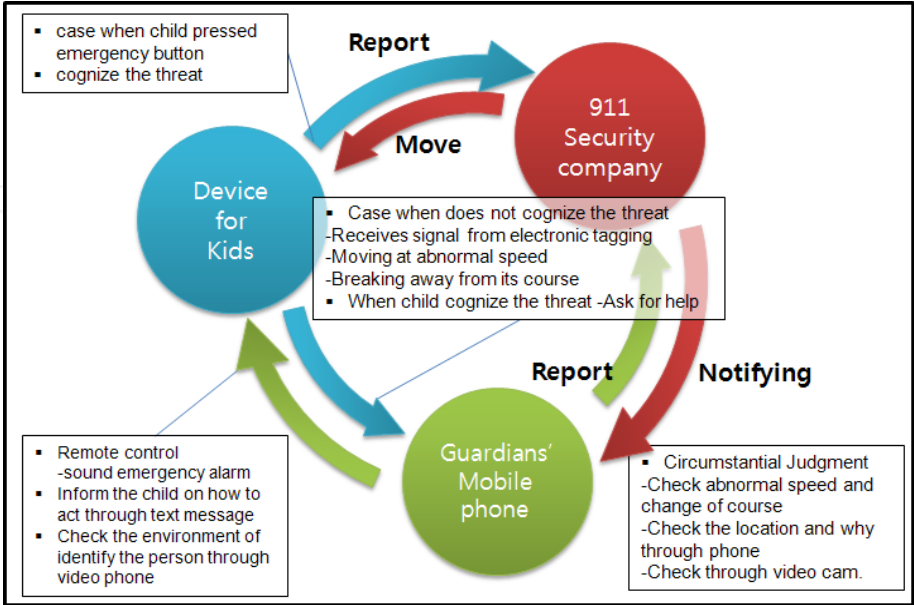

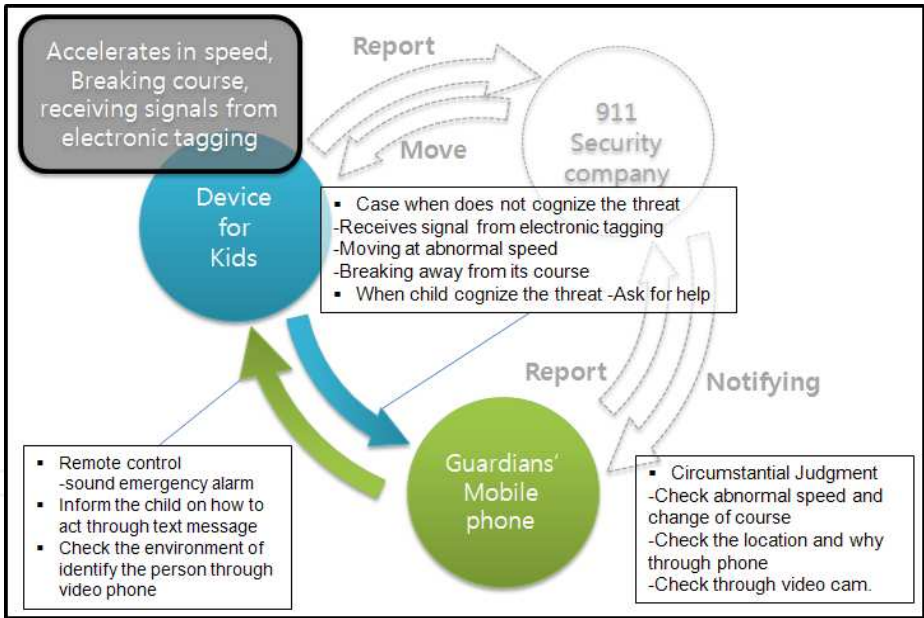**Figure 5.** Model showing function of child protection device

Figure 6. Model showing function of device when abnormal activities are detected

Based on the model illustrated on Fig. 5, Fig. 6 explains how a device for kids uses data on a child's routine pattern, moving speed, and signal from the Electronic Tagging and transmits information to a child's guardian when it detects abnormal activities

