GaussSketch: Add-On Magnetic Sensing for Natural Sketching on Smartphones

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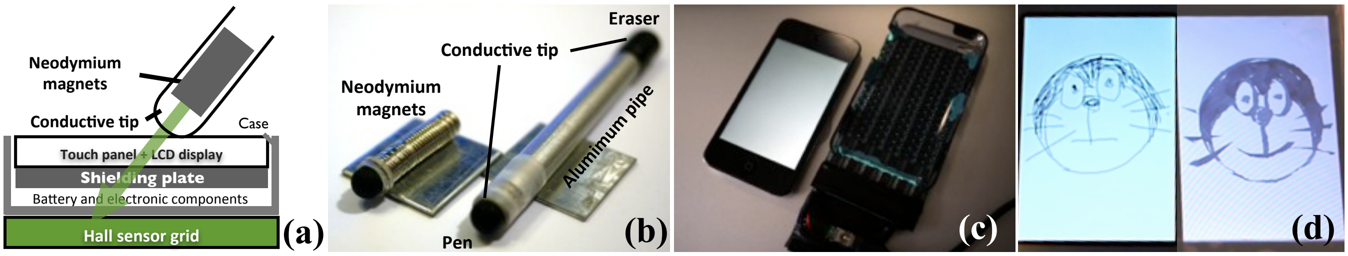

Figure 1: *(a) The principle of GaussSketch. (b) A magnetic stylus with the other side as the eraser. (c) A thin form-factor sensor augments magnetic field sensing on the multitouch display. (d) A comparison of fast sketching without (left) and with (right) GaussSketch.*

Abstract

This work presents *GaussSketch*, a retrofit stylus sensing extension to enable the detection of stylus tilt and pressure for natural sketch simulation on smartphones by utilizing magnetism. Attaching the compatible sensor grid on the back of a conventional smartphone can (1) sense the stylus' tilt degrees and pressure values, (2) discriminate the touch events generated by a finger or the stylus, and (3) detect where the stylus hovers upon the screen.

1 INTRODUCTION

Sketching on readily available smartphones can let users easily preserve ideas or notes for further inspiration or reminding. Nevertheless, fingers are too imprecise for sketching, and therefore some commercial products have started providing a the stylus mechanism. Recent smartphone touchscreen can be divided into resistive-based (e.g., [Rosenberg and Perlin 2009]) or capacitive-based (e.g., iPhone[1]), but neither can detect the advanced features of a stylus, such as tilt angle or pressure, and simulate sketching in a more natural manner. Although commercial available touchscreens tightly-integrated with sophisticated electromagnetic resonance (EMR) sensors[2] can enable the sensing of the aforementioned features. It is hard to attach this as an add-on module to enhance the common smartphones, because the electromagnetic field will be blocked by the shielding materials inside most of the smartphones.

2 DESIGN

To let general smartphones easily enable the stylus sketching feature, *GaussSketch* (Figure 1(a)) has been developed by utilizing the penetrability of the directional magnetism. A prototype stylus (Figure 1(b)) is made of stacked $8mm$-diameter and $30mm$-height cylindrical neodymium magnets with a conductive rubber tip torn down from an Elecom[3] iPhone stylus. To detect the position and status of the stylus, a $60(W) \times 80(H)$-diameter and $2mm$-thin sensor board is made of $12 \times 16 = 192$ Winson[4] WSH138 analog Hall sensors in a grid manner. All sensor data are transferred to a PC through a Teensy[5] micro-controller and upsampled by bi-cubic interpolation from 12×16 to 360×480 $(163dpi)$ to reconstruct the shape of magnetic field consistently over $60fps$. An unmodified iPod touch[6] and a sensor grid attached on a plastic case for external sensing are used for prototyping (Figure 1(c)).

By calculating the centroid of the magnetic field shape as shown in Figure 2(a), we can obtain $O = (O_x, O_y)$, which represents the position of the peak magnitude, and M as the magnetic field. With the incorporation of the actual touch point $P = (P_x, P_y)$ of the stylus on the screen, the following features can be enabled:

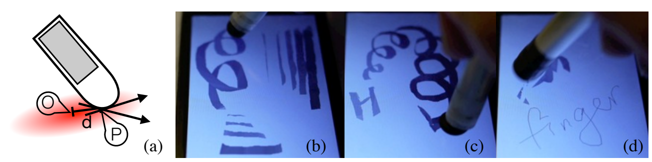

Figure 2: *(a) Overview of stylus sensing. (b) Tilt sensing. (c) Pressure sensing. (d) Implicit mode switching for erasing.*

Tilt Sensing (Figure 2(b)): The relative position between O and P changes during tilting the stylus. Hence, $\vec{d} = \vec{PO}$ and $d = ||OP||$ can be mapped as the tilted direction and angle, respectively.

Pressure Sensing (Figure 2(c)): While a user stresses on the tip, the rubber will be deformed and the distance between the embedded magnets and the sensor board is shortened. Hence, the sensed values M will become higher.

Discriminating magnetic stylus from fingers (Figure 2(d)): If M is above a predefined threshold, P will be regarded as a magnetic stylus event rather than the finger or conventional stylus touch event.

Hover sensing: While the system senses the magnetic field without sensing the touch point P within a predefined diameter r from the calculated centroid O, then O can be treated as the hover point.

References

ROSENBERG, I., AND PERLIN, K. 2009. The unmousepad: an interpolating multi-touch force-sensing input pad. *ACM TOG 28*, 3, 65:1–65:9.

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[2] http://www.wacom.com/
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[5] http://www.pjrc.com/teensy/
[6] http://www.apple.com/ipodtouch/