The Development of User Observation Method and Analysis Tool in Mobile Environment
-With emphasis on the development of observation method at user's point of view by wearable micro-Camera and analysis tool.

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Abstract

User observation becomes the integral parts of understanding user's behaviors in early design process. However, observing user in mobile environment is difficult: it requires not only capturing small screen of mobile devices but also recording user data in various points of view such as detail behaviors in micro point of view, path of events in macro point of view. This paper developed prototype of tools (Mobile Observation System: MOS) which consists of three parts. First, the wearable micro camera equipment, glasses which contains micro camera in its leg, supports to observe from user's point of view and capture small screen of devices. Second, the observation method, shadow tracking, is good to getting user's behaviors in observer's point of view. Third, the user path observation tool with GPS technology can record user data in macro point of view such as user path, changes of space. Furthermore, this paper suggests a software (Mobile Observation Analyzer: MOA) as a means to analyze the observation data taken from MOS in accordance with the mobile environmental factors. The efficiency of MOS and MOA has been proven by factual experiments and such clarifications turned out to supplement the problems that emerge with the current observation methods and data analysis tools. The point of using a wearable camera is that we can observe from the user's point of view. It proved that more accurate observations of the user's behavior in real situations can be made, and the results can be analyzed with the MOA. Recording time and angles of the wearable camera must be revised, and additional experimentations in complex context must be further researched.

1 Introduction

Today, the market demand of portable information devices, such as PDAs and mobile phones, is rapidly increasing and many of these devices have already been widely spread in our daily activities. For example, the number of mobile phone users in Korea reached 32 million people, taking 70% of population, as of 2002 and is expected to increase constantly. These portable information devices are generally referred to as 'mobile products' based on their common characteristic: their mobility.

As market demands for mobile products increase and the markets themselves expand, mobile products attract public attention. In result, companies, colleges and universities, and research institutes have been implementing various researches on mobile products, and user observation researches to understand the reality of mobile product usages have been one of them.

User observation method is a tool of understanding users that records problems that may occur in users unconsciously or distinctive behaviors and patterns of users through observation. For example, video ethnography installs camcorders or other video-capture devices in a designated spot and records the methods or behaviors of how users use the products for a certain period of time. These record data conveys distinctive behaviors, problematic uses, and patterns that occur to the users unconsciously and is analyzed to be applied for new product development. However, mobile products differ from other products that are applicable for existing observation methods in terms of actual user environment. For instance, electronic appliances such as vacuum cleaners, refrigerators and microwave ovens are fixed on interior spaces and are conveniently observed by existing methods, such as the video ethnography. However, the user environment of mobile products is not fixed, but is varied due to the mobility of the products, generating variable interactions between the users and their devices and thus, making it difficult to observe when and where the users user the devices.

Therefore, a new observation method suitable for the characteristics of mobile products was required to overcome the drawbacks of existing methods in the mobile environment and to observe various interactions from multi-perspectives. Also, an analysis frame or tool that can define various factors considering the characters of the mobile environment for the in-depth analysis of observed data to perform integrative analysis accordingly is demanded.

2 Mobile Environment and User Observation Method

2.1 Concept and Characteristics of Mobile Environment

Dictionaries define the term 'mobile' as below.
mobile [mubl, -bil|-bail] 【L moving or movements】 a.1 <objects> movable, have the capacity to move, operative <people> movable, movements
Mobile refers to something that is subject to mobility and the current meaning of mobile generally includes all things in the field of information communication with mobility. Examples include mobile phones and Personal Digital Assistants (PDA) which are characterized by handful size and lightweight.

1) Mobility
The environments in which mobile products are used have mobility to constantly change the user circumstances. Mobility is not simply the character to move, but the situation in which the space or circumstances of usage are not limited.
2) Portability
Mobile products are generally produced in portable sizes. Portability means that the users may always keep something in their pockets or within the reach of their arms.
3) Minimization
Mobile products are produced in small scales fitted for pockets. Mobile phones which are smaller than palm size have already been launched and other mobile products including PDAs have been following the market trend of minimization in sizes.
4) Various Interactions
Mobile products communicate in various relationships: between product and user, between users and between user and services. The flow of communications is enabled by various functions.
5) Personalization
Mobile products display personalized characters as personal belongings because they are portable. Frequently used functions or the way of interaction may be altered by the characteristics of each user.
Based on these characters of mobile environments, this study defines mobile environment as the following:
Mobile environment is an environment that enables communication to another media through wireless connection in any circumstances with no special restrictions and is the actual user environment of mobile products.

