Direct Share: Photo Management System Based on Round-robin Concept-driven User Preference Feedback

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Received August 10, 2010; revised September 15, 2010; revised October 25, 2010; accepted November 13, 2010; published July 28, 2011

Abstract

As the size of camera modules is decreasing and as the computing performance of portable devices is improving, taking photos has become a part of daily life. However, existing photo management programs and products that manage such photos still require extensive user effort to facilitate the sharing and browsing of images. It is especially difficult for novice users to manage and share photos. In this paper, we develop a round-robin concept-driven user preference feedback mechanism for achieving direct photo sharing, instant display, and easy management using optimized user controls and user preference-driven classification. Compared with commercial photo management systems, our proposed solution provides new features: optimized user controls, direct sharing and instant display, and user preference feedback driven classification. These new features boost the round-robin concept-driven user preference feedback. This paper proposes a photo finder that automatically searches for photos in storage spaces or cameras. The proposed photo finder relies on user preference feedback to share photos by leveraging user preferences, and the round-robin connection transmits photos to the family's digital photo frame or web album by arbiter. The proposed method saves time and spares users the effort required for photo management. Moreover, this method does not merely direct photo sharing and simple photo management, but it also increases the satisfaction level of users viewing the photos.

Keywords: Photo management system, round-robin concept, optimized user controls, direct sharing, instant display, user preference feedback-driven classification

This research was supported by MKE, Korea under ITRC NIPA-2011-(C1090-1121-0008) and Priority Research Centers Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2010-0020210).

DOI: 10.3837/tiis.2011.07.008

1. Introduction

1.1 Motivation

Portable devices with cameras are now very common, and it has become part of our culture to take photos in our everyday life. Moreover, it is not difficult to access photos that have been filmed anywhere, at any time. However, sharing and managing user preferred photos requires significant user effort. Accordingly, there has been research on a round-robin concept-driven photo management system that enables users to share and manage preferred photos with family members or friends.

1.2 Related Work

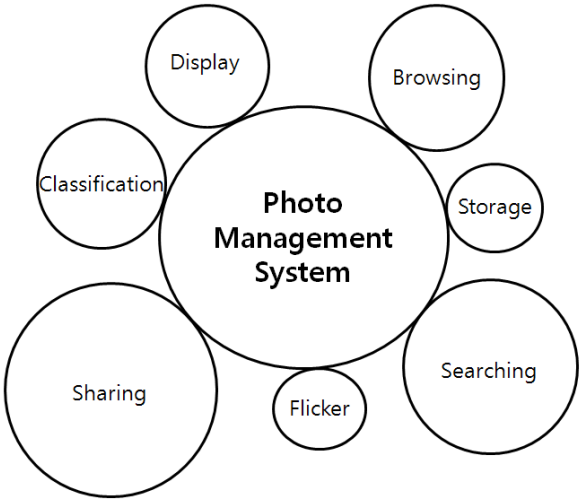


Fig. 1. Photo management system components.

There are many studies on searching, clustering, storing, sharing, browsing and using display devices for photo management systems [**Fig. 1**]. Photo sharing research includes research on methods that use web space as an image database [1], research on interaction methods for sharing and displaying digital photos emotionally [2], and research on visually providing a method for looking after family that live far away to give peace of mind [3]. Additional research includes the invention of a digital frame system that connects numerous digital devices to receive information on groups, display cycles, memory selection and user satisfaction level of managing photos and of the synchronization method [4]. Also, the invention of a digital photo frame with a built-in function that can transmit to other devices and that has the ability to interface with at least one storage medium [5] is relevant to our work. Related to that is the invention of a digital frame that can measure how long it has been activated. This digital frame can activate itself by connecting to the Internet and getting new content, which it then displays for a set amount of time. This digital frame can detect the surrounding environment and synchronize other displays [6]. There is also an invention that can provide social services by connecting digital devices to the Internet [7]. Also notable is research on the composition of a system that enables a theoretical explanation for sharing family culture [8]. Associated with that is research on a method that selects interesting objects in a photo, selects the domain, codes the applicable domain and transmits it to a digital frame

[9]. And finally there is research on the study of consumer photo-sharing culture and practices [10].

Research on photo search includes research on a method that can search data in an image database based on color, context and format [1]. There is also research on a method that enables file data structure modification using a domain with high level characteristics and context-based image search [11]. Additionally, we have seen research on a method that provides contextual search functions and that can search depending on the 2D format [12]. The recommendation of the "VisualSEEk" system with a method that can search images based on visual characteristics is also notable. Research on a method to search for images using spatial alignment when designing based on the color domain [13] is relevant, as is an invention concerning digital photo frames that can search and display the image through date and period selection [14]. Research on a system configuration that can use objects that carry memory from home, souvenirs, and articles left by the deceased to identify relationships [8] is relevant here. Also, we can mention research on the web-scale data integration for a new data integration architecture [15] and research on the utility of a fixed lexicon of visual semantic concepts for automatic multimedia retrieval and re-ranking for query expansion [16].

Research that is relevant to photo browsing includes a study on the access of a photo book's single image or continuous images [12], research on a method to display, access and emotionally share a digital photo [2], and an invention concerning the method that controls the input/output of the back light and storage medium by attaching light detection sensor [17]. Also, it is interesting to note that research on a method to display family photos and the psychological elements that are needed for displaying them has been performed as well [18].

Research on photo classification includes research on a method that enables users to search for photos with greater ease by leveraging image processing, photo classification and natural interfaces to target family members [19]. There is also research on a method to consider city vs. landscape classification and the further classification of landscape images into sunsets, forests, and mountains [20]. The invention of a method to can process images easily and conveniently based on the sequence of the processor at the lower part of the block unit [21], and research on an interactive photo annotation system based on face clustering and re-ranking [22] are also relevant here.

Research on intelligent digital photo frames include an invention on the method to minimize energy consumption by controlling the input/output of the back-light and storage medium of digital photo frames that are attached to a light detection sensor [17]. Also included in this category of research is an invention concerning digital photo frames with a built-in function of transmitting to other devices and that can interface with at least one storage medium and [5]. Finally, an invention concerning a digital frame that can detect surrounding environment [6] is also relevant.

Research on photo storage includes a method that enables file data structure modification using domains with high level characteristics and [10] and an invention that connects numerous digital devices and that can select the memory to store photos [4].

Research on photo filming includes an automatic robotic system in development that can take photos, and factor in the placement of figures in societal events such as weddings, conferences and welcoming ceremonies [23].

1.3 User Questionnaire

Two surveys determine how users manage photos. The first survey targeted 25 subjects, including undergraduates, and graduate school students, and common people. The responses from this survey, show which methods users prefer to manage pictures. The second survey had

18 subjects, including undergraduates and graduate school students. Accordingly, the survey did not fully consider the elderly as users of the photo management system. Some students responded to both the first and second surveys. The volunteers for questionnaire were interviewed in-depth based on the revised survey. The questionnaire included questions about age, type of camera, number of pictures taken, utilization of photos, classification methods, sharing methods and programs used. The survey participants were also asked to answer three method that they use to take and share photos. The photo management method users needed could be determined by the two surveys in **Table 1**.

Table 1. Questionnaire answers.

