QUANTUM EDGE DETECTION

(USING QHED)

BY-KAUSTUBH GUPTA
(2000290110080)

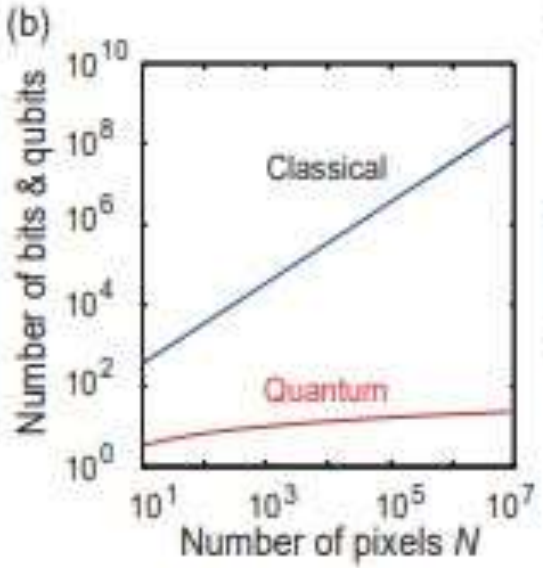
WHAT IS IMAGE EDGE DETECTION

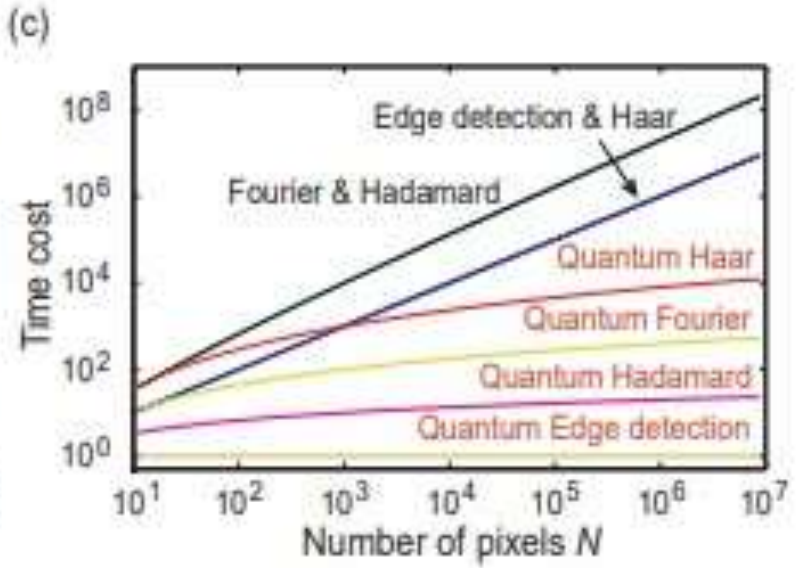
- EDGE DETECTION IS USED FOR IMAGE SEGMENTATION AND DATA EXTRACTION IN AREAS SUCH AS IMAGE PROCESSING, COMPUTER VISION, AND MACHINE VISION.

QUANTUM ADVANTAGE

(a)

	Space resources	Time cost			
	Coding	Haar	Fourier	Hadamard	Edge-detection
Classical	Nd bits	$O(N)$	$O(N\log N)$	$O(N\log N)$	$O(N)$
Quantum	$\log N$ qubits	$O(\log^3 N)$	$O(\log^2 N)$	$O(\log N)$	$O(1)$





Classical	Quantum
Bits: {0, 1} (deterministic states)	Qubits: $\{\alpha\|0\rangle + \beta\|1\rangle\}$ $\alpha, \beta \in \mathbb{C}$ (probabilistic states)
Boolean algebra	Linear algebra
Logic gates (logical operations, irreversible)	Quantum gates (matrix multiplications, reversible)

Single qubit: $|q\rangle = \alpha|0\rangle + \beta|1\rangle = \begin{bmatrix}\alpha\\ \beta\end{bmatrix}$ $\alpha, \beta \in \mathbb{C}$

bra $\langle q| = [\alpha^* \ \beta^*]$ *ket (vector)*

(conjugate transpose of a ket)

probability amplitudes — *standard basis states*

bra-ket: $\langle q_1|q_2\rangle$ *(inner product: scalar)*

ket-bra: $|q_1\rangle\langle q_2|$

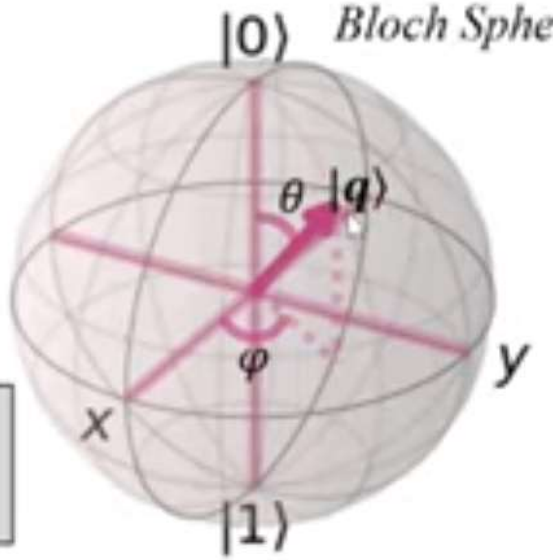
(outer product: matrix, or linear transformation operator)

Measurement

$$P(|q\rangle = |0\rangle) = |\langle 0|q\rangle|^2 = |\alpha|^2$$
$$P(|q\rangle = |1\rangle) = |\langle 1|q\rangle|^2 = |\beta|^2$$
$$|\alpha|^2 + |\beta|^2 = 1$$

$$|q\rangle = \cos\frac{\theta}{2}|0\rangle + e^{i\varphi}\sin\frac{\theta}{2}|1\rangle$$

Bloch Sphere



Process flow: