Rapid, Smartphone-Based Diagnosis of Skin Melanoma through Differences in Tumor Cell Thermal Regulation Combined with Diffuse Spectroscopic Analysis

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Although melanoma is treatable with early detection, it accounts for nearly 80% of all skin cancer-related deaths. Diagnosis is limited to time-consuming and expensive biopsies, leading to late detection. Recent research suggests that increased metabolic activity of skin cancer cells causes more pronounced heating after external cooling relative to normal cells (15-25°C in 50sec for melanoma versus 15-21°C for normal cells); additionally, slight color differences distinguish between malignant and benign lesions. This research focuses on the development of a smartphone-based app to easily diagnose a suspicious lesion through analysis of surface temperature change and the simplified diffuse reflectance spectrum. First, a suspicious lesion was artificially cooled to 15°C and thermal images were obtained for 1min using an infrared smartphone camera (with a PCR-thermocycler being adapted to mimic thermal profiles). A new smartphone app converts the thermal metadata for comparative analysis against data from skin cancer patients, diagnosing the lesion in seconds with ~96%. This diagnosis is reinforced by the supporting detection/analysis, where a traditional smartphone image of the same lesion, taken through a newly designed-3D printed analysis accessory, is converted to a predictive ratio based on red, green, and blue color proportions. This value is compared to internal/standard data for normal and melanoma lesions to produce a unique diagnosis with 85% accuracy. As complementary techniques, a dual lesion diagnosis is provided by the smartphone app in only 5 minutes with a combined sensitivity of 94% and a specificity of 97%, yielding an overall accuracy of ~98.8%.

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