Question	Pilot Questionnaire answer (25 persons)	Final Questionnaire answer (18 persons)
Age	28.5 (Mean)	27.6 (Mean)
Type of camera	Phone (13 persons) Digital Camera (7 persons) - Phone & Digital Camera (5 persons)	Phone (11 points) Digital Camera (6 points) Professional Camera (4 points) -
Number of pictures taken	32.6 (Mean)	26.7 (Mean)
Utilization of photos	Browsing (24 points) Sharing with friends (21 points) Backup (23 points) Blog (19 points) Sharing with parents (20 points)	Browsing (14 points) Sharing with friends (13 points) Backup (10 points) Blog (7 points) Sharing with parents (6 points)
Classification methods	Date & Place (1 points) Date (6 points) Date & Event (7 points) Date & Face (2 points) Date & Event & Place (3 points) Event (3 points) Place (1 points) Group (1 points) Date & Group (1 points)	Date & Place (5 persons) Date (4 persons) Date & Event (3 persons) Date & Face (2 persons) Date & Event & Place (2 persons) Event (1 persons) Place (1 persons) - -
Sharing methods	Messenger (15 points) Blog (1 points) E-mail (2 points) Removable Disk (4 points) Web space (3 points) Home PC (1 points) Print (2 points) Phone Message (1 ponts) Twiter (2 points) Bluetooth (1 points) Compact Disk (1 points)	[with friends] Messenger (41 points) Blog (33 points) E-mail (25 points) [with parents] Home PC (32 points) Print (27 points) E-mail (16 points)
Program used	[Not used] Folder (15 persons) [Used] Picasa (2 persons) Windows Live. (0 persons) iPhotos (0 persons) Photoshop (4 persons) ALTools(4 persons)	[Not used] Folder (17 persons) [Used] Picasa (1 persons) Windows Live. (0 persons) iPhotos (0 persons) Other (0 persons)

Two answers for the questions about “Type of camera”, “Utilization of photos”, and “Sharing methods” were possible. Conversely, two answers for “Classification methods” and “Program used” were not allowed. “Sharing methods” among two-answer available questions

limited them to three double answers. The most preferable answer gives 3 points. The second most preferable answer gives 2 points. The last preference gives 1 point.

The responses from first survey, show which methods users prefer to manage pictures. However, the ability to analyze the results in detail was limited in determining the user's preferred methods. Thus, the survey was revised to analyze users' preferences in detail. For example, it was necessary to distinguish the case where users have a Phone and Digital Camera in "Type of camera" from the case in which the sorts of digital camera are different. The specific analysis about 'Group' in "Classification methods" had limitations. Some participants responded 'place' for 'group' and other ones responded 'event' for 'group'. There was difficulty in "Sharing methods", since the sharing method, except Messenger was responded to at similar times. Thus, methods according to shared subjects needed to be analyzed. Some of the responses received were outside the purview of our study 'Program used'. Photoshop is used to improve image quality. ALTools contracts folders easily and maintains them well. They were determined to be irrelevant to our study. Therefore, the survey was revised to analyze users' preferred methods in details. The duplication of responses and preferences for responses were identified through the survey. After completing the survey, in-depth interviews were used to find the users' experiences managing photos. The average age of the second survey participants was 27.6, and they took an average of 26.7 pictures at a time. Most of them took photos with their cellular phone. They classified the photos by a combination of dates and places. The most popular method for them to share photos was by an Internet messenger, then a blog, and then e-mail when showing pictures to their friends. But when showing pictures to their parents, they most often used their home PC , next most often printed them, and least often used e-mail. The questionnaire respondents said that they use the photos to appreciate them, share them with their friends and family, and manage backups and blogs, in order of most common to least common response.

Here are the specific conclusions drawn from the answers to the survey. First, there are different methods to share photos between friends and parents. When respondents share photos with friends of similar age, they preferred to deliver the photos fast, like via an Internet messenger, to share them with several friends simultaneously in a blog, and to send them conveniently by e-mail. On the other hand, when sharing photos with their parents, respondents usually saved them on the family computer directly or printed photos, because parents have limited ability to use electronic devices. If there were only a few photos, they said that they used e-mail or phone messaging services. The second conclusion that one can draw from this survey is that it is simple to classify the photos. Most of the participants rarely used commercial photo management programs like Picasa, Windows Live, or iPhoto. According to their answers, the respondents mostly appreciated the photos with their computer's native photo viewer and managed them by generating folder names based on dates, places, and events. Therefore, it was understood that the users classify and keep the photos by generating folders directly after appreciating them with a native photo viewer rather than using commercial photo management programs. Also, the respondents said that they do not like to install commercial photo management programs on their own computers to manage photos.

Several commercial photo management programs were analyzed in Section 1.4 to understand the reasons that they were rarely used. This analysis was then used to propose a system in which beginning users who are not familiar with using computer systems can easily manage and share photos.

1.4 Analysis of Commercial Photo Management Programs

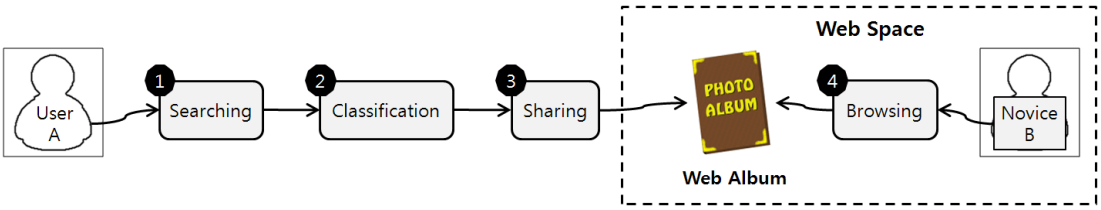


Fig. 2. Commercial photo management program flow.

The photo management programs Picasa by Google, Windows Live Photo Gallery by Microsoft, and iPhoto by Apple were used to manage photos and their performance was analyzed. The photo management was divided into four tasks as shown in **Fig. 2**. Functional summary of commercial photo management programs in **Table 2**.

Table 2. Function Summary of Commercial Photo Management Programs.

Commercial Program	Searching (Task 1)	Classification (Task 2)	Sharing (Task 3)	Browsing (Task 4)	User Controls
Picasa (Google)	Removable driver Digital camera USB video devices Folder Web camera	Face Place Tag Preference(Toggle) Type Date/Time Recently Updated Filesize Number of Face Album	Web Album File Print Collage Video Clip CD/DVD Blog E-mail	Client Viewer Web Login Mobile Applet	Menu: 93 Button: 38 Etc.: 6
Windows Live. (Microsoft)	Removable driver Digital camera USB video devices Folder	Face Tag Preference(0~5) Type Date/Time Filename	Web Album Print Video Clip CD/DVD Blog E-mail	Client Viewer Web Login Mobile Applet	Menu: 32 Button: 12 Etc.: 4
iPhoto (Apple)	Removable driver Digital camera USB video devices Folder Web camera	Face Place Tag Preference(0~5) Date/Time Recently Updated Filename Album	Web Album File Print Video Clip CD/DVD Blog E-mail Mobile Device	Client Viewer Web Login Mobile Applet	Menu: 83 Button: 24 Etc.: 11
This Work (SKKU)	Photo Finder	Preference(1~5) Date/Time	Direct Share	Client Viewer Digital Photo Frame	Menu: 18 Button: 11 Etc.: 5

Note: The objectives which Picasa, Windows Live, and iPhoto pursue can differ from our system's opinions.

Task 1 was searching. Task 2 was date, face, place, and event-driven classification. Task 3 was sharing web albums with others. And Task 4 was browsing web albums. According to the commercial photo management program flows, user A brings the photos that he/she took during Task 1 and arranges them and inputs preferences during Task 2. The user shares the photos which the user prefers through a web album in Task 3. User B can appreciate the pictures that the user A shared in the web album by typing in the web address, and sometimes putting in an account username and password.

We found that Picasa, Windows Live, and iPhoto provide nearly the same functions for the user in both Task 1 and Task 4. Picasa has the most options available in Task 2, and both Picasa and iPhoto have many functions available for the user in Task 3. The common problems of the commercial photo management programs can be seen by comparing **Table 2** with **Table 1**. They are summarized in the following points.

I. Complex User Control

Many studies have shown that user interface design has an effect on usability. According to the Hick-Hyman Law, the number of menus that a user can select decides the time that takes to decide on something using those menus [24][25]. Also, the time it takes to click the elements on the screen can be explained with Fitts Law which say that the time it takes to reach subjects by the pointing device is in proportion to the values which divide the distance to the subjects by the size of them [26][27].

The user interface of a commercial photo management program consists of menus, buttons, scroll bars, search boxes, links, and others. We understood that there are differences in the user control of each photo management program. As shown in **Fig. 3**, the results measured user control by classifying it into menus, buttons, and others (scroll, search box, link). Picasa was found to have 137 controls, iPhoto had 118 controls, and Windows Live had 48 controls. According to the measured results, the programs with the most controls have the highest chance of making users confused, which has a negative impact on usability. Therefore, Picasa is the least usable, followed by iPhoto, and Windows Live is the most usable from the standpoint of the amount of controls.

