

Title	MOTHER APP : a family memories theater
Sub Title	
Author	高, 磊(Gao, Lei) 奥出, 直人(Okude, Naohito)
Publisher	慶應義塾大学大学院メディアデザイン研究科
Publication year	2011
Jtitle	
JaLC DOI	
Abstract	This thesis proposes MOTHER APP, an Application to Media Furniture Platform that creates a Family Memories Theater to document and exhibit shared household life experiences in the living room, automatically capturing spontaneous moments into photos by sensing if the family members are together through furniture. The thesis introduces the research, design process and implementation of MOTHER APP, describe the evaluation about how households use it to gain the new experience in the living room through family photographs. Family memory is a source of family identity, or the sense of belonging to the family. Family album is a rich source of family memory, without family album, it will difficult to recall vividness of those events. While family album can capture planned events, such as wedding. However, there are so many important spontaneous moments in everyday life that are hard to be remembered and recalled when family shared life experiences together in living room. Moreover, picture taking oftentimes requires people to stop their ongoing activities, such party, conversation with guests, or playing with kids, or we say taking pictures breaks the natural sequence of life. Therefore, the purpose of MOTHER APP is to record the communications of family members on the basis of embeded sensing technology in the Media Furniture system constructed intelligent enviroment, and gives the user a digital family album which is displayed through an open Media-Television. The furniture and the living room together construct a system to record and display family memories.
Notes	修士学位論文. 2011年度メディアデザイン学 第131号
Genre	Thesis or Dissertation
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO40001001-00002011-0131

慶應義塾大学学術情報リポジトリ(KOARA)に掲載されているコンテンツの著作権は、それぞれの著作者、学会または出版社/発行者に帰属し、その権利は著作権法によって保護されています。引用にあたっては、著作権法を遵守してご利用ください。

The copyrights of content available on the Keio Associated Repository of Academic resources (KOARA) belong to the respective authors, academic societies, or publishers/issuers, and these rights are protected by the Japanese Copyright Act. When quoting the content, please follow the Japanese copyright act.

Master's Thesis
Academic Year 2011

MOTHER APP: A Family Memories Theater



KEIO MEDIA DESIGN

Graduate School of Media Design ,
Keio University

Gao Lei

A Master's Thesis

submitted to Graduate School of Media Design,

Keio University

in partial fulfillment of the requirements for the degree of

MASTER of Media Design

Gao Lei

Thesis Committee:

Professor Naohito OKUDE (Supervisor)

Professor Masa INAKAGE (Co-supervisor)

Thesis Committee:

Professor Naohito OKUDE (Supervisor)

Professor Masa INAKAGE (Co-supervisor)

Professor Hiroyuki KISHI (Co-supervisor)

Abstract

This thesis proposes MOTHER APP, an Application to Media Furniture Platform that creates a Family Memories Theater to document and exhibit shared household life experiences in the living room, automatically capturing spontaneous moments into photos by sensing if the family members are together through furniture. The thesis introduces the research, design process and implementation of MOTHER APP, describe the evaluation about how households use it to gain the new experience in the living room through family photographs. Family memory is a source of family identity, or the sense of belonging to the family. Family album is a rich source of family memory, without family album, it will difficult to recall vividness of those events. While family album can capture planned events, such as wedding. However, there are so many important spontaneous moments in everyday life that are hard to be remembered and recalled when family shared life experiences together in living room. Moreover, picture taking oftentimes requires people to stop their ongoing activities, such party, conversation with guests, or playing with kids, or we say taking pictures breaks the natural sequence of life. Therefore, the purpose of MOTHER APP is to record the communications of family members on the basis of embeded sensing technology in the Media Furniture system constructed intelligent enviroment, and gives the user a digital family album which is displayed through an open Media - Television. The furniture and the living room together construct a system to record and display family memories.

KeyWords: Family Memories, Family Album, Ubiquitous Computing, Ambient sensing, Smart home, Space Design, Family Memories Theater

Contents

1	Introduction	10
1.1	What is MOTHER APP	11
1.2	Unplanned moments as missing part in Family Album	13
1.3	Family Memories documenting and exhibiting system	16
1.4	MOTHER Concept	18
2	Literature Reviews	21
2.1	Ambient Sensing and Photo Capture	22
2.1.1	SenseCam : “Capture almost evetything”	22
2.1.2	Target the things users find most valuable and want to remember	23
2.2	Experience Family Memories in the Smart Environment	26
2.2.1	MASTABA: A physical space for the family to process digital photos	26
2.2.2	Phenom : Photo sharing system in the Smart Home	26
2.2.3	MOTHER APP : Experience Family Memories in the Smart home Environment	27
3	Design of MOTHER APP	29
3.1	MOTHER Framework	29
3.1.1	MOTHER Sensor	32
3.1.2	MOTHER Camera	32
3.1.3	MOTHER Album	32
3.2	MOTHER APP Signal Detecting System	33

3.2.1	Human Behavior Sensor	33
3.2.2	Wireless data transmission system	34
3.3	MOTHER APP capture system	35
3.3.1	HD Web Camera	35
3.3.2	Media TV	36
3.4	MOTHER Album System	37
3.4.1	Album Review Interface	37
3.4.2	Camera setup Interface	38
3.4.3	Review photos	38
3.5	Application running environment	39
3.5.1	Processing	39
3.5.2	Desktop OS and Xbee	39
4	Evaluation	40
4.1	Framework of this evaluation	40
4.2	Scenario	42
4.3	A Brazilian's Birthday party	44
4.4	A Normal day in the living room	46
4.5	Data Analysis	47
4.6	Limit of MOTHER APP	50
4.7	Result	51
5	Conclusion	53
5.1	Future Work	54

5.1.1	Integrate with Media Furniture Items for nature start- ing	54
5.1.2	Emotion based Sensing System for rich resource	54
5.1.3	Photo archiving system for long - term use	55
5.1.4	Family Objects as Natural User Interface for reviewing Family Memories	56
6	Acknowledgements	59

List of Figures

1	Teddy Bear Documents and Exhibits David’s whole family life. [A.I. Artificial Intelligence (2001)]	11
2	I always take photographs of my parents.(2008)	12
3	First photo when my family moved to the new city.(1996) [Typical type photo in the Family Album]	14
4	Family members interacte with each other. [Spontaneous mo- ments in the Living Enviroment]	15
5	Family Tree & Family Album As memories Documenting and Exhibiting System in the Home	17
6	MOTHER APP System in the Living room	19
7	Microsoft “SenseCam”, a wearable digital camera.	23
8	Images from SenseCam	24
9	SenseCam hardware strucrure	25
10	MASTABA	27
11	MOTHER System in the Living room: Sensing, Recording, Displaying	31
12	MOTHER APP trigger	33
13	Force Sensing Resistors	34
14	The interface of MOTHER APP Signal Detecting System . . .	34
15	Wireless data transmission	35
16	Logicool HD Web camera	36
17	Media TV	36
18	MOTHER Album Interface	37

19	Experience MOTHER Album through Media TV	38
20	First example : Birthday party in the Living room	41
21	Stuff for birthday	41
22	Background photo capturing	45
23	Manual photo capturing	45
24	Second example : A Normal day	46
25	Subject enjoy taking photos before say goodbye.	48
26	MOTHER Album review mode	49
27	Subjetc playing guitar	49
28	Camera can only take pictures from an angle.	50
29	Sony Cybershot T200	55
30	Mark McIlveen and his Family Album project	56
31	Vase in the home	58

1 Introduction

In my favorite science fiction movie " A.I. Artificial Intelligence (2001)", an intelligent machine called Teddy Bear accompanies the boy through his life journey. It grows with the boy, records his life, and plays for him the past memories to console him. [Figure 1]

People often use photos to keep the memory of the past, spending those happy hours with their kids or parents again through the photos. Each year when I return home, I always take photographs of my parents. Last year when I visited them during my school vacation, I found my parents had grown older.[Figure 2] I said I was so sorry that I had not been able to spend more time with them because I studied elsewhere. "No, no, we have been very happy." my father interrupted me. Then he turned on the TV and showed me the photos that had been taken in the past year. I saw on each weekend, they were preparing small family party, my grandpa coming and bringing flowers to their home, my cousins coming to help them clean the house. I saw Father was preparing his fishing rod in the spring. I saw they were celebrating Mother's birthday in the summer. I saw my little sister brought her boyfriend home in the autumn. I saw all the family members are preparing firecrackers together to celebrate the coming New Year. I was glad and surprised and I asked who took those pictures as I was the only photographer in the home. Father said, MOTHER APP did that.



