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Computer Assisted System to Help in Developing Capacitive Touch Sensing Applications

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Abstract

Using the properties of capacitors, touch can be used as an enormously effective technique of input and control, but is a challenge when it comes to large-sized touch electrodes especially those with complex shapes because they impose electrical and industrial constrains on the designer. This paper addresses the design of a computerized system to help in selecting the right parameters of the sensing system and computing the effect of them in addition to the insulation materials effect on the touch detection algorithm and sensitivity of the system and that is extremely useful in case of electrodes having large size and/or complex shape.

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Keywords: Capacitive touch sensing; system modeling; system design; touch electrode.

1. Introduction

Electrical sensors are of great importance nowadays and studies based on them are increasing[1-4] and capacitance measuring sensors are the most popular. The main uses for capacitive touch sensors in commercial products today

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are a simple switch and multi-touch input. The conductive electrolytes allow the human body to be detected, which allows charge to be held and transferred. A parallel-plate capacitor consists of two conductive layers of material with an insulating material called the dielectric in between them. Fig. 1 shows the parallel plate capacitor formed by a finger and the copper traces of the sensing pad, with the glass overlay as the insulating dielectric[5]. Charge exists in the finger as conductive electrolytes and in the copper traces from a constant current being applied to it. The net difference in charge between the finger and the copper traces is what creates capacitance. The detection of this capacitance is the main operating principle in capacitive touch sensing, where this design has many parameters that affect each other and force the designer to make some tradeoffs[6]. Touch sensitivity is affected by electrode size, insulation material and its thickness, electrode charging current and electrode charging time. As the electrode size increases, its capacitance increases and the design becomes harder because the ratio between additional capacitance added by human touch to electrode capacitance becomes smaller and that means decreased sensitivity. The electrode sized is determined by the application and the designer has to tune other parameters to enable capacitive touch sensing using that electrode. The insulation material covering the electrode is characterized by its dielectric constant, which depends on the type of the material, and its thickness. Insulation material may add more constrains, as some applications require specific type and/or thickness like thin layer painting. Charging current and charging time are connected to each other and the designed should change only one of them during the tuning process and see its effect on the system performance because increasing charging current or charging time will lead to higher voltage on the electrode after the charging process, thus increasing the sensitivity. However, increasing the charging current will increase the system power consumption and increasing the charging time causes slow response. Most capacitive touch sensors have configurable filters to minimize low frequency noise before A/D conversion. The designer needs a tool to help him configure the sensing parameter quickly and see the effect of this configuration on the measured capacitance signal and the touch effect in presence of noise. Most available developing kits do not provide the user with the true measured signal data without filtration and cannot save these data to a file and that data are needed for analysis and touch detection algorithm design. In addition, they lack the flexibility to be connected to the different test electrodes. This paper addresses a development system designed to overcome the previous problems in addition to electrode signal monitoring and data analysis tools.

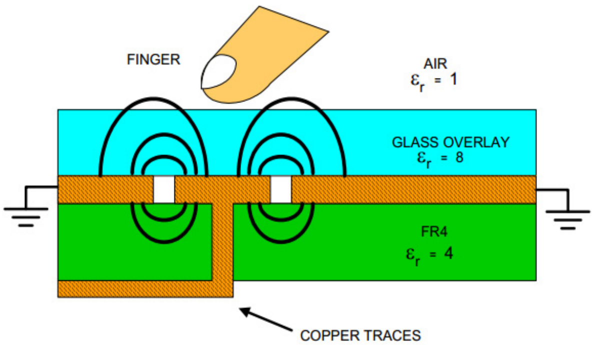

Fig. 1. The parallel plate capacitor formed by finger and traces[5]

2. Materials and methods

2.1. Hardware

The system hardware consists of a microcontroller with integrated USB and I2C modules, the general-purpose capacitive touch sensor MPR03, voltage level shifters and relay driver circuit as shown in Fig. 2. The USB provides a great advantage for the system because it enables the system to connect to any USB 2.0 port. The USB module is configured to operate at full speed mode (12Mb/s) which is good enough for this application. In addition, I2C module of the MCU is configured as master and operates at 400Kb/s, which is the maximum speed of the touch sensor chip to ensure high signal resolution at the software side.