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A QUANTUM-INSPIRED SEGMENTATION ALGORITHM APPLIED TO THERMOGRAPHIC FOOT IMAGES

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ABSTRACT

The usage of medical image analysis in modern healthcare is an indispensable and irreversible process, covering a wide range of phases from early diagnosis to surgery planning [6]. Within this field, infrared thermography has been successfully established as a rapid, non-contact, and non-invasive technique to visualize the temperature distribution of diabetic-foot related problems [3].

Classical machine learning and deep learning approaches have immensely enhanced the capability of segmentation, classification and image processing. Recently, more complex AI-driven and deep learning algorithms have intensified this process. However, these conventional computational methods face critical bottlenecks, namely high computational costs and an absolute dependency on massive, heavily labeled training datasets that are rarely available in specialized medical fields [2, 6].

Quantum computing emerged as a promising route to overcome these limitations of classical computing. It operates on the principles of quantum mechanics, offering new computational paradigms such as the use of qubits, superposition, massive parallelism, and quantum gates and circuits that operate under unitary transformations [6]. However, the limited availability of such hardware in the current Noisy Intermediate-Scale Quantum era, its operational unfeasibility, and the extreme infrastructure costs involved make pure quantum computing still not a viable option for immediate clinical application [1, 6].

Quantum inspired algorithms are designed to mathematically simulate quantum mechanics principles but operate entirely on conventional classical devices with the aim of achieving and exceeding the performance of previously known classical methods [4, 7]. They can learn with fewer parameters and lower sample requirements than their classical counterparts in some instances [6, 7], enhancing performance and being better cost-efficient in training and execution, emerging as a viable alternative to overcome both classical and quantum hardware boundaries.

This paper proposes the application of a quantum-inspired clustering algorithm focused on automated image segmentation for plantar thermograms aimed at the detection of diabetes anomalies. By dividing the plantar region into independent clinical angiosomes [5] without requiring massive datasets, the proposed algorithm offers a mathematical tool for localized thermal analysis [3, 4], paving the way for data-efficient, automated monitoring of diabetic foot pathologies.

***K*eywords** Quantum-Inspired Algorithms · Image Segmentation · Clustering · Infrared Thermography · Diabetic Foot

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