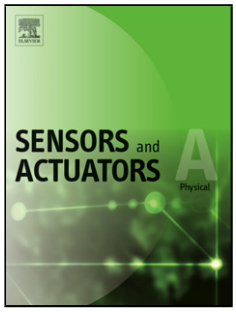

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Author: Satoshi Tsuji PhD Teruhiko Kohama

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A Proximity Touch Screen Method Using Separation-Type Electrodes

Satoshi Tsuji [*1], Teruhiko Kohama [*1]

*1 Dept. of Electrical Engineering, Fukuoka University

CORRESPONDING AUTHOR

Satoshi Tsuji PhD
Dept. of Electrical Engineering, Fukuoka University, 8-19-1 Nanakuma, Jonan-ku, Fukuoka 814-0180, Japan,
e-mail:tsuji@fukuoka-u.ac.jp
TEL:+81-92-871-6631

ABSTRACT

Touch screens are widely used in smartphones, tablet PCs, and other electronics. Most touch screens detect contact position only. We propose a proximity touch screen method using separation-type electrodes with mutual capacitance measurement to improve functionality. In the experiments described in this paper, the proposed proximity touch screen detects an object and its position before contact (within the proximity range). In addition, we compare the proposed proximity measurement with conventional measurement. We expect that the proposed proximity touch screen will be a functional and useful interface.

KEYWORD

Touch screen, Proximity sensor, Mutual capacitance measurement.

1. INTRODUCTION

Touch screens have become common as interfaces between humans and smartphones, tablet PCs, handheld game consoles, etc. Various sensing techniques have been developed for touch screens using resistive [1], capacitive [2-4], optical [5], and other approaches. In addition, in-cell touch screens have been developed to reduce production cost [6]. Among these approaches, mutual capacitance measurement has been used mainly for small touch screens such as smartphones and tablet devices because it can detect multi-touch events [7]. Most previous studies detect the contact position between the touch screen and the object (i.e., a finger or stylus). Proximity touch screens have also been proposed to improve the functionality of such devices. Using a camera to detect the finger has also been proposed [8-9]; however, the resulting devices become large because an external camera is required. Hence, it is difficult to use this strategy for small mobile devices. Another method involves mounting a large number of infrared sensors around a display to detect a finger within the proximity range [10], but the resulting display surface and infrared sensor are not flat. In sensors for small mobile devices, the method of attaching an infrared sensor to the side of a smartphone has been proposed to detect the movement of a hand [11]. However, it is difficult to accurately detect the position of a finger on the display. A technique using an external camera attached to the side of a smartphone to detect fingers on the display has been proposed [12]. However, again, an external camera is required. In sensors and displays combined as one unit, an infrared sensor mounted onto the back of the display detects fingers within the proximity range [13]. Additionally, a method combining self-capacitance measurement and mutual capacitance measurement to detect fingers within the proximity range and their contact position has been presented [14]; moreover, smartphones using this technology have already been sold [15]. However, it is difficult to detect multi-point touch using self-capacitance measurement because ‘ghosts’ occur [7].

The goal of our research is to develop a proximity touch screen using mutual capacitance measurement that can detect an object within the proximity range for operation of the display of the device. With such a device, for example, it is possible to enlarge a window using the position of the finger within the proximity range. Previously, a method has been proposed whereby the keyboard on a smartphone is enlarged using a fisheye lens according to the X-Y proximity position of a finger within the proximity range [16]. However, enlarging an image according to the distance between a finger and the display has