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.

\[
C_{new} = \epsilon \frac{A_{new}}{d} = \epsilon \frac{(a-x)b}{d}
\]

\[
\Delta C = C_{new} - C_{old}
\]

\[
\Delta C = \epsilon \frac{A_{new}}{d} - \epsilon \frac{A_{old}}{d}
\]

\[
\Delta C = \epsilon \frac{(a-x)b}{d} - \epsilon \frac{ab}{d}
\]

\[
\Delta C = -\epsilon \frac{bx}{d}
\]

• 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

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

<table>
<thead>
<tr>
<th>Test</th>
<th>Freq Pads</th>
<th>Freq Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>8 Hz</td>
<td>&lt; 2 Hz</td>
</tr>
<tr>
<td>ON</td>
<td>55 Hz</td>
<td>&gt; 57 Hz</td>
</tr>
<tr>
<td>CLOCK</td>
<td>18 Hz</td>
<td>20 Hz</td>
</tr>
</tbody>
</table>

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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