A Vision-Based Dual Touch Panel

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Abstract — *User interface and size are one of the main concerns in the design of consumer electronics. The conventional user interfaces provide limited interactions to user. In this paper, we introduce a new method to implement the dual touch panel. The dual touch panel makes users operate the devices with their two fingers. It provides more touched interactions for personal devices.*

Index Terms — Dual touch panel, user interface.

I. Introduction

User Interface (UI) is one of the main concerns in the design of consumer electronics because users interact with devices through it all time. The conventional user interface design commonly based on multi-layered approach [1], which is not very user-friendly. The dual touch panel can help us to implement much more user-friendly and single-layered user interface that single touch panel is unable to achieve.

To design a user interface with the dual touch panel will be easier to achieve the five major principles with simple, aesthetic, productive, customizable and others (SAPCO) in UI design [1]. We do not need many physical buttons on our device that make it simple and aesthetic. The instinctive operations make user more productive. The software defined interface is easily customizable. Furthermore, it can bring more enjoyments to the user.

II. Main Idea and Hardware Architecture

We use two cameras to achieve the dual touch panel. The two cameras are installed on the top left and top right corners of the panel. Fig. 1 shows the apparel.

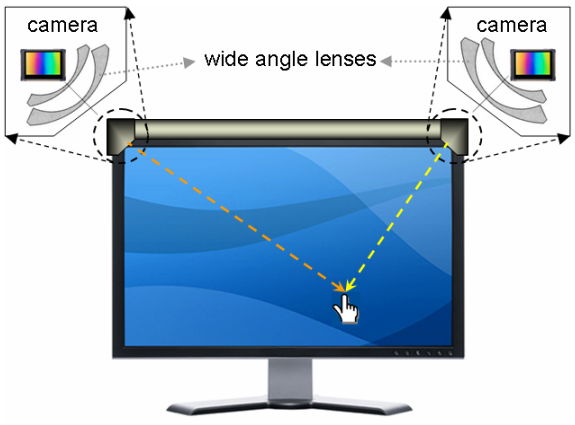

Fig. 1. The apparel of our dual touch panel design.

The optical-axis of the two cameras is parallel with the panel surface and we can capture two scenes above the panel surface. The two scenes look like Fig. 2.

Fig. 2. The two scenes which got from the two cameras. The left and right image was captured from the left top and right top cameras, respectively

Our approach uses these two images to identify how many fingers touched the panel, and calculating the finger position on the panel.

III. Proposed Algorithm

There are four main parts in our algorithm and they are pre processing, identifying fingers position in the images, calculating the finger position on the panel and selecting truth position. The algorithm runs the four parts and output the finger position when capture new images. The followings are the descriptions of the implement method for each part.

A. *Pre-processing*

In this part, our aim is to reduce the noise and project the images to one dimension data.

At first, we take the two input images to subtract background images and smooth them to reduce the noise. Then, we transfer the image to bi-level image. In the next step, counting the number of white pixels in each column to project the image to one dimension data and apply equalization on it.

B. *Identifying fingers position in the images*

We need to know whether there are any finger touched the panel and how many fingers touched on it. Additionally, we also need to know the fingers horizontal position on the image. Fig. 3 is the flow of identifying fingers position.

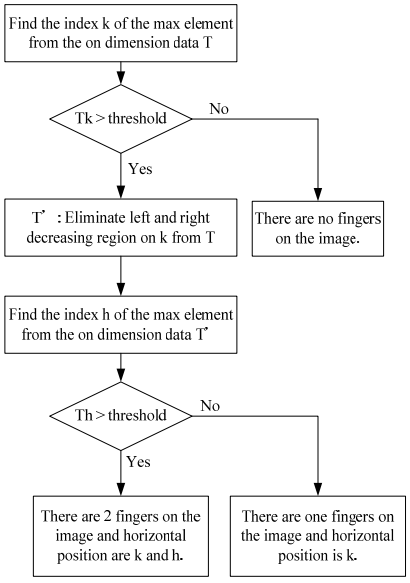

Fig. 3, The flow of identifying fingers position.

C. Calculating the fingers position on the panel

Let θ_1 and θ_2 are the angle of the finger, left camera and right camera and the angle of the finger, right camera and left camera. Fig. 4 shows the diagram.

