Implementation of Differential Sensing Scheme to Remove Panel Noise in Touchscreen Controller

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Abstract—Differential sensing scheme is an improvement method from single-line sensing to cancel display or panel noise in touchscreen system. However, differential sensing method raised a multiple-touches cancellation issue. As a consequence, the recovery algorithm is invented to overcome those issues. This paper introduces several methods to implement differential sensing scheme with recovery algorithm to remove panel noise and white noise in touchscreen system.

Keywords-- Digital system design, System on chip, ASIC digital design, Capacitive touch sensing.

I. INTRODUCTION

Nowadays, we can find many applications of touchscreen panels in industrial and consumer electronics such as smartphone, car, computer, electronic voting machines, point of sale system, personal digital assistance, ATM, keyboard, mouse,... [1] The basic architecture of a touchscreen system includes the driving signal parts, the sensing part, the analogue-digital-converter, a Microcontroller Unit for calculation of touch-point, noise cancellation [2].

Among many possible architectures of a touchscreen system, the capacitance sensor touchscreen is popularly used since its advantage [3-5]. In capacitance sensing, single line sensing is the most basic sensing scheme. To improve and overcome the issues in single line sensing, differential sensing schemes is proposed for the panel noise cancellation [6-8]. In this article, we will discuss the several methods for implementation of differential sensing scheme with in touchscreen system. The organization of this article is as follows. In the section 2, we discuss the capacitance sensing concepts, the architecture of differential sensing scheme. Section 3 will explain the implementation of the differential sensing with via ASIC hardware and firmware (MCU).

II. DIFFERENTIAL SENSING SCHEME

A. Capacitance Touchscreen and Sensing Schemes

FIGURE I shows two touchscreen architectures using single-line and differential sensing schemes. They differ to each other by the sensing switches and the analogues parts (integrator vs differential amplifier and differential integrator).

Figure I. Sensing Schemes in Capacitance Touchscreen

B. Recovery Algorithm for Differential Sensing Scheme

To improve the effective of touchscreen system, instead of using single-line sensing, we consider the method of differential sensing (DS). The algorithm of DS can be seen in FIGURE II. As the influence of threshold, we can cancel the display or white noise.

Figure II. Recovery Algorithm For Ds Scheme

III. PROPOSED METHODS TO IMPLEMENT DS WITH RECOVERY ALGORITHM

In touchscreen system, the analogue signal will go into the ADC module for data digital conversion. Then, it is converted into ADC data. After that, we will extract the frequency power by FFT module.

With DS scheme, we can have three methods for implementation of recovery algorithm as FIGURE III part 1, part 2, and part 3. The simulation results are attached together for each method. As the consequence, we can implement Recovery algorithm as hardware module (as figure 3.1 or figure 3.2, and it can be implemented by firmware as figure 3.3.

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% First: singed detection
d1 = fftxR1_pow - fftxR2_pow - fftxR3_pow - fftxR4_pow - fftxR5_pow;
d2 = fftxR1_pow + fftxR2_pow - fftxR3_pow - fftxR4_pow - fftxR5_pow;
d3 = fftxR1_pow + fftxR2_pow + fftxR3_pow - fftxR4_pow - fftxR5_pow;
d4 = fftxR1_pow + fftxR2_pow + fftxR3_pow + fftxR4_pow - fftxR5_pow;
d5 = fftxR1_pow + fftxR2_pow + fftxR3_pow + fftxR4_pow + fftxR5_pow;

d = [d1, d2, d3, d4, d5];
% d_sign = [d1, d2, d3, d4, d5];
% Second: recovery based on the signed detection
if d5 > 0.0000001
    fftxR5_r = fftxR5_pow;
else
    fftxR5_r = -fftxR5_pow;
end
if d4 > 0.0000001
    fftxR4_r = fftxR5_r + fftxR4_pow;
else
    fftxR4_r = fftxR5_r - fftxR4_pow;
end
if d3 > 0.0000001
    fftxR3_r = fftxR4_r + fftxR3_pow;
else
    fftxR3_r = fftxR4_r - fftxR3_pow;
end
if d2 > 0.0000001
    fftxR2_r = fftxR3_r + fftxR2_pow;
else
    fftxR2_r = fftxR3_r - fftxR2_pow;
end
if d1 > 0.0000001
    fftxR1_r = fftxR2_r + fftxR1_pow;
else
    fftxR1_r = fftxR2_r - fftxR1_pow;
end
  
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Figure III: Scenarios To Apply DS Into Touchscreen System.

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IV. CONCLUSION

In this paper, three methods for implementation of recovery algorithm for DS scheme in the touchscreen system are discussed. As the consequence, we can implement it as hardware module or by software (in firmware). Author hopes that it will be a good reference for researchers and engineers in digital system design for touchscreen system.

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