ACM GreekCHI-CYCHI Symposium 2026

# Quantum Artificial Intelligence

Dimitrios Gryllakis  Kyriakos N. Sgarbas

Department of Electrical & Computer Engineering, University of Patras, Greece | AI-Hub

AI-Hub

Connect

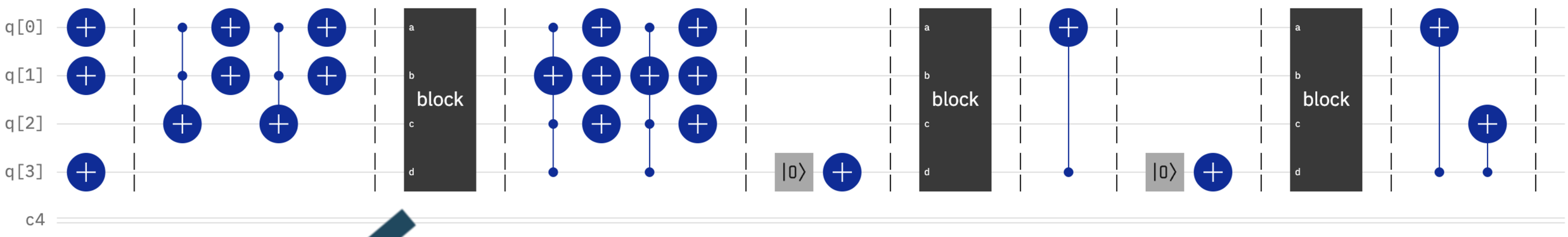
Quantum Artificial Intelligence (QAI) is an emerging interdisciplinary research field that explores the convergence of quantum computing and Artificial Intelligence. As quantum computers offer new computational approaches to complex problems in areas such as optimization, simulation, and information processing, their integration with AI may create new opportunities for the development of future intelligent systems and human-centered technologies.

## *A Resource-Efficient 4-Qubit Circuit for Bit-Flip Error Correction Using Feynman Gates*

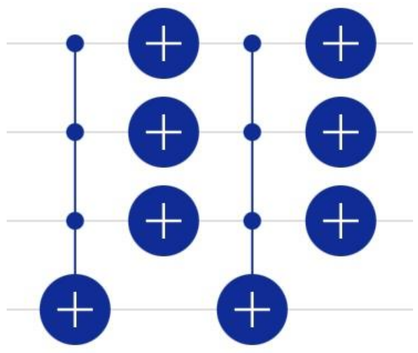
We propose a **resource-efficient 4-qubit quantum circuit** for detecting and correcting single-qubit bit-flip errors. The design achieves full correction fidelity under ideal simulation conditions with minimal qubit and gate overhead, demonstrating a compact approach toward more reliable quantum computation.

| Error State | Target State | Detection Accuracy | Correction Fidelity |
|---|---|---|---|
| $\|001\rangle$ | $\|000\rangle$ | 100% | 100% |
| $\|010\rangle$ | $\|000\rangle$ | 100% | 100% |
| $\|100\rangle$ | $\|000\rangle$ | 100% | 100% |
| $\|110\rangle$ | $\|111\rangle$ | 100% | 100% |
| $\|101\rangle$ | $\|111\rangle$ | 100% | 100% |
| $\|011\rangle$ | $\|111\rangle$ | 100% | 100% |
| $\|111\rangle$ | $\|111\rangle$ | 100% | 100% |
| $\|000\rangle$ | $\|000\rangle$ | 100% | 100% |

*Simulation results showing fidelity comparison across all test cases.*




*Block Diagram of the Full 4-Qubit Bit-Flip Error Correction Architecture.*



*Repeated Subcircuit Block*

| Input State | Output State |
|---|---|
| 0000 | 1000 |
| 0001 | 0001 |
| 0010 | 0010 |
| 0011 | 0011 |
| 0100 | 0100 |
| 0101 | 0101 |
| 0110 | 0110 |
| 0111 | 1111 |
| 1000 | 0000 |
| 1001 | 1001 |
| 1010 | 1010 |
| 1011 | 1011 |
| 1100 | 1100 |
| 1101 | 1101 |
| 1110 | 1110 |
| 1111 | 0111 |

*Substructure-Block Truth Table.*

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

*Substructure-Block Unitary Matrix.*

Read the Paper

## From Reliable Quantum Circuits to Responsible and Human-Centered Intelligent Technologies

**Healthcare & Life Sciences**
Drug discovery, protein folding, personalized medicine, and medical imaging optimization.

**Energy & Sustainability**
Energy systems optimization, climate modeling, and sustainable resource management.

**Industry & Logistics**
Scheduling, supply chain optimization, smart manufacturing, material's design.

**Artificial Intelligence**
Quantum Machine Learning, data analysis, and hybrid AI systems.

**Science & Engineering**
Simulation of complex systems, new materials, and fundamental research.

### HCI Implications of Quantum Artificial Intelligence

As Quantum AI advances, human-centered design will be essential for translating emerging computational capabilities into meaningful user experiences. Key HCI implications include:

**Trust & Reliability**
Reliable quantum computation can provide a technical foundation for future intelligent systems, while user trust also requires clear communication of uncertainty and limitations.

**Explainability & Transparency**
Quantum-enhanced AI outcomes should be communicated through understandable explanations and interfaces that support informed decision-making.

**Human Oversight & Interaction**
Future QAI interfaces should enable users to explore recommendations, question outcomes, and maintain meaningful control over AI-assisted decisions.

**Accessibility & Usability**
Complex quantum technologies should be made accessible through intuitive, inclusive interfaces that do not require users to understand the underlying quantum computations.

Quantum computers offer new computational capabilities for addressing complex problems in areas such as optimization, simulation, and data processing. As the integration of quantum computing with Artificial Intelligence continues to emerge as an active interdisciplinary research field, Quantum Artificial Intelligence (QAI) may open new possibilities for the development of human-centered intelligent technologies. By combining advanced AI methods with quantum computational approaches, QAI could contribute to future applications in healthcare, personalized services, intelligent decision support, sustainable energy, transportation, scientific discovery, and other domains where complex computational problems directly affect people and society.

### HCI Implications: From Quantum Reliability to Human-Centered Decision Support

Illustrative future scenario — quantum-enhanced logistics decision support

**Scenario**
A logistics planner interacts with a future quantum-enhanced AI system that recommends delivery routes under changing traffic, resource, and scheduling constraints.

**Trust & Reliability**
Communicate solution confidence, uncertainty, and computational limitations.

**Explainability**
Explain why a route is recommended and what trade-offs it involves.

**Human Control**
Allow planners to adjust constraints, compare alternatives, and override recommendations.

**Usability**
Present actionable results through an intuitive interface without requiring quantum expertise.