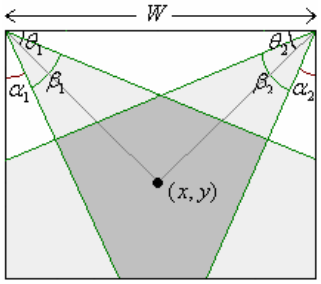

Fig. 4. β_1 and β_2 are the viewing degree of the two cameras, respectively. The black circle point is the position finger touched.

We can calculate θ_1 and θ_2 by the following expression.

$$\theta_1 = \frac{\pi}{2} - (\frac{k_1}{L_1}\beta_1 + \alpha_1) \quad , \quad \theta_2 = \frac{\pi}{2} - (\frac{L_2 - k_2}{L_2}\beta_2 + \alpha_2) \qquad (3)$$

Where k_1 and k_2 are the finger position in left and right images, respectively. L_1 and L_2 are the length of the one dimension data. α_1, α_2, β_1 and β_2 are the angles as in Fig. 9. With having θ_1 and θ_2, we can calculate the intersection of the two lines and it is the position of the finger on panel. The expression to calculate the intersection is

$$x = \frac{W \tan\theta_2}{\tan\theta_1 + \tan\theta_2}, \quad y = x \tan\theta_1 \qquad (4)$$

Where x and y are the coordinate of the panel. The top left corner is the origin. W is the width of the panel.

D. Selecting truth position

In previous part, we describe how we calculate the finger position, but if there are two fingers on the panel, that will make two pairs of position with the calculation as in Fig. 5.

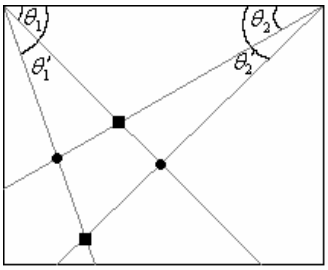

Fig. 5. The circle points and the square points are the two pairs of possible fingers position on the panel.

In this part, we want to decide which pair is the truth one that user touched. Our idea is to select the pair that is closer with the previous two finger positions.

IV. Prototype Development

We implement our system on a personal computer with two web cameras and a 19-inch monitor. The web cameras can capture 320 by 240 pixels images and camera lens only can capture about 40-degree views. Due to this limitation of camera lens, the section we can used to perform our dual touch panel is limited. However, we can change the cameras with wide angle lens to enlarge the section.

Fig. 6 shows serial images when two fingers touched the panel, our system drew a line between the two points where the two fingers touched on the screen.

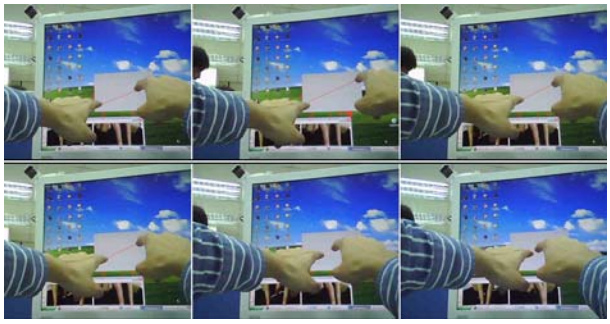

Fig. 6. Serial images of two fingers touched the panel and our system drew a red line between the two fingers which touched on the screen.

Fig. 7 is the result of the implementation with 90-degree wide angle lenses and 42-inch monitor. The video of the demonstrations are available in [2] and [3].

Fig. 7. An example of one finger touched the panel and our system drew a red point at where the finger touched on the screen.

V. Conclusion and Future Work

In this paper, we proposed a vision-based approach to implement a dual touch panel. A dual touch panel can provide the user more instinctive interaction with the device. In our approach, there still has many things can be improved. We should consider more situations in our algorithm to improve the precision and performance. Furthermore, we want to implement as an embedded system in the future.

References

[1] P. H. J. Chong, P. L. So, P. Shum, X. J. Li, and D. Goyal, "Design and Implementation of User Interface for Mobile Devices," *IEEE Transactions on Consumer Electronics.*, vol. 50, no. 4, pp. 1156-1161, Nov. 2004.

[2] The video of picture viewer with our touch panel is available in http://www.csie.ncu.edu.tw/~965202058/TouchPanel/pictureDemo.wmv

[3] The video of writing recognition with touch panel is available in http://www.csie.ncu.edu.tw/~965202058/TouchPanel/writingDemo.wmv