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Time Threshold for Classification between 2D-Touch and 3D-Touch Based on User's 3D-Touch Input

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Abstract. As 3D-Touch technology has recently developed, 3D-Touch technology, which was applied only to the touch display of mobile devices, has been introduced to various devices. Although many researches have proposed applying the 3D-Touch technology to various devices, these researches have been confined only to apply 3D-Touch technology without considering 2D-Touch technology. Therefore, there is no clear criterion for distinguishing between 2D-Touch and 3D-Touch. In this paper, we suggest a time threshold for distinguishing between 2D-Touch and 3D-Touch on a display that supports 3D-Touch.

Keywords: 3D-Touch, Fast Touch, Slow Touch, etc.

1. Introduction

As 3D-Touch technology has recently developed, 3D-Touch technology, which was applied only to the touch display of mobile devices, has been introduced to various devices. 3D-Touch technology was first introduced by Apple in 2016 and refers to a technology that includes not only 2D-Touch technology which only receives input values for the X-axis and Y-axis on a touch display, but also an input belonging to the Z-axis to measure the strength of the force of a user's press [1]. 3D-Touch technology was first applied to Apple's iPhone 6s and has been introduced to other iPhones, and it is also applied to Samsung's Galaxy S8 series and Xiaomi's Mi 5s [2]. It is also applied to various devices, such as MacBook, MacBook Pro and Apple Watch [3 4]. A lot of researches have been conducted to apply 3D-Touch technology before applying 3D-Touch technology to these various devices.

In order to develop a display that can use 3D-Touch input, Gunnar, and Mats classify the display into three layers, then measure the intensity of the force applied to the second layer located between the first layer and the third layer when the user touches the display [5]. Also, Jeffrey et al added a pressure sensor to each corner of the touch pad to measure the force and apply the 3D-Touch technology to the touch pad [6].

However, these researches are confined to the application of 3D-Touch technology, so there are no clear criteria for distinguishing between 2D-Touch and 3D-Touch on a touch display. Therefore, in this paper, we measure the time that can distinguish between 2D-Touch and 3D-Touch technology in a touch display that supports 3D-Touch technology and find a time threshold to distinguish 3D-Touch and 2D-Touch.

2. Related Work

2.1. 2D-Touch Recognition Method

The most widely used method for 2D-Touch is the capacitive touch method. The capacitive touch method is a method that recognizes the coordinates of the touched place by using the current flow in the human body. The input method of Capacitive touch type is to gather electrons on a screen due to the current

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flow in our body when touching display. When electrons gather, the recognition sensor recognizes the coordinates of the electrons, that is, the X and Y coordinates, and the screen is touched based on the coordinates [7]. Fig. 1 shows the structure of capacitive touch display. Capacitive touch display consists of cover glass, OCA, ITO and display panel. The role of the cover glass is to protect the touch screen and the Optical Clear Adhesive (OCA) functions as an adhesive for adhering the cover glass, each ITO and display panel. The ITO calculates the X and Y axes when a user touched the touch screen. Therefore, two ITOs are used to separate the X and Y axes. Fig. 2 shows the operation of touching the capacitive touch display. Without touching, the magnetic field of all ranges of the display remains the same because the magnetic field only occurs within the display. However, when a touch occurs, the magnetic field moves into the finger that touches by the electrical current in our bodies, causing a difference in voltage and finally an task is executed within the affected area.