Fig. 7 shows how parents can explain to a child how to act through texting or calling based on the level of the threat. If a serious threat is determined, parents can sound the alarm and notify people nearby or contact a preregistered 911(US), 119(Korea), 112(Korea), or security company.
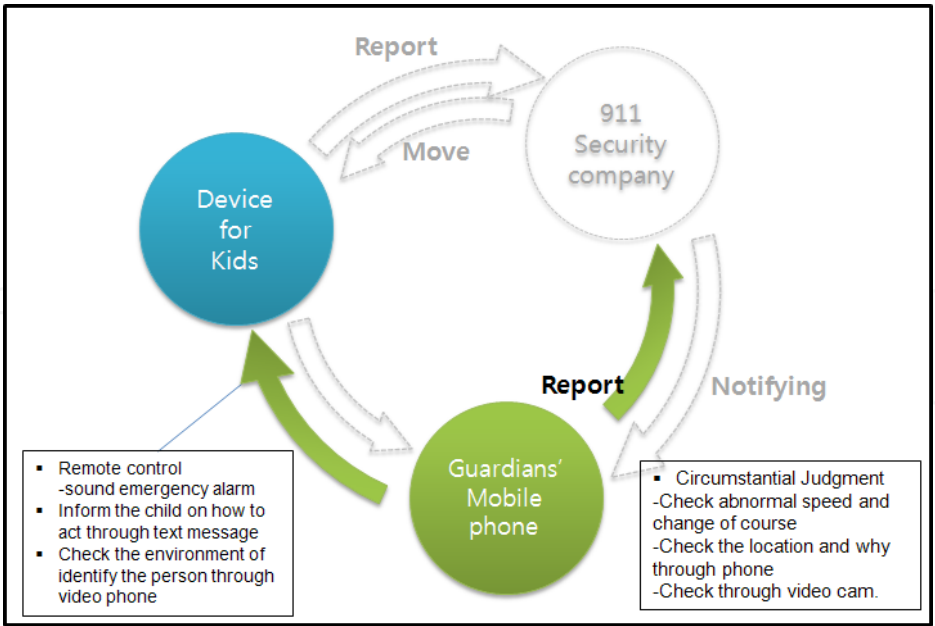
Figure 7. Role of guardians through understanding the situation

Fig. 8 shows how a system can automatically be activated and reported to the police when the device is damaged, the battery is forcibly removed, or the child presses the emergency button.
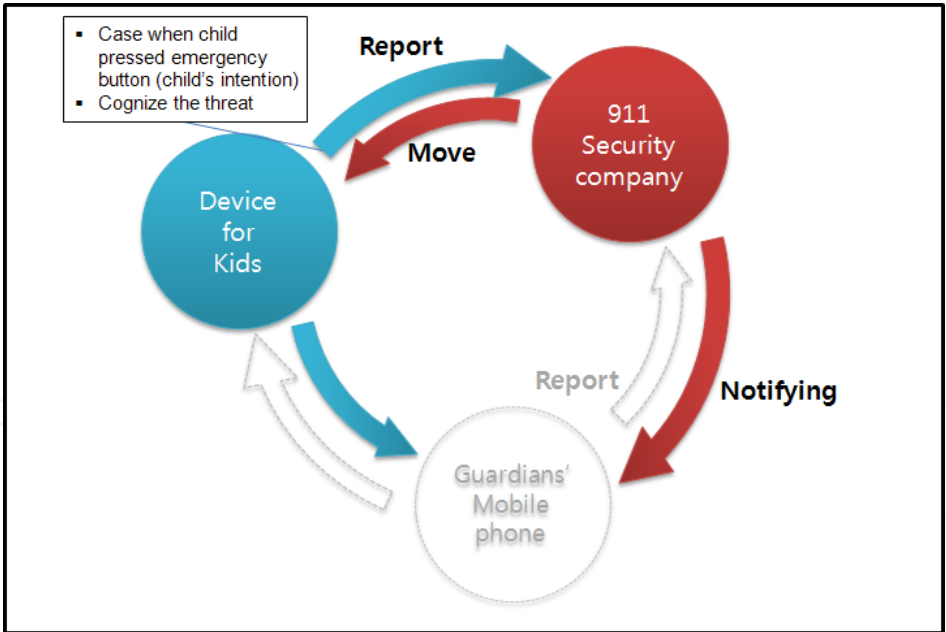
Figure 8. Model showing how children can report.