2.2 User Observation Method

User Observation Method is a method of observing the user behaviors in the actual environment of their use of products and is used to analyze any distinctions or discoveries from the observation results to understand particular pattern of user behavior and to grasp unconscious needs for the early stages of designing.
User Observation Method is classified by observation point-of-view and continuity of time. In relation to the observation point-of-view, it is classified into first-person method observed from user's point of view and second-person method observed from observer's point of view; and by the continuity of observation time, it is classified into fragmental method of recording instant characters and continuous method of recording continued behaviors.
Existing User Observation Methods display common characters as to the observation point-of-view and the continuity of observation time and can be summarized into four major types as shown below.

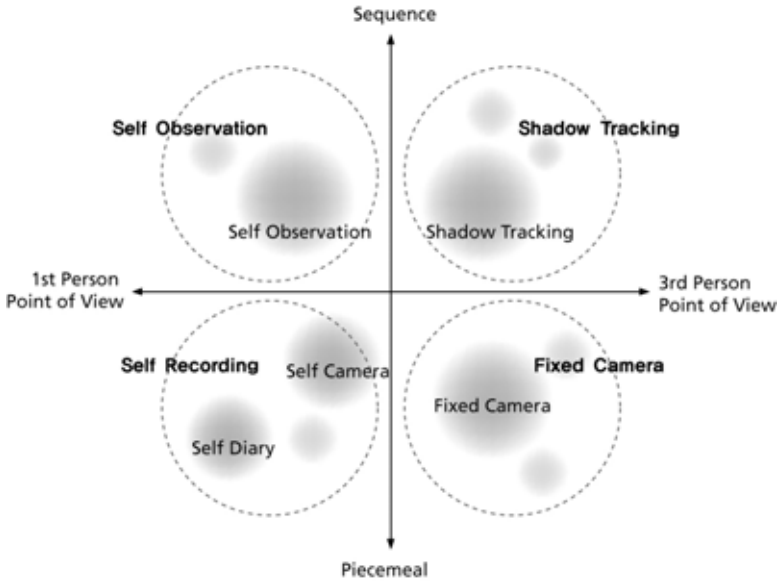

Figure 2- 1 Four Types of User Observation Method

When applied to the mobile environment, the four major types have the following strengths and weaknesses according to the characters of the mobile environment.

Table 2- 1 : Strengths and weaknesses of User Observation Method According to the Characters of Mobile Environment**.**

Observation Methods	**Detail Observation Methods**	**The Characteristics of Mobile environment.**				
		Mobility	**Portability**	**Minimize**	**Interactivity**	**Personalization**
1st – Person Point of View	Self Diary	--	--	--	The Problem of Possibility of Interaction or Memory of interaction.	The Self Protection of Privacy.
	Self Camera	The objection of recording while environment is changing.	-	The Objection of Recoding point of view.	The objection of recording as variety interactions.	Illegal problem of privacy.
2nd – Person Point Of View	Shadow Tracking	It's way too hard tracking the position.	-	Patients feels Uncomfortable and labouredly while doing observe.	Observing the detail interaction is not so easy.	Illegal problem of privacy.
	Fixed Camera	Patient is always moving.	Setting of observation position is hard.	Observing patients action is hard.	Observing patients detail action sequences is not so easy.	Illegal problem of privacy.

3 Mobile Observation System (MOS)

3.1 Drawback of Existing User Observation Method

The existing observation methods are roughly divided into first-person observation and second-person observation according to the observation point-of-view, but generate the following drawbacks when applied to the mobile environment.

First-person Point of View:

1) The user must always be aware that he/she shall conduct observations.
2) Observation is difficult due to variable user environment.
3) The user cannot remember or record all functions used as varieties of functions are provided.

Second-person Point of View:

1) Naturally induce observation to provide the most natural user environment possible.
2) Because of the constantly changing user environment, it is difficult to conduct observations tracing the users at every moment.
3) It is difficult to accurately record all details about operations or functions used.