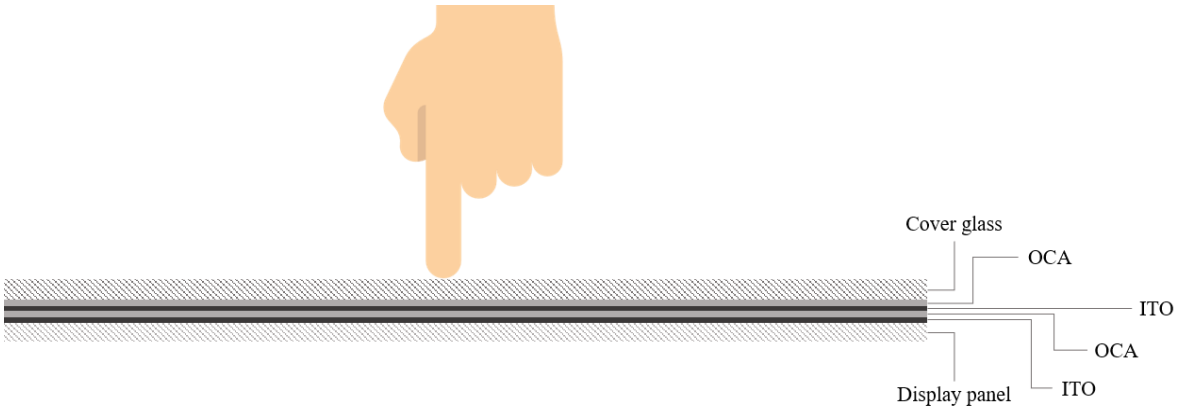

Fig. 1: Display structure of Capacitive Touch method

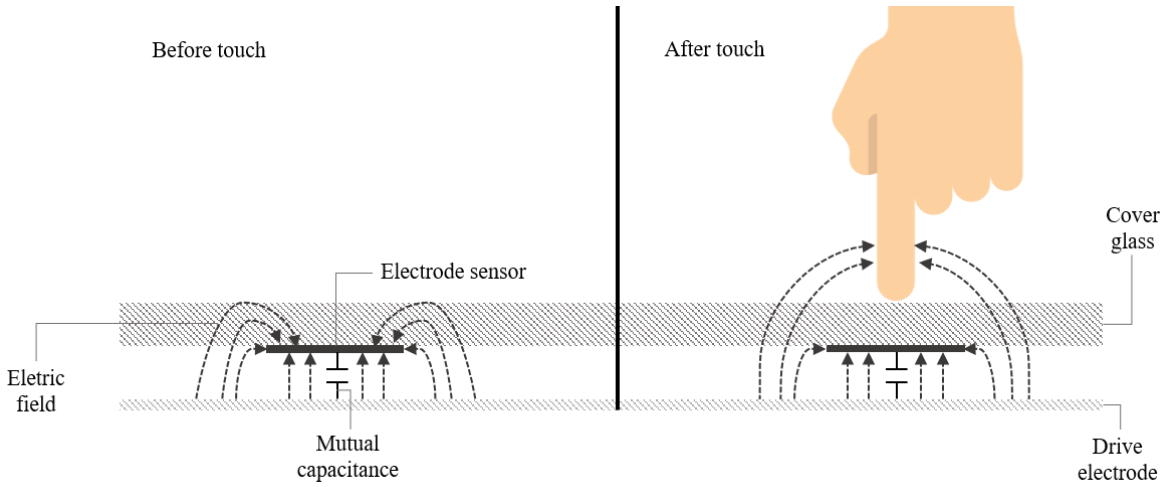

Fig. 2: Capacitive Touch method

2.2. 3D-Touch Recognition Method

3D-Touch is a technology that includes not only 2D-Touch technology which only receives input values for the X-axis and Y-axis on a touch display, but also an input belonging to the Z-axis to measure the strength of the force of a user's press. A method to apply the 3D-Touch technology is to add a sensor that measures the pressure at each point on the bottom or inside of the display, and to use the voltage difference occurred by touching or bending the display module. Fig. 3 shows a structure for applying 3D-Touch by measuring the degree of a display's bend. When the user touches the display with certain force, the display is bent slightly, which causes to change the voltage between panels. At this time, if the difference of voltage is large, the device recognize that the touch is 3D-Touch and then, 3D-Touch operation will perform. Fig. 4 shows a structure of applied 3D-Touch by adding a pressure sensor inside the display. When the user touches the display, the pressure sensor measures the force given by the user. At this time, if the force is above a

certain level, the device will determine the touch is 3D-Touch and the same operation as the previous case will operate