Figure 1: Teddy Bear Documents and Exhibits David's whole family life. [A.I. Artificial Intelligence (2001)]

1.1 What is MOTHER APP

MOTHER is an Application to Media Furniture Platform that creates a Family Memories Theater to document and exhibit shared household life experiences in the living room, automatically capturing spontaneous moments into photos by sensing if the family members are together through furniture, create the experience of finding hidden surprise by reviewing these natural and non-invasive photo recordings which can make family life move attractive, For example, youth can mentally re-livied them infancy period, observing how parents take care of him before his memory has been started.



Figure 2: I always take photographs of my parents.(2008)

1.2 Unplanned moments as missing part in Family Album

In *Family memories in the home contrasting physical and digital mementos* (Daniela Petrelli 2010) [23], it is told that “Family memory is a source of family identity, or the sense of belonging to the family. Memorabilia and family objects can be a source of family memory.” One is family album. Family album is a rich source of family memory, such as the memory of childbirth, funeral, wedding, parties, and so. It provides vivid images of familial events long after the events. Thus, A traditional family album provides a way for people to review the past with their family by documenting and exhibiting moments of memories in serial photos. Without family album, it will difficult to recall vividness of those events, or it is difficult to recall those events at all. In a way, it can be said that part of family memory is located in the family album. [Figure 3]

While family album can capture planned events, such as wedding. However, there are so many important unplanned moments, or specifically, Spontaneous moments in everyday life that are hard to be remembered and recalled when family shared life experiences together in living room. because people are not aware of their importance at the moment of occurring. Moreover, picture taking oftentimes requires people to stop their ongoing activities, such party, conversation with guests, or playing with kids, or we say taking pictures breaks the natural sequence of life. It seems to miss out unplanned moments, which could be as important as planned events, perhaps, in the hindsight. Importance of unplanned moments Appeals to our intuition. The moment of falling in love is usually entirely unplanned, for example. For another example, unplanned laughter in the family might have priceless value for the family. [Figure 4]



Figure 3: First photo when my family moved to the new city.(1996) [Typical type photo in the Family Album]



Figure 4: Family members interact with each other. [Spontaneous moments in the Living Enviroment]

1.3 Family Memories documenting and exhibiting system

Actually, systems that document and exhibit family Memories have been universally available, like the Family Tree and the Family album. [Figure 5] They have been used to document the history of the family and the growth of the family members respectively. But due to the limitation of the recording media, these documenting and their exhibition are fragmented. Nowadays, Digital way brings the possibility of creating a new experience of documenting and exhibiting family memories. Therefore, we provide MOTHER APP, a new digital family memories documenting and exhibiting system with Digital photograph and sensing technology, It provides a recording method which is more free and natural, that is to say, it captures moments in a non-invasive way when things happen naturally in the home, e.g. The system takes pictures in the moment when parents and their kids are playing and these pictures are stored in MEDIA TV in the living room.

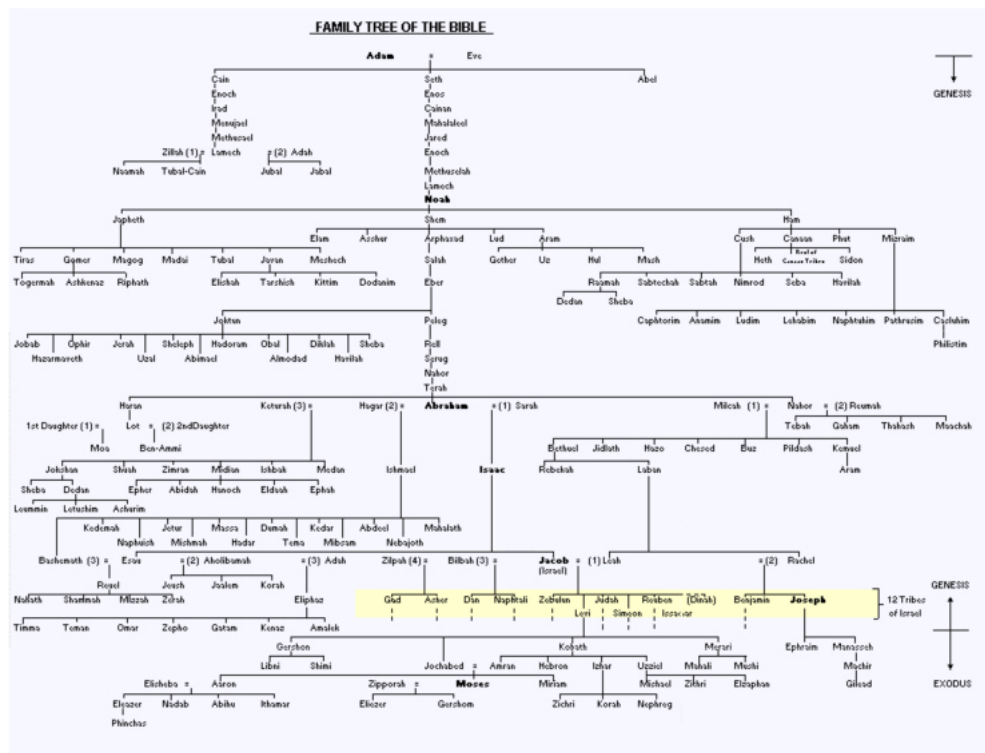


Figure 5: Family Tree & Family Album As memories Documenting and Exhibiting System in the Home

1.4 MOTHER Concept

MOTHER APP is supposed to be used in the living room environment. This is a system for documenting and exhibiting family memories by senses the communication and activities of family members through Media Sofa, automatically takes photographs and save them in the album in Media TV for future display. [Figure 6]

The living room is where family members usually spend their time with each other, watching TV, chatting or enjoying small parties and gatherings together. Therefore, the living room is an active area for the family whereby they share life experiences. Thus, the Mother APP is installed in the living room to document and exhibit these shared life experiences. For example, the experience of the kids growing up was captured when their behavior were sensed by the system while they were playing in the living room with their parents. With mother APP, the media TV in the living room is not only a focus of attention, but an observer, a recorder, which detects human behavior through media sofa and makes continuous recording to provide to family members a chance for observing and reviewing precious moment of get-togethers. Therefore, the whole growing up process, like when kids first speak and stand, go to school, and eventually entering adulthood can be experienced once again by their parents, who can perhaps better understand the reasons for past joys. In fact, by doing so, they might get inspirations to better plan their family future. Thus, memories are no longer just tools to review the past, but have become tools to enhance the future.