3.2 Future Development of Mobile Observation (MOS)

A new observation method that is suitable for the mobile environment and that overcomes above drawbacks of the existing methods is proposed and its future development objectives are as follows.

1) Supplement the drawbacks of the existing observation methods. For first-person method, a wearable observation tool should be developed to allow observations from user's point of view.
2) In order to obtain general observation data from the mobile environment, tools to acquire information that is not provided in first-person or second-person points of view, such as user's location and course of movements, should be developed.
3) The methods of various points of view shall be generalized into an integrated observation system.

3.3 Mobile Observation System (MOS)

Mobile Observation System (MOS) is presented in three observation methods according to the observation point-of-view.
First, first-person method is the observation conducted from the user's point of view and is made available through a wearable micro-camera introduced by this study.
Second, second-person method is the observation from the observer's point of view that is available through Shadow Tracking using video camcorders.
Third, third-person method is an indirect recording method for user's location information and functions used with no direct observations. It is made possible by GPS location receiving devices and location information tracing software.

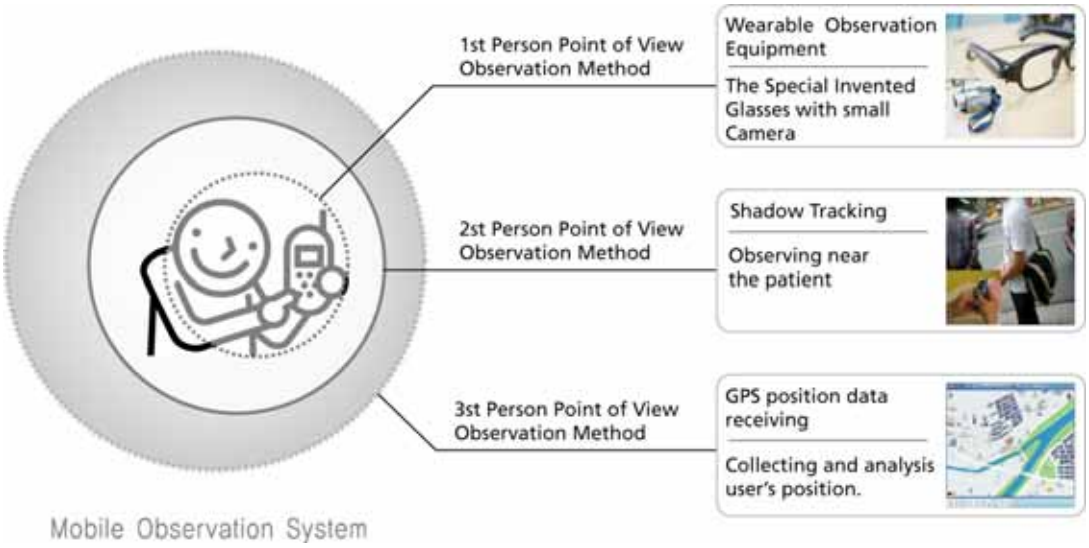

Figure 3- 1 : Structure of Mobile Observation System

1) First-person Method: Wearable Observation Tool

A micro-camera is inserted into a leg of a glasses to record videos from the user's point of view.

