Variation in Capacitance with different Conditions of Sensor

Seema Paliwal
Assistant professor
EC Department
Shri Dadaji Institute of Technology & Science, Khandwa

Jyoti Krayla
Under graduate Student
EC Department
Shri Dadaji Institute of Technology & Science, Khandwa

ABSTRACT
The projected capacitive sensor is very significant technology for the touch screen in smart phones, tablets and computers. Touch is an integral part of the human experience. Capacitive sensing is a technology based on capacitive coupling which takes the capacitance produced by the human body as the input. The Main advantages that capacitive sensing has over other detection approaches are that it can sense different kinds of materials (skin, plastic, metal, liquid), it is contactless and wear-free, it has the ability to sense up to a large distance with small sensor sizes, the PCB Sensor is low cost, and it is a low-power solution.

Keywords
Capacitive sensor, Dielectric, capacitance, Equilibrium

1. INTRODUCTION
Capacitive sensors detect anything that is conductive or has a dielectric different from that of air. Capacitive sensors work by detecting the change of capacitance due to the influence of external objects. The most amazing feature of capacitive sensor is its ability to sense through completely shield housing. Capacitive sensors comprise of electronic circuits that measures capacitance across electrodes also known as antennas.

2. EFFECT OF EXTERNAL OBJECT ON CAPACITANCE
Effect of external object on capacitance: When conductors are connected to the source the electric field from the source pushes the charges out to the conductors. The positive charge & negative charge are attractive so they move to each other as close as possible. Charges on the same place are repulsive so they push each other away to the edges. Small charges joined the plate they build up electric field to oppose the others from joining in. Eventually the net force along the conductor is zero and the charges stay in equilibrium.

3. THE FUNDAMENTAL PRINCIPLE OF CAPACITIVE TOUCH SENSING
A common model is studied where electrode forms the one plate of capacitor and the grounded finger forms another plate and changes the overall capacitance of the sensor. In most sensors design one antenna is made touch focus point where another is integrated to the ground plane. The ground plane can pick up the object influence as well. Sensitivity of one plate is increase and sensitivity of other plate reduce by making one antenna more accessible than the other. Another method is to control the size of the antenna. In a simulation to a finger on & above the coplanar structure the capacitance increases by 12.4 %. When the human body is included in the calculation the capacitance increases by 21.7 %. The human
body itself doubles the influence on the capacitance. The body by its huge surface area and finger by its close proximity couples themselves to antennas. If one of the plates is enlarged then the finger approaching the smaller plate becomes the deciding factor for the change of capacitance. If the finger approaches to big plate the capacitance change is minimum (0.846%) up to 5.8 %. By having large ground plane which is one of the antennas the sensitivity automatically goes to the smaller antenna which is meant to be the touch focus point.

Like the mechanical key matrix switch which uses row and column scanning to locate the switch which seen pressed. The capacitive sensors uses the same method for the sensing and this increase the number of sensing channels with the least I/O pins.

The matrix scanning requires the rows and columns to be electrically isolated and so as one electrode is used as transmitter the electrode is placed next to it without physical contact to sense the influence from the finger. When the transmitter is excited with fixed the voltage the charges induced on the receiver will be affected by the external object. The touch quantity is regarded as mutual capacitance $M_c$.

The smaller antenna gains more sensitivity because of high percentage of change compared to the bigger antenna in the same configuration. Even if the ground plate is made smaller and touch antenna may bigger the sensitivity follows the smaller plates. But the smaller antenna do not necessarily get more absolute delta C than a bigger but less sensitive antenna in another configuration. So to enjoy higher sensitivity from a higher percentage change of smaller antenna the sensing IC must have good signal to noise ratio to begin with.

### 4. TECHNOLOGY

Capacitive touch screens are made up of transparent electrodes arranged in rows and columns. The technology of projected capacitive sensors evolves from its predecessors the self (surface) capacitive sensors. In the self capacitive sensors the touch electrode and the finger tip performs parallel plate capacitors. As the gap $h$ between them closes up the capacitance increases according one over $h$. The charges on electrode which are proportional to the capacitance can be measured to infer the presence of external object.

Like the mechanical key matrix switch which uses row and column scanning to locate the switch which seen pressed. The capacitive sensors uses the same method for the sensing and this increase the number of sensing channels with the least I/O pins.