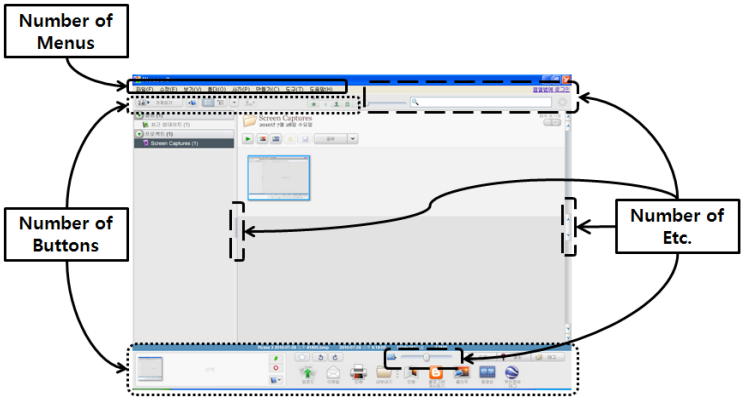


Fig. 3. Group of user controls in commercial photo management system.

II. Going Against User Expectations

According to the answers of the questions about photo utilization, sharing methods, and program usage in **Table 1**, we understood that users appreciate photos with simple viewers only in the execution of Task 1, browsing. In the execution of Task 3, sharing, they need some kind of messenger program to transmit a large number of photos quickly, or they need a way to quickly print up photos in order to share them with people who are not good at using computers. But the way it works now is that they have to install separate photo management programs to appreciate photos with the commercial photo management programs, and there is no functionality to share a large volume of photos with some sort of messenger program.

III. The Excessive use of Technology

According to the special details of the answers in the questionnaire in Section 1.3, it was understood that most users classify photos by date, place, or event, and rarely use other methods. Also, we found out that users most often manage photos using folders. These survey results from users are very different from our ideas. These survey results fly directly into the face of the fact that most commercial photo management programs provide many functions for classification (Task 2). According to Nielsen's web design guidelines, web design should be formed to keep the text of web page simple and help

users to navigate them conveniently [28]. Also, users have difficulty in setting orders because the interface becomes more complicated if categories overlap or it is difficult for users to distinguish between categories. Therefore, people can find the information more easily by reducing excess and minimizing confusion [29]. Therefore, it is judged that excessive provision of many classification functions by commercial photo management programs has a negative effect on usability.

1.5 Our Proposed Photo Management System

Our proposed photo management system consists of the client program, Photo Gallery and instant display on the digital photo frame. User A carries out Task 1, searching, that brings the photos from cameras to the client program. The user then performs Task 2, classification, which arranges the photos that user wants into categories according to dates or preferences and inputs them. User A continues with Task 3, sharing, which transmits the photos with a high preference to the instant display. User B carries out Task 4, browsing, appreciates the photos through the instant display and additionally inputs preferences [**Fig. 4**].

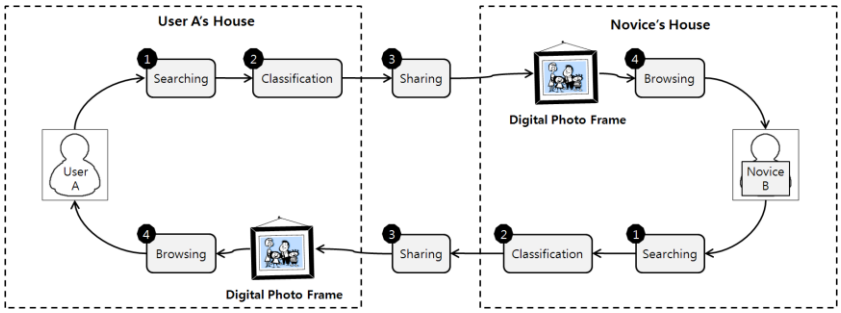


Fig. 4. Round-robin concept-driven User Preference Feedback.

The proposed photo management system supports the functions that users want as expressed through the user questionnaire (Section 1.3) and supplements the disadvantages of commercial photo management programs that the commercial program analysis (Section 1.4) discovered. In summary, our proposed management system supports intuitive classification, sharing, and browsing. The aim of the proposed concept is to easily manage who manages the photos whether the user is a competent computer user or a novice computer user.

The proposed concept has three categories of features:

I. Optimized user controls

Our proposed system focuses on simplifying the user interface for photo searching, classification, sharing, and browsing. The commercial photo management program or method is exceedingly complex. There are too many functions included in these programs. And also there are too many user controls. Thus, we eliminated all the functions except those which met the needs of the user questionnaire in Section 1.3. The functions of the Photo Gallery that we proposed are summarized at the bottom of **Table 2** (See Section 1.4).

II. Direct Sharing and Instant Display

As you see in Section 1.3, users want to appreciate photos conveniently and to share a large volume of photos with other people quickly and directly. Designing a photo management system to specifically perform Task 3, sharing, and Task 4, browsing, will be very convenient. In "Utilization of photos" in **Table 1**, users took pictures for the purposes of 'Browsing' and 'Sharing'. Therefore, "Direct Sharing and Instant Display"

deliver a great deal of data like ‘messenger’, which can transmit data easily like e-mail, to substitute the functions of ‘Blog’ and ‘E-mail’. Therefore, the direct sharing method can share a large number of photos like an Internet messenger, and a digital photo frame which can easily view the photos can reduce the workload of sharing and viewing photos. In summary, our proposed Direct Sharing with a digital photo frame can share photos with another person with just one click.

III. User preference feedback-driven classification
As we mentioned in Section 1.3, users use comparatively simple methods of dates and places to organize photos. But to searching for and sharing photos among a large saved database of photos will still take a lot of work. Therefore, simple and convenient methods to classify them should be found. Like the preceding studies [30] that classify things which are scattered in a room with a simple algorithm after observing the habits of ants, we thought of a method to classify photos that users prefer with a simple and repetitive algorithm. This paper uses the method in that users can select photos which will be shared by them with preferences and directly search the photos which will be displayed by them. All the photos have preference levels. The level of preference is used during photo searching, classification, and sharing tasks. If the photo has a high level preference, then this photo is shared to another person’s digital photo frame or uploaded to a web album. If not, then the photo is removed from storage. A photo without user preference feedback makes the rounds between one user and another by the round-robin concept.

2. Build Round-robin concept-driven Photo Management System

2.1 Components and System Flow

The proposed round-robin concept-driven photo management system is composed of a photo finder that automatically finds the photos on the local disk or camera, user preference feedback that gets the preference input from users in a round-robin process, and an arbiter that manages photos and transmits them via User Datagram Protocol/Internet Protocol (UDP/IP) according to a user’s preferences, as shown in **Fig. 5**. The photo management system executes the received photo, saves to storage, searches for photos, displays photos, gets user preference feedback, determines preferences, adds photos to or deletes photos from photos the web album, and transmits the photo to other display device (digital photo frame), as shown in **Fig. 6**.

2.2 Photo Finder

The photo finder generates photo management lists and registers the photos found in the list. One photo management category includes information on one photo. One photo management category includes a configured category number, group number, date/time, file size, counter flag, user preference value, file name and file path, as shown in **Fig. 7**. The photo finder includes a search and path management function. The search function finds photos from storage after getting a request via the arbiter. The path management function gets back the path of the photo that is found from storage and adds the photo management category to the photo management list. When the photo search is completed, the path management function notifies the arbiter that the photo search is completed. The generated photo management list is saved in storage, as is shown in **Fig. 8**.