Findings suggest that a government agency (the police or a private company), a protector, and a child need to be linked to one another for cooperation when equipped with the system above as the device acts as a link. From examining products with similar or available functions among those on the market, smart phones are the technologies that best meet these requirements. However, given children aged 6 to 12 and such peripheral functions as

an emergency button, it is difficult to apply existing smart phones as they are, and guidelines are deemed necessary for developing beneficial devices.

3.3. Summary

* Ex-cons, first offenders, luring and kidnapping have been mixed to categorize four scenarios based on four stages of a crime as extracted from the study: crime prerequisite → approaching → luring and kidnapping → movement → committing crime. Research has been conducted to determine the status of a child and the role of a device in each phase.
* Research has been conducted to comprehend the role of a device through these scenarios. Toward this end, research has been conducted on detailed functions of a device through a systematic diagram.
* This process revealed that practical preventive measures can be generated when a protector – the government (the police) or a private company (a security service provider) and a child communicate with one another to effectively prevent crimes. A protector can immediately estimate the situation on behalf of a child and a government agency or a private security service provider must intervene to protect a child while the device acts as a link.
* From examining products on the market with regard to a device that can fulfill such a role, smart phones are deemed the closest ones and, given that users are children, separate developmental guidelines are needed.

4. Drawing mobile phone design and demanding app

The chapter suggests guidelines for developing a device for children so that crimes can be prevented.

Information herein has been established based on useful factors on previous research, technologies, and services.

4.1. Guideline for figure design

Categories		Types	Contents
LCD Screen	Without	-	May be limited as it allows only text informing
	With	-	Informs a child of how to respond through various information
	Type	Window	Provides information through text or illustrations
		Full touch	Button type (Hotkey & 10-key) can be jointly used and age-specific usage is possible
	Size	-	Should not be larger than 5x9cm for usage by children aged over 6
Button	Number of buttons	6-9 year old	Number and size of buttons should be designed while carefully examining abilities of 6-9 year old child's operational skill. Buttons with icons are preferred over letter and should be limited with call, end, select menu,

			and number button (includes emergency button)
-	9-12 year old		Number and size of buttons should be designed while carefully examining ability of 6-9 year old child's operational skill. Uses numeric keys and should be limited with call, end, select menu, and number button (includes emergency button)
Size of buttons	-		Size and shape of buttons should consider one hand and two hand operation separately
Shape of buttons	General		Should have convex design for easy operation of frequently used buttons
	emergency		Should be differentiated with general button and minimize unintended operation
Arrangement of buttons	-		General and emergency buttons should be separated to minimize unintended operation, but should not hide it
Type of buttons	Hot key		Specified key type makes for easy operation for a child under the age of 9. However, cannot make calls to many people
	10 key		Able to make phone calls to many people, but losses rapidness and is easy to operate for a child over age of 9
	Emergency key or strap		Can use specified key in addition to keypad to supplement weakness of 10-key type
	Track me		Unlike emergency button or strap, it has general button and different operational strategies
Color of buttons	Achromatic color		-
	Low /high chroma		Change of chrome can visually alert people to cognize threat
Text of buttons	-		-
Emergency function	Emergency buttons	Button type	Separate button can activate emergency button. It is easy to locate but has high risk of malfunctioning and is easily exposed to criminals
		Projected type	Projected type looks as if part of a mobile phone but activates when broken. Once it is broken, it is hard to restore. It is not easily exposed to criminals and may be hard for a child to break under certain circumstances
Emergency function	Emergency strap		Has a strap with hook. The hook may lead into malfunctioning; however, it has the advantage that a child can operate quickly compares to a button in any case
	Track me button		Child can inform guardians of his/her location when it is hard to make phone call or cognize great danger (unlike emergency button, it is used with general button and transmits signal with special operational method in emergency)
	Lighting	Lamp	-During night time phone calls -Notifying self location through flickering -Used as lantern in dark areas
	Sound	Speaker	Informs a child what he/she should do through sound
		siren	Ask for help through sound
Battery	Battery cover	Enclosed type (integrated)	Main body has integrated battery and powering off should not be easy

