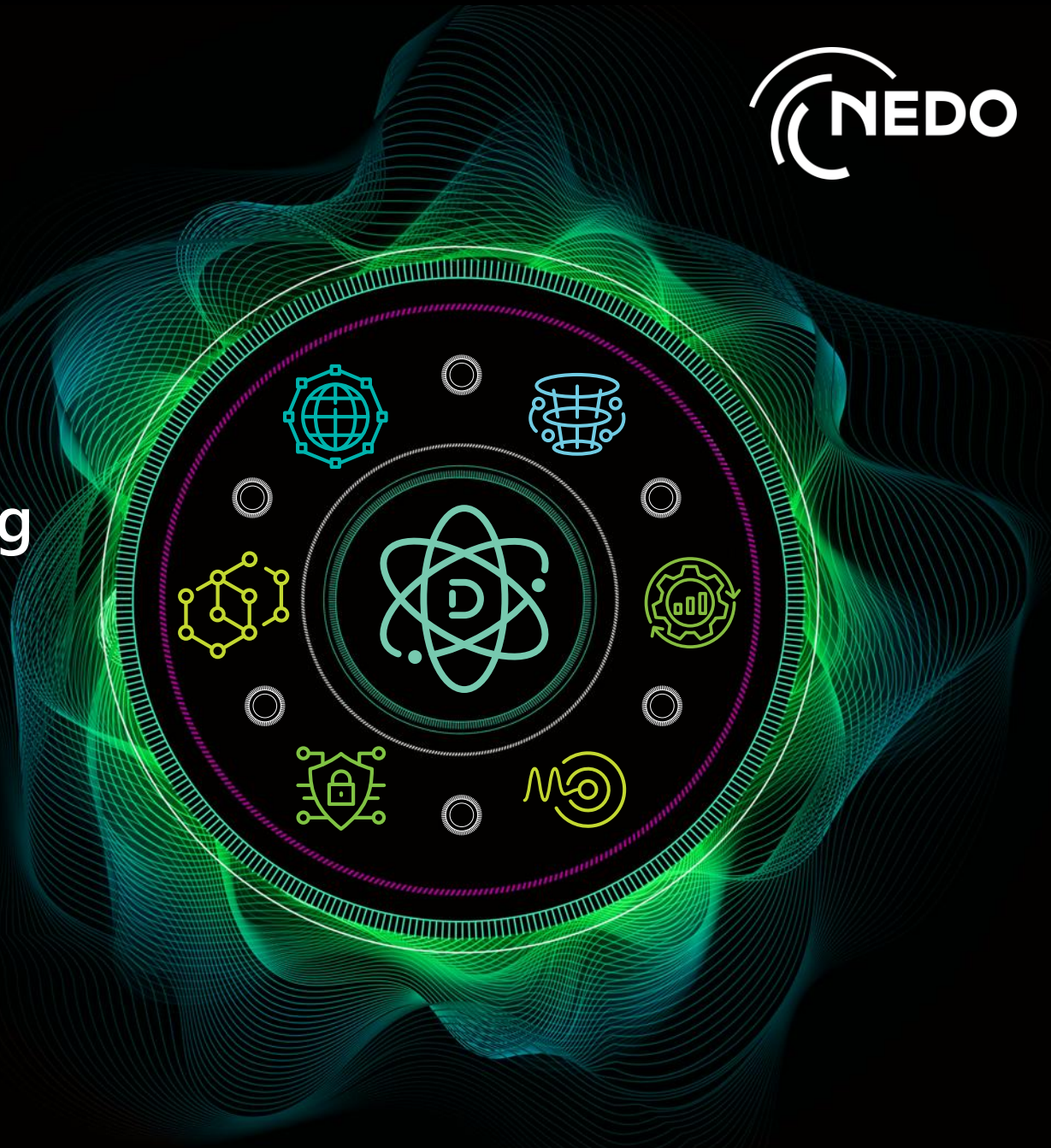
Quantum Computing Use Cases

# AI Model Compression for 3D Model Conversion of Images Using NeRF Model

HAKUHODO



New Energy and Industrial Technology Development Organization (NEDO)

# HAKUHODO: AI Model Compression for 3D Model Conversion of Images Using NeRF Model [2024/5] 1/2

Concept

| | |
|---|---|
| Industry | Other |
| Method | AI |
| Process | inference |
| Category | Gate* |

## Background

- **NeRF (Neural Radiance Field) (*1) refers to a 3D reconstruction technique that can generate a free-viewpoint image from a subject image. The NeRF model can represent a free-viewpoint image as a continuous function that maps three-dimensional coordinates and viewpoint direction to color and density using a neural network trained on images.**
- The Marketing Technology Center (MTC), the R & D division of HAKUHODO DY Holdings, is cooperating with blueqat to **explore the potential use of quantum computers in advertising and marketing in anticipation of the arrival of the quantum computer era in the future.**

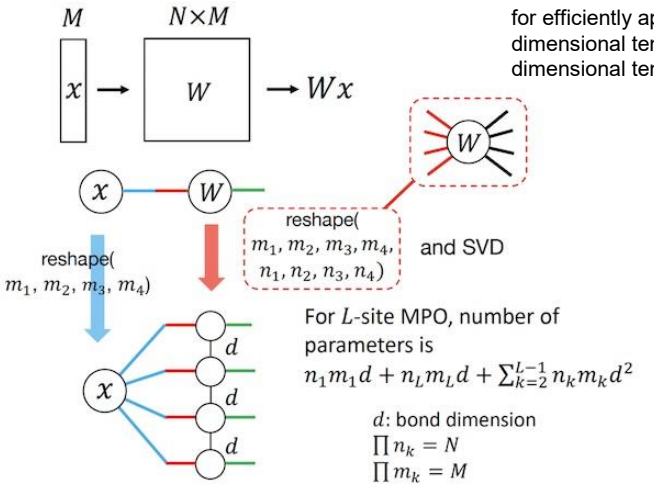
## Issues and motivation to be solved

- **In the field of machine learning, reliance on high-performance GPUs and their associated energy consumption is a key sustainability issue. Furthermore, for applications that require strict response times and security standards, the ability to perform tasks locally without cloud resources is critical. Various model compression techniques have been introduced to address these challenges.**