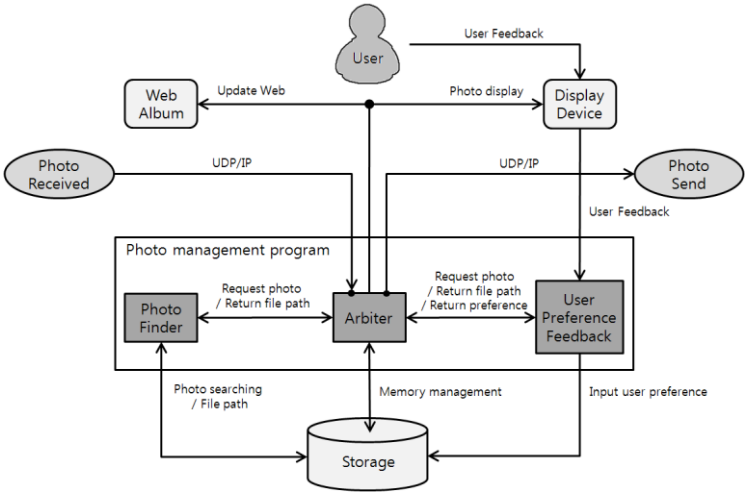


Fig. 5. System framework.

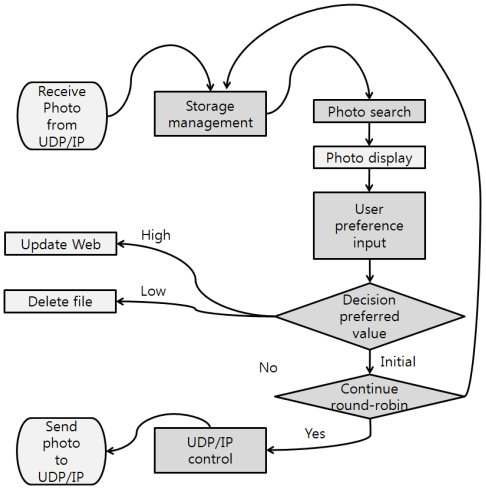
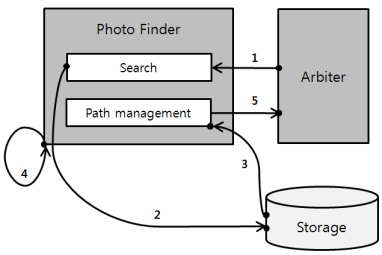


Fig. 6. System flow.

Category num.	Group num.	Date/Time	File size	Counter flag	Preference	File name	File path

Fig. 7. Configuration category of photo management list.



1: Request photo search
2: Photo searching
3: Return file path
4: Add photo info
5: Stop photo searching

Fig. 8. Photo Finder operation process.

2.3 User Preference Feedback

User preference feedback is configured via the photo display and preference input function, as is shown in **Fig. 9**. The photo display function receives the preference search request from the arbiter, and the photo that does not include user preferences is found in the photo management list. What is special here is that the photo management category that exists in the photo management list is searched randomly as shown in **Fig. 10**. The random search method helps users to thoroughly evaluate the photos that are scattered in storage. The method that thoroughly enables browsing and evaluating photos can present many fun memories to the users. This is like an experience in which users can enjoy diverse genres and albums using the iPod's random play function. The preference input function gets the preference input of the user from the display device to input the preference into the photo management category of the applicable photo. From there, it transmits the information to the arbiter concerning the modification made to the photo management list. User preference can be classified into five levels, as shown in **Table 3**, and users leverage the input method on the display device via the single layer user interface, as shown in **Fig. 11**. The single layer user interface simplifies management for novice users.

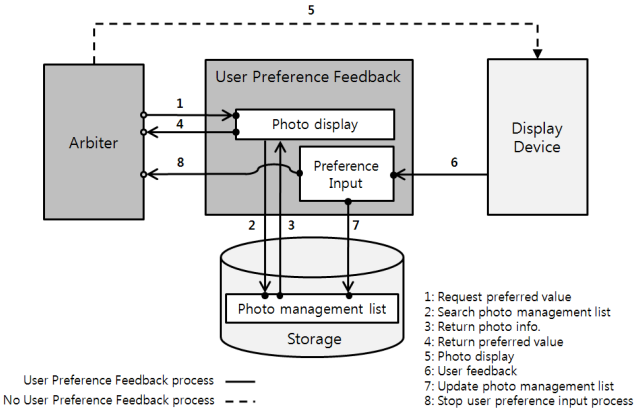


Fig. 9. User preference feedback operation process.

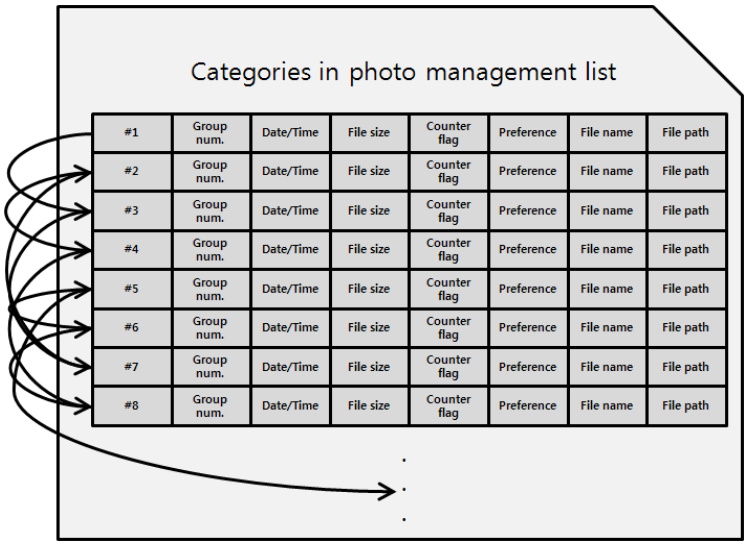


Fig. 10. Random category search in photo management list.

Table 3. User preference level.

Preference	Mean	Arbiter processing
1	Delete	Delete from the storage
2	Does not like	Prepare to delete, transmit photo to UDP/IP
3	Initial value	Request user preference input
4	Does like	Standby to upload, transmit photo to UDP/IP
5	Upload Web album	Add into photo album

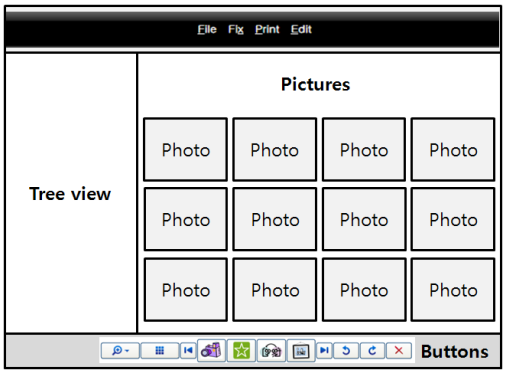


Fig. 11. Single layer user interface.

2.4 Arbiter

The arbiter adjusts the operation performed by the photo finder and user preference feedback. The arbiter is comprised of communication and memory management functions. The communication function requests that the photo finder searches for photos, and a request is made to the user preference feedback to search for preference. Moreover, the photo is transmitted to the display device so that users can view it according to an input preference. The memory management function receives information on the completion of the preference application from the user preference feedback, and the photo in the photo storage space is managed. Photo management leverages user preferences to store highly preferred photo values in the directory for specific programs or addresses of the designated web. A photo with a low preference value is deleted from the storage space, as is shown in **Fig. 12**.

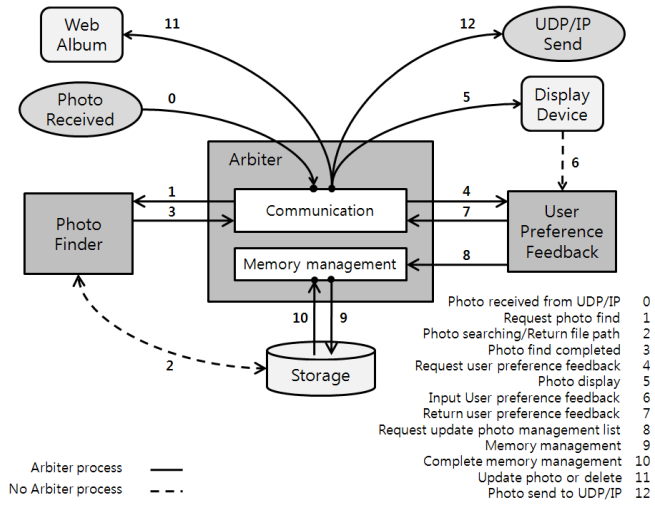


Fig. 12. Arbiter operation process.

