Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 22 (2013) 762 – 771

Procedia Computer Science

17th International Conference in Knowledge Based and Intelligent Information and Engineering Systems - KES2013

Development of MMRS (Mind Map and Relief System), an Information Sharing System for Children's Safety

Hiroko Kanoh *

Yamagata University, Institute of Arts and Sciences
1-4-12 Koshirakawamachi, Yamagata-shi, Yamagata, 990-8560 Japan

Abstract

MMRS was developed as a system that eliminates parents' anxiety by watching over their children and sharing information about their safety. Through MMRS, parents and school staff can confirm the location of children through GPS and at the same time view a visualization of their mental state, which cannot be seen by the naked eye. Also, in areas cell phone signals cannot reach, one special feature of the system is that it is equipped to use ad hoc and multihop networks.

Keywords: Children's Safety; School; Parents, Ad hoc networks; Multihop networks; MMRS

1. Introduction – Source of the Problem

In recent years, along with indiscriminate murders, incidents of abduction or kidnapping with unclear motives, or where the only motive seems to be shocking the public with the obscenity of the crime, as well as cases in which minors are victimized by people living in their neighborhoods, have been occurring. One example is the incident in 2006 in Akita prefecture, where in the course of one month, two children living in the same neighborhood, one 9 years old and one 7, were murdered. The perpetrator of these crimes was the mother of a child living in the neighborhood, who had helped with the search efforts for the missing children since the start of the investigation. In Shiga prefecture in 2006, there was a case where in the course of meeting and seeing off the children to and from school, a role that was performed by rotation, a child was pushed off a bridge and killed by the parent of a child who lived in the area and attended the same kindergarten. In 2004 in Nara prefecture, a little girl was killed by an acquaintance from the neighborhood (a newspaper salesman

*Hiroko Kanoh. Tel.: +81-23-628-4689; fax: +81-23-628-4685.
E-mail address: kanoh@pbd.kj.yamagata-u.ac.jp.

doi:10.1016/j.procs.2013.09.158

working in the area). In Nagasaki prefecture in 2003, there was a case in which a 4-year-old boy was kidnapped from an electronics wholesaler within the city and murdered by a male 12-years-old 1st year junior high school student. The 12-years-old who committed the crime said to the boy, “Mom and dad have already left. Let's catch up with them together” and took him from the store. While they were riding the trolley, the 4-year-old boy believed what the 12-years-old had told him and didn't cry out to anyone for help. As a result, in an 8 floor parking garage 4 km from the site of the abduction, the perpetrator stripped the boy, teased him and cut parts of his body with scissors, then finally killed him by throwing him from the rooftop of the building.

Even when it doesn't end in murder, the victims of kidnapping are often minors and females. According to the Cabinet Office's 2012 White Paper on Crime Victims [1], there were a total of 185 incidents involving kidnapping and human trafficking in that year, and in roughly 80% of these cases, the victims were minors (148), or female (146). Among the 32 cases where victims were of ages less than 1 to 5 years, 17 cases involved females. Among the 59 cases involving victims of ages from 6 to 12 years, 45 cases involved females. And among the 57 cases involving victims of ages from 13 to 19 years, 52 cases involved females. Of all the minors, the 6 to 12 age group was the most victimized, and females made up the largest percentage of the victims among the 13 to 19 age group.

According to the 2012 White Paper on Police[2] , the changing trends of arrest rates in kidnapping cases are although up until 1999 the arrest rate was over 95%, it changed a continual decline from the years 2000 to 2004, falling as low as 72.5%. The rate began rising after that, but since 2009 it has never exceeded 90%. Although in the past kidnapping was driven by clear motives such as ransom money, in recent years the motivations have become more diversified, and this change may be connected to the trend of falling arrest rates. The truth is, in cases like those discussed in the opening which were not motivated by ransom money, the investigation begins without even a clear understanding of whether the victim has been kidnapped or just been in an accident. These kinds of incidents are on the rise, and this is most likely connected to the declining arrest rates, and has also led to an increased nervousness and anxiety among people.

