QAMP Spring 2023 CheckPoint-2

Quantum Autoencoder and QML used on Medical data #12

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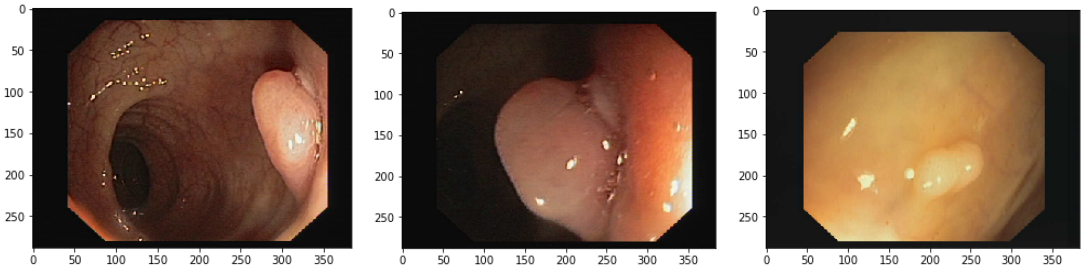
The first step of our project was to explore and do research to understand the current research field in anomaly autoencoder and dimension reduction/feature selection and segmentation techniques for Healthcare data, or other possible techniques/methods.

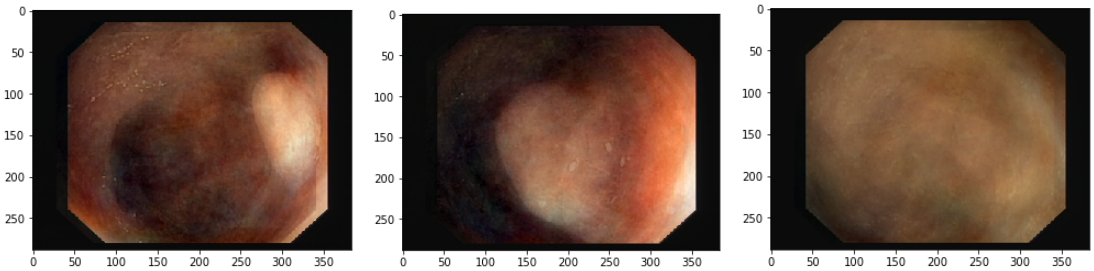
We have studied different research techniques and algorithms in both quantum and classical machine learning, and now we are working on implementing it on our medical data set. We have currently implemented different techniques for dimension reductions using classical machine learning algorithms.

Here are the results of applying PCA to our CVC-ClinicDB database, Original Images:

Original Data Set with size: 331776, shape: (288,384,3)