The Family Memories Theater, or we say this Digital Family Memories documenting and exhibiting system is made up of three parts: MOTHER Sensor, MOTHER Camera and MOTHER Album. It can sense human behavior through media sofa and begin recording automatically when parents and their children are playing in the living room and enjoying a getting-together in the evening on weekends. With Mother APP, there is no need for any

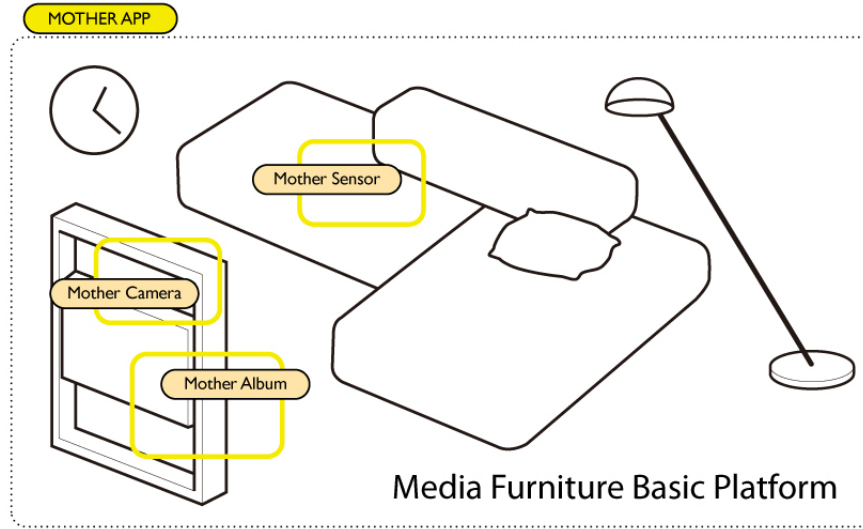


Figure 6: MOTHER APP System in the Living room

person to hold the digital camera, in which case the one who holds the camera will not be in the picture. This sensing capture method of photography can grasp moments, in a non-invasive way, of what's going on at home when parents and children are enjoying themselves naturally. These photos will be saved in a digital family album running in media tv. The TV located in the living room provides an open environment for viewing the family photos.

When the user starts MOTHER APP Application software running in media tv, the software will initiate the force sensor embedded in Media Sofa. When the user uses media sofa in the living room, his or her behavior will be sensed by force sensor. Wireless data transmitter connected to the force sensor will send the user data to MOTHER APP. This signal detecting system can sense the family members' activities in the living room, and trigger MOTHER Camera to start recording family life. HD Web Camera connected to Media TV is placed on the top of TV in the middle. It starts or shuts down Camera according to the state that the user uses media sofa. It can take high-

resolution photos. According to different settings, it can take one photo each day or it can be manually operated to record in detail the activities in the living room, such as birthday parties, New Year celebrations. MOTHER Album System allows the user to check the photos on the graphical interface, and view the photos in timeline.

Therefore, the purpose of MOTHER APP is to record the communications of family members on the basis of embedded sensing technology in the Media Furniture system constructed intelligent environment, and gives the user a digital family album which is displayed through an open media - Television. The furniture and the living room together construct a system to record and display family memories.

2 Literature Reviews

“Taking pictures of what we see” “Save the information we have receive and the performances we have watched”. Lifelog thus helps people to build a “total capture” electronic memory, and to enable people to “total recall” all these past events. Gordon Bell observed the advantages and methods of lifelogging with electronic devices in his book *Total Recall* (2009).

“Holiday videos. The snow diorama that you brought back from skating. The first blanket (or Grandma’s first blanket). The lyric you wrote in high school. Birthday cards. Concert tickets. What Father said at the third critical juncture of the important game. Toasts. Words of praise. The baby’s first cries. ” Through lifelogging, these fragmented memories can be kept for a long time and then become worth remembering. While through a wider range of recording, such as “the change in one’s blood pressure, food, sports, working environment, etc” these information can be analyzed scientifically to explore the cause of health change. He made attempts through *MyLifeBits Project*, and observed, “lifelogging could permanently change how we use and share personal data, enabling us to look back over our lives or search through and organize past experiences. ”[1]

Richard Harper brought similar lifelogging system home[17], and invited six household members to wear a special camera which was able to record automatically by sensing the environmental changes and made evaluations of lifelogging. Through exchanging these life records between family members, they achieved better understanding of each other, and the members, by watching themselves in the pictures and were able to make certain changes in their behavior and way of conduct. But during the evaluation, a large quantity of useless photos had been produced, so he suggested, “In designing to support reflection then, it is necessary to consider the way in which lifelogging content is captured, and the level of freedom that the user has to control or stage its use.”

In the *Say Cheese! A history of the American snapshot* (Mia Fineman 2007), it is told that “One of the most important use of photography is taking pictures of oneself and one’s family members to do the lifelogging, then collecting these pictures in their family album, which becomes a remembrance which keeps and updates family memories, while displays these memories whenever needed.” Thus, many papers focused on the way to design digital family album system based on Ambient Sensing Capture, this chapter sums up related studies. The first subsection reviews the “SenseCam”, a wearable automatic camera developed by Microsoft Research as a tool for household members to keep family memories. Then we reviews "MASTABA" and "Phenom“ for displaying digital photos in the family environment. In the end, we discuss how to bring family members experiences based on documenting and displaying digital photos through intelligent environment, which is the goal of the MOTHER APP.

2.1 Ambient Sensing and Photo Capture

2.1.1 SenseCam : “Capture almost evetything”

SenseCam is a wearable digital camera that is designed to take photographs passively that without user intervention, while it is being worn, It will captures a series of still images based on movement and changes in the intensity of light and heat, has been shown to support the recollection of everyday experience, as well as retrieval of information about past events for household members. [Figure 7]

SenseCam digitally captures almost everything users do through the environment sensing system. It is worn on one’s breast, so it can record varieties of activities of family members, such as birthday parties, dinner parties, family chit-chat, or visits to parks or to a friend’s home. Meanwhile, through sensing the changes in environment, it continually takes pictures, recording



Figure 7: Microsoft “SenseCam”, a wearable digital camera.

family members’ activities. [Figure 8]

Unlike a regular digital camera or a cameraphone, SenseCam does not have a viewfinder or a display that can be used to frame photos. Instead, it is fitted with a wide-angle (fish-eye) lens that maximizes its field-of-view. This ensures that nearly everything in the wearer’s view is captured by the camera. It also contains a number of different sensors. These include light-intensity and light-color sensors, a body heat detector, a temperature sensor, and a multiple-axis accelerometer. These sensors are monitored by the camera’s microprocessor, and certain changes in sensor readings can be used to automatically trigger a photograph to be taken. This structure of SenseCam makes it possible for the user to concentrate on activities and disregard the camera, so there is no need for him to stop what he is doing and handles the camera. [9]

2.1.2 Target the things users find most valuable and want to remember

This automatic way of taking pictures brings the user a large amount of photos. As told in *Memory and Practice* (Dave Randall 2009), “According to the