According to the 2012 White Paper on Crime[3], the changing trends of anxiety related to crime are shown anxiety is increasing. In this paper related to the rate of anxiety when walking alone at night (taken from the ratio of responses to the question “How safe do you feel it is to walk alone after dark in the area where you live?”), the combined total of the responses “it's very dangerous” and “it's a bit dangerous” increased 22.4% in 2000 to 32.7% in 2012. Also, the fear of being the victim of trespassing (taken from the responses to the question “How likely do you think it is that someone will trespass in your home within the next year?”), as shown by the combined total of the answers “extremely likely” and “likely,” increased from 39.1% in 2000 to 60.7% in 2012.

In this kind of environment, expanding the use of security cameras and increasing the power of security systems is not enough. In order to get to the core of the issue, an information sharing system that can show the mental state of children and deliver a full sense of security and peace of mind is essential.

2. Research Circumstances and Objectives

Concerning sharing systems for information related to the safety of children, Yasunori Takeuchi (2009) [4] set up position searching base stations in locations such as the telephone poles in the area where students traveled to and from elementary school, and used these to develop a system which allowed parents and school staff to search and confirm the locations of children using a computer. Daisuke Fujita, et al. (2011) [5] also used electromagnetic wave badges (RFID tags), and developed a system that notified parents when students' RFID tags were read (in the form of location information), and recommended the use of this system together with traveling in large groups to and from school for the best protection of students. Also, Nobuhiko Nishio (2010) [6] constructed a communication system to support the local volunteers in safeguarding students'

traveling to and from elementary school, through the application of ICT to RFID and other sensor networks. This system implements sensors and volunteers along with having students travel in large groups, and the combination of the strong points of machines and humans creates an ideal protective environment. However, while the participants' morale was rising, and the implementation of large groups was successful thanks to the volunteers' efforts, there was some concern about the participants' actions causing the volunteers to get tired out, and shifting responsibilities among different generations. This could possibly lead to declining morale, which raised some doubts about the sustainability of the system.

Starting from this point, in this project, I have developed a system which allows parents and school staff to confirm positional data using a computer, and at the same time to access tools for visualization of children's mental states, without the need for a group of volunteers to encourage traveling in large groups. The result is an information sharing system that aims to confirm safety and give users complete peace of mind.

3. MMRS (Mind Map and Relief System): A System for Sharing Information Related to Children's Safety

3.1. What is MMRS (Mind Map and Relief System)?

It is often said that “children get unexpectedly wrapped up in crimes,” but is it really impossible to predict these things happening, or are we just not trying hard enough to see the signs? Through the visualization of the mental states of children, we can consider preventive measures. For example, if a child is being bullied, and the bullies are gathering in a group along the path to school, the child may take a detour down a narrow alley to avoid them. If children fight with their friends, they may separate from them and return home by themselves. In this kind of situation, if a stranger were to call out to them kindly, in some cases they could become the victims of a crime. No matter how many side streets are fitted with IC tags and security cameras, there will always be an unlimited number of additional paths. If children fight with their close friends, and make plans to meet up with strangers they've met on the internet, this can be the start of a kidnapping. As a new means of preventing this kind of crime before it happens, the “Mind Map and Relief System” is a tool which makes use of information technologies to produce a visualization of the unseen workings of children's mental state.

The “Mind Map and Relief System” is a method for visualizing happenings and the thoughts and feelings that accompany them around a central time axis. Happy events and happenings inspiring positive thoughts are depicted on the left hand side. Events that inspire negative thoughts, such as sadness, regret, and emotional pain, are depicted on the right hand side. The most recently entered feeling information will be displayed at the top. Through the development of a MindMap (a table logging the history of feelings data over time), users can take an objective look at themselves, stimulating the faculties of metacognition and aiding in the achievement of self-control and objectivity in their actions (Kanoh, 2006[7], 2007[8], 2009[9]) .

