The Research of Touch Performance for Huge Displays

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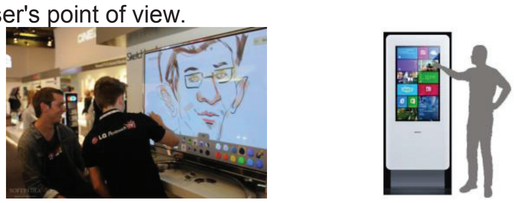
ABSTRACT

In this study, we research the major touch performance evaluation methods for touch-applied products on large displays and examine the studies that reflect cognitive evaluation and visual characteristics. Based on this, I would like to suggest an appropriate quantitative indicator of touch performance by investigating the environment where large touch products are utilized.

1. INTRODUCTION

The touch display is being used in various types of products such as mobiles, tablets and laptops. In particular, large touch technology is mainly used in the form of IWB (Interactive White Board) and KIOSK. However, due to the functional difference between the environment and application of IWB or KIOSK products, the performance should be different. Therefore I consider the need to define the evaluation methods and standards for the performance of the large touch display from the user's point of view.



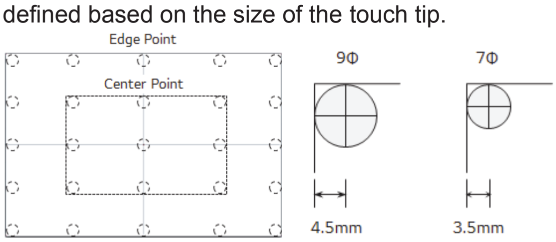
a) Interactive White Board (IWB) b) KIOSK Products

Fig.1. Types of touch Products for large-sized displays

I would like to select an appropriate evaluation method by reviewing the environment of IWB and KIOSK products, which are mainly used for large touch products. To do this, we reviewed the touch performance that users use the most to define the touch performance that they usually use. The main performances can be summarized in several ways, and the functions such as Click, Drag, Text and Paint are generally the most utilized. In the case of KIOSK, it is analyzed that the precision in the user environment is not required very much because only the simple click function is implemented. However, IWB has a high performance of use of Click, Drag, Text and Paint functions, so it can be regarded as relatively demanding performance precision. In this regard, I would like to conduct research that can express quantitative touch performance considering user environment for IWB products that have higher touch performance requirements.

2. EXPERIMENTS

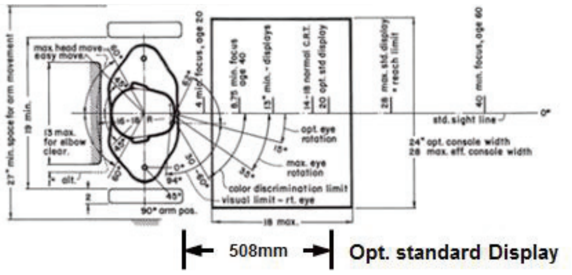
Considering the actual usage environment of IWB products, it can be classified into two categories: user's perspective and viewer's perspective. In case of users, it performs the actual touch gestures, and for viewers, it performs the role of watching from a certain distance. In this study, we want to define performance mainly from the user's perspective. From the viewer's point of view, touch performance is required at a distance of about 2 meters when the optimal viewing distance is derived, so the touch performance is not cognitively high. However, from the user's point of view, accuracy is required in an environment where touch is directly performed and responded, so we want to derive quantitative index. First of all, it is necessary to define the evaluation items in order to derive quantitative index. The first evaluation method is Tap Accuracy, which is one of the methods of expressing performance through the positional difference between the reference touch coordinate and the actual touched coordinate. Figure2 shows, the evaluation position is selected based on 25 points of center and edge area, and the measuring position of each point can be defined based on the size of the touch tip.