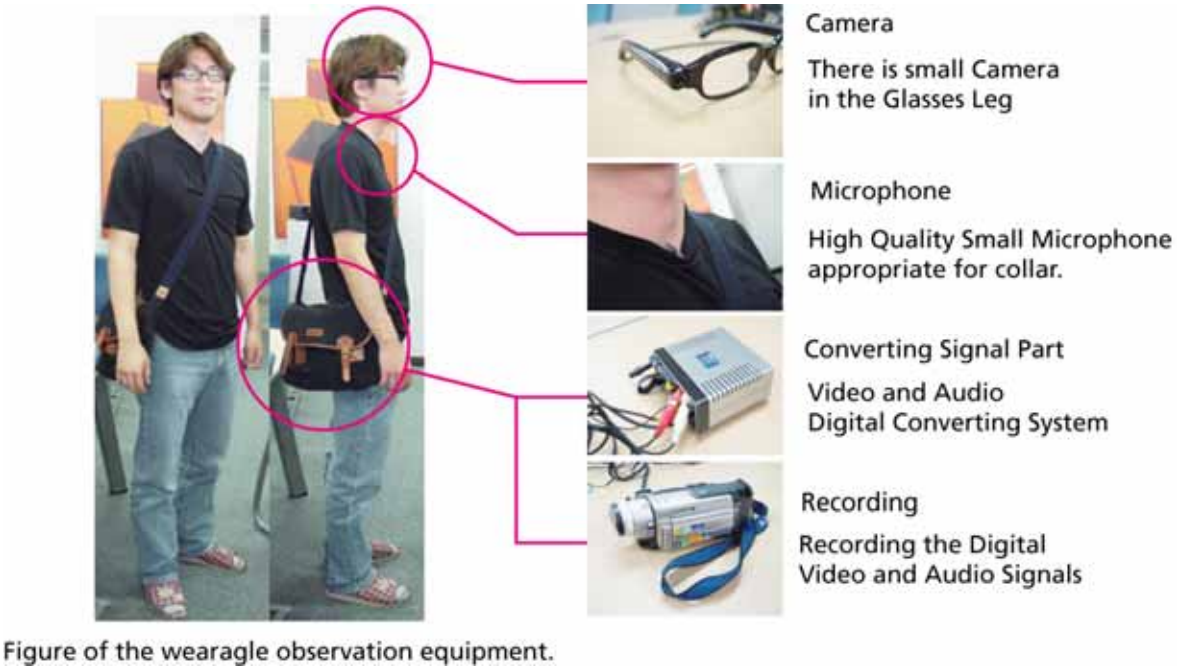

Figure 3- 2 : Composition and Structure of Wearable Micro-Camera Observation Tool.

2) Second-person Method: Shadow Tracking

As the existing observation method, a camcorder is applied to follow the user to conduct observations from the observer's point of view.

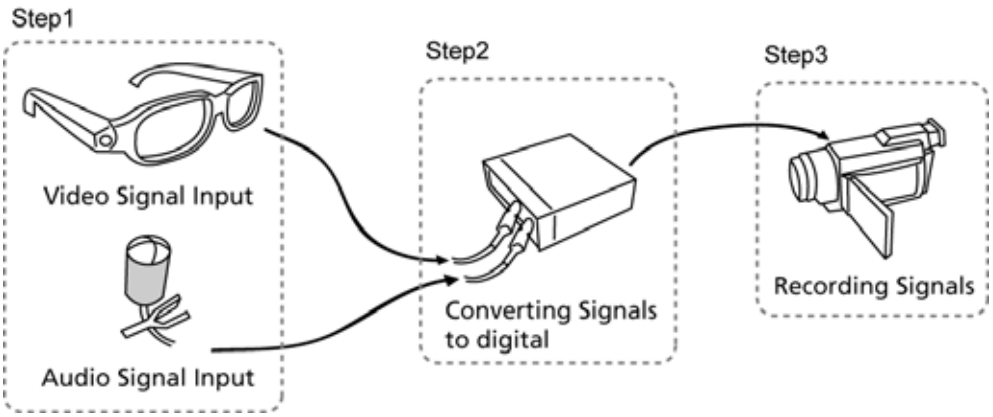

Figure 3- 3 : Structure of Wearable Micro-Camera Observation Tool and Flow of its Signal**.**

3) Third-person Method: Location Tracing through GPS

Third-person method uses GPS technology to trace the user's location and course of movements. The GPS receiver used is Almap GPS Receiver as shown in Fig 3-4 and the software is Almap 2.0.

Figure 3- 4 : GPS Receiver : Almap GPS Receiver

Appearance - 127mm x 64mm x25mm
Internal Memory - 32MB Flash
CPU-25MIPS 8051
GPS Engine USA SiRF II
Error Ratio Below 10m

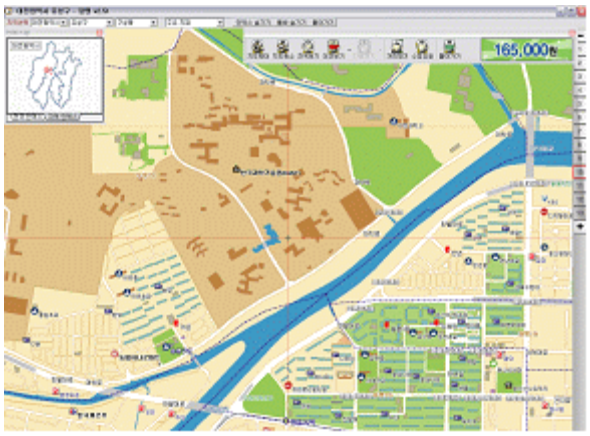

Figure 3- 5 : GPS Software : Almap 2.51 . Public Release

GPS software separately gathers all information needed and RT1.0 Midware was developed to save the data in adequate format. The log information of the user's location, such as latitude, longitude, time, and name of location, is recorded.