In addition, by inputting when, under what circumstances, and where an event occurred using a cell phone with GPS functionality, action records can be saved on a map using the location data. Parents, by viewing this screen, can find out where their children are and how they are feeling from any computer. With the combination of this map and the MindMap, parents and their children can look back on the children's activities together, and discuss important issues such as why the children were sad at certain times, whether the children have had a falling out with their close friends, and how it's best to stick to the main roads which have many pedestrians even if taking a detour when coming back home from the park. In this way the children can analyze their own actions and try to understand the causes in their own way.

3.2. Use of a Study History in the Pursuit of a Base Level Model

As techniques for grasping the changes in learning patterns, a number of different models such as the concept mapping method devised by Novak, et al. (1992) have been established. In the case of the concept mapping method, the main goal was to see how concepts changed in terms of cognition. However, not all aspects can be understood through this method. For example, even if a problem is difficult, the experience of taking the time to consider and eventually understand it can stimulate confidence and desire to learn, in turn leading to the desire to challenge oneself and take on still more difficult problems. In cases where new achievements are attained, changes on the emotional side are important, but these kinds of changes are difficult to visualize. Therefore, as a method for grasping changes on either the emotional side or the cognitive side of things, I have implemented a systematic method for diagramming changes in study habits, called a study history. By drawing up a study history, students are encouraged to look back on their studying process, which can lead to both feelings of accomplishment and improved confidence.

The pursuit model using study histories is a circular application of the recursive elements of the autopoiesis theory of Humberto Maturana and Francisco Varela (1991). This autopoiesis theory was constructed from Maturana's nervous system model, and viewed neurons as "units of self-referencing regeneration and heredity," suggesting that the operations of neurons themselves determined their boundaries. According to Kawamoto (2000), such systems are defined as follows: "An autopoietic system is a network involved in a repetitive process of production of components (including both transformation and destruction), which has been constructed organically (from regulated units). (i) The components produced by this repetitive process, through various conversions and interactions, become a part of the system construction itself. At this time they have become integrated into the network related to this component production, and driving further network operations. The components drive further operations of the system and become part of its construction, and through this operating process the extent of the system architecture is determined. (ii) When the configuration has established a closed system, the network (system) can be seen as a collection of definite units, and a characteristic space takes form. At this time, the space projected into by the continuous formation of the closed network forms the topological space of the system, and this is the system's operating boundary." In addition, an autopoietic system is a system that is autonomous, self-referencing, and self-constructed, and although circular, is closed. Although these systems are closed, they are autonomous and have a dynamic nature.

Pirie, et al.'s transcendental recursive theory of mathematical understanding is one application of autopoiesis theory to a study model (Koyama, 1992; Kanoh, 1998) [10]. Pirie, et al. classified mathematical understanding according to 8 different standards, primary recognition, image creation, image ownership, property recognition, form creation, observation, structuring, and invention. However, considering the study not just of mathematics, but science education as a whole, not all studies involve a process of invention. Some studies don't require the process of form creation, either.

Therefore, the learning process is constructed as a circular, autonomous, self-referencing, self-constructed system of "feeling accompanied by understanding," and can be classified into the 3 levels of "the process of acquiring individual pieces of knowledge," "the process of pursuit of knowledge," and "the process of real-world application and reduction of knowledge to basic elements." Also, the process of acquiring individual pieces of knowledge is expressed as a collection of "specific knowledge2," and after passing through the process of pursuit of a magnification of the image, the circle expands still larger, into the realm of real world application and reduction. Knowledge that has been put through application and reduction in this way becomes a characteristic element of the system, ready to be applied at a future date, and a part of the recursive model of pursuit, as shown in the circular model of Figure 1. The real world is defined as all of the ubiquitous phenomena that are a part of the world, and within this omnipresent real world are individual and particular points of knowledge, which through pursuit of knowledge and the learning process became bound together as a

part of our individual knowledge bases. As knowledge is always being applied and expanded in this real world, I have chosen to represent it with the image of an expansive circle.

