Notification No: 595/2026

Date of Award: 13/02/2026

Name of Scholar: Ms. Geetika Aswani

Name of Supervisor: Prof. Tarikul Islam

Name of Department/Centre: Department of Electrical Engineering, Faculty of Engineering and Technology

Topic of Research: Development of Capacitive Sensor for Moisture Measurement in Agricultural Products and Pore Morphology Studies

Findings

1. The primary goal for this work is to explore various structures based capacitive sensors to measure moisture in chickpea grains. Chickpeas are a good source of fibre, vitamins and minerals in addition to being a significant source of proteins. A wide variety of International Cuisines, including Middle Eastern, Mediterranean and Indian recipes includes chickpeas. For moisture measurement in grains various methods including gravimetric, ultrasonic, infrared, optical, resistive and dielectric capacitive are already reported. The capacitive method is again found to be convenient, sensitive, and cost effective to measure moisture over wide varieties of grains.

2. For measurement of moisture in mustard seeds and chickpea, three different concentric fringing field sensors were designed, simulated and fabricated on copper clad printed circuit board (PCB). Experimental results show that the capacitance values of all three sensors vary almost linearly with change in moisture concentration of chickpea grains and mustard seeds. These sensors were then interfaced to Texas Instruments FDC 1004 capacitance to digital evaluation board to measure the capacitance values of the sensors. Experiments were conducted to determine response parameters such as capacitive response, sensitivity and repeatability. The calibration equations were obtained for these capacitive sensors to measure moisture in grain.

3. For measurement of moisture in variety of chickpea grains three more fringing field capacitive sensors such as interdigital electrode (IDE), circular and rectangular spiral electrodes were designed, modeled, and simulated. These fringing field sensors were fabricated as per the dimensions used in the simulated structures using copper clad

PCBs. Necessary precautions were taken to avoid error due to external electrostatic field. Experiments were conducted with the sensors to measure moisture in chickpea grains. All the fringing field sensors show almost linear response with increase in moisture in grain samples. However, one of the configurations showed optimum response in moisture detection. Additionally, the calibration equations for these capacitive sensors were determined to correlate capacitance value with the moisture content in percentage.

4. The parallel plate capacitive sensors with different configurations were also designed and experimentally validated to measure moisture in grains. Two structures were designed and fabricated on a copper cladded PCB. The shapes of the electrode were circular and square. Four different varieties of chickpea grains were tested with single, double circular parallel plate and square parallel plate sensors. The static response parameters such as sensitivity and precision of the sensors were determined. The variation of dielectric constant values for different grains was determined using the ratio of the capacitance values of the parallel plate capacitive sensor.

5. Finally, to develop a prototype electronic system for moisture measurement an oscillator based electronic circuit was designed and implemented on hardware. A 555 timer circuit was designed for taking frequency output (quasi digital) with variation of capacitance values of the sensors. This output was fed directly to a microcontroller. A calibration equation representing moisture in grain with frequency signal was developed.