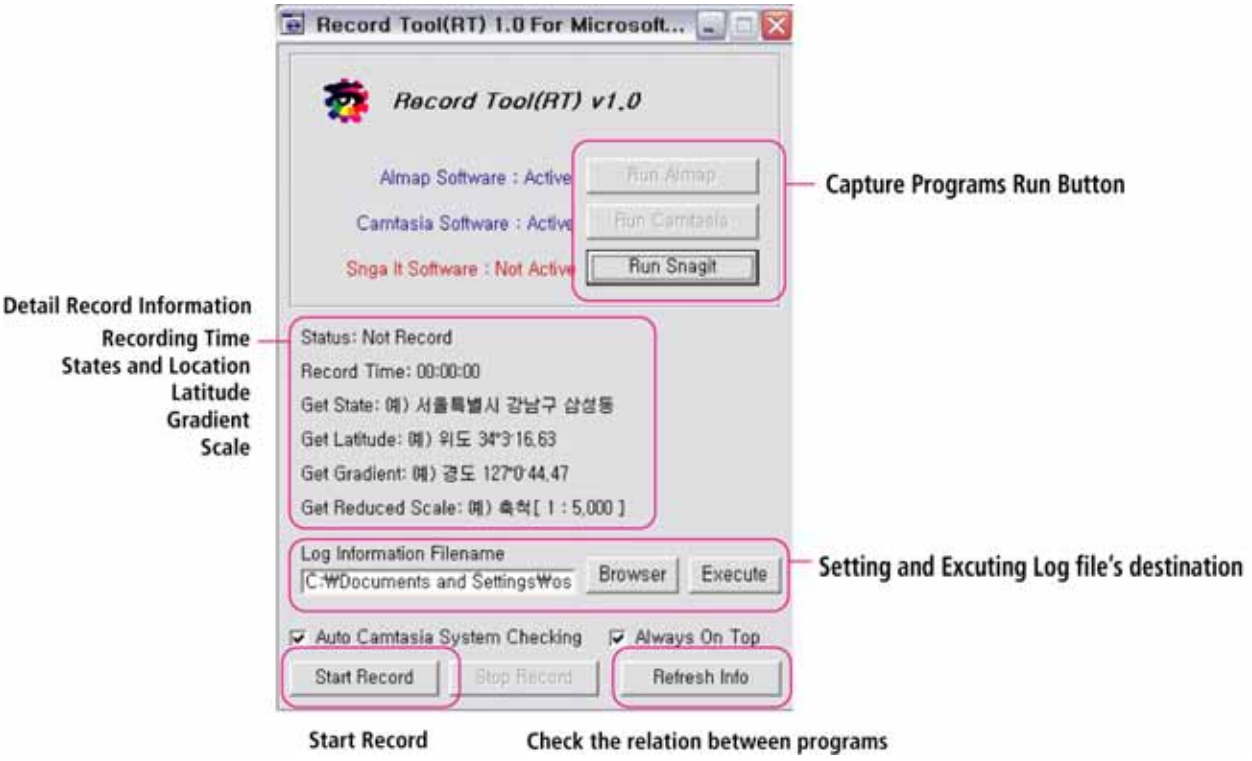

Figure 3- 6 : RT v1.0

4 4. Development of Mobile Observation Analyzer (MOA)

A Mobile Observation Analyzer (MOA) is developed to generally analyze the observation data recorded through MOS from each mobile environment.

MOA was based on the basic structure of Videow, one of existing analyzers with strengths in identifying the observation data and recording events and its identification and recording of events and analytical functions were supplemented for the characteristics of data observed by MOS.

The contents supplemented by MOA are as follows.