Also, the thin lines marked with arrows indicate changes in learning. These changes are shown in chronological order beneath the circle. The arrow that goes straight across from left to right represents the time sequence, and the emotional state is plotted vertically over time, with 0 as the middle, positive feelings above the line, and negative feelings below it. Events (such as the content of study activities, etc.) are shown in squares, and the impressions of the student at that time (an introspective description of their emotional state) is shown in a circle. This format is called a study history. The system which displays this history is the MMRS (Mind Map and Relief System).

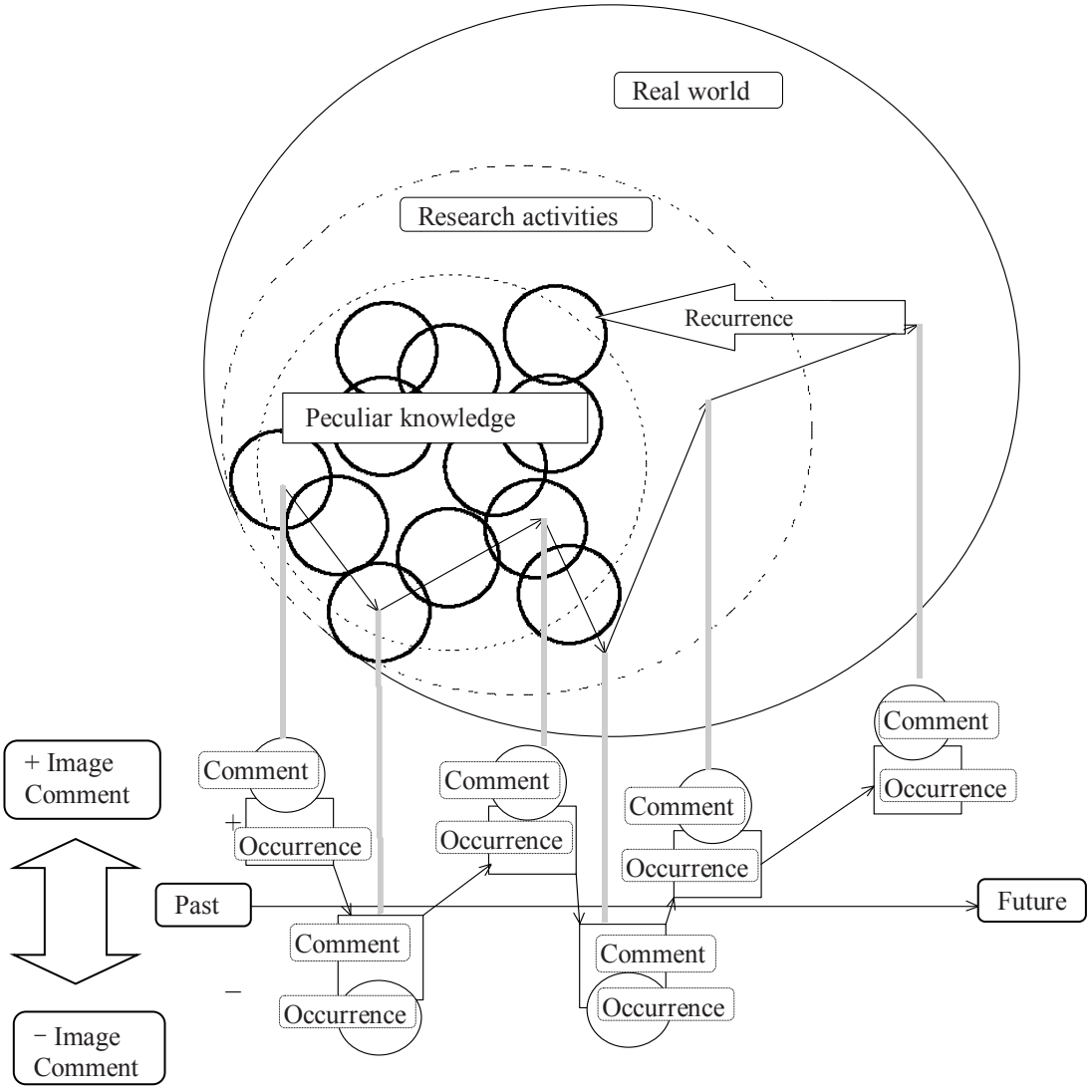


Figure 1 Pursuit Model and Study History

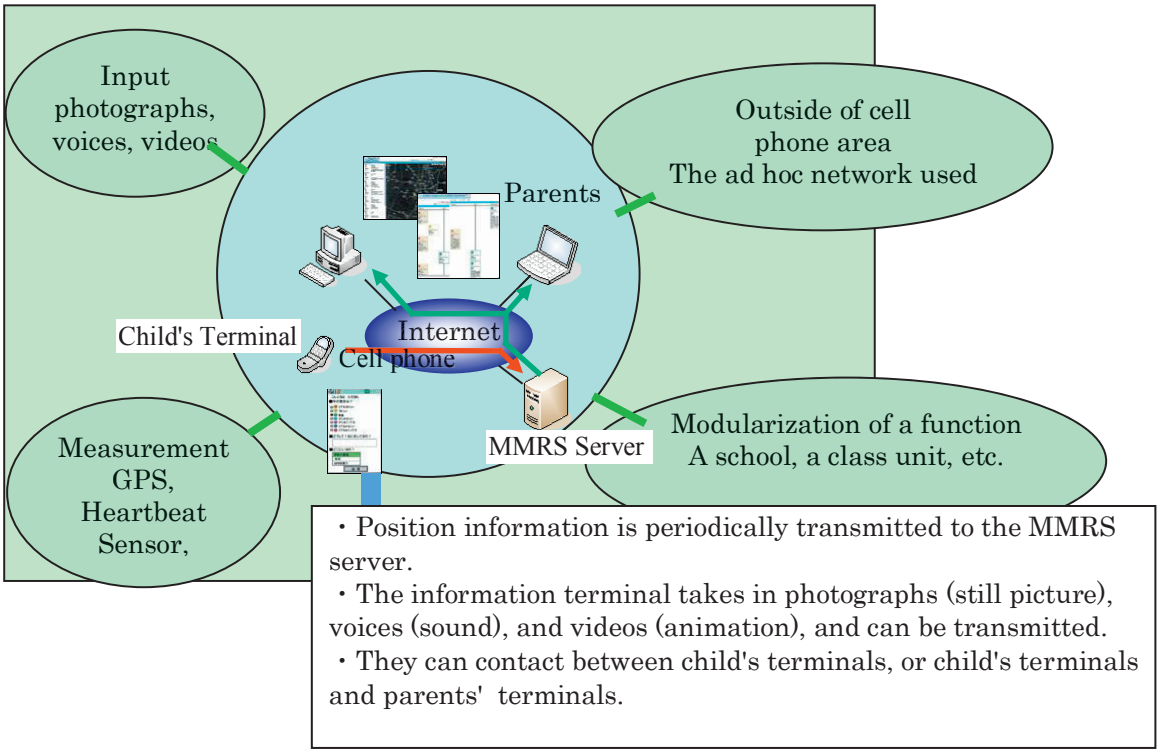


Figure 2 MMRS (Mind Map and Relief System) System Overview

3.3. Overview and Functionality of the MMRS (Mind Map and Relief System)

An overview of the MMRS (Mind Map and Relief System) is shown in the image of Figure 2, and the system's functionality is the following list. This system is equipped with the following functionality.