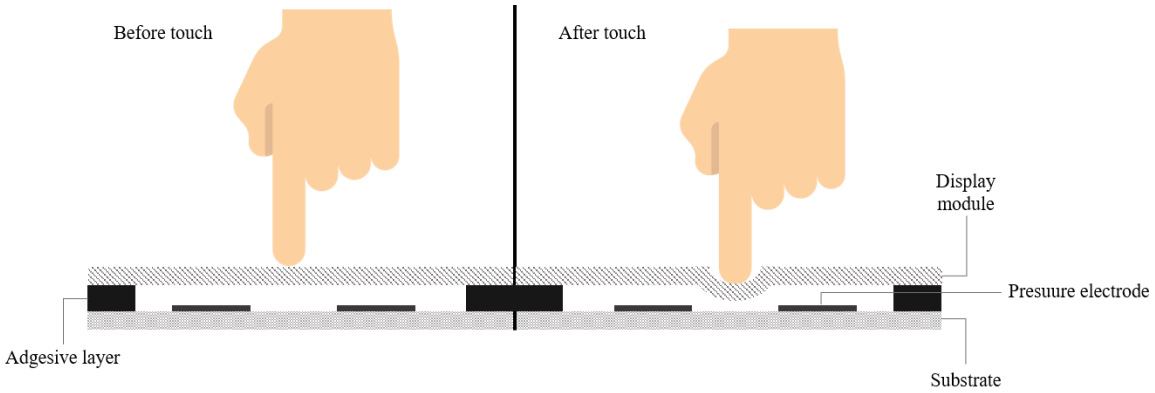

Fig. 3: 3D Touch method using Display bending degree

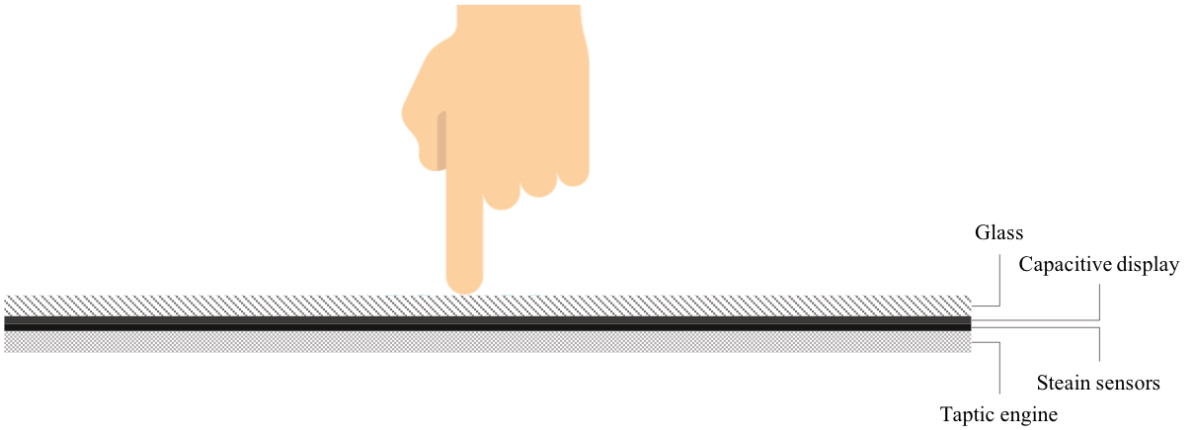

Fig. 4: 3D Touch method using Pressure sensor

2.3. Comparison between 2D-Touch and 3D-Touch Interface

2.1 and 2.2 explained the operation and structure of 2D-Touch technology and 3D-Touch technology. As both touch methods operate by touching the display, in order to operate both 2D-Touch and 3D-Touch correctly on a display that supports 3D-Touch technology, it is necessary to establish standards that can distinguish between 2D-Touch and 3D-Touch. J.H Oh, E.T Kim, M.J Kim, et al studied the differences between Long Touch of 2D-Touch and 3D-Touch [8]. Long Touch of 2D-Touch is touching the display for a long time, which is similar to the input method of 3D-Touch. So they experimented and it took an average long time to reach the maximum value with 3D-Touch, but it did not exceed 800ms which is the time threshold to execute Long Touch. However, when the Long Touch was performed, the pressure exceeded the maximum value before 800ms. It raised a problem that if a user performs 3D-Touch against low pressure, the error rate could increase. In addition, the research was conducted on the basis of 2D-Touch to distinguish 2D-Touch and 3D-Touch [9]. When user press the display with any pressure on 2D-Touch, can't measure any pressure after 200ms. This shows that 2D-Touch terminated within 200ms, so they conclude that 200ms is time threshold to distinguish between 2D-Touch and 3D-Touch. Otherwise, the research was conducted to support the user interface so that the user could recognize what kind of touch was performed [10]. Apple added the taptic engine at the bottom of the display to alert the user using vibration when 3D-Touch operations are performed.

