

SECURE-THERM-AI SENTINEL: A PRIVACY-PRESERVING AI PIPELINE FOR BREAST CANCER CLASSIFICATION USING THERMAL IMAGING

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Abstract—Breast cancer is a major health issue for women around the world. In 2022, 2.3 million women were diagnosed, and 670,000 died from the disease. Detecting breast cancer early and accurately can improve outcomes. This study presents a non-invasive method for identifying breast irregularities using thermal imaging and deep learning. The method utilizes Distance Regularized Level Set Evolution (DRLSE) for image segmentation and Gaussian Smoothing to aid in detecting features and reducing noise. To keep patients' thermal breast images secure, the system uses AES-CBC encryption with HMAC-SHA256, implemented through the Fernet protocol. Experimental results show that the encryption process introduces only ~33% data overhead and achieves decryption in under 10 ms, supporting real-time clinical applications. SecureThermAI Sentinel also uses metaheuristic algorithms, such as dolphins' Echolocation and Jellyfish optimization, to adjust the network's weights. The proposed deep learning model achieved an **overall accuracy of 91.76%**. Combining deep learning with these optimization techniques helps improve medical diagnostics. The model is available as a web application, offering a full workflow from image capture to classification report.

Index Terms—Portable image acquisition, Distance Regularized Level Set Evolution, Thermal Imaging, Breast Cancer, Dolphin Echolocation optimization, jellyfish optimization