1. Simultaneous control of video controllers and event displays from observation point-of-view (first-person, second-person and third-person)
2. Definition and control (modification and addition) of analytical factor based on mobile observation analysis frame
3. Provision of general analytical results through a general analyzer

The interface structure of MOA is composed of a video controller that identifies the observation data, an event table that displays the events recorded, and an editor that records all detailed descriptions about each event.

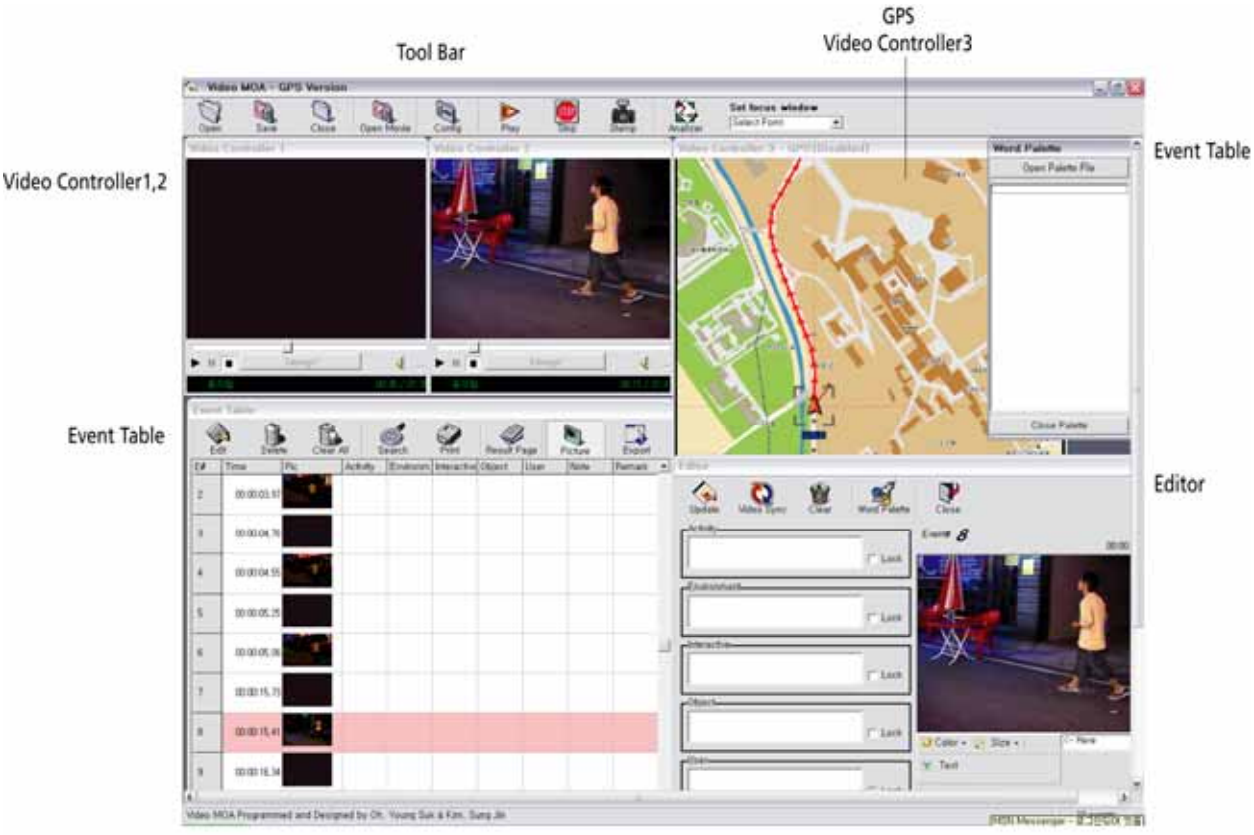

Figure 4- 1 : Structure of MOA Interface

A distinctiveness of MOA is that it identifies the first-person, second-person and third-person data observed through MOS at one glance. Thus, newly distinguished data that were not available from the existing data observed from single type of perspective becomes identifiable.

Figure 4- 2 Video Controller 1,2,3

5 Application Case Study of Developed Method and Tool

5.1 Planning and Implementation of Experiments

In order to verify the accountability of MOS and MOA, an experiment of observation was conducted using MOS to the mobile users in an actual environment and the data observed was analyzed through MOA.

