# Stimulation Board for Automated Verification of Touchscreen-Based Devices

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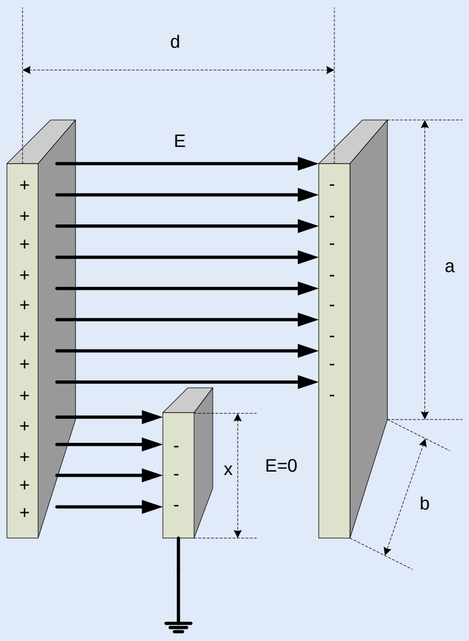
## Introduction

- **Nowadays, touchscreen-based devices are tested using mechanical stimulation with the stimulus "finger" touching the screen.**
- **The goal of this research is to find an efficient and reliable method for electrical stimulation of capacitive touchscreens to eliminate mechanical issues in the existing testing systems.**
- **The outcome is the more controllable, smaller, faster and more reliable automated testing system.**

## Stimulation Model

- **A situation when a finger touches the capacitive touchscreen can be modeled as introduction of the long grounded conductor into the electric field of a capacitor.**
- **As shown below, this leads to the elimination of the electric field on one side of the inserted conductor, effectively reducing the capacitance detected by the touchscreen sensors.**




$$C_{new} = \varepsilon \frac{A_{new}}{d} = \varepsilon \frac{(a-x)b}{d}$$

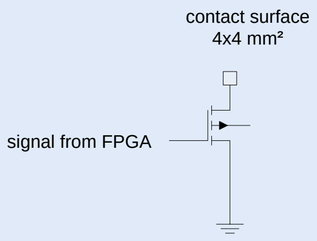
$$\Delta C = C_{new} - C_{old}$$

$$\Delta C = \varepsilon \frac{A_{new}}{d} - \varepsilon \frac{A_{old}}{d}$$

$$\Delta C = \varepsilon \frac{(a-x)b}{d} - \varepsilon \frac{ab}{d}$$

$$\Delta C = -\varepsilon \frac{bx}{d}$$

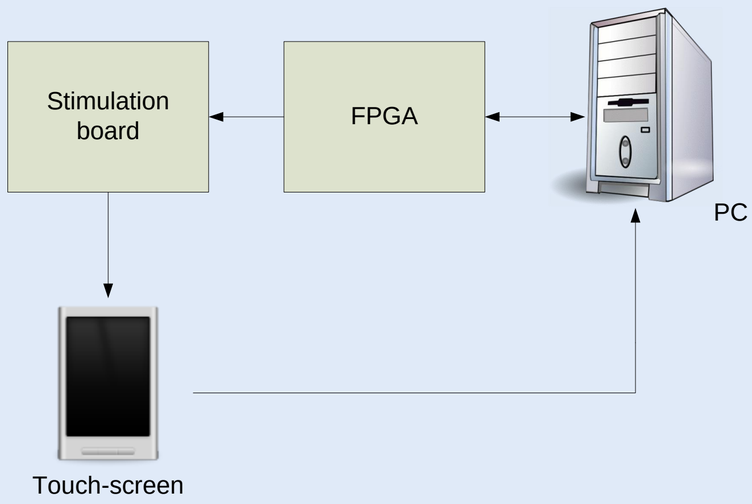
- **In order to have a system which introduces the conductor automatically, i.e. with no mechanical movement, we need a switched grounded conductor always touching the touchscreen. When we turn off the switch, the conductor is disconnected from the screen, therefore not inducing the touch. We used MOSFET as a switch.**




**ON – touch pad is grounded**

**OFF – touch pad is disconnected from the ground – no touch**

## Application

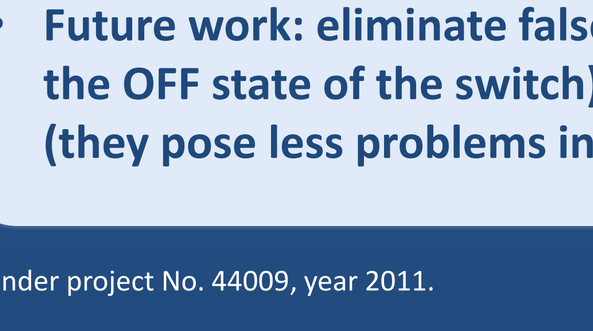



- **System for automated verification of touchscreen-based devices**
- **PC controls the execution of test cases**
- **FPGA communicates with PC and controls MOSFET switches on the stimulation board**
  - **matrix: 16 x 16 stimulation pads**
  - **pad area: 4 x 4 mm²**
- **Device response is grabbed and send to PC**
- **PC compares received response with the referent (expected) response and decided if the test passed**

## Results

| Test | Freq Pads | Freq Board |
|---|---|---|
| OFF | 8 Hz | < 2 Hz |
| ON | 55 Hz | > 57 Hz |
| CLOCK | 18 Hz | 20 Hz |

**The table compares touch frequency of the stimulation board with the earlier work (pads) False positives are significantly reduced.**




**Lessons learned from verification of TV sets:**

**comparison of the times needed by automated and manual verification for several input interfaces**

## Conclusions

- **Initial research results show that the proposed method controllably stimulates the touchscreen.**
- **Electrical stimulation will allow fast automated verification of touchscreen-based devices.**
- **Future work: eliminate false positives (touches in the OFF state of the switch), reduce false negatives (they pose less problems in a real testing system).**

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