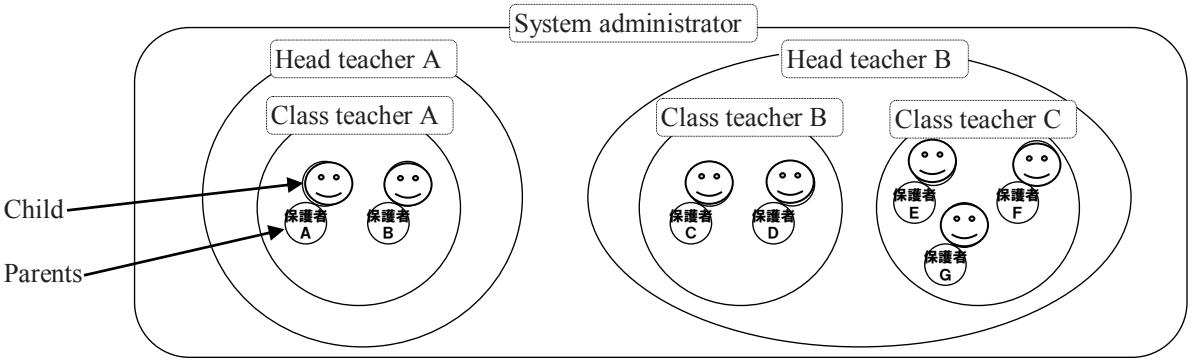
- Missing Children Search Function
- Group Display Function
- Real Map: Confirms Children's Current Location through GPS
- History Map: Confirms Children's Past Activities through GPS
- MindMap: Feelings Data Entry and Browsing Function
- Heartbeat Information Notification Function (Heartbeat mean the beat of the pulse.)
- Movement Speed Display Function
- Danger Information (Sound / Video / Picture) Report Function
- Contact Function for Parents, Teaching Staff, and Children
- Checkpoint Information through FeliCa Card and Parent Notification Function
- Attendance Roll Call Function

In underground parking areas or the mountains, cell phone signals cannot reach. Although children are unlikely to travel to this kind of place on their own, they could be taken there as a prank and abandoned in this kind of location, or get lost on the road back from a study trip into the woods.

This system was developed precisely for this kind of emergency situation, with a function that allows users to create a network to search for missing children with only a computer. This is the “Missing Children Search” function, which uses an ad hoc network and cell phone lines.
Also, even if its not an emergency, the ad hoc network can be used when internet service is unavailable, and data can be sent to a computer that is connected to the internet, enabling continuous free usage. In this way, the cost-benefit ratio of this system, as well as its level of sustainability, are both high.

3.4. MMRS Network Installation Method

Ad hoc networks, multihop, and a network using cell phone lines have all been installed. One of the merits of multihop is that, unlike in the base station systems of Nishio (2010) and Fujita, et al. (2011), base stations are not necessary with this kind of network. Because direct transmission is possible at all nodes within range, the connectivity of the network as a whole is high. The management screen for controlling user permissions on the parent and teacher side is shown in Figure 3. The network installation methods are shown in Figure 5, and the appearance of the input system is shown in Figure 5.



	ChildA	ChildB	ChildC	ChildD	ChildE	ChildF	ChildG
System administrator	o	o	o	o	o	o	o
Head teacher A	o	o	×	×	×	×	×
Class teacher A	o	o	×	×	×	×	×
ChildA	o	o	×	×	×	×	×
Parents A	o	×	×	×	×	×	×
ChildB	o	o	×	×	×	×	×
Parents B	×	o	×	×	×	×	×
Head teacher B	×	×	o	o	o	o	o
Class teacher B	×	×	o	o	×	×	×
ChildC	×	×	o	o	×	×	×
Parents C	×	×	o	×	×	×	×
ChildD	×	×	o	o	×	×	×
Parents D	×	×	×	o	×	×	×
Class teacher C	×	×	×	×	o	o	o
ChildE	×	×	×	×	o	o	o
Parents E	×	×	×	×	o	×	×
ChildF	×	×	×	×	o	o	o
Parents F	×	×	×	×	×	o	×
ChildG	×	×	×	×	o	o	o
Parents G	×	×	×	×	×	×	o

