Low-Cost Portable Device for At-Home Early Multi-Cancer Detection Using Bioimpedance and Multispectral Imaging Technologies

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The objective of this project is to develop a low-cost, portable, multi-sensor device for accurate early detection of multiple cancers, designed for home use and resource-limited settings. This system integrates RGB, NIR, and Thermal imaging with bioimpedance analysis, leveraging machine learning to enhance diagnostic accuracy. To achieve this, convolutional neural networks (CNNs) were trained on publicly available RGB and Thermal image datasets for skin, oral, and breast cancer classification. Bioimpedance analysis was conducted using phantoms mimicking cancerous and non-cancerous tissue compositions, validated through statistical analyses for measurement repeatability. The multi-sensor approach enables complementary data fusion, improving detection accuracy and early-stage cancer differentiation. The results demonstrated high accuracy in skin and oral cancer detection using RGB imaging, while thermal imaging was effective for breast cancer identification. Bioimpedance analysis successfully distinguished different cancer stages, showing a decrease in impedance values with increasing malignancy. The combined system outperformed individual sensor-based detection, confirming the hypothesis that a multi-sensor approach improves diagnostic accuracy. This research advances physical and life sciences by improving diagnostic methodologies and has the potential for clinical translation and commercialization. Future steps include clinical trials, optimization for deployment, and potential military and aerospace applications. This device represents a significant step toward democratizing cancer diagnostics, offering an affordable, scalable, and metric-driven solution for widespread healthcare use in low-resource areas.

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