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Colored Image Classification Using Quantum Convolutional Neural Networks Approach

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Abstract : Recently, quantum machine learning has received significant attention. For various types of data, including text and images, numerous quantum machine learning (QML) models have been created and are being tested. Images are exceedingly complex data components that demand more processing power. Despite being mature, classical machine learning still has difficulties with big data applications. Furthermore, quantum technology has revolutionized how machine learning is thought of, by employing quantum features to address optimization issues. Since quantum hardware is currently extremely noisy, it is not practicable to run machine learning algorithms on it without risking the production of inaccurate results. To discover the advantages of quantum versus classical approaches, this research has concentrated on colored image data. Deep learning classification models are currently being created on Quantum platforms, but they are still in a very early stage. Black and white benchmark image datasets like MNIST and Fashion MINIST have been used in recent research. MNIST and CIFAR-10 were compared for binary classification, but the comparison showed that MNIST performed more accurately than colored CIFAR-10. This research will evaluate the performance of the QML algorithm on the colored benchmark dataset CIFAR-10 to advance QML's real-time applicability. However, deep learning classification models have not been developed to compare colored images like Quantum Convolutional Neural Network (QCNN) to determine how much it is better to classical. Only a few models, such as quantum variational circuits, take colored images. The methodology adopted in this research is a hybrid approach by using penny lane as a simulator. To process the 10 classes of CIFAR-10, the image data has been translated into grey scale and the 28 × 28-pixel image containing 10,000 test and 50,000 training images were used. The objective of this work is to determine how much the quantum approach can outperform a classical approach for a comprehensive dataset of color images. After pre-processing 50,000 images from a classical computer, the QCNN model adopted a hybrid method and encoded the images into a quantum simulator for feature extraction using quantum gate rotations. The measurements were carried out on the classical computer after the rotations were applied. According to the results, we note that the QCNN approach is ~12% more effective than the traditional classical CNN approaches and it is possible that applying data augmentation may increase the accuracy. This study has demonstrated that quantum machine and deep learning models can be relatively superior to the classical machine learning approaches in terms of their processing speed and accuracy when used to perform classification on colored classes.

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