3. Time Threshold setting method through User's 3D-Touch

3.1. Experimental Environment and Experiment Method

A total of 22 people (11 men, 11 women, mean: 26.14 years) participated in the experiment. All participant conducted the experiment with one of their hands depending on which hand is more comfortable to use. During the experiment, the participants sat in a comfortable chair, manipulated the smartphone, placed the other hand which was not used for the experiment on the desk, and then grabbed the input device with the hand around the touch. The application for the experiments was developed in the environment as shown in Table. 1.

Table. 1: Development experience

	Smart device (iPhone 6s)	Development Computer (Macbook pro 2013
CPU(AP)	Apple A9	Intel Core i7
Memory	2GB	16GB
OS	iOS 10.0	OSX 10.10.3
Language	Swift 2.0	
Display	4.7 inch	
Touch Type	2D-Touch & 3D-Touch	

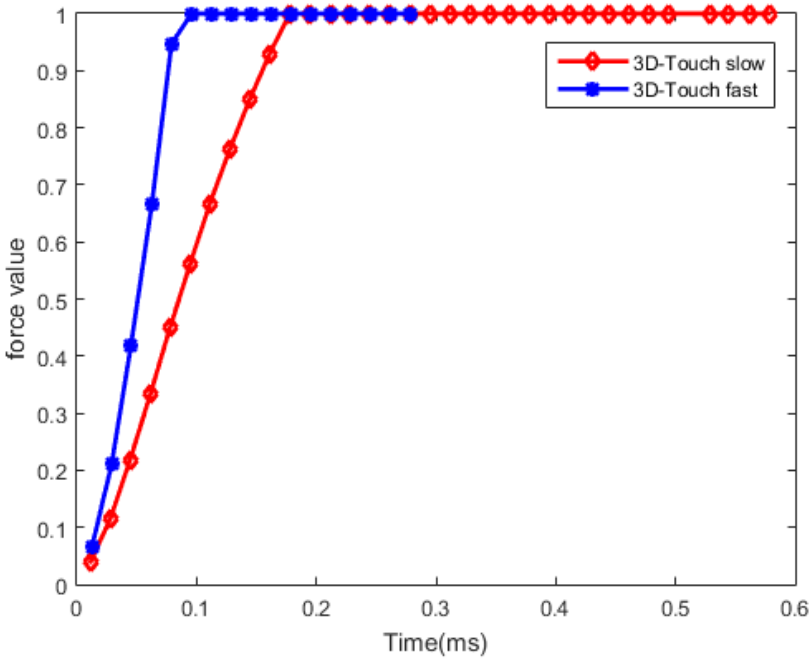

Fig. 5: Comparison between Slow Touch and Fast Touch on 3D-Touch

3.2. Slow Touch and Fast Touch input time analysis on 3D-Touch

In Fig. 2, when the implemented program is tested on iOS device, it can be seen that the force measurement measures the force intensity about once every 16ms, and the maximum force value as an input on the 3D-Touch is 1(400g). Base on this, the participant pressed Slow Touch and Fast Touch and we measured the time when the value reached 1. The results for measuring the time using both Slow Touch and Fast Touch are 100ms and 200ms. The difference between Slow Touch and Fast Touch has a time interval of 100ms. Since it is difficult to recognize 100ms difference between Slow Touch and Fast Touch, mobile users can hardly distinguish between two touches. In addition, we confirmed that after 200ms, both Slow Touch and Fast Touch have the same value, so any input after 200ms can be measure as 3D-Touch. This results in a traditional study that determines the time threshold for distinguishing between 2D-Touch and 3D-Touch means. It is possible to conclude that even if user press display by using 2D-Touch or 3D-Touch, it is acceptable to recognize it as a 3D-Touch after 200ms.

4. Conclusion

In this paper, we calculate the time spent on performing the Slow Touch and Fast Touch operations to distinguish between the 2D-Touch and 3D-Touch on 3D-Touch enabled device. Since it takes 100ms and 200ms respectively to do Slow Touch and Fast Touch. It is difficult for the user to recognize the difference between 100ms and touch. After 200ms, however both touches had the same value. As this would result in the termination of the 2D-Touch in 200ms if an input was made on a 2D Touch phase during the previous research, 200ms could be determined as the Time Threshold for the 2D-Touch and 3D-Touch experiments. As a conclusion, it is significant that the time threshold is able to be used to distinguish between 2D-Touch and 3D-Touch based on the 2D-Touch, and to distinguish between 2D-Touch and 3D-Touch based on 3D-Touch.

5. Acknowledgement

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