Figure 3 User Permissions

The ad hoc network used DECENTRA by Skyle Network

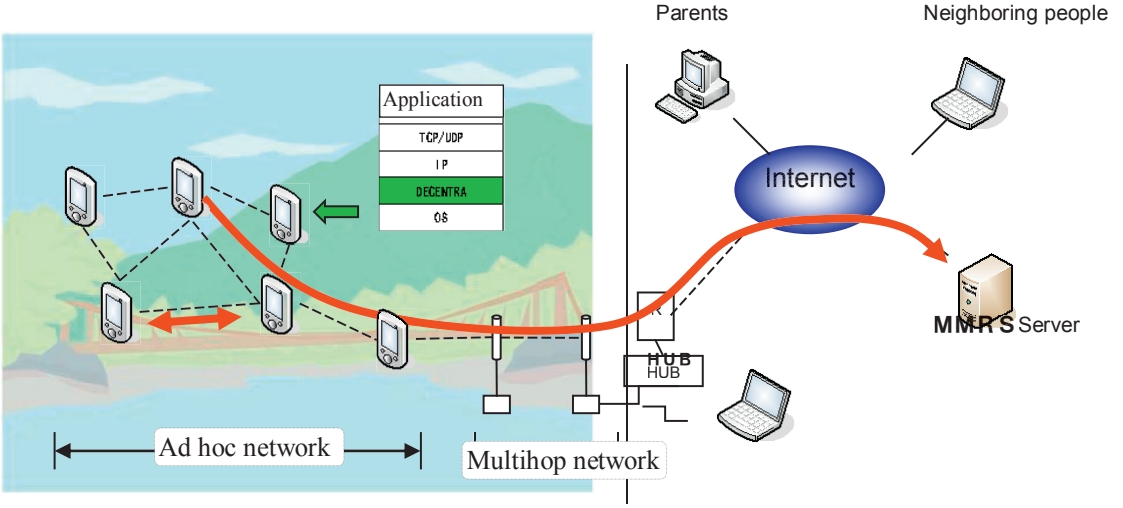


Figure 4 Network Installation Diagram

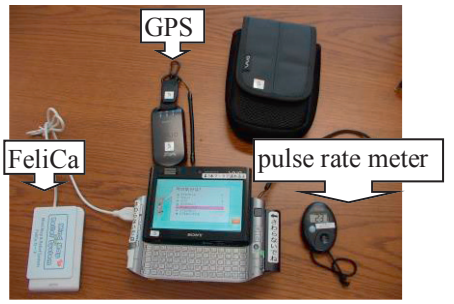


Figure 5 Complete System

Children's location information and input emotion data can be checked on a computer by parents or teaching staff. This confirmation screen is organized as shown Figure 6.

3.4.1. Roll Call Check

Click on “Roll Call” and the registered data appears in a list format.

Students who were present are marked by a green icon, and others are marked with a gray icon.

○Meaning of Marks

Roll Call is marked with this icon: . Very happy is shown with this icon: , a bit happy is this one: , OK is this one: , a little sad is this one: , a little angry is this one: , very sad is this one: , and very angry is this one: .

