Practical Training

Design and Development of a Capacitance-to-Voltage Conversion System for Measuring Moisture in Raw Cashew Nuts

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1.1 Introduction and Objectives

- The aim of the project is to design and development of a Capacitance-to-Voltage Conversion System (CVCS) for measuring moisture in raw cashew nuts
- Project provide a cost-effective, high-precision, and non-destructive solution for moisture measurement, which is crucial for the quality control and preservation of cashew nuts.
- The project uses advanced capacitance sensing techniques and a combination of innovative filters to achieve accurate moisture content quantification

1.2 Motivation

- Quality Assurance: By accurately measuring and controlling moisture levels, we can ensure that consumers consistently receive top-quality cashew nuts.
- Safety and Shelf Life: High moisture content in cashew nuts not only affects taste but also poses health risks due to microbial growth.
- Sustainable Agriculture: Accurate moisture measurement can assist in optimizing the drying process of cashew nuts, reducing energy consumption, and contributing to sustainable agriculture practices.

1.3 Methodology and Design

- The CVCS consists of a custom-designed capacitance sensor, an all-pass filter, a zero-crossing detector (ZCD), an XOR gate, a low-pass filter, an offset removal circuit, an amplifier, and a voltmeter.
- The capacitance sensor measures the changes in capacitance between two parallel plates due to varying moisture levels in cashew nuts.
- The all-pass filter captures the phase changes due to capacitance variations and passes them to the ZCD and XOR gate, which convert them into voltage signals proportional to moisture content.
- The low-pass filter removes the noise from the voltage signals and the offset removal circuit corrects the baseline voltage for open circuit conditions.
- The amplifier boosts the voltage signals and the voltmeter displays the moisture content in terms of voltage.

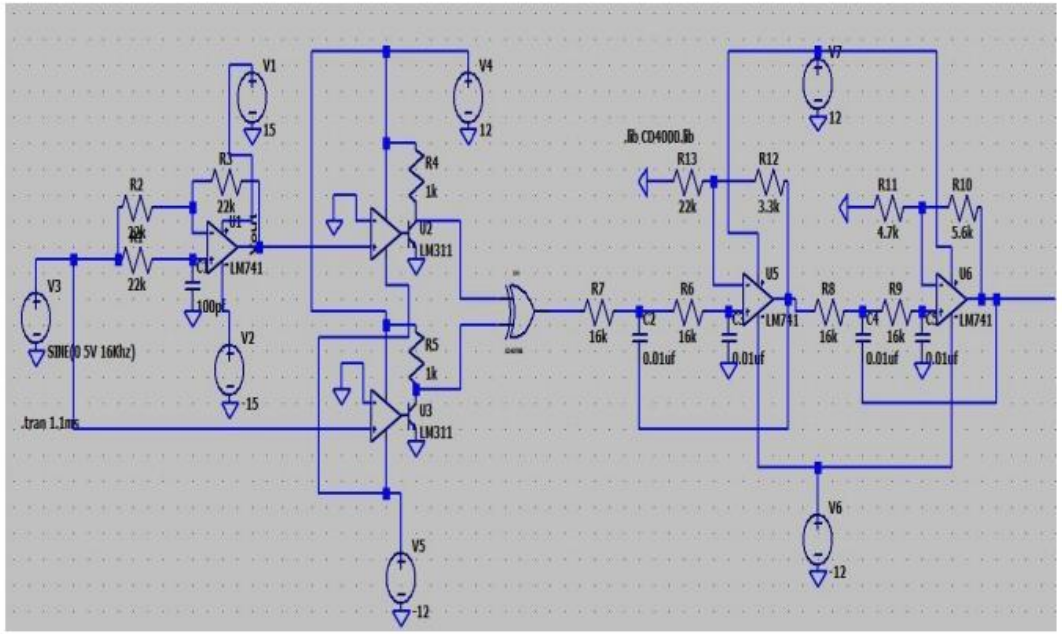

Fig 14: Overall Circuit Diagram of the system:- Consists of all-pass filters, ZCD, and filter(4th order).

1.4 Testing and Calibration

- The CVCS was tested and calibrated with different values of capacitance and moisture content using a waveform generator, an oscilloscope, and a multimeter.
- The results showed that the CVCS was sensitive and responsive to variations in moisture content and had a high resolution and accuracy.
- The CVCS was also validated with a representative sample of raw cashew nuts under practical conditions.

Fig 16: Circuit Implementation, Power Supply, and Wave Generator

1.5 Conclusion

- - The CVCS represents a significant advancement in the field of moisture measurement for agricultural products, especially raw cashew nuts.
- - The CVCS offers significant benefits to the cashew nut industry by reducing product wastage, enhancing product quality, and increasing profitability and sustainability.
- - The CVCS also holds potential for broader applications in other agricultural and food processing domains where accurate moisture measurement is pivotal.
- - The project opens several avenues for future research and development, such as advanced calibration, real-time processing, wireless connectivity, data analytics, cross-industry applications, and commercialization.

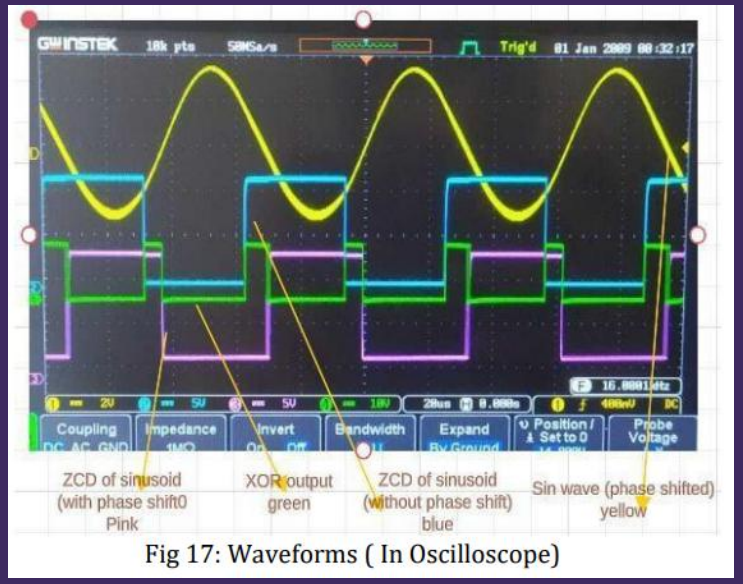

Fig 17: Waveforms (In Oscilloscope)


Fig 24: parallel plate capacitor box used to measure the moisture of the cashew

1.6 Future Scope

- Advanced Calibration: Conduct further calibration with a larger and more diverse sample of raw cashew nuts to refine the system's accuracy and reliability.
- Real-Time Processing: Explore the possibility of real-time data analysis and processing to provide instant feedback to cashew nut processing units.
- Wireless Connectivity: Integrate wireless communication capabilities to enable remote monitoring and control of moisture measurement systems in processing facilities.
- Data Analytics: Develop advanced data analytics and machine learning algorithms to analyze the collected moisture data and provide predictive insights for quality control and decision-making.

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