The Multimedia Interface using "Paper" : Ultra Magic Key

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Abstract

We have developed a new multimedia interface called Ultra Magic Key which uses "Paper". The new interface will allow users to access multimedia information simply by "Turning over a Paper" or "Touching a Paper". The "Paper" sheet has no electric devices or batteries. The system recognizes the "Paper" sheet and the action of user's finger by image processing. All the information printed on each "Paper" sheet is hyper-linked with each TV Channel and AV/IT device.

1. Introduction

Currently, many kinds of remote control units are needed for Audio and Video devices control at home. But popular user interfaces in current computers (ex. keyboard, mouse, touch panel, and so on) don't match to handle Audio and Video devices and IT systems seamlessly. Then, many people need more simple and ease-of-use user interface to control TV channel selection and AV/IT devices (particularly, for children or senior people).

In the domain of user interface, various approaches for developments were proposed by the computer scientists. For example, Computer Augmented Environments[1],[2],[3],
Ubiquitous Computing [4],[5],[6],[7],
Augmented Reality[8],[9],[10],[11], and so on.
But they have some problems with regard to the large-scale system and its expensive costs. Therefore, the most suitable user interface to handle AV/IT devices for ordinary people has not been proposed yet.

2. "Paper" Features

Our purpose is to develop the most simple and ease-of-use interface. Then we noticed the fact, "Paper" has a lot of advantages for such a user interface.

Advantages of "Paper":
(1)The media to print information from ancient times (perhaps, the oldest).
(2)The thinnest and lightest media to publish information
(3)The most convenient media to move, carry, and deliver
(4)The material is very soft to the touch.
(5)The cost to produce and print is very inexpensive.

But "Paper" has some disadvantages.
Disadvantages of "Paper":
(1)not be able to link with multimedia information directly.
(2)not be able to download multimedia information directly.

3. Architecture

To resolve these disadvantages, we developed the original architecture using "Paper" for multimedia information with the following features.

(1)The "Paper" called "UMK Sheet", whose format is original.
(2)The category code called "UMK Code", whose format is original.
(3)The method to hyper-link with multimedia information.
(4)The method to download multimedia information.

3.1 "Paper" Sheet : UMK Sheet

The "Paper" we discuss in this paper is made of plain paper material and has no electric devices and batteries.

The architecture of our developed "Paper" Sheet (called UMK sheet) is shown in Fig.1.
(A) is the area used for the certification of "Paper" Sheet itself.
(B) is the area used to adjust the displacement of "Paper" Sheet.
(C) is the area used to select the category of multimedia information.
(D) is the area used for the category functions of multimedia information.
(E) is the area used to display the services of multimedia information.
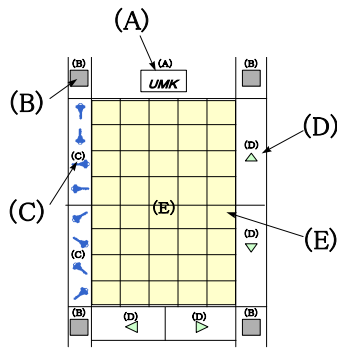
(A) certification code of UMK sheet
(B) detection area for adjustment
(C) category code of UMK sheet
(D) function area for category
(E) service area for category

Fig.1 "Paper" Sheet : UMK Sheet

3.2 "Paper" Code : UMK Code

The "Paper" needs its original "Paper" Code to distinguish each other by image processing.
The format of our developed "Paper" Code (called UMK Code) is shown in Fig.2.
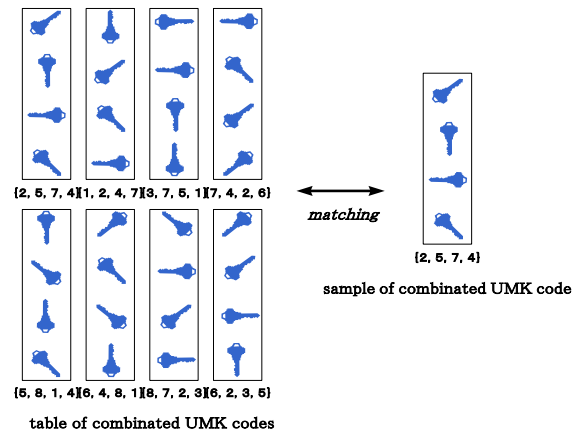And the algorithm of matching UMK Code is shown in Fig.3

code=1 code=2 code=3 code=4

code=5 code=6 code=7 code=8
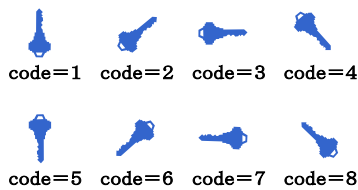
This character has eight directions which mean single UMK codes.

combinated UMK code ＝{2, 5, 7, 4}

A row of four single UMK codes consist of a combinated UMK code.
And so there are 4096 (=8×8×8×8) types of combinated UMK codes.