Reconstructed Image from PCA Data for Size Dimension reduced to 100

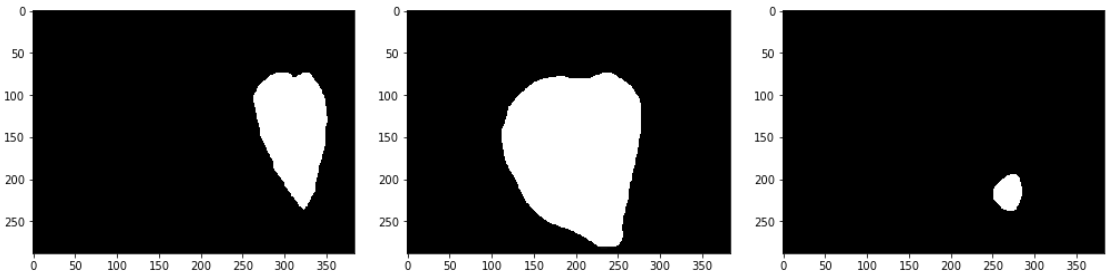


The Explained Variance Ratio : 0.933

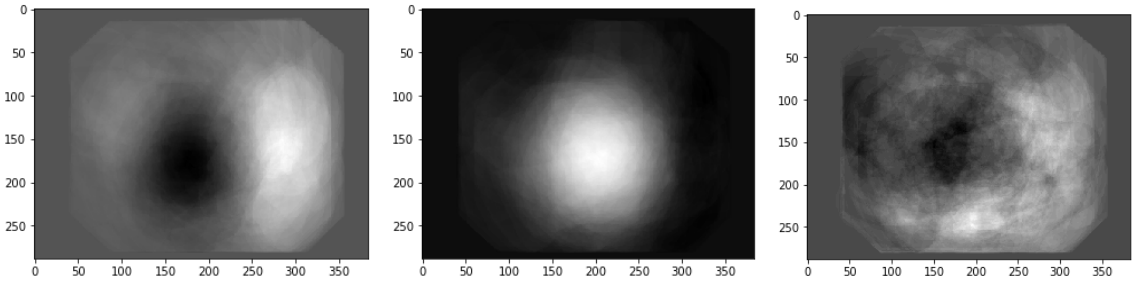
Reconstruction Error (MSE) came : 0.0015

Here are the results of applying NMF to our CVC-ClinicDB database, Ground Truth Images:

Ground Truth Data Set with size: 262144, shape: (288,384)



Reconstructed Image from NMF Data for Size Dimension reduced to 4

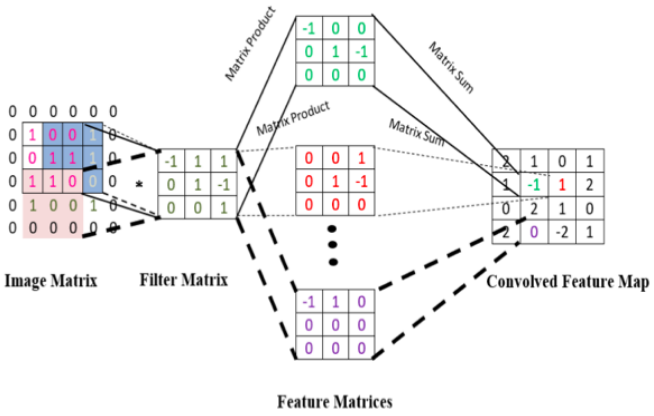


Now we are working on implementing a feature selection algorithm using quantum hardware. Based on paper[1] It proposes a feature selection algorithm as a QUBO problem to find appropriate weights for linear terms, the signal between a feature and the target variable, and appropriate weights for quadratic terms, the common information between each feature. This method chooses features with strong statistical associations with the target variable while discarding features that, even though they had a similar connection with the target variable, stored redundant information already captured by other features.

Simultaneously we are working on implementing Convolutional Neural Networks for segmenting polyps from the colonoscopy images data. As the CNN architecture itself is capable of automatically learning

and extracting the relevant features from the images during the training process. [2] Based on the architecture given in the paper, we are trying to build the network.

Fig: CNN Architecture



And then our goal will be to build a Quantum Neural Network for Segmentation and compare its results with CNN. Implementing image segmentation using a QNN involves mapping the image data to a quantum circuit, which requires careful consideration of encoding techniques, feature extraction, and decision boundaries within the quantum framework. It also involves significant challenges in terms of circuit depth, noise, and scalability. Our goal is also to explore quantum machine learning algorithms and architectures that can handle image data and improve the performance of QNNs. Trying different feature selection and dimensionality reduction techniques can help us to build a better QNN model, hence we are also working simultaneously to try different techniques like Autoencoders.

Reference:

[1] Mücke, S., Heese, R., Müller, S., Wolter, M. and Piatkowski, N., 2022. Quantum Feature Selection. *arXiv preprint arXiv:2203.13261*.

[2] Kaushik, Ravi, and Shailender Kumar. "Image segmentation using convolutional neural network." *Int. J. Sci. Technol. Res*8, no. 11 (2019): 667-675.