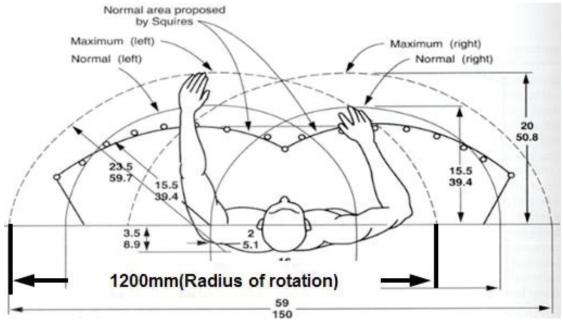
a) Tap Accuracy Positions b) Based on tip size

Fig.2. The measurement condition of tap accuracy

The second evaluation method is the Line Linearity item, which reflects the use of the Drag, Text & Paint functions. Unlike the small and medium sized products, the length of the line needs to be defined in the large sized products. For this purpose, the evaluation method was defined by limiting the range to the user's usability. As shown in Figure 3, the distance between the user and the display based on the work place is about 508mm in terms of ergonomics, and the range of workable area is about 1200mm depending on the radius of rotation of the arm.



a) Anthropometric data – Adult male seated at console



b) Normal and maximum working areas

Fig 3. The distance between the user and the display based on the work place

Based on this, the maximum line linearity criterion is defined as 1200mm for the large displays, and we propose to limit the area to the maximum length of 1200mm with the long axis of 55 inch 16: 9 or more. As shown in Figure 4, similar to Tap Accuracy, the number of lines was defined based on 5 horizontal, 5 vertical and 2 diagonal considering the center and edge area.

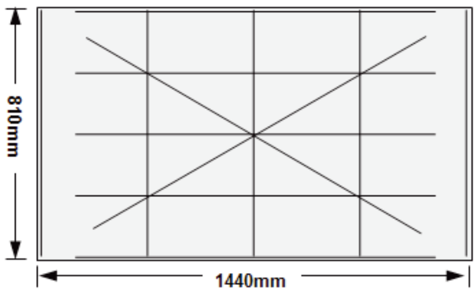
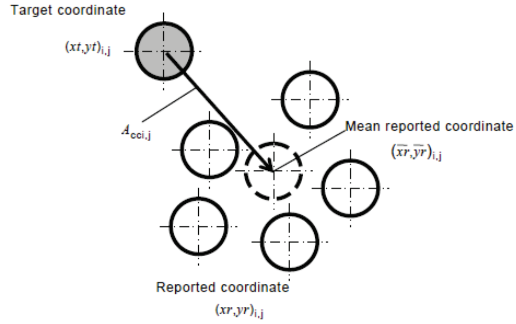


Fig 4. Defining evaluation methods applied to 75-Inch displays (16:9)

Consequently, the method proposed in the IEC-62908 (International Electronical Commission) standard is intended to derive the quantitative index of the proposed evaluation items. As shown in Figure 5-6, the final result can be calculated by calculating the difference between the reference value and the measured value. There are two types of measurement methods that tap accuracy and line linearity.



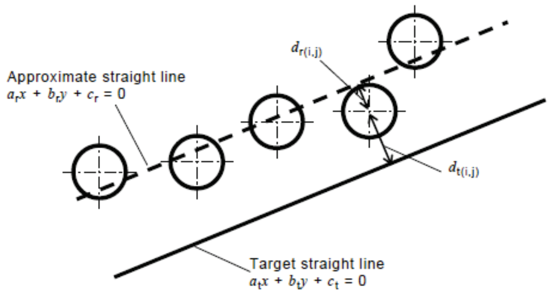
$$\overline{xr}_{i,j} = \frac{\sum_{k=1}^{p} xr_{i,j,k}}{p}, \quad \overline{xr}_{i,j} = \frac{\sum_{k=1}^{p} xr_{i,j,k}}{p} \tag{1}$$

$$A_{cci,j} = \sqrt{\left(\overline{xr_{i,j}} - xt_{i,j}\right)^2 + \left(\overline{yr_{i,j}} - yt_{i,j}\right)^2} \tag{2}$$

$$A_{ccmax} = \max(A_{cci,j}) \tag{3}$$

p : is the number of reports at a target point (1,2,…);
q : is the number of measurement points = $m \times n$
i, j, k : is the k-th data in number of reports (p) at a target point (i, j)
$A_{cci,j}$: is the distance between the target coordinate and the mean reported coordinate;
A_{ccmax} : is the maximum of accuracy

Fig 5. The calculation of tap Accuracy (IEC-62908)



$$d_{r(i,j)} = \frac{|a_r x_{r(i,j)} + b_r y_{r(i,j)} + c_r|}{\sqrt{a_r^2 + b_r^2}} \tag{4}$$

$$d_{t(i,j)} = \frac{|a_t x_{r(i,j)} + b_t y_{r(i,j)} + c_t|}{\sqrt{a_t^2 + b_t^2}} \tag{5}$$

$$L_r = \max(d_{r(i,j)}) \tag{6}$$

$$L_t = \max(d_{t(i,j)}) \tag{7}$$

(x_i, y_i) : Each drawn line, calculate the linearity of the reported data

Fig 6. The calculation of line linearity (IEC-62908)

