Quantum VHN Layer for 3D-SAS Data Inference Optimization

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*Abstract*— We propose an efficient, novel quantum algorithm that computes the Hadamard product in O(f(n)) (where n is input size in bits), achieving a x% reduction in computation time for the preprocessing layer and producing \_\_\_\_\_ performance to the classical counterpart and the relevant pipeline introduced in *Volumetric Hadamard Normalization for Sub-Bottom SAS ATR* by Vetaw et al. [1]

Keywords—Synthetic Aperture Sonar, Quantum Algorithms, CNN, Dynamic Range Compression

# Project Description

**Motivation:** Sub-Bottom SAS ATR is used for detecting unexploded underwater ordnances, which poses high risk to ocean environments. An efficient and high performing detection method is imperative to increase safety in ocean environments and ocean expeditions that may be located in places with previously high military activity. [2] With increasing quantum fidelity in the recent years, novel applications for quantum computing is researched such that algorithms may be transferred to quantum computers once it achieves practicality.

**Research problem:** Efficiently compute preprocessing

**Why it is important:** Elective efficiency and robustness

**What was done before:** Previously, Brown et al, introduced a classical CNN architecture that was well performing in the context of PR-AUC score. Vetaw et al later introduced a VHN preprocessing layer that could increase PR-AUC score as well as interpretability of the model.

**What you propose:** We propose a quantum VHN layer [1] that efficiently computes the VHN layer proposed by Vetaw et al.

**How it is different:** From our literature review in the general oceanic engineering landscape, quantum methods have yet to be applied in efficiently computing the VHN layer proposed by Vetaw et al.

**Anticipated results:** We hope to reduce training and inference time by x%, a polynomial time speedup.

**Anticipated impact:** Our proposed algorithm saves valuable training and inference time.

Include one **figure related to the research** and one **figure** **related to the preliminary result**. This might be of a device, algorithm block diagram, etc. The image can be taken from another paper but be sure to cite the source.

Place figures at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures may span across both columns. Figure captions should be below the figures. Insert figures after they are cited in the text. Use the abbreviation “Fig. 1”, even at the beginning of a sentence.

1. Example of a figure caption. (*figure caption*)
2. *Performance of various circuits as a function of number of qubits and environments*

# Methods

Describe research conducted during the summer program.

# Results

Describe results from your summer research experience.

# Conclusions

Describe conclusions formed during your summer research experience in this section.

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##### References

The references are listed as number citations consecutively within brackets [1] as they appear in the paper. The sentence punctuation follows the bracket [2].

*For example:*

**Paper Published in Conference Proceedings**

[1] Insert Greg Vetaw’s paper here

[2] D. Williams and D. Brown, “New target detection algorithms for vol- umetric synthetic aperture sonar data,” *Proc. of Meetings on Acoustics*, vol. 40, p. 070002, Sept. 2020.

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