Fig.2 "Paper " Code : UMK Code

{2, 5, 7, 4}{1, 2, 4, 7}{3, 7, 5, 1}{7, 4, 2, 6}

matching

{2, 5, 7, 4}

sample of combinated UMK code

{5, 8, 1, 4}{6, 4, 8, 1}{8, 7, 2, 3}{6, 2, 3, 5}

table of combinated UMK codes

A sample of combinated UMK code is compared with the table of combinated UMK codes.
In this case, {2, 5, 7, 4} is matched as the recognized type of combinated UMK code.

Fig.3 The Algorithm of Matching UMK Code

3.3 Hyper-link of multimedia information

The method of Hyper-linking multimedia information is consisted of two operations.
(A)The operation "Turning over a Paper" :
turning over a paper to browse multimedia information.
(B)The operation "Touching a Paper" : touching a paper to select multimedia   information.
These operation can be recognized by image processing units via CCD camera.
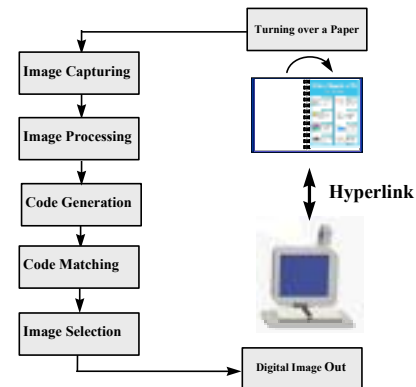The detail sequence is shown in Fig.4, Fig.5.

Image Capturing
Image Processing
Code Generation
Code Matching
Image Selection
Turning over a Paper
Hyperlink
Digital Image Out

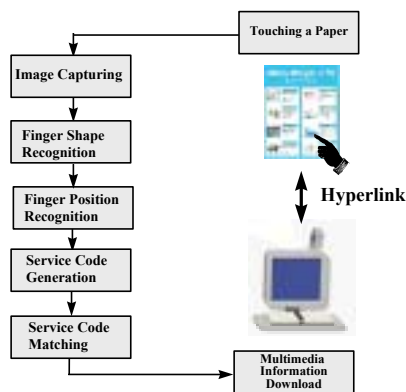Fig.4 The Operation "Turning over a Paper"

Fig.5 The Operation "Touching a Paper"

3.3.1 Recognition of "Turning over"

The algorithm of recognizing "Turning over a Paper" operation is shown in Fig.6.

(a) gravity of gray level

(b) surrounding rectangle

Using the position of (a)gravity and the shape of (b)rectangle, the direction of single UMK code can be calculated.
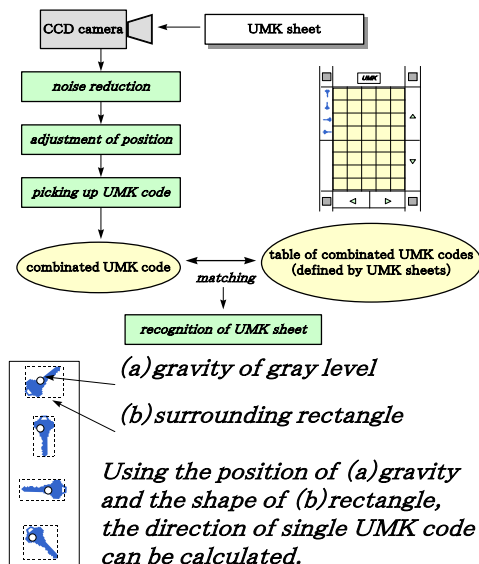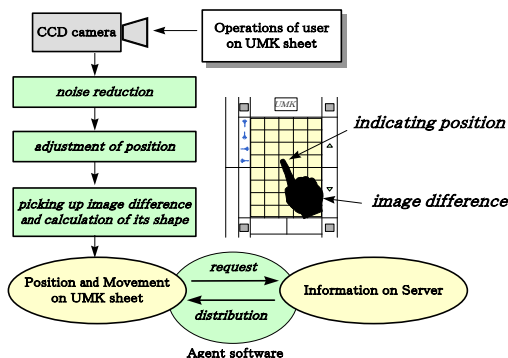
Fig.6 The Algorithm of Recognizing "Turning over a Paper"

3.3.2 Recognition of "Touching a Paper"

The algorithm of recognizing "Touching a Paper" operation is shown in Fig.7.