NeRF* 1: A 3D representation method that maps 3D coordinates and viewing direction to color and density

## Problem setting as a quantum computer

- **Tensor network**, *2 and **ability to extract features effectively from high dimensional space** are attracting attention in the field of machine learning.
  - ✓ By applying tensor decomposition techniques to the large number of weighted parameters in a neural network, **features can be extracted efficiently and the number of parameters can be reduced.**
- We aim to **compress NeRF (Neural Radiance Field) using MPO decomposition** because there is a precedent of successfully reducing model size when applying Tensor-Train (MPO) decomposition (below) to LLM (Large Language Model).




MLP layer replaced by Tensor-Train (MPO) layer

Tensor network * 2: Refers to a method for efficiently approximating a high-dimensional tensor by using a low-dimensional tensor

Reference: HAKUHODO "HAKUHODO DY Holdings demonstrates compression of NeRF models using a tensor network that can be applied to quantum gate computers, enabling efficient 3D image generation" (https://www.hakuhodody-holdings.co.jp/news/corporate/2024/05/4809.html), blueqat"HAKUHODO DY Holdings/blueqat demonstrates compression of NeRF models using tensor network technology. Presented at the SQAI-NCTS International Workshop" (https://blueqat.com/blueqat_official_news_ja/0233c282-1f78-447a-ac5f-bc4727e33857)

*Gate（gate-based）: A computing approach in which operations are applied sequentially to qubits to perform calculations. Similar in concept to logic circuits in classical computers, it can address a wide range of problems.

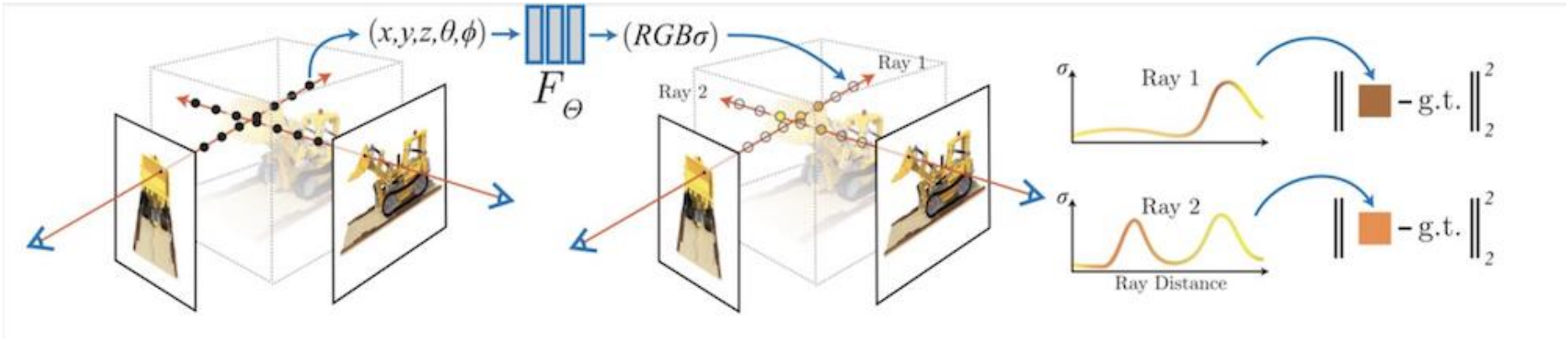
# HAKUHODO: AI Model Compression for 3D Model Conversion of Images Using NeRF Model [2024/5] 2/2

Concept

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## Expected business benefits

- Applying tensor networks to NeRF models **demonstrates efficient reduction in model size while maintaining rendering quality**
- This work shows the applicability of tensor network for the efficiency improvement of image rendering. Tensor networks are also known to work well with quantum circuits, **leading us to envision that when quantum gate computers are completed in the future, this technology can be applied directly.**




Schematic diagram of NeRF image generation and rendering method

Reference: HAKUHODO "HAKUHODO DY Holdings demonstrates compression of NeRF models using a tensor network that can be applied to quantum gate computers, enabling efficient 3D image generation" (https://www.hakuhodody-holdings.co.jp/news/corporate/2024/05/4809.html), blueqat"HAKUHODO DY Holdings/blueqat demonstrates compression of NeRF models using tensor network technology. Presented at the SQAI-NCTS International Workshop" (https://blueqat.com/blueqat_official_news_ja/0233c282-1f78-447a-ac5f-bc4727e33857)
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**More use cases are available on our website. We invite you to explore them.**
**https://www.quantum-computing-use-cases.nedo.go.jp/english/**

More Use Cases

**New Energy and Industrial Technology Development Organization (NEDO)**
**AI and Robotics Department (e-mail: quantum_ai@ml.nedo.go.jp)**

**This collection of use cases was obtained as a result of the work commissioned by the New Energy and Industrial Technology Development Organization (NEDO) "Cyber-Physical Development Business of Quantum/Classical Hybrid Technology/Study of Use Case of Quantum Technology" and the "Post-5G Information and Communications System Infrastructure Reinforcement R & D Project (Quantum Industrialization)/Comprehensive Study for Promoting the Industrialization of Quantum Computers".**