Figure 8: Images from SenseCam

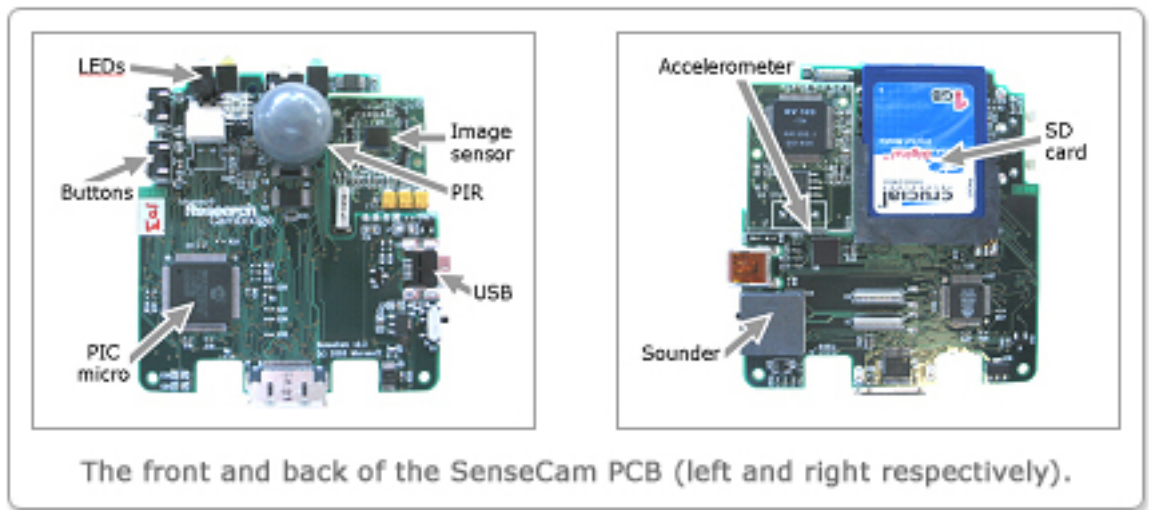


Figure 9: SenseCam hardware structure

user's habitual way of using digital photographs, the user with collections of thousands of digital photos never access the majority of them". so researcher from SenseCam suggested that rather than the overambitious goal of "logging everything", Ambient Capture system designers should channel their efforts more fruitfully by identifying the situations where human memory is poor or targeting the things users find most valuable and want to remember. In Beyond Total Capture (Abigail Sellen 2010), it is told that "Rather than try to replace human memory with digital systems, system designers should look to capitalize on the strengths of human memory and help overcome its weaknesses. ". Different from SenseCam, MOTHER APP system focuses on what is happening in the living room, esp. what is going on between family members, and provides more convincing photographs to the user.

2.2 Experience Family Memories in the Smart Environment

2.2.1 MASTABA: A physical space for the family to process digital photos

At present, most studies on digital family album are focused on establishing a set of digital pictures and managing and displaying them in ubicomp-based intelligent environment. MASTABA is a household Digital Shrine in the future. It attempts to construct a physical space for the family to process digital photos, and through photos of generations, gives the family a chance to hands down one's memories to posterity. This concept gives hint for constructing a digital family archive and displaying system. MOTHER get the inspiration for the system framework, through home objects, like furniture, home itself has the possibility of constructing "physical viewing system" which as told in *MASTABA : A Digital Shrine for Family* (Daisuke Uriu 2006). esp. in the smart home environment which is capable of handling digital data.

2.2.2 Phenom : Photo sharing system in the Smart Home

"A smart home is a house that is responsive to its inhabitants and their actions by being aware of their context. Potential Applications for smart homes address economic and comfort aspects of living, or could provide unobtrusive support for the elderly or disabled to promote independent living." This definition comes from *Programming the smart home* (U. Bischoff 2007). "Phenom" in Homelab is an Application in the smart home context where family members share their memories through photo browsing and photo sharing system, in which family members can view digital photos in hand-held device and share it with other members of the family, or share the digital memories with them using TV. It is a complete framework for viewing and sharing photos in the family environment. Different from MASTABA, it does



Figure 10: MASTABA

not have the good user experience, i.e. to “hands down one’s memories to posterity”[30]

2.2.3 MOTHER APP : Experience Family Memories in the Smart home Environment

In the context of media furniture platform, living room is a common space for members of family. It is a space where family members actively participate in what a family life can offer, enjoying pleasures of family life by way of watching movies together, sitting at a get-together, cooperating in family affairs. At the same time, family objects in this area also play a supplementary role in enhancing a strong family tie. For example, the reading material left on the sofa reveals the children’s interests at the time, the vase of flowers on the table shows the love of the one who buys it for the family. These provide sufficient context, and make it possible for MOTHER APP

to take photographs of the living room to grasp the precious moment and record the growth of the children. In this way, family is not only a place for taking photos, but the birthplace of memories, while in MOTHER APP system, MOTHER Sensor, which is used to sense family members' behaviors, MOTHER Camera connected to media TV, and TV itself, combined with media furniture platform, have constructed a complete system which can sense, record, and display family memories in the same time.

Therefore, the purpose of MOTHER APP is to record the communications of family members on the basis of embedded sensing technology in the mf- system constructed intelligent environment, and gives the user a digital family album which is displayed through an open media - Television. The furniture and the living room together construct a system to save and display family memories.

3 Design of MOTHER APP

3.1 MOTHER Framework

MOTHER is an Application to Media Furniture Platform that creates a Family Memories Theater to document and exhibit shared household life experiences in the living room, automatically capturing spontaneous moments into photos by sensing if the family members are together through furniture, create the experience of finding hidden surprise by reviewing these natural and non-invasive photo recordings which can make family life move attractive, For example, youth can mentally re-lived them infancy period, observing how parents take care of him before his memory has been started.

The aim of Mother application is to detect the family activities and the communication between the family members through intelligent media furniture and the living environment. It captures every precious moments by photo taking. It helps to construct a family memorize documenting system. It enriches the documentation of family life and individual growth which the traditional family album hardly fulfills. This would bring a whole new experience of family memory in documenting, archiving and displaying.

In order to implement this goal, I have designed three functions in this Mother application. They are family activities detecting, non-invasive photo capturing and digital family album.

Family activities detecting: Through the build-in force sensors in the media sofa, Mother application can detect the number of the users and how they interact with the media sofa. Along with the algorithm in Arduino, it sends the data to trigger the invisible photo capturing system and start capturing. For example, if there are more than three users on the media sofa, Mother application will analyze it as a family event status. It would send the signal to the non-invasive photo capturing system.

Invisible photo capturing: It transfers the data through the wireless Xbee with the Family activities sensing system. Once it receives the signal from the media sofa, it turns on the camera embedded in the media tv, then starts capturing. After that, it sends the photos to the digital family album.

Digital family album: It is an application running on the media tv. It displays the photos according to the timeline. Compared to the laptop and iPad, media tv is part of the furniture inside the living room which is opened to everybody. There is no need to worry about personal privacy. It is opened for every family members and as the device of displaying the digital photos.

When the user sits on the media sofa and turns on the media tv to browse the photos, the living room become the place to recall family memories. Through this, media furniture and the living room construct as a family memories theater together.

MOTHER APP can sense human behavior through media sofa and begin recording automatically when parents and their children are playing in the living room and enjoying a getting-together in the evening on weekends. With Mother APP, there is no need for any person to hold the digital camera, in which case the one who holds the camera will not be in the picture. This sensing capture method of photography can grasp moments, in a non-invasive way, of what's going on at home when parents and children are enjoying themselves naturally. These photos will be saved in a digital family album running in media tv. The TV located in the living room provides an open environment for viewing the family photos. This Digital Family Memories documenting and exhibiting system is made up of three parts: MOTHER Sensor, MOTHER Camera, and MOTHER Album. In the meanwhile, working with Media Furniture Platform, it can be manually operated so that the photographer can play an active role in the photographing process. [Figure 11]



Figure 11: MOTHER System in the Living room: Sensing, Recording, Displaying

3.1.1 MOTHER Sensor

MOTHER Sensor is a sensing device embedded in media sofa. It is made up of force sensors and micro controllers that are connected to force sensors. MOTHER Sensor can sense the users' behavior in the living room by measuring the quantity of family members on the sofa and their behavior. Then it will judge whether to send signals to start MOTHER Camera to begin taking photos.

3.1.2 MOTHER Camera

MOTHER Camera is a photographing device connected to Media TV. It is a HD Web camera. It is connected to media tv in the living room through usb. When it it started, it will wait for information from MOTHER Sensor, then it will begin photographing tasks or end them, and save the photos in MOTHER Album.

3.1.3 MOTHER Album

MOTHER Album is an Application software running in Media TV for saving and displaying photos taken by MOTHER Camera. It provides a set of interfaces for the user to view photos , and the user can use MOTHER Album to set up the sensing, photographing and displaying methods of MOTHER APP.