Based on the above, I would like to extract conclusions through research that reflects cognitive characteristics to define the criteria for the specification. According to the literature, a large number of researches on touch performance has been developed and tested. However, there are not many researches on their own criteria for large touch products. For this reason, we want to study more in-depth the performance of large touch display. In particular, to examine the level of proper performance on large displays through an ergonomic approach, we would like to suggest a level for optimized touch performance based on visual characteristics and cognitive evaluation. First, the CSF (Contrast Sensitivity Function) is reflected by the visual characteristics to derive the level of optimal performance from the user's perspective, and the quantitative indicators of the final performance were derived by comparing the results through cognitive tests.

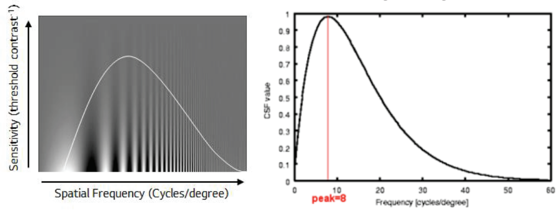
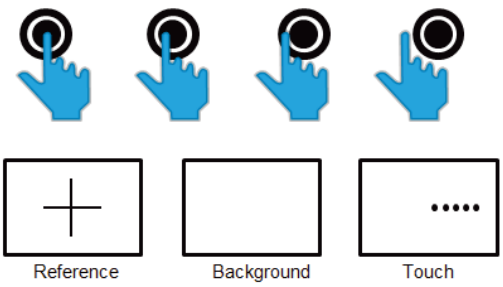
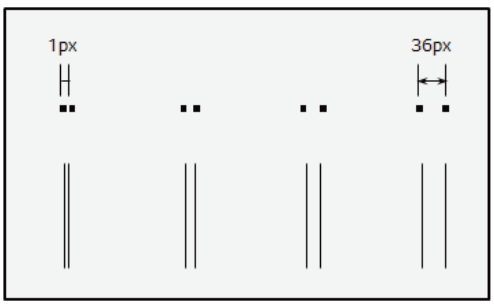


Fig 7. Contrast Sensitivity Function

Cognitive evaluation consisted of 5 image experts and 5 general people with about 10 people, and the degree of distinguishing the accuracy of touch when touching on the touch display was compared by the difference between the reference coordinate value and the touched coordinate value. As shown in Figure 8, the perceived area was defined for each person by varying the position difference of the touched coordinate with respect to the reference touch coordinate from about 0.2 mm to 10 mm. The sample for the actual cognitive evaluation was tested based on the 50inch UHD Model, and the pixel pitch was converted to mm.



a) A test condition for cognitive Characteristics



b) A test Sample for cognitive Characteristics

Fig 8. Recognition to compare reference coordinates with touched coordinates

3. Result

In this experiment, we recognized the actual reference coordinate value and found that there was a difference in discrimination ability when touching. Figure 9 shows, the most cognitive distinction is apparent from about 1 second to 5 seconds, and within 1 second and more than 5 seconds; it is saturated, so there is no big difference in performance change.

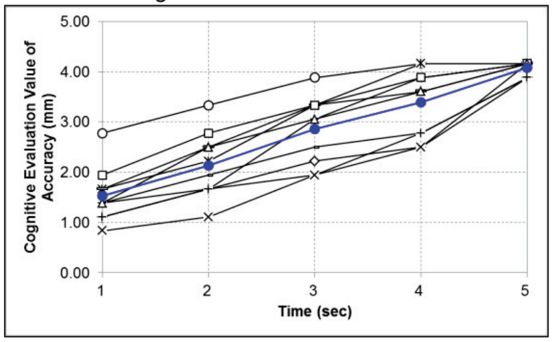


Fig 9. The Cognitive evaluation value of accuracy

As a result of the test, the touch recognition performance in the time of less than 1 second was analyzed in the range of about 1.5mm on average to 10 people, and it was found that the most sensitive user could recognize up to about 1.00mm.