The UDP/IP sender and receiver in communication with the arbiter support sharing between one user and another. For example, user A (novice or elderly) sends a photo to user B while viewing this photo. User B receives the photo from user A. User B adds one point and then sends it to user C. Also, user C adds one point. Finally, the preference level is five. The photo marked 5 points is uploaded to the web album by the arbiter [**Fig. 13**].

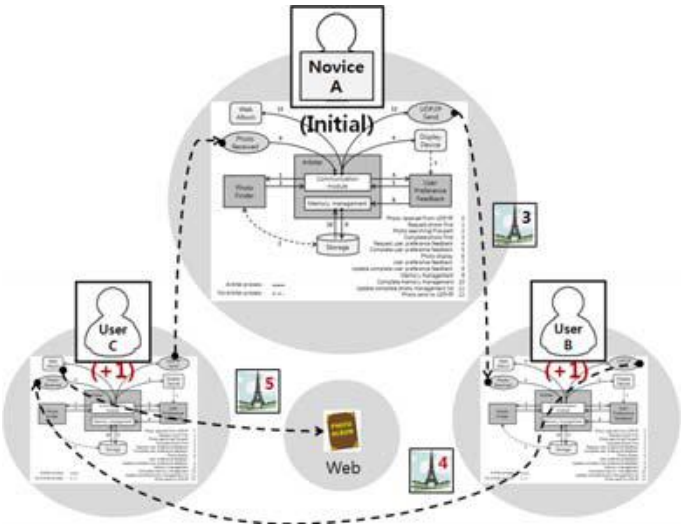


Fig. 13. Round-robin connection.

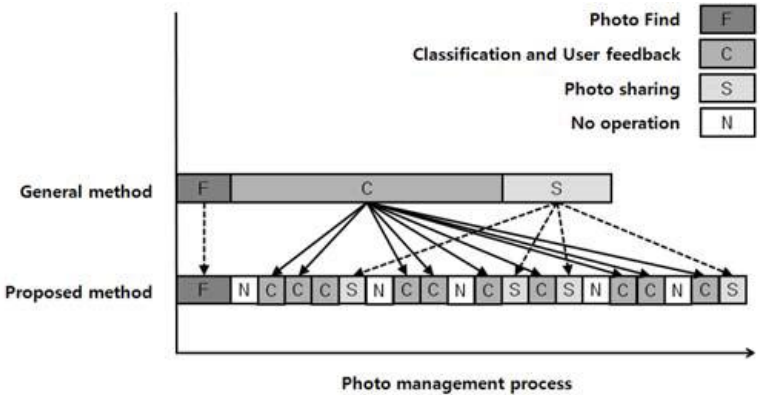


Fig. 14. Workload sharing.

The round-robin connection has workload sharing effect through UDP/IP by the arbiter. As we mentioned earlier in Section 1.5, we thought of the method to classify photos that the users prefer by a simple and repetitive algorithm. This paper uses the method in which users can select photos which will be shared by an arbiter with preference and also allows users to directly search the photos which will be displayed by the arbiter. The workload does not only take a long time, but it is also difficult for novice computer users. That is a common problem with management systems: too many functions exist in the commercial photo management program. Moreover, the program has too many user controls. Except for experts, users in general are fond of simple and easy programs. To make a program simple, functions must be simplified. Moreover, complex architecture should be avoided. To solve this problem, we use a single layer user interface (optimized user controls) [**Fig. 11**] and round-robin connection by

arbiter [**Fig. 13**]. This solution enables us to simplify photo management programs and to save time through user preference feedback by many users [**Fig. 14**].

3. Experiment and Usability Testing

3.1 Experiment Design

The experiments are carried out by dividing it into tasks to compare the performance of the proposed photo management system and the commercial programs effectively [**Fig. 15**]. The experiment of Task 1, searching, carries out the one that brings the saved photos to the computer. 400 photos of figures and backgrounds are saved in a camera. The experiment of Task 2, classification, carries out the process of finding a designated "picture 1" in the photos brought from the camera [**Fig. 16**]. The experiment of Task 3, sharing, shares the designated background photo, "picture 2" [**Fig. 17**].

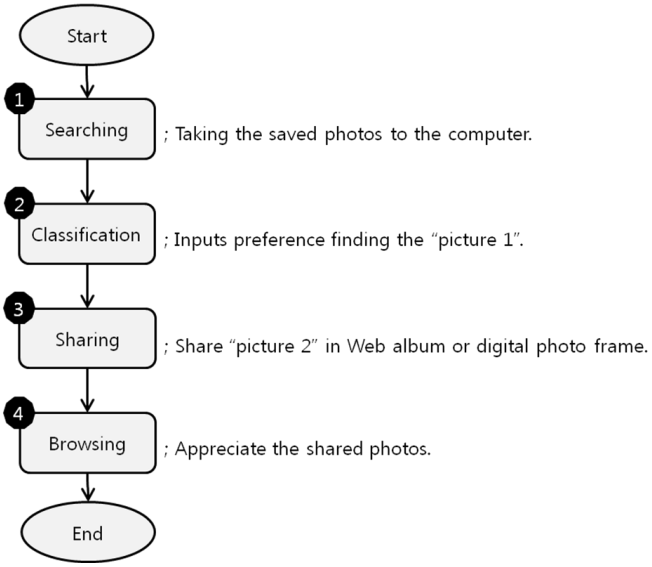


Fig. 15. Usability test flow.

Fig. 16. Test picture1.

Fig. 17. Test picture2.

Picasa and Windows Live share "picture 2" in a web album and Photo Gallery but this paper proposes sharing the photos in the digital photo frame via the direct sharing method [**Fig. 18-20**]. The experiment of Task 4, browsing, appreciates the shared photos with a web album or the digital photo frame and finishes the experiment by pressing the "Termination" button. To carry out the mission which will be done in each task, papers with simple hints were provided for the subjects.

Fig. 18. Direct sharing and Instant display.

Fig. 19. Our digital photo frame prototype.

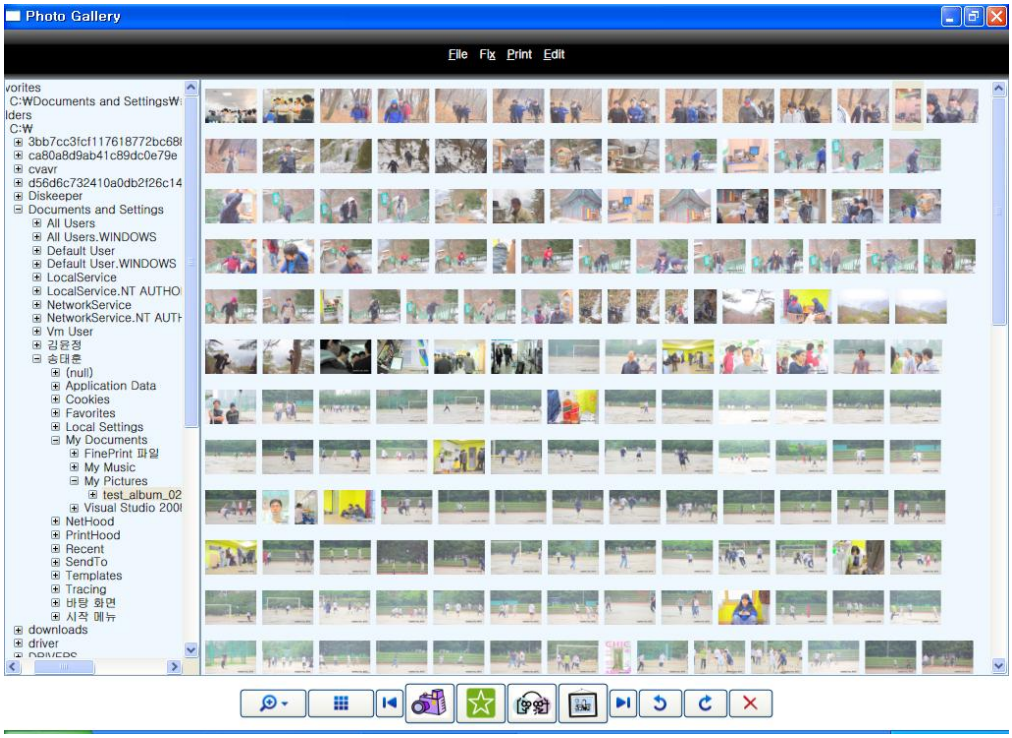


Fig. 20. Our photo management program (Photo Gallery).