Figure 12: MOTHER APP trigger

3.2 MOTHER APP Signal Detecting System

When the user starts MOTHER APP Application software running in media tv, the software will initiate the force sensor embedded in Media Sofa. When the user uses media sofa in the living room, his or her behavior will be sensed by force sensor. Arduino and Xbee connected to the force sensor will send the user data to MOTHER APP. This signal detecting system can sense the family members' activities in the living room, and trigger MOTHER Camera to start recording family life. [Figure 12]

3.2.1 Human Behavior Sensor

The force sensing resistor (FSR) under the sofa can sense force ranging between 100 g and 10 kg, so it does this the moment the user sits on the sofa, and judges whether someone is using the sofa. Then it will send the data to

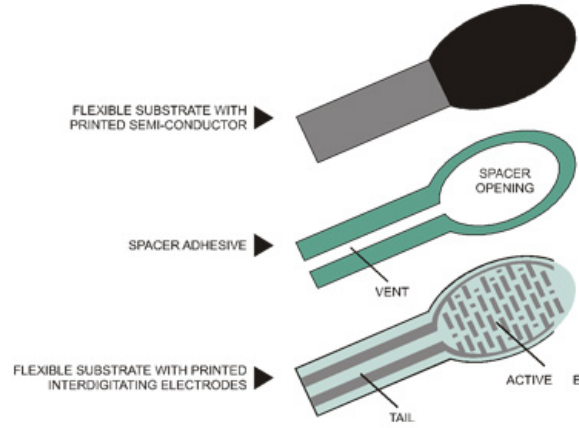


Figure 13: Force Sensing Resistors

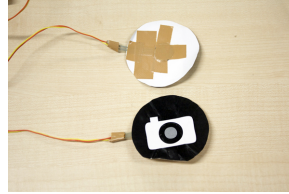


Figure 14: The interface of MOTHER APP Signal Detecting System

MOTHER APP Signal Detecting System. When the user leaves, it can also sense and make correct judgment and send data to the system informing the system that the user leaves. [Figure 13]

Five separate Force Sensing Resistors (FSR) are embedded in media sofa. They can sense one to five persons' behavior. Then working with MOTHER Album System, different recording methods can be achieved. The current prototype changes the way of sensing through connecting or disconnecting the sensors. [Figure 14]

3.2.2 Wireless data transmission system

MOTHER APP Signal Detecting System transmits data through a wireless device. The prototype of the current wireless data transmission system is

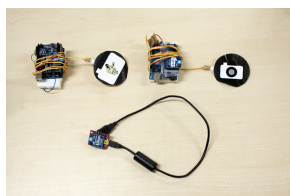


Figure 15: Wireless data transmission

made up of Xbee and Arduino and AC/DC devices. They provides low voltage wireless transmission, keeps a clean family environment, and brings better user experiences. [Figure 15]

3.3 MOTHER APP capture system

HD Web Camera connected to Media TV is palced on the top of TV in the middle. It starts or shuts down Camera according to the state that the user uses media sofa. It can take high-resolution photos. It provides two different photographing methods: automatic and manual. According to different settings, it can take one photo each day when the childre are growing up, or it can be manually operated to record in detail the activities in the living room, such as birthday parties, New Year celebrations, or family get-togethers.

3.3.1 HD Web Camera

Logicool HD Web Camera is connected to Media TV. It has auto-focusing functions, and it takes high-quality 10 million-pixels pictures. The photos will be displayed with great effect when the user views them on high definition television. [Figure 16]



Figure 16: Logicoool HD Web camera



Figure 17: Media TV

3.3.2 Media TV

The current Media TV has a 42-inch screen with a 1080-pixel resolution. It provides very good photo displaying effect in the living room. In the meanwhile, it has facial recognition function and can adjust the height automatically according to the person's position, such as on the sofa, or on the floor, thus providing the most comfortable angle for viewing the photos. Besides, its mobility enables Camera to adjust its angle to capture different scenes or keep track of a particular person. [Figure 17]

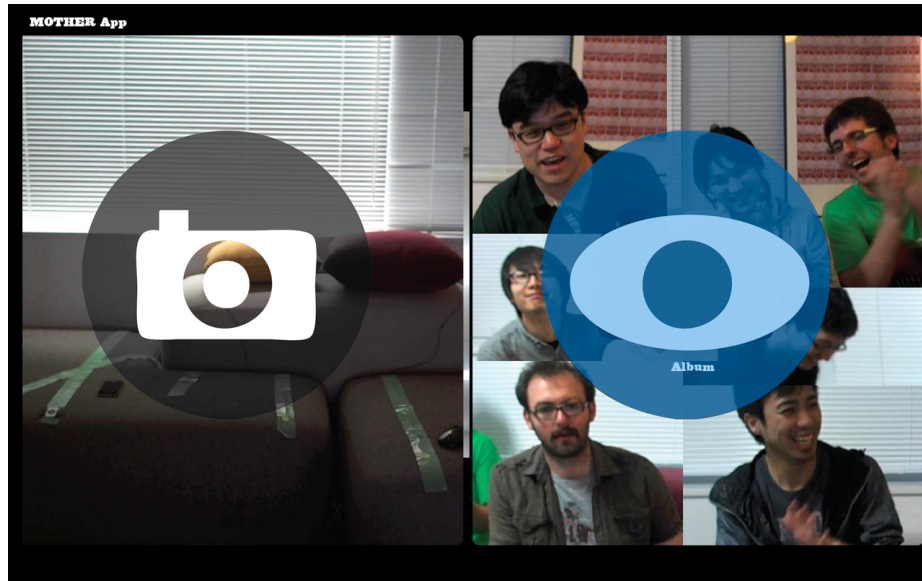


Figure 18: MOTHER Album Interface

3.4 MOTHER Album System

MOTHER Album System includes two parts. The first part is to allow the user to check the photos on the graphical interface, and view the photos in timeline. The other part is to allow the user to set up the photographing methods with manual or automatic choices, i.e. taking one photo each day automatically or operating manually to start taking pictures. [Figure 18]

3.4.1 Album Review Interface

The graphical interface for viewing photos is made up of the following icons: icons for clicking and moving, including play, pause and scrollbar. The user clicks on the icons to start or stop playing photos, or he drags the scrollbar to a specific time.



Figure 19: Experience MOTHER Album through Media TV

3.4.2 Camera setup Interface

The graphical interface for adjusting photographing methods contains the following icons: automatic and manual. The user clicks the icons to change the recording methods, i.e. choosing automatic icon to take one picture each day, or choosing the manual icon to begin taking pictures after receiving specific signals from the user.

3.4.3 Review photos

In Media Furniture Platform, Keyboard and Mouse for personal computer are used as a remote device of MOTHER APP. The user can use it to choose different methods for viewing photos, or change the photographing settings. [Figure 19]

3.5 Application running environment

3.5.1 Processing

The Application that runs on the computer terminal which is made up of two parts. One part is sensing and photographing system. It reads the data sent from MOTHER Sensor through Xbee which is connected to the usb port of the computer. Then, it initiates HD web camera connected to another usb port of the computer to take photos, and save them in jpg format. Another part is the displaying and setting system. It can read the photos taken, and provide two methods for the user to view photos, i.e. random viewing in the form of slides and timeline viewing.

Processing is an open source programming language and environment for people who want to create images, animations, and interactions. Initially developed to serve as a software sketchbook and to teach fundamentals of computer programming within a visual context, Processing also has evolved into a tool for generating finished professional work. Today, there are tens of thousands of students, artists, designers, researchers, and hobbyists who use Processing for learning, prototyping, and production.