		Screw down type	Stops criminals from forcible powering off of a child's mobile phone. There will be an interval time to power off
	Battery charging	Use solar power	Should be sustained to enable communication with a child under any circumstances
		Self charged kit	Install portable or integrated self charger
	Latent battery		Has enough power to transmits signal of one's position for a certain length of time even after the battery is removed
Ubiquitous	camera	General phone call	Video telephone
		Emergency	Remotely collects data about the environment
	Mic.	General phone call	Telephone
		Emergency	Remotely collects data about the environment
	sound	Siren	Third party can remotely sound the alarm
Optional device	Watch, ring, necklace		Report the threat automatically once child's mobile phone is removed by criminals
	waterproof		Should operate under any circumstances

Table 14. Guideline for figure design

4.2. Guideline for application design

| Categories	Features	Characteristics
Screen layout	Selective layout is possible.	Cognition and operational skill of 6-9 and 9-11 year olds should be considered, respectively, for age-specific design.
		Using illustration is suggested over text for UI.
Text	Font size can be adjusted.	Suggests using 16 font of computer monitor and could be modified, if necessary.
	Font type can be adjusted.	Suggests using Gothic type, but may choose other types.
	Maximum number of characters within screen.	Should be able to give information with minimum number of letters; Korean 4-6, English 9 letters, and should be legible instantly (e.g., emergency)
Electronic Tagging	-Receives signal from Electronic Tag. -Informs preregistered guardians about the signal.	Receives signal once Electronic Tag and a child falls within certain distance.
Emergency service	Informs when child breaks out of route.	Warns guardians when child breaks time-based activity pattern.
	Informs when detects change of moving speed.	When detecting dramatic change of speed; from 2-3km/h (normal walking speed) to 30-60km/h or stop moving for long period.

	Guardians can remotely control child's camera and microphone of mobile phone.	With prior consent, guardians who received warning message may access and control child's camera, microphone, and siren, which are installed in child's mobile phone.
SMS	Able to transmits short texts	
	Transmits preregistered message in case of emergency.	Child can transmit text message to his/her guardians with one touch.

Table 15. Guideline for application design

5. Example

5.1. Device specification

The chapter introduces an example of a selective application of guidelines for a crime-prevention device for children.
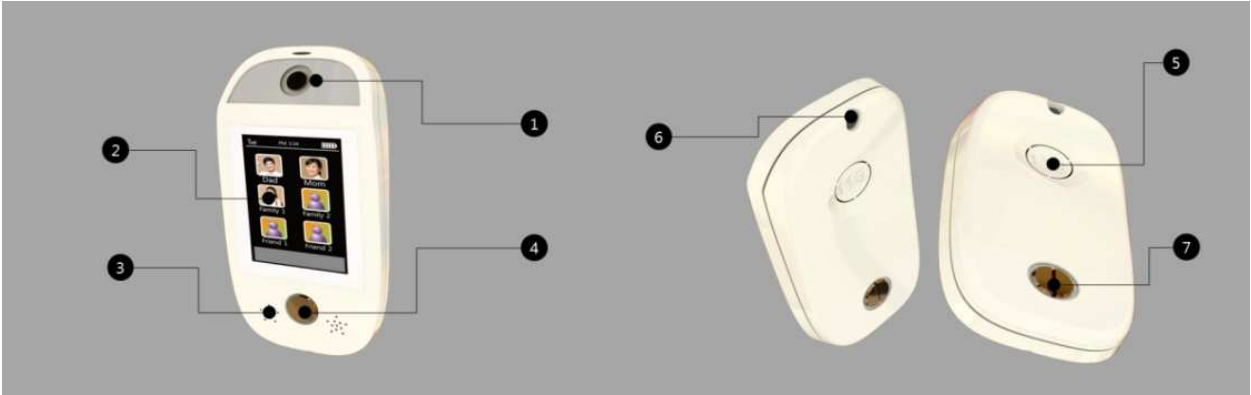
1   Remote Control Camera - Parents/Guardian can check up the child's surrounding using the child's mobile phone

2   Full Touch Screen - The layout can be made to suit one's taste. If the child is too young, parents/guardian can set it up.