Our photo management programs suggested in this paper comprise a simple structure and small number of User Controls. Like **Fig. 4**, the photo management system we suggest can be shared with the Digital Photo Frame. Actually, our client programs (**Fig. 20**) were loaded in the Digital Photo Frame prototype [**Fig. 19**]. The client program does not have to be loaded in the PC. The client program and Digital Photo Frame prototype were used in our experiment to

compare the suggested system to the performance of commonly used programs' objectively

3.2 Performance Comparison

We conduct a user study to compare the Photo Gallery with Google Picasa 3.6.0 and Microsoft Windows Live Photo Gallery 2009. We measure time cost comparisons while searching, classifying, sharing, and browsing our laboratory student face photos. To test the performance comparison, we use a test album randomly selected from our laboratory web album. The test album contains 400 photos. We design six schemes for our experiments involving different software shown in **Table 4**. We alternatively select one of the schemes for each of the users in case there is an ordering effect. Since there are 18 users, all volunteers have no experience with photo management systems, and their ages range from 23 to 33. The mean age is 27.6 years old. Each scheme is done 3 times. During the test of searching, classifying, sharing, and photo browsing, the activities of the mouse, including the number of mouse clicks and the total distance of mouse cursor movement, are recorded. We also record the time consumption and the number of user faults. The volunteers do not learn anything and refer only to the quick user guide.

Table 4. Schemes for performance comparison.

Scheme	Task1	Task2
1	Picasa	Windows Live.
2	Windows Live.	Photo Gallery
3	Photo Gallery	Picasa
4	Picasa	Photo Gallery
5	Windows Live.	Picasa
6	Photo Gallery	Windows Live.

The evaluation of the experiments is divided into subjective evaluation and objective evaluation [31]. The subjective evaluation developed various surveys to evaluate the levels of each task. Task load index (NASA-TLX), Cooper-Harper scale and Subjective Workload Assessment Technique (SWAT) are known as the typical methods [32][33][34]. The NASA-TLX method which has been the most stable evaluation method of subjective task level was used in this study [35][36]. The objective evaluation referred to the Easy Album test of Cui [22] and the experimental method of Spreadsheet Software Interaction by Olson, E. Nilsen [37]. During the test of searching, classifying, sharing, and photo browsing, the activities of the mouse, including the number of mouse clicks, the total distance of mouse cursor movement, and the number of mouse scrolls, are recorded. We also record the time consumption and user fault. To check user faults, the computer screen that the users use in the experiments was recorded, the number of user faults through an interview of the users while watching a recorded screen after the experiment ended were checked. The volunteers did not learn anything and referred to the quick user guide only.

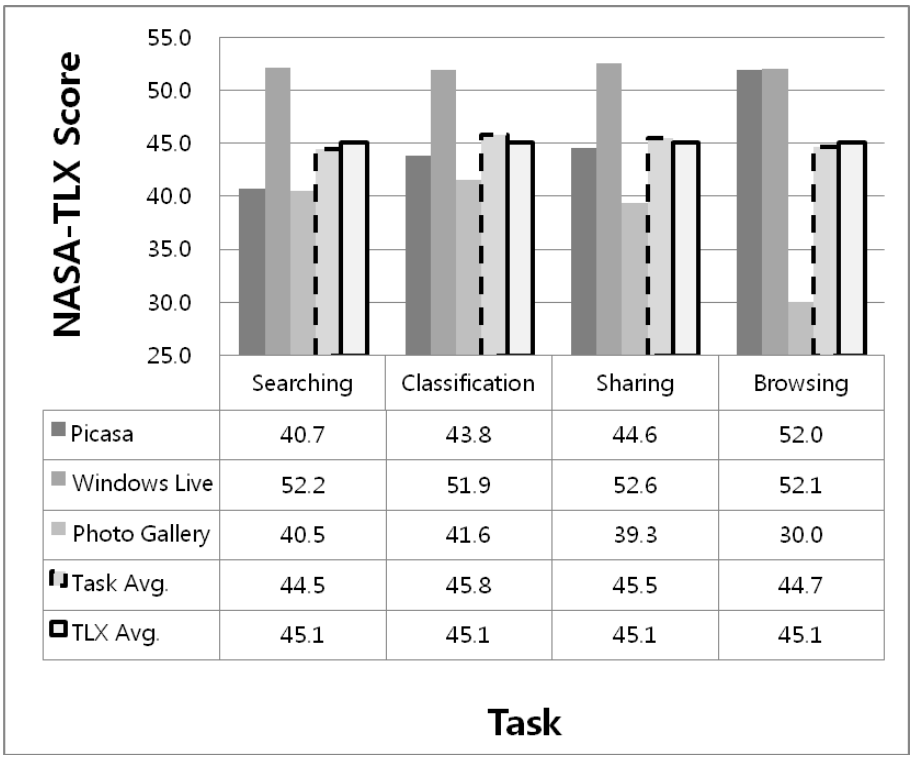
3.3 Experimental Results

The analytical results of NASA-TLX about 4 tasks load of the photo management programs were arranged in **Fig. 21**. The average NASA-TLX values of the 4 tasks was 45.1.

As for the level according to task, it has found that the level of classification (45.8) is the highest and the level of searching (44.5) is the lowest. The order of level according to task shows that similar results with survey results in the questionnaire. According to the

questionnaire of Section 1.3, they answered that they carry out Task 2, classification as the simplest method to manage photos with the folders using dates & places usually. Our classification experiment (Section 3.1) evaluated the level of tasks to input the preference of the photo finding "picture 1" out of 400 is the highest. As for the level according to programs, the average level when searching, classifying, sharing and browsing were carried out with Windows Live (52.2) and Picasa (45.3) was high and the one when Photo Gallery (32.2) was used was the lowest.

Pictures are delivered to the digital photo frame prototype through "Direct Sharing" in the 'Sharing' stage. The experiment for Browsing' was performed. Classification' from the NASA-TLS score (**Fig. 21**) in Section 3.3 and "Work Load Index" from ''Sharing' Task showed a lower level than other commonly used programs. Especially, scores of Browsing' Task on **Fig. 21** and Browsing' score were determined to have good results, compared to other commonly-used programs.



	Searching	Classification	Sharing	Browsing
Picasa	40.7	43.8	44.6	52.0
Windows Live	52.2	51.9	52.6	52.1
Photo Gallery	40.5	41.6	39.3	30.0
Task Avg.	44.5	45.8	45.5	44.7
TLX Avg.	45.1	45.1	45.1	45.1

Fig. 21. Task load index score.

When the usability of programs according to execution time is compared, the average tasks takes execution time of 71.3. Browsing tasks takes the longest time, 76.7 seconds on average. Sharing tasks recorded the shortest average execution time of 65.4 seconds. When the execution time according to programs is compared, all of Picasa and Windows Live takes more time than the average one. As for the searching task and browsing task, the execution time of Picasa takes more than the Windows Live. And as for classification tasks and sharing tasks, the execution time of Windows Live takes the longest. Photo Gallery recorded the lowest execution time in all the tasks [**Fig. 22**].