3.5.2 Desktop OS and Xbee

The Application running in the computer terminal receives data information sent from MOTHER Sensor through Xbee Toolkit connected to a usb port. This Toolkit includes a Xbee and a Xbee Explorer USB. They are compatible with mac, windows and linux systems, and through Processing executable files can be exported that are compatible with mac, windows and linux systems. So there is very good compatibility.

4 Evaluation

4.1 Framework of this evaluation

In this evaluation, MOTHER App must be evaluated under real environment, including whether it will start the sensors embedded in the sofa when the user is sitting on the sofa, and whether it can start the camera to take photographs through the wireless data transfer system, and whether it is able to save the photographs in the photo folder and whether MOTHER Album is able to read the photos. And at last, whether the user can acquire a pleasant experience from using this system.

MOTHER APP is a system that designed to be used in the living room, so it is crucial for the evaluation whether the user can obtain the expected experience. So we decided to put MOTHER APP, the system designed for the home in real environment, which includes actual furniture, the homely layout, and an atmosphere that is comfortable for the user. So, the evaluation used Media Furniture Items, including furniture, the Cushion, the TV, and the light to create the environment of a living room. [Figure 20]

In the same time, we prepare two different examples to be meant for users to use MOTHER APP naturally, thus the environment was going to be a casual and comfortable one. The first example is a young man, who was hosting a birthday party at home. [Figure 21] He used MOTHER APP to view the picture taken on the previous day. The second example was designed for a young man and a young woman. On the first day, MOTHER APP took pictures when they were together. On the second day they were invited to look at the picture. Each example took two days to complete a user experience.



Figure 20: First example : Birthday party in the Living room



Figure 21: Stuff for birthday

4.2 Scenario

Before evaluation, we designed a scenario to display how MOTHER App system is operating and what experience it is going to bring to the user.

At the present time when the digital cameras are ubiquitous, people take a great many photographs each day. In the internet album Flickr, the users upload 3 to 5 millions photographs in one day. And one of the hottest tag is “Family.”

Liu is a thirty-two-year old gentleman in Shanghai and very successful. Four years ago, after he had graduated from Keio Media Design in Japan he established his own design company. Two years ago, he was married, and he has just had his first baby. He is very happy and his parents and relations are visiting his home to have a look of his new-born baby. He is very thankful to everything that the family brings him, then hopes to record and save the precious moment.

He turned on Media TV, connected to the internet and downloaded MOTHER Application, and automatically installed the application in Media Furniture Platform. This is a set of intelligent furniture designed and produced in Japan. It can take on new functions by installing Application.

The function of MOTHER Application is: “This is a system for recording and displaying family memories. It senses the communication and activities of family members through Media Sofa, automatically takes photographs and save them in the album in Media TV for future display.” He clicked MOTHER and the systems began initializing. When he sat on the sofa, the system sensed one person on the sofa and this information was shown on the television. Then he took his baby in his arms and sat on the sofa, this time, the message was shown on the television that the system sensed too persons on the sofa. At this time, the camera embedded in the television began to take photographs automatically. With the flash of the Led light, there appeared on the television the his first picture with his baby. Then he

asked other people to sit on the sofa and took pictures. The date was shown on the television and the number of photographs taken was increasing. He was satisfied with MOTHER App, because he needed not hold the camera to take pictures, while if he did so, he would not appear on the pictures. In the meanwhile he was able to sit leisurely in the living room and display the pictures to his parents and his relations through the television without turning on his laptop and logged on Flickr.

Half a year later, he left for Japan for business. When he was back, he found that his baby had already learned to walk and talk. He felt sorry that he missed those important moments. Then his wife turned on Album of MOTHER Application and showed him how his baby attempted to stand up, how his parents taught the baby to speak, and how his baby finally stood up and began to talk. He felt as if he had experienced everything with his baby.

Thirty years later, Liu invited his parents to celebrate the New Year and his boy had just come back from the United States. They were preparing food and everything. Just before the coming of the new year, he turned on MOTHER Application, watching the photos and remembering the past events. He saw that his child was growing up, entering the primary school, the middle school, and experiencing the adolescence, and going abroad, then he watched his child coming back from the United States, and their bond becoming stronger. He saw himself growing older. But his parents were still healthy, and having all the parites in the living room. This experience of spending time together with his family made his contented and happy.

This is the MOTHER system, a sytem to record and display family memories, not only captures the precious but transient moments in family life, but also keeps a family history of photos, making the living room a theater full of precious memories.

4.3 A Brazilian's Birthday party

The first test user was an easy-going Brazilian. The event was his 26th birthday party. The young man enjoys holding and attending parties, and collecting photographs taken of him, then uploading and sharing the photographs with friends. He owns an old Cannon and an iPhone. The photographs taken by the camera and iphone are of the same quality or definition. During the party, he rarely uses the camera because if doing so, he has to stop what he is doing and miss his conversation with his friends, the merriment, drinking, etc. But in order to keep some wonderful memory, if he meets a friend who he hasn't seen for a long time, he usually takes photographs using iphone. So he most frequently Appears in the pictures taken by others, and seldom takes the role of a recorder, but has to stop what he is doing to take photographs. His birthday was held in a living room which consists of Media Furniture items. The guests are his friends in real life, and in this environment they accomplish all the activities that they do in a real living room, like drinking, conversing, taking rests, watching TV on the sofa. In the first half of the evaluation, we did not tell the guests that they were going to be taking photographs of, thus we were able to obtain actual records. [Figure 22] In the latter half of the evaluation, we told the guests to observe what changes were going to be brought about as for their way of using furniture. [Figure 23]



Figure 22: Background photo capturing



Figure 23: Manual photo capturing



Figure 24: Second example : A Normal day

4.4 A Normal day in the living room

The second test user is a young man and a young woman. The girl is a first-year graduate student. The boy is an editor of a fashion magazine. They have a small living room in their home, so they seldom invite their friends to their home. For the young couple, the living room is a space for them to enjoy what life has to offer, like watching a movie on weekends, reading books, playing Nintendo Wii, in a word, enjoying a sweet space with each other. They were asked to take part in some activities in the living room for an hour, at the same time their activities were going to be photographed by MOTHER APP. They were shown the photographs the following day and we observed their responses and asked how they felt. The evaluation was based on the first scenario in the living room context. [Figure 24]

4.5 Data Analysis

In the first evaluation, the Subject used his iphone to take photos in the beginning. When we showed him the photos taken by MOTHER APP, he was surprised that his moments with his friends had been recorded. After that he did not use his iphone any more and enjoyed himself from the afternoon to the evening entertaining his friends, having conversations, playing games. When the party was about to end, he invited his friends to sit on the sofa, and found the Sensors, then made poses to the TV which had a camera with it and took pictures together. [Figure 25] The next day, he said this was a very good experience for him when he viewed the photos taken. He remarked that he would not worry about the problem of who was going to play the role of photographers in future parties. [Figure 26]

In the second evaluation, the young girl brought a guitar. She said she was learning to play the guitar, but she never had any photographs of her playing it, so she hoped to take this chance to keep the memory. After having known that her behavior would be recorded, she voluntarily tended to do more activity in the living room. Her boyfriend watched a film in the living room, which took him more than an hour. The following day, when we showed them the photos, the girl was not enthusiastic about the photos. She remarked that she hoped to make a better impression in the pictures. [Figure 27] She showed more interests to her boyfriend's photo. She said it was the first time for her to find out how lovely her boyfriend's countenances are, esp. his countenances when he was watching a comedy movie. The young man remarked that it was interesting to find out more about each other through the system, and what impressed him was how earnest his girlfriend was in learning guitar.