3   Emergency Speaker - In emergency situation where child needs help, siren blows to inform their location; parents /guardian can also remotely activate blow the siren

4   Power Button

5   Emergency Button - If the button is pressed in an emergency where a child needs help, pre-set dial is activated to seek help.

6   LED Lamp / Emergency Light - Acts as a lamp and is automatically turned on when a child is isolated in the dark or will blinks to draw attention in the face of danger.

7   Battery Cover - If the power is turned off or battery is removed deliberately, it reports to a preset number.

Has a function that reports the location if the batter is removed.

Figure 9. Example of Device Specification

5.2. Age specified set-up

It is possible to set up the screen by age or taste. As users are aged 6 to 12, it has been divided into hotkey method and 10-key method based on children aged 9; however, can be set up in consideration of cognitive ability and manipulability.
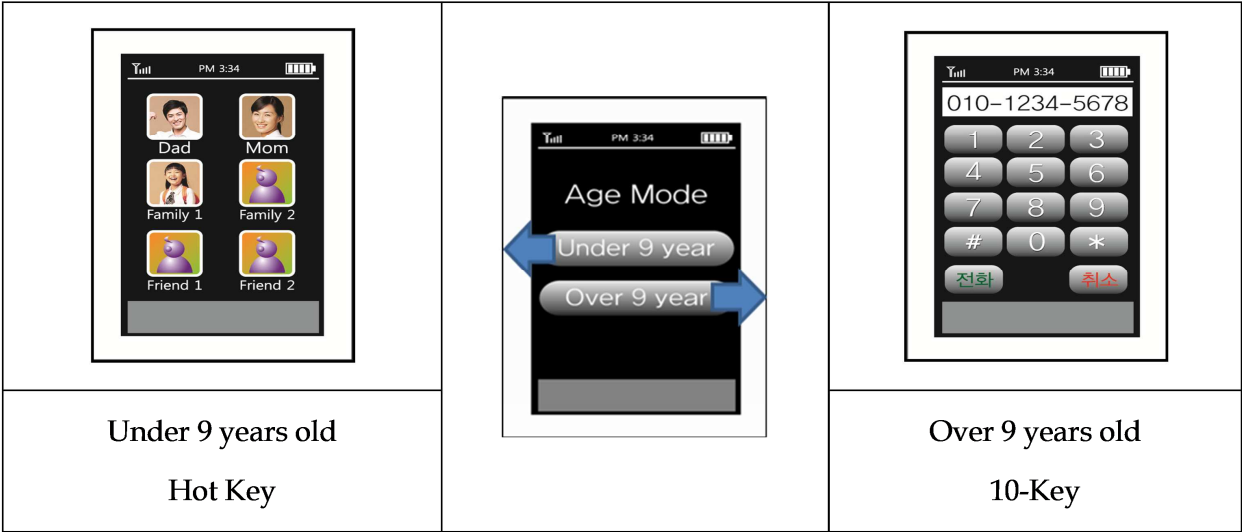
Under 9 years old		Over 9 years old
Hot Key		10-Key