Table 5- 1 : Experiment plan

Case Study Plan		
Mobile Product	Mobile Phone	The Mobile phone which has camera and mobile service. (Pentec & Quritel- S2M)
Patient	Patient should be Expert who experienced at least 3years of mobile phone. (Camera Phone Functions, Mobile Services etc.)	A 20 aged male University Student.
Observation Time	Considering Battery's stamina.	No more 2 Hours (It had taken 1 hour)
Observation method	Mobile Observation System (MOS)	First-person Method : Wearable Observation Facility (Invented) 2nd-person Method : Video Camcorder (Sony-TRV 900) 3rd-Person Method : GPS Position Tracking (Almap GPS 2.0)
Others	Considering Wearable Observation Facilities observing angle. Flaming Effect of Sunshine. Critical Contrast cases from backlight.	Moderator's explains and advices for proper observation angle.

The analysis process was conducted through repeated identification using MOA and distinguished behaviors from the user's movements and operations were recorded as events.

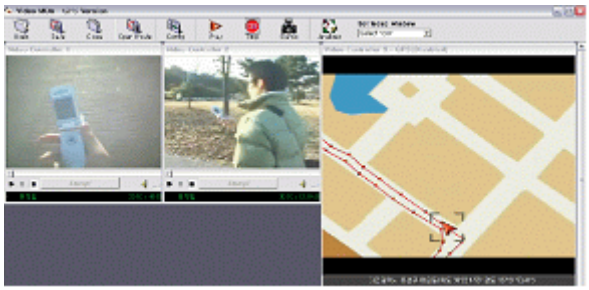

Figure 5- 1 : Repeated Identification of MOA Observation Data

The events recorded were presented by the event display method in relation to the final course shown in Fig 5-2 and the events containing the user's movements were generally analyzed.

Figure 5- 2 : Behaviour Events in Relation to the Final Course Image

5.2 Result of Case Study

The results from the case study are organized into the following three categories.
First, the case study enabled the identification of operations and functions (information) used in each situation in relation to the movements and spaces of certain users.
Second, all details about the user's operations and display screens were recorded through MOSto make the information on the function used available.
Third, MOA allowed simultaneous identification of observation data from various points of view to discover more varied events. Also, the general analyzer and the event list saved as an Excel spreadsheet made multi-perspective analysis possible.

6 Conclusion and Future Research Objectives

6.1 Conclusion

This study presented MOS as a user observation method suitable for the mobile user environment to understand various behavioral patterns and operations of users displayed in the actual environment of mobile product uses, and developed MOA as a tool to record and analyze data for a more general analysis of the data observed. The detailed information of progress and step-by-step results of this study can be organized as below.

First, the use of User Observation Methods were examined to define the mobile environment through project reviewing in relation to various reference data and to observe the behaviors of the users and major functions used in the mobile environment. Also, by identifying the problems generated by the application of existing User Observation Methods on mobile environments, the significance of this study on the development of a new observation method and analytical tool suitable for mobile environments was emphasized.

Second, the characteristics of the mobile products were analyzed to propose a new observation method suitable for the mobile environment and the characteristics and strengths and weaknesses of the existing User Observation Methods were identified. The existing User Observation Method is roughly divided into first-person method from the user's point of view and second-person method from the observer's point of view. However, both methods accompanied ethical problems: the first-person method in the user's feeling burdened by the observation and the second-person method in the observer's tracing and observing method.

Third, the limits of the existing observation methods in the mobile environment were considered to develop a new observation method, and the newly developed method and the existing methods were generalized to propose

MOS. For the first-person observation method, a wearable observation tool that inserts a micro-camera in a leg of a glasses to allow an observation from the user's point of view was developed to satisfy the prerequisite that the tool must be wearable. Also, a third-person observation method that observed information of the user's location and course of movements using GPS was proposed.

Fourth, a mobile observation analysis frame was presented for a more systematic and general analysis of data observed in accordance to the elements of the mobile environments and MOA was developed as a tool to analyze the data observed more effectively based on the analysis tool presented. The analysis frame presented for the basic elements in behaviors, information, environment, communication and context as well as for the additional elements in the states of movements and spaces.