In the process of taking photographs by MOTHER APP, as the system adopts a background type of recording method, the user does not need to control the system manually, so in this aspect, we can not learn how the user feels



Figure 25: Subject enjoy taking photos before say goodbye.

by asking them how they felt at using it. However, the ample videos and photographs and the responses that they gave are sufficient to learn how the user felt. In the displaying process of MOTHER APP, the interface between the user and the system is provided, and we asked the user how they felt about the interface, but not in detail. The key of the evaluation is the user's response for the new experience of recording, so we emphatically used the method of observation, and asking a small amount of questions, which are not technical ones, but still about how they felt to find the user's responses.

In the four days' evaluation, we obtained a great deal of information, with consideration for different examples. As stated above, the key of this evaluation is the user's response for the new experience of recording. So we viewed a large amount of videos, pictures, and word information, tried to sum up the responses of the user, like whether they accepted the new mode of recording, whether the user liked the result as shown by the displaying system. These evaluation not only verified the concept, but also provided information for future improvement.



Figure 26: MOTHER Album review mode



Figure 27: Subject playing guitar



Figure 28: Camera can only take pictures from an angle.

4.6 Limit of MOTHER APP

As the camera of MOTHER APP is installed on media tv, so when the sofa is one and a half meters from the TV, the system takes the user's facial countenances clearly. But it has a limited scope, and can not take pictures when the users is fairly away from the sofa. On the other hand, as it is fixed, it can only take pictures from an angle. Those who want to use it to take the place of digital camera will not be satisfactory. [Figure 28] After all, MOTHER APP is not meant to take the place of digital camera. And for the limitation of time, it is impossible for use to evaluate what the experience brings to the user after a long period of use, say, a 30-year-old man watches what he looked like when he was celebrating his 16th birthday, when he was in love and might look like silly.

4.7 Result

Through the evaluation which lasted four days, the user's positive responses verified that the user accepted the experience brought by MOTHER APP. For the first test user, the sensing and capture parts of MOTHER APP had a high score. It is important for him to attend parties and have pictures taken. He felt deeply esp. when he looked at his photos that he took with his friends. As he had to stop conversation with his friends when a picture was taken with a digital camera or iphone, he has only a small number of pictures, sometimes, only a picture of the whole group taken at the end of an occasion. MOTHER APP, which takes pictures through detecting human behavior, not only gives him the chance to enjoy a party, but also records the unexpected interesting moments during the party. So he was especially happy when he saw the picture in which he and his friends were throwing themselves together. He also said that in his Brazilian home, he often invited friends to come over for a party. In these parties, his parents or other family members often came to say hello to his friends or make conversations. He said that he would like to have the system in his Brazilian home and expect to see those precious pictures in which his parents would share many happy moments with him. In the same time, he liked the way the photos were displayed through Media TV. When he saw the pictures on model tv, he said that "I have never had this kind of experience". Now he felt that the system made the furniture in the home very interesting, as if they have the power of understanding. The conclusion through observation and interview strongly has strongly proved that for the user, being recorded by MOTHER APP in the living room naturally is a pleasant and satisfactory experience.

In the second evaluation, the test users also gave positive responses. Their responses have shown that this natural recording of life can reveal to the user a different home, in which some parts are very lively but often neglected. When the boy found out how his girlfriend's passion for her hobby, he said

that he was moved, and he had never noticed that. The he suggested that he should take some friends who are good guitarists home to teach her. This is out of our expectation, but it make the relationship between family members more active and it is so useful as a supplementary media in helping family member to communicate with each other.

5 Conclusion

Documenting and Exhibiting the shared experience in the home not only makes it possible for the family to have a recording in which they could be able to see how they grow and enjoy life together, but also reveals hidden surprises in the home, and therefore makes the family members get more involved in home activities and keeps the home life going more attractive. This is what MOTHER APP proposes. When the user starts MOTHER APP Application software running in media tv, the software will initiate the force sensor embedded in Media Sofa. This signal detecting system can sense the family members' activities in the living room, and trigger MOTHER Camera to start recording family life. According to different settings, MOTHER Camera can take one photo each day or it can be manually operated to record in detail the activities in the living room, such as birthday parties, New Year celebrations. Thus, user can view the photos in timeline through the MOTHER Album running in Media TV. Therefore, the whole growing up process, like when kids first speak and stand, go to school, and eventually entering adulthood can be experienced once again by their parents, who can perhaps better understand the reasons for past joys. In fact, by doing so, they might get inspirations to better plan their family future. Thus, memories are no longer just tools to review the past, but have become tools to enhance the future.

In the four days' period, we made the evaluations on the user experience of MOTHER APP through two examples. The positive responses from the user to MOTHER APP have verified that the new experiences it brings to the user has been accepted.

For the first test user, attending gatherings and then having photographs taken are the best way of keeping the good memories of the past. MOTHER APP makes it possible for him to enjoy the warm atmosphere of the gatherings without stopping his activities and taking photographs. When he

viewed the photographs in on TV in which he was having a very good chat and drinking wine with a girl he was attracted to, he was especially hAPPy. He said that it had been embarrassing for him to invite a girl to take photographs together. The non-invasive way of recording life has brought him lots of surprises.

For the second test user, recording their everyday life revealed what they had neglected. For example, the boy said that he found out how his girlfriend was passionate about her new hobby and he was deeply touched, then he said he would bring friends to teach her. The new discovery is going to bring new changes to their home.

5.1 Future Work

5.1.1 Integrate with Media Furniture Items for nature starting

The first day, we evaluated MOTHER APP and MUSIC Life together, MUSIC Life is an Application to Media Furniture Platform that creates the experience of playing music together with your family and friends in the living room. When using MUSIC Life, the test users tapped the sofa to play music together, in the meanwhile, MOTHER APP system was started and began to recording the party and the activities of the users. How to combine MOTHER APP with the other projects of Media Furniture Items will be what we are going to consider next.

5.1.2 Emotion based Sensing System for rich resource

MOTHER Sensing system has a limitation that is it only senses human behavior through the sofa. Sony Cybershot T200 digital camera uses smile detection technology, which detects the user's smiles and begins to take photographs automatically. In this case, human emotion triggers the system to



Figure 29: Sony Cybershot T200

begin taking pictures. [Figure 29] Incorporating emotion detection in Mother Sensing system will make it be able to record more colorful home activities.

5.1.3 Photo archiving system for long - term use

The current family album can only store and display non-continuous moments. To build a family history which records and displays a complete family memory and the growth of the family would take a great deal of time. For example, Mark McIveen, who is from Canada, digitalized his family album. His family has accumulated about 10000 photographs since 1895. He spent 120 hours choosing 6000 of them and having them scanned. These photographs took up 40 disks. Finally he digitalized all the photographs, which recorded his family history of 130 years. [Figure 30] Nowadays, digital capture and management system can help a user to establish a family history with photographs easily. For example, iphoto, which adopts facial recognition system, can recognize different family members, and build his or her individual photo album. The current prototype does not incorporate a well-developed photo management system. Therefore, in the future, building an intelligent photo sorting and storage system will bring the user better



Mark McIlveen digitized six generations' worth of family photographs, dating back to 1895.
Photograph by: Greg Southam, edmontonjournal.com

Figure 30: Mark McIlveen and his Family Album project

experience. We are considering to make use of classifying photos by facial recognition technology and then making an intelligent sorting of the photos, such as sorting out all the photographs in which the user has Appeared.