Figure 10. Example of Age Specified Set-up

5.3. Initial route set-up

Because it is difficult for a child to conduct an initial setup for oneself, it can be set up with the help of parents as seen below. The initial setup is conducted based on synchronization of a device with a computer. Figure 11 provides an explanation for the initial setup. First, if the home address and school address (destination) are entered, movement section is indicated, and if a private academy or friends are added, destinations are additionally entered as well. At that time, a child enters all possible routes. Although all routings have not been entered, they can be added during the period of collection of data.
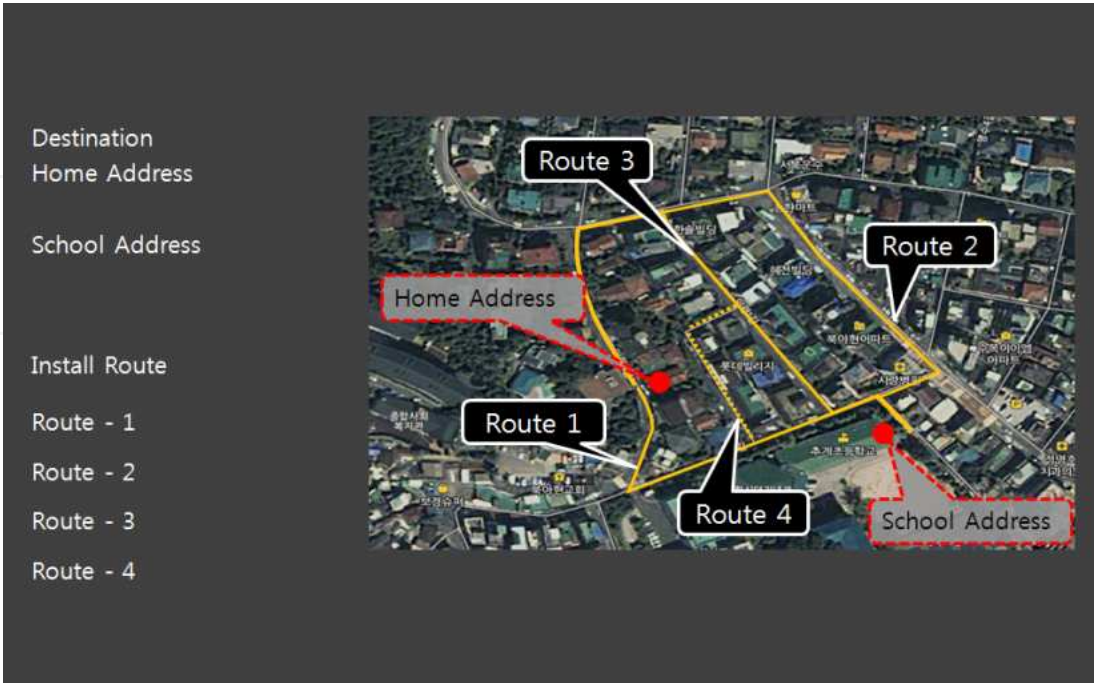

Figure 11. Example of Computer-Based Initial Setup Screen

After the setup, the device collects and records the routing of a child during a certain period. At that time, the direction and speed of movement are recorded by time and routes. The minimum unit of time is a week during a certain period and considerations are given for time of end of the class and after-school activities by day; learning schedule is designated by the week. Figure 12 below shows an example of recording changes in the daily movement of a child.
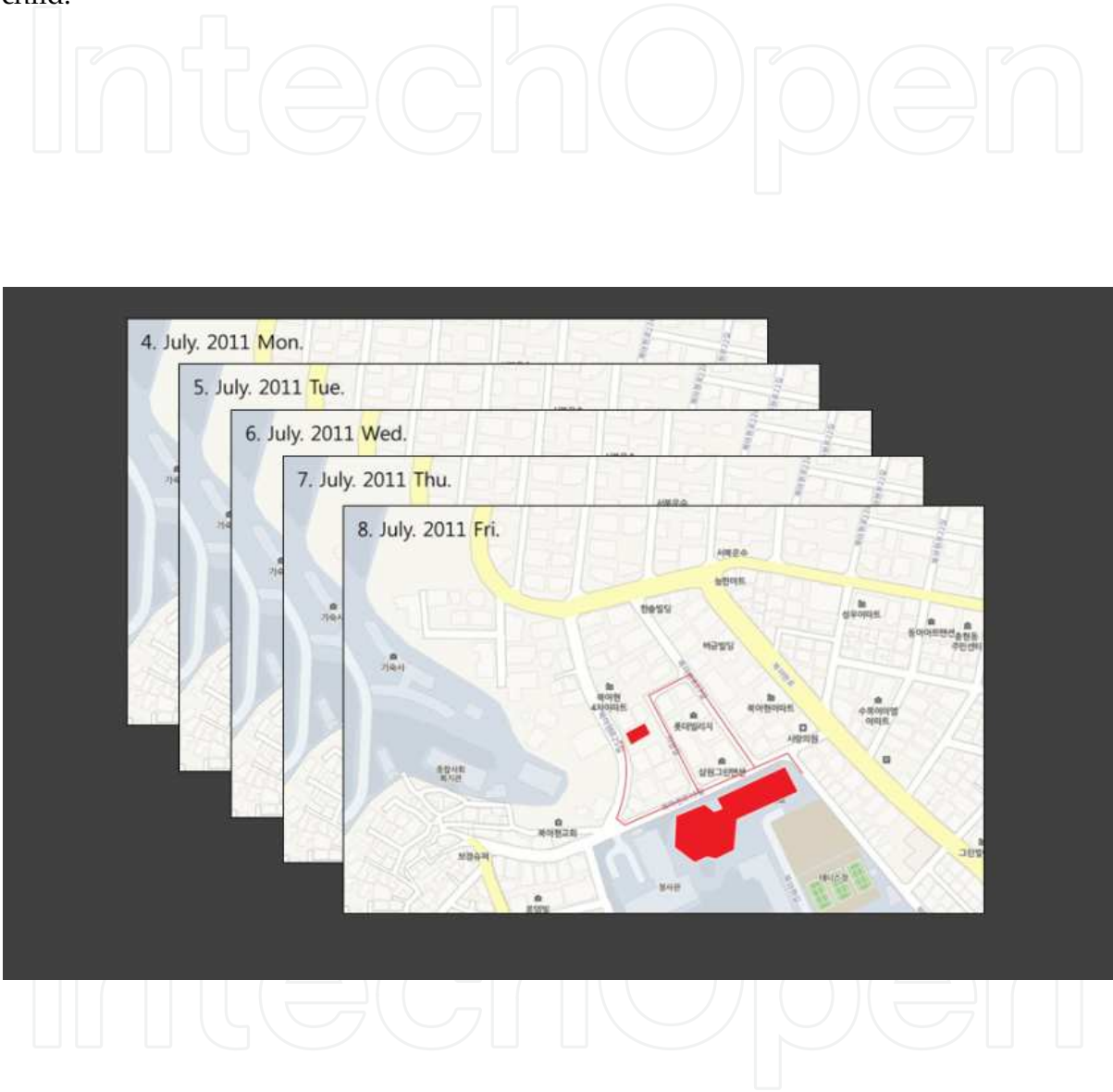
Figure 12. Example of Collection of Routing Data by Time and Day

