Hybrid quantum algorithms in computer vision for automated quality assessments

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Image recognition and machine learning have revolutionized Quality Assessment in the past decade with improvements in computer vision algorithms and CNN's being the standard. We have created a Quanvolutional Neural Network Algorithm [1] that efficiently maps high resolution classical images to the quantum space for high quality image predictions.

Our algorithms is a bridge to using Quantum devices in the field of computer vision using a Quantum Convolution in a classical CNN stack [2]. Our hybrid model achieves higher quality predictions using much fewer training data than fully classical CNN's.

We created our quantum embedding in the following fashion.

1. We convolved the input image with many applications of random quantum circuits on input u spatially local n x n kernels. See Figure 1.
2. Our measurement consisted of a PauliZ gate which is $Z=|0\rangle\langle 0|-|1\rangle\langle 1|$ to produce our quantum encoding where output o_x = quantum state $q(i_x)$. See Figure 2.

We then made a quantum hybrid model by inputting our quantum tensor into a classical CNN and compared our results to a fully classical model. Our experiments show that the Quanvolutional Neural Network produced more accurate results using less training data as we will demonstrate in our Oral.

References

[1] Henderson, Maxwell | Shakya, Samriddhi | Pradhan, Shashindra | Cook, Tristan (2019): "Quanvolutional Neural Networks: Powering Image Recognition with Quantum Circuits": https://arxiv.org/pdf/1904.04767.pdf

[2] Cong, Iris | Choi, Soonwon | Lukin, Mikhail D. (2019): "Quantum Convolutional Neural Networks": https://arxiv.org/pdf/1810.03787.pdf

Figures

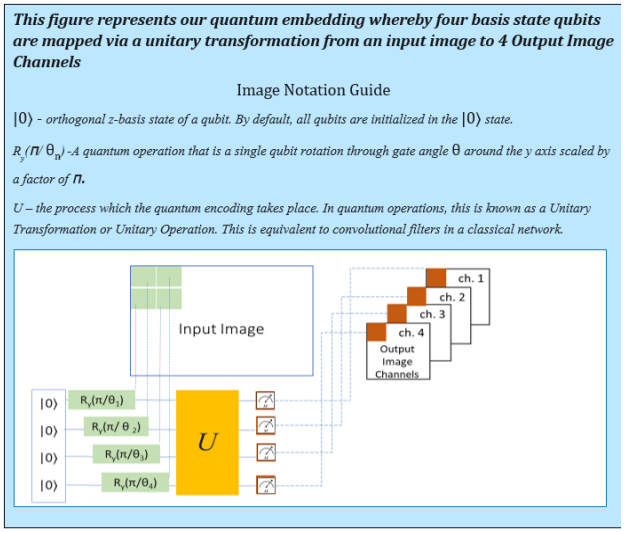

Figure 1: Mapping Classical Data to the Quantum Space for better expressability

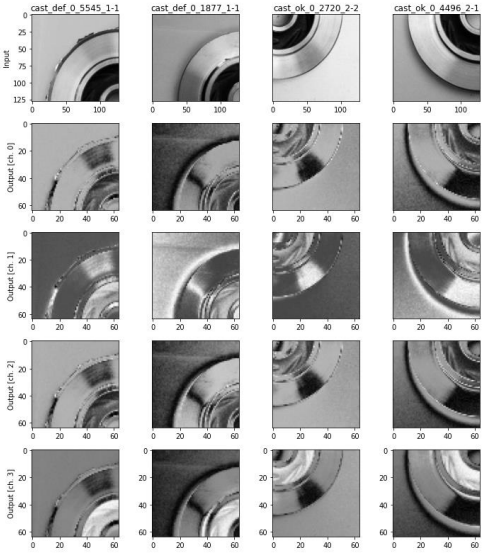

Figure 2: Effect of mapping classical data to Quantum Space using a Quantum Convolution