

Low-cost electronics for automatic classification and permittivity estimation of glycerin solutions using a dielectric resonator sensor and machine learning techniques

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Abstract-

Glycerin is a versatile organic molecule widely used in the pharmaceutical, food, and cosmetic industries, but it also has a central role in biodiesel refining. This research proposes a dielectric resonator (DR) sensor with a small cavity to classify glycerin solutions. A commercial VNA and a novel low-cost portable electronic reader were tested and compared to evaluate the sensor performance. Within a relative permittivity range of 1 to 78.3, measurements of air and nine distinct glycerin concentrations were taken. Both devices achieved excellent accuracy (98–100%) using Principal Component Analysis (PCA) and Support Vector Machine (SVM). In addition, permittivity estimation using Support Vector Regressor (SVR) achieved low RMSE values, around 0.6 for the VNA dataset and between 1.2 for the electronic reader. These findings prove that low-cost electronics can match the results of commercial instrumentation using machine learning techniques.

Index Terms- dielectric resonator; microwave sensor; machine learning; dielectric characterization; glycerin purification; low-cost electronics; arduino

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