Information collected for a week is recorded and the longer the period of data collection, more accurate patterns are displayed. The frequency of a child's movements are indicated as the thickness of a line and a private academy and a friend's house that have not been initially set up are recognized as abnormal routes to be reported to a protector for confirmation before the addition of the new destination and route. Figure 13 exhibits patternization of collected information.

Figure 13. Example of Patternization Based on Collected Information

This figure refers to collecting routing and speed and direction of movement by unit time in addition to frequency of routing.

It senses abnormal changes in speed, long-time stoppage, and reverse-directional movement on the part of a child to report them to a protector for interaction.

6. Conclusion and limitations of the study

6.1. Conclusion

Theoretical examination and statistical research have helped understand serious problems in crimes against children who cannot protect themselves because of physical differences between when children perceive imminent danger. Such research has led to understanding that it is necessary for a third party to intervene for the sake of children. In the process of conducting research on including a third party, finding suggest that effective prevention can be realized when three factors exist (e.g., a child, society (the government or a private company), and a protector) and cooperate with one another. To facilitate such cooperation, a device enabling interaction is required to act as a link among the three factors. Among commercial products that are equipped with such functions, smart phones have been deemed appropriate; however, children are expected to have difficulties using existing

smart phones as they are. In this regard, guidelines have been suggested through the application of available technologies and functions based on collected information.

With regard to the effectiveness of the study, it seems desirable that the government, rather than private companies, take the initiative for the welfare of children. This is because more children from low income families could benefit from measures taken by the government as it incurs costs of purchasing and maintaining such devices.

6.2. Limitation of the study

In the process of conducting interviews at welfare facilities, it was found that more sexual assaults are committed by acquaintances than by strangers and unofficial small crimes are frequently committed by relatives, which has not been accurately reported to protect children.

According to the study, it is impossible to protect many children from acquaintances committing a crime; however, it is difficult to prevent ex-con acquaintances from accessing children as they are acquainted with children.

In the process of conducting interviews with experts, other circumstances than usual situations were discussed with regard to evaluation of scenarios, which has been excluded as it appears difficult to consider each circumstance.

The longer the period for collecting data, the more sophisticated patterns; however, it might result in difficulties in preventing crimes that occur in the process of collecting data. Additionally, if it is difficult for parents to use a computer, it might be tricky to get help immediately.

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