Table 1. Average value of cognitive evaluation

Average	Expert	General
1.53mm	1.22mm	1.83mm

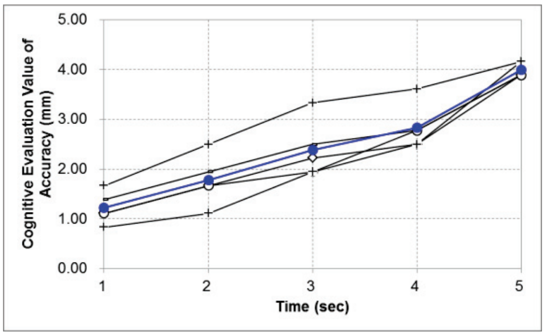


Fig 10. The Cognitive evaluation value of accuracy by 5 expert people

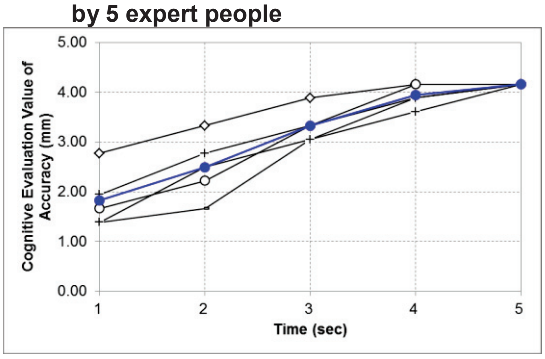


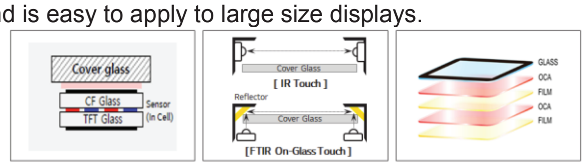
Fig 11. The Cognitive evaluation value of accuracy by 5 general people

Table 2. Average value of cognitive evaluation

CSF Simulation	Proposed Index	The best Sensitivity
1.01mm	1.53mm	1.22mm

The results were compared with the CSF study, which reflected the visibility characteristics, and the results were similar to the results obtained based on the values used at the most sensitive cycles. With a user distance of about 500mm and 1 degree, the perceived range is about 1.00mm at the highest sensitivity of 8 cycle per degree, which is similar to the most sensitive user. The quantitative Index proposed by the authors is based on the results of cognitive tests including the general public. In addition, although the evaluation specifications for the center part and the edge part are generally defined according to the touch function, this study only considers the general visual sense and sensory characteristics except the functional aspect of the touch.

At a result, we compared the performance with three touch technologies that are commonly used in large touch products. Three types of AIT (Advanced In-Cell Touch), GFF (Glass/Film/Film Structure), and IR (Internal Reflection) were used. First of all, in case of AIT, it is a product that uses Touch technology in TFT and CF of panel. It does not need a separate film or CG, so it has the advantage of being thin. Secondly, in the case of GFF, the film is applied between the panel and the CG. It is relatively easy to process and has a thin and light advantage. Lastly, the IR method reflects infrared rays on the reflector to detect the position of an object and recognizes the touch, so it has good light transmission and is easy to apply to large size displays.



a) AIT b) IR c) GFF

Fig 12. Three Touch Technologies

The performance of the three touch technologies is evaluated using the proposed evaluation method, and the results are shown in Table 3. In comparison review of each product, AIT product is the best performance aspect, and AIT is the only product that meets the proposed specification.

Table 3. The data among three touch products

Products	AIT	GFF	IR
Tap Accuracy	1.41mm	4.55mm	2.66mm
Line Linearity	0.99mm	3.95mm	1.40mm

Of course, the performance of GFF and IR is somewhat lower than that of AIT, but it can be expected to improve performance by increasing the resolution of the sensor, but it is difficult to apply due to high cost and process. In addition, the difference in touch performance can be expected depending on the resolution of the display, and I think it will help to improve the touch performance if the direction for product development is further examined. In the future, in addition to considering these areas, it will be proposed to review the criteria for the performance of a touch on the large product further.

4. Discussion

In this study, the IWB touch display was reviewed, and the level of actual touch performance required for users was derived. However, even in large products, we concluded that the distance of users to use is constant, and that the performance part is not greatly affected by the product size. However, for large products, the resolution and OS environment are flexible; therefore more of functional studies are required. Based on this research, we will cover in-depth research through reasonable approach to touch performance in large displays.

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