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FLEXIBLE MOISTURE SENSORS - A VERSATILE ARDUINO-BASED SYSTEM FOR AUTOMATED ELECTRONIC COMPONENT MEASUREMENT USING AN LCR METER

SANJAY D S, DINESH S, GUHANKARTHICK C, VIJAYASARATHI R

[1]Studuent, Dept. of Electronics and Communication Engineering, Anna University, IN
[2]Studuent, Dept. of Electronics and Communication Engineering, Anna University, IN
[3]*Studuent, Dept. of Electronics and Communication Engineering, Anna University, IN*
[4]*Studuent, Dept. of Bio Medical Engineering, Anna University, IN*

Abstract - *This project introduces an Arduino-based automated system for accurately measuring moisture levels in electronic components using flexible moisture sensors and an LCR meter. Excess moisture can compromise electronic component reliability, so this system is designed to enhance quality control by automating data collection and analysis. The setup includes flexible moisture sensors connected to an Arduino microcontroller, which manages real-time data acquisition and compensates for temperature variations. Integrating the LCR meter allows the system to measure impedance, capacitance, and resistance, offering dual insights into component quality by linking moisture content with electrical properties. Processed data can be analyzed offline in OriginPro for a deeper understanding of moisture-induced changes. Future enhancements could include expanded sensor options, portability, and wireless data transmission. This versatile system provides an efficient, automated solution for monitoring moisture in electronics, valuable for manufacturers, suppliers, and quality control labs focused on moisture-sensitive components.*

Key Words: Automated moisture measurement, Arduino-based system, Electronic component quality control, Flexible moisture sensors, LCR meter integration.

1.INTRODUCTION

The demand for automation and smart technologies is rapidly growing, especially in industries requiring accurate environmental monitoring. Moisture content is a key factor impacting the quality, durability, and performance of materials across sectors such as agriculture, construction, and electronics. Excess moisture can harm crop health, compromise building integrity, and damage electronic components. Traditional moisture sensors, however, are often rigid and less adaptable to dynamic environments. Flexible moisture sensors address these limitations with greater versatility and reliability, allowing precise, real-time monitoring across diverse applications. This project presents an automated system integrating flexible moisture sensors, an Arduino microcontroller, and an LCR meter to efficiently measure moisture levels. The Arduino-based platform enables data collection, real-time analysis, and adaptability, offering a robust solution for industries where maintaining optimal moisture levels is critical. Through this innovation, the system offers a streamlined approach to monitoring moisture, benefiting applications that rely on accurate environmental data.

1.1 Background of the Work

Moisture monitoring is essential across various industries, as excessive moisture can negatively impact product quality, durability, and functionality. Traditional moisture sensors often lack flexibility, making them unsuitable for applications with dynamic or irregular surfaces, such as soil, building materials, or sensitive electronics. To address this, flexible moisture sensors have been developed to provide greater adaptability, accuracy, and reliability in diverse environments. This project integrates flexible sensorswith an Arduino microcontroller and an LCR meter, enabling precise, automated moisture measurement. The system aims to overcome the limitations of traditional sensors, offering an efficient solution for real-time monitoring in agriculture, construction, and electronics.

1.2 Motivation and Scope of the Proposed Work

The motivation for this project stems from the need to address the adverse effects of moisture on electronic components, which can lead to corrosion, altered conductivity, and even component failure. Industries reliant on sensitive electronics, such as manufacturing, agriculture, and construction, face significant downtime, maintenance costs, and quality issues due to moisture exposure. Traditional moisture measurement methods, often manual and rigid, are prone to human error and lack the flexibility required for real-time, accurate monitoring. This project proposes an Arduino-based, automated system integrating flexible moisture sensors with an LCR meter to provide precise, real-time moisture data, thereby enhancing efficiency and reducing human error.

