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Electromechanical Impedance Simulation-Based Evaluation of Cracks in Photovoltaic Solar Cells
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Abstract
Structural Health Monitoring (SHM) based on electromechanical impedance (EMI) has been widely used in different engineering domains for the detection of structural damages, especially for detecting cracks that happen due to multiple reasons such as various natural conditions and operating cycles. However, studies of SHM based on EMI technique for the detection of faults in photovoltaic (PV) solar cells are very limited. This study aims to develop and integrate the EMI technique as a permanent monitoring system, to detect structural faults in advance, to maintain the PV system's effectiveness and to ensure safety from catastrophic accidents. This work presents a numerical analysis of different models, such as free piezoelectric PZT patches of various shapes and several scenarios for healthy and cracked solar cells in order to investigate the capabilities of this technique. The crack is highlighted as a common damage in PV solar cells, and two of its characteristics were investigated namely, the crack location and the crack depth, where both are simulated with a pseudo-square monocrystalline solar cell. In addition, the root mean square deviation damage index is used to assess the severity of the damage. The results indicate that the damage index frequently changes with the variation in location and depth of the crack. Indeed, the proposed EMI technique can efficiently estimate the damage and its severity, which makes it possible to integrate it as a permanent detection and monitoring technique in a PV system.

Author Keywords
Crack depth; Crack location; Electromechanical impedance; Finite element analysis; Piezoelectric patch; Solar cell

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