The matrix scanning requires the rows and columns to be electrically isolated and so as one electrode is used as transmitter the electrode is placed next to it without physical contact to sense the influence from the finger. When the transmitter is excited with fixed the voltage the charges induced on the receiver will be affected by the external object. The touch quantity is regarded as mutual capacitance $M_c$.

### 5. CHARACTERISTICS OF CAPACITIVE SENSORS

1. Simple structure, strong adaptability and capacitive sensor structure is simple, easy to manufacture high precision, capacitive sensors are generally made with a metal electrode, inorganic materials for insulation support, so you can work in the high and low temperature, strong radiation and strong magnetic field and other harsh environments, can withstand large temperature changes, under high pressure, high impact, overload, etc.; can measure the difference between high pressure and low pressure.

2. Dynamic response capacitive sensors as electrostatic attraction between the plates is small, the role of the energy needs of small, moving parts can be made small and thin, light weight, so the high natural frequency, dynamic response time is short, can In the work of a few MHz frequency, special suitable for dynamic measurement; can use high frequency power supply, so the system operating frequency is high. It can be used to measure the rapidly changing parameters, such as vibration.

3. High resolution sensor is charged because of gravity between the plates is extremely small, low input energy needs, it is particularly suited to solve the problem of low input energy, such as measuring very small pressure, force and acceleration is very small, displacement can be made very sensitive, very high resolution, can feel 0.001 m, or even smaller displacement.

4. Temperature stability of capacitance capacitive sensor generally has nothing to do with the electrode materials is conducive to choose materials with low temperature
coefficient, but also because of their minimal heat, thus affecting the stability is extremely small.

Also figure 7 shows the mutual capacitance begins with some initial value (C_m0), decreases slowly hits the maximum deep turns around and then shoots up suddenly. So now it is the DIP not the increase in capacitance that is used for inferring the touch. The turnaround infer the finger moving away and off course there is force detection

6. RESULT AND CONCLUSION

Table 1 Variation in capacitance with different conditions of antennas

<table>
<thead>
<tr>
<th>Condition</th>
<th>Before</th>
<th>After</th>
<th>Capacitance change</th>
<th>Percent change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small antennas</td>
<td>0.189pF</td>
<td>0.245pF</td>
<td>0.056 pF</td>
<td>30%</td>
</tr>
<tr>
<td>Large antennas</td>
<td>0.433pF</td>
<td>0.594pF</td>
<td>0.161 pF</td>
<td>37%</td>
</tr>
<tr>
<td>Antennas at short distance</td>
<td>0.613pF</td>
<td>0.746pF</td>
<td>0.133 pF</td>
<td>22%</td>
</tr>
</tbody>
</table>

Table 1 shows two antennas which are same size then the capacitance increases to 0.056 pF & there is 30% change.

- If the antennas are enlarged then the capacitance increases more by 0.161 pF and there is 37% of increment in capacitance. so larger antennas are easier for measuring the circuits.
- If the distances between them are shortened the electric field is more confined. Although the capacitance is higher but the delta change of capacitance is actually less and make it a less effective sensor.

Figure 6 and figure 7 shows matrix scanning requires the rows and columns to be electrically isolated and so as one electrode is used as transmitter the electrode is placed next to it without physical contact to sense the influence from the finger. When the transmitter is excited with fixed the voltage the charges induced on the receiver will be affected by the external object. The touch quantity is regarded as mutual capacitance C_m. As we know that in parallel plate capacitor the capacitance increases according one over h but experiments has shown that the mutual capacitance at the receiver behaves totally different.

Also figure 7 shows the mutual capacitance begins with some initial value (C_m0), decreases slowly hits the maximum deep turns around and then shoots up suddenly. So now it is the DIP not the increase in capacitance that is used for inferring the touch. The turnaround infers the finger moving away and off course there is force detection.

7. FUTURE SCOPE

Capacitive touch sensor will continue to expand to provide manufacturers with more opportunities to incorporate proximity capacitive sensors in their new product designs. Capacitive touch sensing technology has brought new levels of accuracy, usability and reliability in control panel design, and it will continue to help customers create new applications in emerging markets worldwide.

8. ACKNOWLEDGEMENT

Our special thanks to SDITS college of Khandwa which provide MATLAB Laboratory for this work.

9. REFERENCES