The scope of this work is broad, encompassing applications in electronics (circuit board monitoring), agriculture (soil moisture), and construction (building materials). The system's data processing allows for immediate response as well as trend analysis, supporting quality control and preventive maintenance. Its modular design enables scalability, future sensor integration, and potential upgrades like wireless connectivity for remote monitoring. Ultimately, this project provides a versatile, adaptable tool for industries where controlling moisture levels is essential to maintaining the performance and longevity of moisture-sensitive components.

2. METHODOLOGY

The methodology for this project involves a structured workflow that integrates hardware, cloud storage, machine learning, and user interface components. Each step is designed to ensure that battery health is monitored in real-time, with any anomalies promptly detected and conveyed to the user.

2.1 System Architecture

The system is structured around flexible moisture sensors, an Arduino microcontroller, and an LCR meter. The moisture sensors measure the electrical properties of materials, such as resistance and capacitance, which vary with moisture content. The Arduino serves as the central control unit, handling data acquisition, processing, and communication with the LCR meter. This integrated setup provides real-time, accurate moisture data, ensuring the system's adaptability for multiple industry.

2.2 Component Selection and Integration

Key components include flexible moisture sensors, an LCR meter, an Arduino microcontroller, and a stable power supply. The sensors are chosen for their sensitivity and flexibility, allowing precise measurement across irregular surfaces. The LCR meter measures impedance, capacitance, and resistance, critical for assessing moisture impact on components. The Arduino is selected for its versatility in data collection and processing, ensuring the system can reliably measure and interpret moisture-related changes in materials.

2.3 Sensor Calibration and Testing

Calibration ensures accurate moisture readings across different materials and environmental conditions. Known moisture levels are used to establish a calibration curve, allowing the system to convert sensor data into accurate moisture content. Testing involves varying moisture conditions to assess system response, stability, and reliability. By adjusting the calibration parameters based on environmental factors like temperature, the system maintains consistent accuracy, enabling dependablereal-time monitoring in diverse applications.

2.4 Data Processing and Analysis

The Arduino processes raw sensor data, converting it into actionable moisture readings using algorithms that reduce noise and normalize values. This processed data is stored for real-time monitoring and can be further analyzed using software like OriginPro. Real-time alerts are triggered when moisture exceeds thresholds, while trend analysis supports preventive maintenance. This data-driven approach allows industries to maintain quality control by monitoringmoisture impact on materials over time.

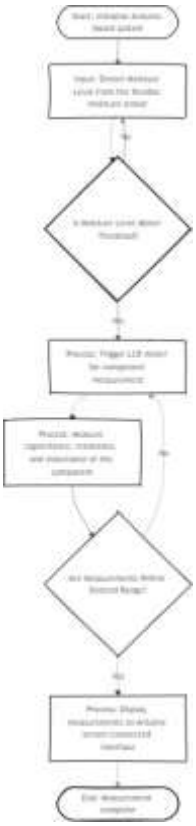

Fig -1- Flowchart

3. CONCLUSIONS

The project titled "Flexible Moisture Sensors - A Versatile Arduino-Based System for Automated Electronic Component Measurement Using an LCR Meter" successfully highlightsan innovative approach to improving quality control in the electronics industry. The system developed integrates flexible moisture sensors with an Arduino and an LCR meter, creating a highly efficient and automated setup that measures moisture levels in electronic components with precision. This automation minimizes the need for human intervention, leading to higher accuracy, repeatability, and ease of operation in routine testing environments.

Suggestions for Future Work

1. **Expanding Data Sensitivity**: Enhancing sensitivity to measure lower moisture levels or a broader range of moisture conditions would expand the system's applicability to even more sensitive electronic components and varied environments.

2. **Integrating Wirelessly :**
   Additionally, as wireless technologies continue to advance, incorporating wireless communication modules, such as Wi-Fi or Bluetooth, could enable remote monitoring and data access.
3. **Remaining Useful Life (RUL) Estimation**: To improve usability, the system could be miniaturized, making it more portable for field applications and adaptable to compact or constrained spaces.

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