Last, a case study for the mobile phone users in an actual mobile environment was conducted to identify the accountability of MOS. Also, an evaluation was implemented to verify the usability of MOA. The results of the case study and the usability evaluation could grasp the strengths and weaknesses of the observation method and analysis tool presented in this study for the derivation of improvement measures.

Below is the result of this study based on accountability and usability of the final outcomes of this study: the Mobile Observation System (MOS) and the Mobile Observation Analyzer (MOA).

Mobile Observation System (MOS)
Mobile Observation System is composed of the first-person observation method that allows observations from the user's point of view using a wearable observation tool; the second-person observation method that uses the existing method of Shadow Tracking; and the third-person observation that uses GPS technology. The results of the case study revealed that the observation data collected by the wearable observation tool from the first-person observation method included information on the user's whispering, major functions used, and detailed operations that were not easily available from the existing observation methods. Therefore, the usability of the wearable observation tool was identified. However, certain information was unidentifiable due to the angle of the lens, movement of the user, reflections on the screen, and backlights, and the observation time was limited by the life span of the battery. The third-person observation method using GPS technology could provide information on the user's location and overall course of movements in real-time. However, the reception of the portable GPS receiver was frequently lost once the user entered interior spaces. The inconvenience of carrying a laptop computer also generated problems as the data was required to be recorded constantly on the laptop computer.
In summary, MOS method, although it had major drawbacks in artificiality and restrictions in observing time, was determined to be useful in understanding the unconscious needs of the users in the mobile environment as it provides various information that were not available by the existing methods, such as the user's whispering, frequently-used functions, detailed operations, and user's location and overall course of movements.

Mobile Observation Analyzer (MOA)
The Mobile Observation Analyzer (MOA) is a recording and analyzing tool that is built upon the interface of an existing analysis tool (Videow)to be suitable for mobile data. The results of usability evaluation and the comparison analysis of the existing analyzer and MOA revealed that the existing analyzer generated problems as it focuses on recording the events of certain behaviors and fails to present other analysis processes, whereas MOA could record the events and save the recorded event list as an Excel spreadsheet to analyze the data from various perspectives intended by the analyzers and to display the flow of overall events and the characteristics of events occurred in each location at one glance through a general analyzer. However, it was rather difficult to identify the events from overall course of movements as the indication method was too complex and detailed, and multiple windows displayed simultaneously interfere with the concentration of the identifier.
In summary, MOA was somewhat complex in its overall composition and display, but allowed analysis from various perspectives by saving the events recorded as an Excel spreadsheet. Also, as it used a general analyzer to understand the general flow of the events, it presents a more efficient analysis process for the events that were not available by the existing tools. Therefore, it is determined to be useful for the general analysis of observed data.

6.2 Future Research Objectives

As pointed out by the above results, the usability of the Mobile Observation System (MOS) and the Mobile Observation Analyzer (MOA) developed by this study revealed various drawbacks. Therefore, the following future study objectives would be necessary to overcome these drawbacks.

First, a new measure should be sought for to solve various interruptive factors present in MOS. First of all, the angle of the lens must be easily adjustable. The wearable observation tool has a fixed lens that cannot be adjusted for the desired angle. Therefore, the case study required the user to make unnatural postures for the lens to look directly at the screen. Second of all, it is the problem of adjusting contrast due to the reflection on screens and backlights. When the user is in outdoors or in a dark interior space, the screen was not easily observable due to the reflection of sunlight or the screen's backlights. Eliminating these interruptive factors is expected to provide more accurate information.

Second, the interface must be improved to enhance the usability of MOA. As the data to be observed increases, the factors to be controlled and the number of events increases to require the arrangement or grouping of events according to various analytical factors. Also, the display of the general analyzer is neither easy nor concise and displays too many windows at once to be distracting to the users. The experimenter of the usability evaluation also pointed out the necessity of the improvement of interface for easier application. The improvement of interface is expected to generate more effective recording and analyzing of events.

Third, a case study must be implemented for various users and products to identify the application and usability of MOS and MOA more broadly. As the case study implemented in this study is limited to certain users and to the mobile phones, the observation methods and tools presented cannot be determined to be useful in all mobile environments. Therefore, more case studies must be implemented for various users in various circumstances and for other mobile products such as PDAs and smart phones.

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