When the usability of programs according to mouse clicks is compared, the average tasks number of clicks was 12.9 used. The number of clicks was the most when Picasa (15.0) was

used. Especially, the users clicked 19.5 times on average during the task that brings photos to the computers with Picasa, searching. The number of click was the least when Photo Gallery (9.7) was used. Searching tasks the most, 16.1 clicks on average. Sharing tasks the least, 11.0 clicks on average [**Fig. 23**].

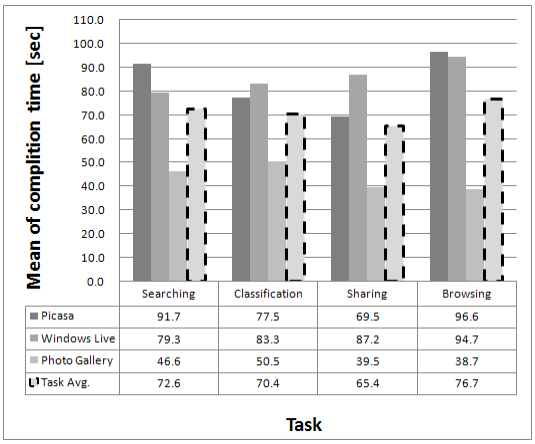


Fig. 22. Mean of completion time.

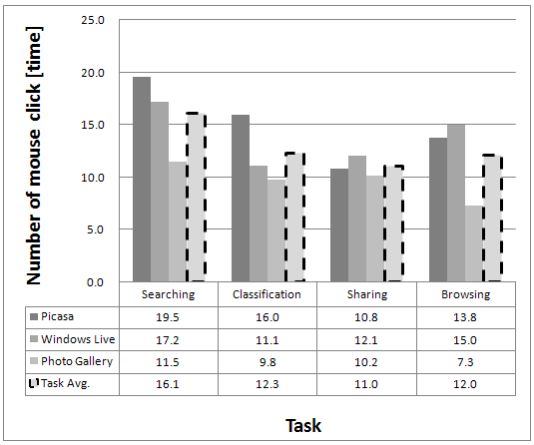


Fig. 23. Number of mouse click.

When the usability of programs according to mouse scroll is compared, the average tasks number of mouse scroll was 52.7 used. The task of classification photos averaged 79.2 scrolls, the most. Searching only took 17.5 scrolls, which is the smallest amount. The most scrolls used in Photo Gallery were during the classification tasks and the least were during searching tasks [**Fig. 24**].

When the usability of programs according to the distance of mouse movement is compared, the average tasks the distance of mouse movement was 12070.1. Picasa (14412.0) recorded the most movement distance in all the tasks and Photo Gallery (9116.8) showed the shortest movement distance in all the tasks. Windows Live (12681.4) recorded a similar movement distance with the average in all the tasks [**Fig. 25**].

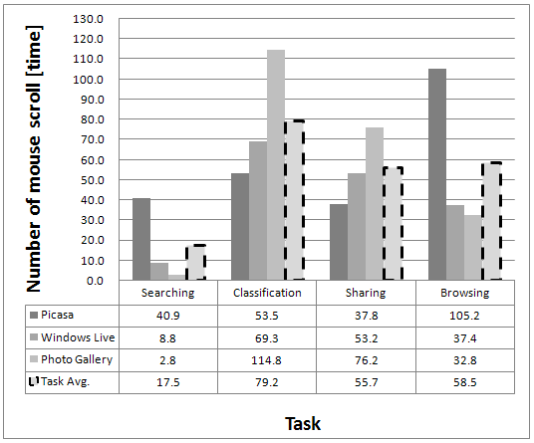


Fig. 24. Number of mouse scroll.

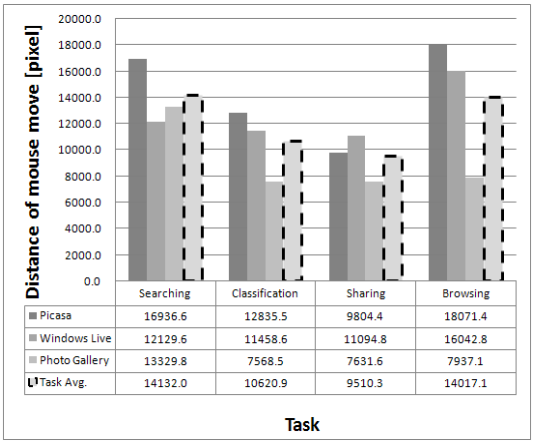


Fig. 25. Distance of mouse movement.

When the usability of programs according to user fault is compared, the average user fault was 0.4. The average level when searching, classifying, sharing and browsing were carried out with Picasa (0.8) was high and the one when Photo Gallery (0.3) and Windows Live (0.3) was

faulted the lowest. Picasa and Photo Gallery was faulted when searching, because of confused function and did not display process state, carries out the one that brings the saved photos to the computer. Picasa was faulted when classification, preference input function is confused. So user did not recognize user's preference input value. Windows Live was faulted finding "web album" link when browsing, appreciates the shared photos with a web album [**Fig. 26**].

When usability of programs according to user satisfaction is compared, the average tasks satisfaction was 5.0. The satisfaction of Photo Gallery (6.4) was the highest and Windows Live. (4.0) recorded the lowest satisfaction. When satisfaction according to Task is compared, most of them show a similar value but there is a big difference of satisfaction between classification (5.1) and browsing (4.6) [**Fig. 27**].

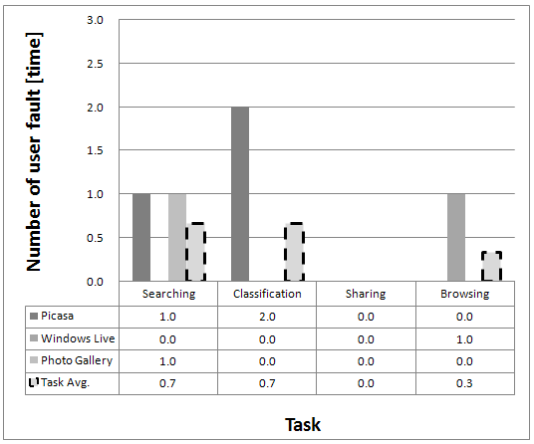


Fig. 26. Number of user fault.

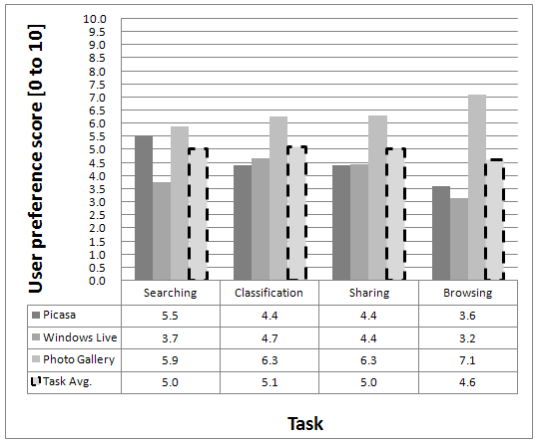


Fig. 27. User satisfaction score.

4. Conclusion

It is not easy for someone to learn new tasks as they grow older. Furthermore, modern technologies rapidly change every day. Therefore, there is a lot of effort to make easy computer programs for beginners, the elderly, or the infirm. This paper understood the necessary functions for users through a survey and analyzed what they actually find difficult in tasks by subjective and objective measurement methods. The analytical results by the survey are understood. Users need the methods to transmit many photos conveniently and prefer to classify photos using simple folders named for places and dates. Also, users rarely use commercial programs. The analytical results by the subjective measurement has been understood that users workload are virtually the same in all the tasks. According to the interviews with users, they answered that they feel difficulty in many options to upload the photos and the process of sharing and appreciating the photos. When the results that carried out the objective measurement were checked, we found that it takes a long time to bring and share photos and the number of mouse clicks, movement distance and mouse scroll have increased. The number of mouse clicks used in the process to bring photos increased to carry out many options and tag input like the subjective analysis and the number of mouse scrolls in the process to share them has rapidly increased to find the ones which will be shared. When the subjective and objective evaluation is synthesized, the users had complaints about many options and tag tasks when they use commercial photo management programs. It was understood that they needed a lot of time and efforts to classify their photos. But the users also did not need to classify photos by face or place and just needed the physical effort of the users.