5.1.4 Family Objects as Natural User Interface for reviewing Family Memories

The user uses the conventional HCI like the keyboard and mouse to use MOTHER APP system. In China, there is a phrase called "Things remind the person", which means seeing something will make you think of some person who has some connection with the thing. This phrase is often used to describe how one misses a person who is away. In Mother APP, this phrase has a new explanation. In the home, family objects sometimes represents the role of mementos, e.g. the vase on the desk reminds people the love of the purchaser for the family, the gift that is brought home from a travel abroad shows a period of beautiful time has been had. In an intelligent environment, through object recognition technology, the future MOTHER

APP can recognize objects in the home, and these objects will start the playing of the photo album. The following will be a good example. When scanning a vase in front of MOTHER APP, MOTHER album will show the user stories in connection with the vase: Twenty-five years ago, Father bought this vase to welcome the birth of his first baby. In the twenty-five years, Mother bought flowers for the vase, Father brought flower back home, and visitors brought flowers too. These stories record the love and affection in the home and they are told in the form of photographs. [Figure 31]



Figure 31: Vase in the home

6 Acknowledgements

Here I would like to extend my gratitude to my supervisor, Professor Naohito Okude, who, in the past two years, has corrected my mistakes over and over again, and taught me how to observe and examine. I have learned so much from him which will help me in my studies and work, more over, will guide my life, let me know how to face and solve problems in future.

I am very grateful to Professor Masa INAKAGE and Professor Hiroyuki KISHI. I not only have gained a great deal of benefit from their lectures, I also have had the pleasure of talking with them some times, which has given me great encouragement. I am particularly indebted to the help they gave me in my thesis writing.

I will never forget Media Furniture Group. I would like to thank Ryo KASHIWAGI, Shigeru Kobayashi, DAisuke Uriu gave me feedback and advice with great patience. I will always remember Malek Anouti , Gustavo Dore for the great moments we had discussing the project. I will not forget Jun Yabuki, Araki Ruri, Takao Tanigaki for your great help. All of you have enriched my campus life in Japan as a single guy.

In the past two years in kmd, I have had a great many pleasant weedend gathering with my classmates, able, wailing, etc. Thank you all, and thank you, kmd, kmd has great influence in my growth.

In the last, I will thank my parents. They have spent a great deal of energy on me with my studies, my life, and my growth.

References

- [1] Beyond total capture : a constructive critique of Lifelogging.
- [2] Richard Banks, Cambridge Cb, and Abigail Sellen. Shoebox : Mixing Storage and Display of Digital Images in the Home. pages 35–40, 2009.
- [3] U. Bischoff, V. Sundramoorthy, and G. Kortuem. Programming the smart home. *3rd IET International Conference on Intelligent Environments (IE 07)*, pages 544–551, 2007.
- [4] Joëlle Bitton, Stefan Agamanolis, Matthew Karau, and Sugar House Lane. RAW : Conveying minimally-mediated impressions of everyday life with an audio-photographic tool. *Media*, 2004.
- [5] Microsoft Corporation and One Microsoft Way. The Past is a Different Place : they Do Things Differently There The Past is a Different Place : They Do Things Differently There. *Sociology The Journal Of The British Sociological Association*, 2008.
- [6] Abigail Durrant, David Frohlich, Abigail Sellen, and Evanthia Lyons. Home curation versus teenage photography: Photo displays in the family home. *International Journal of Human-Computer Studies*, 67(12):1005–1023, December 2009.
- [7] Abigail Durrant, Alex S Taylor, David Frohlich, Abigail Sellen, David Uzzell, Roger Needham Building, and J J Thomson Ave. Photo Displays and Intergenerational Relationships in the Family Home. *Processing*, pages 10–19, 2009.
- [8] Abigail Durrant, Alex S. Taylor, Stuart Taylor, Mike Molloy, Abigail Sellen, David Frohlich, Phil Gosset, and Laurel Swan. Speculative devices for photo display. *Proceeding of the twenty-sixth annual CHI con-*

ference extended abstracts on Human factors in computing systems - CHI '08, page 2297, 2008.

- [9] Rowanne Fleck and Geraldine Fitzpatrick. Reflecting on Reflection : Framing a Design Landscape. *Technology*, 2010.
- [10] Connor Graham, Lancaster La, and Mark Rouncefield. Photo Practices and Family Values in Chinese Households. *Human Factors*, 2007.
- [11] Colleen M Grogan. Introduction to special issue: critical essays on health care reform. *Journal of health politics, policy and law*, 36(3):369–71, June 2011.
- [12] Jennifer Healey and Rosalind W Picard. StartleCam : A Cybernetic Wearable Camera Introduction : Cybernetic Control of Wear- able Computers.
- [13] H. Ichikawa. Special Section on Ubiquitous Sensor Networks. *IE-ICE Transactions on Communications*, E90-B(12):3335–3335, December 2007.
- [14] Heekyoung Jung and Kay Connelly. Exploring design concepts for sharing experiences through digital photography. *Proceedings of the 2007 conference on Designing pleasurable products and interfaces - DPPI '07*, (August):313, 2007.
- [15] Jeong Kim and John Zimmerman. Cherish : Smart Digital Photo Frames. *System*.
- [16] Tae-young Lee, Heon-hui Kim, and Kwang-hyun Park. Gesture-Based Interface Using Baby Signs for the Elderly and People with Mobility Impairment in a Smart House Environment. *Signs*, pages 234–237, 2010.
- [17] Siân E. Lindley, Maxine Glancy, Richard Harper, Dave Randall, and Nicola Smyth. “Oh and how things just don’t change, the more things

- stay the same”: Reflections on SenseCam images 18 months after capture. *International Journal of Human-Computer Studies*, 69(5):311–323, May 2011.
- [18] Siân E Lindley, Richard Harper, Dave Randall, Maxine Glancy, and Nicola Smyth. Fixed in Time and “ Time in Motion ”: Mobility of Vision through a SenseCam Lens. *Work*, 2009.
 - [19] Siân E Lindley and Dave Randall. Reflecting on Oneself and on Others : Multiple Perspectives via SenseCam. pages 1–6, 2009.
 - [20] Siân E Lindley, Dave Randall, Wes Sharrock, Maxine Glancy, Nicola Smyth, and Richard Harper. Narrative , Memory and Practice : Tensions and Choices in the Use of a Digital Artefact. *Analysis*, 2009.
 - [21] Sara Ljungblad, Maria Hakansson, Lalya Gaye, and Lars Erik Holmquist. Context photography. *Extended abstracts of the 2004 conference on Human factors and computing systems - CHI '04*, page 1191, 2004.
 - [22] Elly Pelgrim. Research in CareLab Seniors. pages 30–33.
 - [23] Daniela Petrelli and Steve Whittaker. Family memories in the home: contrasting physical and digital mementos. *Personal and Ubiquitous Computing*, 14(2):153–169, January 2010.
 - [24] a J Sellen, G Louie, J E Harris, and a J Wilkins. What brings intentions to mind? An in situ study of prospective memory. *Memory (Hove, England)*, 5(4):483–507, July 1997.
 - [25] Molly Stevens, Florian Vollmer, and Gregory D Abowd. The Living Memory Box : Function , Form and User Centered Design. *Memory*, pages 668–669, 2002.

- [26] Molly M. Stevens, Gregory D. Abowd, Khai N. Truong, and Florian Vollmer. Getting into the Living Memory Box: Family archives & holistic design. *Personal and Ubiquitous Computing*, 7(3-4):210–216, July 2003.
- [27] Laurel Swan and Alex S. Taylor. Photo displays in the home. *Proceedings of the 7th ACM conference on Designing interactive systems - DIS '08*, pages 261–270, 2008.
- [28] Alex S. Taylor, Richard Harper, Laurel Swan, Shahram Izadi, Abigail Sellen, and Mark Perry. Homes that make us smart. *Personal and Ubiquitous Computing*, 11(5):383–393, July 2006.
- [29] Alex S Taylor, Laurel Swan, and Abigail Durrant. Designing Family Photo Displays.
- [30] Daisuke Uriu, Takahiro Ogasawara, Naohito Shimizu, and Naohito Okude. MASTABA : A Digital Shrine for Family. *Computing*.

Appendix :

The Selected images of Prototype testing

