SIMPLE DIRECT MICROCONTROLLER INTERFACE FOR CAPACITIVELY-COUPLED RESISTIVE SENSORS

IITM Technology Available for Licensing

Problem Statement

- Capacitive sensors often **need complex signal conditioning to achieve output insensitivity**
- For resistive sensors complexity associated with signal conditioning is relatively less compared to that for capacitive sensors, as they possess **higher selectivity to the sensing parameters of interest**
- However, in certain circuits resistance measurement itself **could be sensitive to variations in coupling-capacitance**

Technology Category/ Market

Category – Electronic Systems and Design manufacturing
Applications –Electronics, Automation, and Automobiles, Mobile interface, Touchscreens ,displays
Industry – Sensors, Electrical and Semiconductors
Market -Sensors Market size was valued at USD 151.90 Billion in 2021 and is projected to reach **USD 324.51 Billion by 2030,** growing at a **CAGR of 8.8% from 2023 to 2030**

Key Features / Value Proposition

Technical Perspective:

- **Simple direct microcontroller interface** used to determine the value of **coupling-capacitance** independent of the value of the sensor and reference resistors, supply voltage and threshold voltage.
- The capacitively-coupled resistive sensor includes a resistor element **coupled to a pair of capacitors in series connection.**
- The **output** of the disclosed device is **independent** of the values of the coupling-capacitors, the reference capacitor, the DC excitation voltage, and the preset threshold voltage.

User Perspective:

- The device has a **simple design and completes measurement in a few milliseconds.**
- The device may be extensively used in **non-intrusive sensing and monitoring applications** based on capacitively-coupled resistive sensors.

Technology

- A device with a **direct microcontroller interface unit**, the device comprising:

A capacitively-coupled resistive sensor **configured to measure one or more physical parameters**

A resistor element **coupled to a pair of capacitors in series connection**

Microcontroller **directly coupled to the capacitively-coupled resistive sensor**

Also, a method of directly interfacing a microcontroller (108) and a capacitively-coupled resistive sensor (102), the method comprising steps of:

1. ***Decoupling*** *a capacitively-coupled resistive sensor with a reference resistor and a reference capacitor*
2. ***Operating the microcontroller*** *in a first measurement mode and a second measurement mode for predetermined time periods*
3. ***Determining a first time interval and a second time interval*** during discharging in the first measurement mode
4. ***Determining a third time interval and a fourth time interval*** *during discharging in the second measurement mode*
5. ***Determining resistance of the capacitively-coupled resistive sensor*** *as a function of the first time interval, the third time interval, and the resistance of the reference resistor*
6. ***Determining effective coupling-capacitance of the capacitively-coupled resistive sensor***

✓ **The microcontroller operating in the first measurement mode** configured **to perform charging and discharging of the reference capacitor**

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Industrial Consultancy & Sponsored Research (IC&SR)

- ✓ The effective **resistance** of the charging and discharging paths is **equal to the resistance of the capacitively-coupled resistive sensor**
- ✓ In some embodiments, **the method includes disconnecting the capacitively coupled resistive sensor and the reference resistor in the first measurement mode.**
- ✓ **The first time interval** is indicative of time taken for decrease in voltage across the reference capacitor to a first predetermined threshold voltage and **the second time interval** indicative of time taken for decrease in voltage across the reference capacitor to a second predetermined threshold voltage
- ✓ **The third time interval** is indicative of time taken for decrease in voltage of the reference capacitor to a first predetermined threshold voltage and **the fourth time interval** indicative of time taken for decrease in voltage across the reference capacitor to a second predetermined threshold voltage

Images

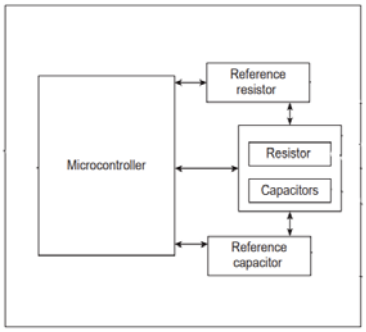

Fig. 1

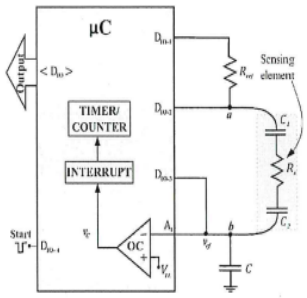

Fig.2

FIG. 1 illustrates a block diagram of a device with a direct interface between microcontroller and sensors

FIG. 2 illustrates a block diagram of a device with a directinterface between microcontroller and sensors

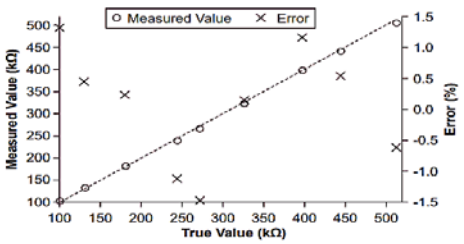

FIG. 3 is an illustration of a plot of the resistance measurements as disclosed in the present invention

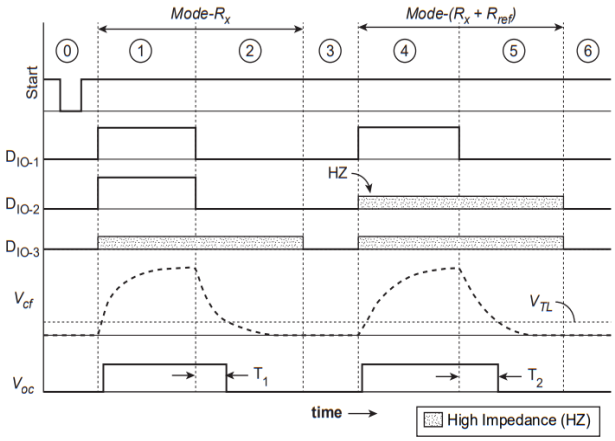

FIG. 4A illustrates a timing diagram of charging and discharging in different operational modes, according to one embodiment of the present subject matter.

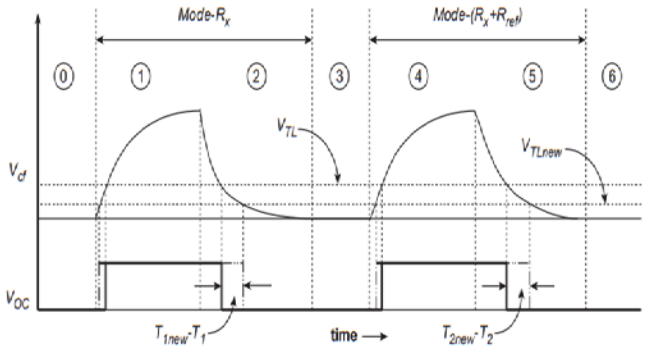

FIG. 4B illustrates another timing diagram of charging and discharging in different operational modes, according to one embodiment of the present subject matter

Intellectual Property

- **IITM IDF Ref. 1985**
- **IN436429-Granted**

TRL (Technology Readiness Level)

TRL- 3,Experimental Proof of Concept

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