As for the results that investigated user satisfaction, they did not use the classification functions and felt most satisfactory in the classification Task in spite of much physical effort. In conclusion, it could be understood that satisfaction of the users were highly evaluated even though there are tasks required much time and physical effort. The users felt very difficult when they used complicated and confused functions even though there are simple options available where much physical effort is not required. Therefore, the proposed photo management program could obtain high satisfaction of the users by using the client program and digital photo frame including simple user design and the ability to share many photos easily.

References

[1] C. Faloutsos, R. Barber, M. Flickner, J. Hafner,W. Niblack, D. Petkovic, and W. Equitz, "Efficient and effective querying by image content," *Journal of Intelligent Information Systems*, vol. 3, pp. 231-262, 1994. Article (CrossRefLink).

[2] J. Kim, J. Zimmerman, "Cherish: Smart Digital Photo Frames for Sharing Social Narratives at Home," in *Proc. of CHI 2006*, Montreal, Quebec, Canada, pp. 953-958, Apr. 2006.

[3] E. Mynatt, J. Rowan, A. Jacobs & S. Craighill, "Digital Family Portraits: Supporting Peace of Mind for Extended Family Members," *in Proc. of CHI 2001*, ACM Press, pp. 333-340, 2001.

[4] J. Stafford, "System and Method for Digital Picture Frame Syndication," freepatentsonline.com.

[5] J. Peng, "Digital photo Frame with Storing Functions," freepatentsonline.com.

[6] A. Wang, "Internet Connected Digital Photo Frame," freepatentsonline.com.

[7] A. Wang, "Social Contact Service System for Internet Connected Digital Photo," freepatentsonline.com.

[8] M. Nunes, S. Greenberg, C. Neustaedter, "Sharing Digital Photographs in the Home through Physical Mementos, Souvenirs, and Keepsakes," in *Proc. of DIS 2008*, ACM Press.

[9] T. Yao, J. Ahu, X. Chen, M. Yip, "Methods for displaying Objects Of Interest On A Digital Display Device," freepatentsonline.com.

[10] A. D. Miller, W. K. Edwards, "Give and Take: A Study of Consumer Photo-Sharing Culture and Practice," in *Proc. of the Seventeenth Conference on Hypertext and Hypermedia*, Aug. 22-25, 2006.

[11] A. Pentland, R. W. Picard, and S. Sclaroff, "Photobook: Content-based manipulation of image databases," *SPIE vol. 2185: Storage and Retrieval for Image and Video Databases II*, pp. 34-47, Feb. 1994.

[12] J. R. Smith and S. F. Chang, "Visualseek: A Fully Automated Content-based Image Query System," in *Proc. ACM Multimedia*, pp. 87-98, Nov. 1996.

[13] R. C. Dubes and A. K. Jain, "Random Field Models in Image Analysis," *Journal of Applied Statistics*, vol. 16, no. 2, pp. 131-164, 1989. Article (CrossRefLink).

[14] W. Lian, X. Li, K. Hsieh, "Digital Photo Frame and Method of Displaying Images According to a Data," freepatentsonline.com.

[15] J. Madhavan, S. R. Jeffery, S. Cohen, X. Dong, D. Ko, C. Yu. A. Halevy, "Web-Scale Data Integration: You can only afford to Pay As You Go," in *Proc. of the Conference on Innovative Data systems Research*, 2007.

[16] A. Natsev, A. Haubold, J. Tesic, L. Xie, R. Yan, "Semantic Concept-Based Query Explansion and Re-ranking for Multimedia Retrieval," in *Proc. of the 15th International Conference on Multimedia*, pp. 25-29, Sep. 2007. Article (CrossRefLink).

[17] J. Peng, "Digital Photo Frame For Saving Power," freepatentsonline.com.

[18] L. Swan, A.S. Taylor, "Photo displays in the home," in *Proc. of the 7th ACM Conference on Designing Interactive Systems*, ACM, pp. 261-270, 2008.

[19] Y. Sun, H. Zhang, L. Zhan, and M. Li, "MyPhotos - A System for Home Photo Management and Processing," in *Proc. of ACMMM 2002*, Juan-les-Pins, France, Dec. 1-6, 2002.

[20] A. Vailaya, M. Figueiredo, A. Jain, H. Zhang, "Bayesian Framework for Hierachical Semantic Classification of Vacation Images," *IEEE Transactions on Image Processing*, pp. 117-130, Dec. 2000.
[21] Y. Liao, "Image Processing Method, And Processing Methods for Digital Photo Frame and Interactive Image Process," freepatentsonline.com.
[22] J. Cui, F. Wen, R. Xiao, Y. Tian, and X. Tang, "Easy Album: An Interactive Photo Annotation System based on Face Clustering and Re-ranking," in *Proc. of ACM Special Interest Group on Computer-Human Interaction* (*SIGCHI*), 2007.
[23] Z. Byers, M. Dixon, K. Goodier, W. Smart, and C. Grimm, "Say Cheese! - Experiences with a Robot Photographer," in *Proc. of the Fifteenth Innovative Applications of Artificial Intelligence Conference* (*IAAI-03*), Aug. 2003.
[24] W. E. Hick, "On the Rate of Gain of Information," *Quarterly Journal of Experimental Psychology*, vol. 4, pp. 11-26, 1952. Article (CrossRefLink).
[25] R. Hyman, "Stimulus Information as a Determinant of Reaction Time," *Journal of Experimental Psychology*, vol. 45, pp. 188-196, 1953. Article (CrossRefLink).
[26] P. M. Fitts, "The Information Capacity of the Human Motor System in Controlling the Amplitude of Movement," *Journal of Experimental Psychology*, vol. 47, pp. 381-391, 1954. Article (CrossRefLink).
[27] P. M. Fitts, "Information Capacity of Discrete Motor Responses", *Journal of Experimental Psychology*, vol. 67, pp. 103-113, 1964. Article (CrossRefLink).
[28] J. Nielsen, "Designing Web Usability: The practice of Simplicity," *New Riders Publishing*, 2000.
[29] J. Nielsen, H. Loranger, "Prioritizing Web Usability," *New Riders Publishing*, 2006.
[30] C. Melhuish, Sendova-Franks, S. Scholes, I. Horsfield, "Ant Inspired Sorting by Robots: the Importance of Initial Clustering," *Journal of the Royal Society Interface*, pp. 235–242, 2006. Article (CrossRefLink).
[31] V. J. Gawron, "Human Performance Measures Handbook," *Lawrence Erlbaum Associates*, London, UK, 1st edition, 2000.
[32] Y. Liu, C. D. Wickens, "Mental Workload and Cognitive Task Automaticity: an Evaluation of Subjective and Time Estimation Metrics," *Ergonomics*, vol. 37, no. 11, pp. 1843-1854, 1994. Article (CrossRefLink).
[33] K. C. Hendy, K. M. Hamilton, and L. N. Landy, "Measuring Subjective Workload: When is One Scale Better than Many?," *Human Factors*, vol. 35, no. 4, pp. 579-601, 1993.
[34] S. Miyake, "Multivariate Workload Evaluation Combining Physiological and Subjective Measures," *International Journal of Psychophysiology*, vol. 40, pp. 233-238, 2001. Article (CrossRefLink).
[35] T. E. Nygren, "Psychometric Properties of Subjective Workload Measurement Techniques: Implications for Their Use in the Assessment of Perceived Mental Workload," *Human Factors*, vol. 33, no. 1, pp. 17-33, 1991.
[36] S. G. Hill, H. P. Iavecchia, J. C. Bittner, Jr., A. L. Zaklad, and R. E. Christ, "Comparison of Four Subjective Workload Rating Scale," *Human Factors*, vol. 24, no. 4, pp. 429-439, 1992.
[37] J. R. Olson and E. Nilsen, "Analysis of the Cognition Involved in Spreadsheet Software Interaction," *Human-Computer Interaction*, 1987-1988, vol. 3, pp. 309-349, 1987.

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