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ig.7 The Algorithm of Recognizing "Touching a Paper"

3.4 Download of multimedia information

To apply these original architectures and methods in practical use, we developed the method of downloading multimedia information stored in PC Server. (Fig.8)

The PC Server is equipped with a certain standard Pentium Processor and video card device, and a general purpose video authoring software is installed in the PC Server. The multimedia information data is edited by the authoring software in advance, and stored in the hard disk of the PC Server. Any data format of multimedia information can be stored as long as the PC Server can play back it.
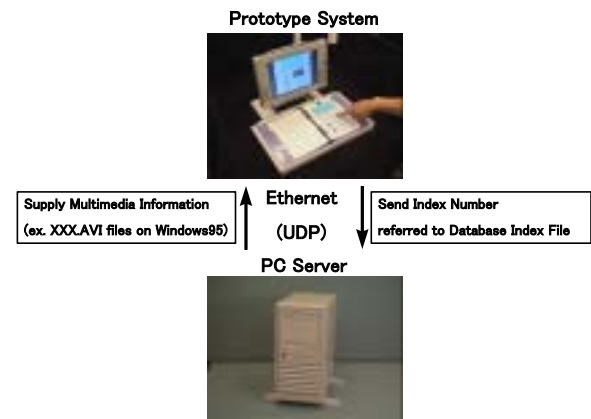

Fig.8 The Method of Downloading Multimedia Information in PC Server

4. Examination

We developed a prototype system to examine the performance of the "Paper" interface as shown in Fig.9,Fig.10. We examined about the following five items by the prototype system.

(1) The ratio of recognizing "Turning over a Paper" correctly
(2) The speed of recognizing "Turning over a Paper"
(3) The ratio of recognizing "Touching a Paper" correctly
(4) The speed of recognizing "Touching a Paper"
(5) The speed of downloading multimedia information in PC Server

The results of the examination are :
(1) "Turning over a Paper" ratio = over 90 %
(2) "Turning over a Paper" speed = about 300 msec/page
(3) "Touching a Paper" ratio = over 80 %
(4) "Touching a Paper" speed = about 200 msec/touch
(5) Download speed = about 2 sec

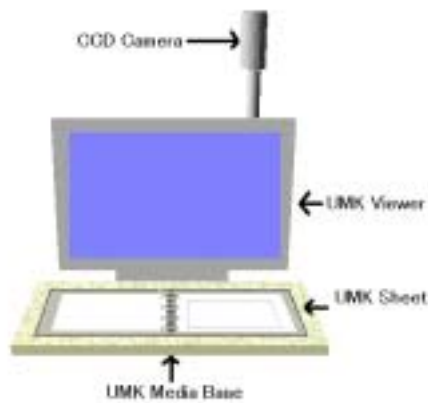Judging from these results, our "Paper" interface can be applied in practical use.
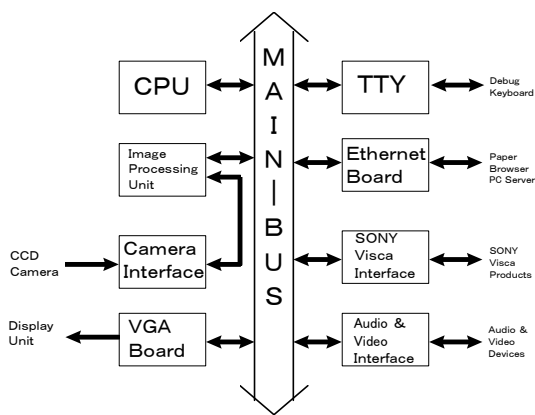
Fig.9 Prototype System

Fig.10 Block Diagram of Prototype System

5. Conclusion

We exhibited this system in SIGGRAPH 97 Electric Garden for 6 days. Then we reached some conclusions concerning the convenience of user's operation on the exhibition system for SIGGRAPH 97 (Fig.11)

1. "Turning over a Paper" is an effective operation to make random accesses with the items of multimedia information (corresponding to the Paper) quickly.
2. "Turning over a Paper" is a very comfortable operation for all generations regardless of sex.
3. "Touching a Paper" is an effective operation to download multimedia information in the PC Server very quickly.
4. "Touching a Paper" is a novel and interesting operation to get further information from the Paper. (Many visitors in Electric Garden said : "Oh! It's so Cool !", "Oh! so smart !")
5. Therefore, "Paper" Interface is considered as the most suitable interface for multimedia information in public use.

Fig.11 Exhibition System for SIGGRAPH 97

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