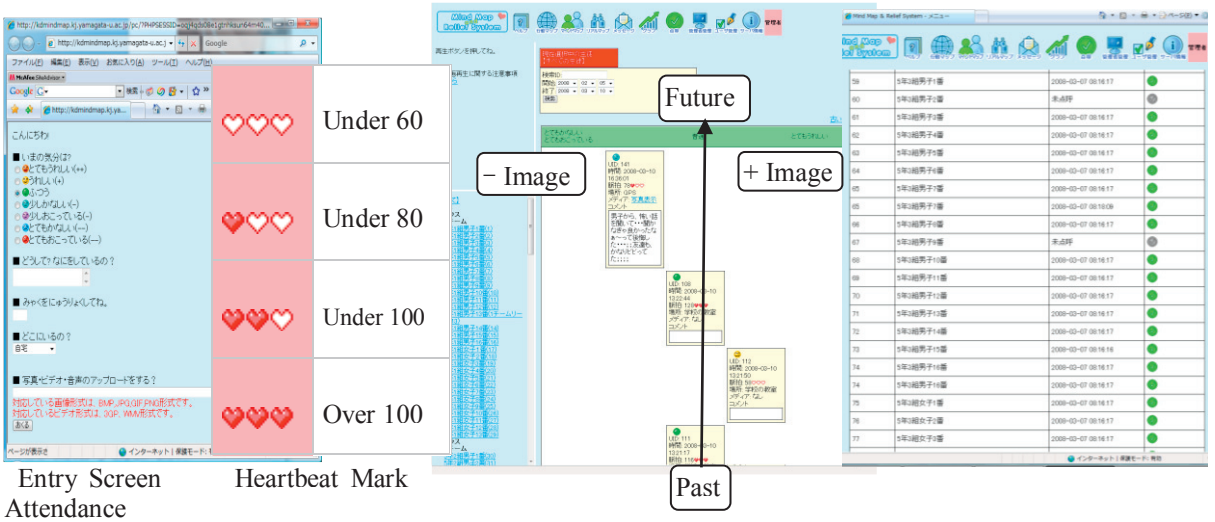


Figure 6 Entry Screen and History Chart (Negative Feelings Positive Feelings)

Figure 7 The real map and behavior history

3.4.2. Emotion Input Confirmation

Heart rate is displayed with heart icons as shown in the table to the right.
Also, the location where the feeling data was entered is displayed on the map with an icon. Pictures, video, and comments about the area the student was walking in are also displayed.

3.4.3. Confirming Behavior History

Click on the real map and behavior history is shown in Figure 7. The green line connects the icon in the light blue square with the measured values. As long as the computer has power, this information will be automatically updated once every 5 minutes.

4. Conclusion

In this paper, I have related the circumstances leading to the development of the MMRS information sharing system for children's safety, as well as given the reader an overview of the system and its functionality. What's special about MMRS is that while supplying children's location information to parents and school staff, it also transmits sound, video, emotional status, and heartbeat information to these users' computers, making the role of volunteers in making sure students travel to and from school in large groups no longer necessary. With these tools for visualization of children's unseen mental state, this information sharing system aims for complete security and peace of mind. In areas out of reach of cell phone signal networks, ad hoc and multihop networks can be used to run missing children search functions. The next step for this project is the performance of field testing to accumulate proof of the system's effectiveness.

References

[1]2012 White Paper on Crime Victims (May 22, 2013)
http://www8.cao.go.jp/hanzai/whitepaper/w-2012/html/zenbun/part3/s3_12_01.html
[2]2012 White Paper on Police (May 22, 2013)
http://www.npa.go.jp/hakusyo/h24/honbun/index.html
[3]2012 White Paper on Crime (May 22, 2013)
http://hakusyo1.moj.go.jp/jp/59/nfm/gmokuji.html
[4]Yasunori Takeuchi (2009) Application of a High-Precision Location Tracking System to the Development of a System for Watching Over and Safeguarding Children, 2009 IEICE Proceedings Archives Essay Collection ;**2**, 16 -17.
[5]Daisuke Fujita, Junko Toyosawa, Yasushi Sasaki (2011) Empirical Research into the Use of Electromagnetic Badges (RFID Tags) to Manage the Safety of Students Traveling to and from Elementary School, School Crisis and Mental Care 3, 1-11, National Mental Support Center for School Crisis, Osaka Kyoiku University.
[6]Nobuhiko Nishio(2010) Construction and Real-World Testing of a Child Safeguarding System, with the Cooperation of Local People (<Report> Protecting and Raising Children) Operations Research and Management Science 55;**8**, 459 - 465.
"Osaka Ubiquitous Center Street Corner Safeguarding Robot Project" (May 22, 2013)
http://www.osakacity.or.jp/mimamori/index.html
[7]Hiroko Kanoh (2006) PBD SPACE, a Support System for Interview Lessons in Higher Education, Yamagata University Faculty's Practical Education Research 1, 99-107.
[8]Hiroko Kanoh (2007) Analysis of Emotional States of Information Technology Class Participants through the Use of Study Histories, JSSE Research Report 21;**6**, 27-32.
[9]Hiroko Kanoh (2009) Analysis of Study History in Spontaneous Pursuit of Learning – Expansion of the Autopoiesis Theory Model, The Japanese Journal of Educational Objectives and Evaluation Studies ;**19**, 57-66.
[10]Hiroko Kanoh (1998) Consideration of a Process Model for the Understanding of Mathematics Education, Practical Education Psychology Research 14;**20**, 14-18.