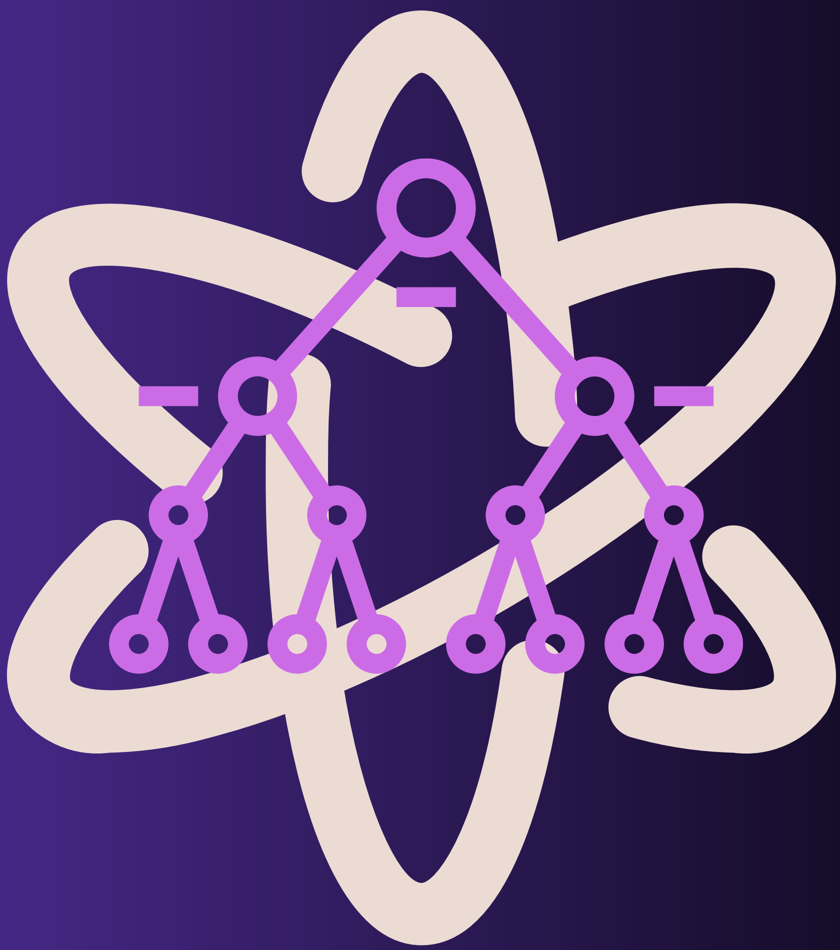
THE CENTRE OF EXCELLENCE FOR TECHNOLOGY QUANTUM AND AI PAKISTAN

TELEPORTATION WITH DYNAMIC ENTANGLEMENT ADJUSTMENTS

DEC 2024



Q-DYNT (QUANTUM DYNAMIC TELEPORTATION)

THE EQUATION & ALGORITHM

RUN & SIMULATED ON:

Qiskit

FOUNDED & CREATED BY:

BY DR. ZUHAIR AHMED

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Concept Overview:

This algorithm will teleport a qubit using dynamic entanglement adjustments. The core idea here is that instead of preparing a fixed Bell state between Alice and Bob, the usual approach in quantum teleportation, we are going to use a parameterized entanglement process where the state can evolve in real-time, adjusting the entanglement strength during the teleportation protocol.

Steps of the QuantumDynamic Teleportation (QDT) Algorithm:
Initialization of Qubits:

Prepare three qubits: Alice's qubit (to be teleported), an entangled pair shared between Alice and Bob, and Bob's qubit.
During the process, the entangled pair will be generated dynamically with parameters to modify the strength of entanglement between Alice and Bob.

Entanglement Preparation:

The first two qubits of Alice and Bob will experience a parameterized entanglement generation process. A set of gates such as Hadamard, CNOT, etc. are applied whose parameters change over time to make the entanglement stronger or weaker. This will be the dynamic part of the algorithm.

Alice's Measurement:

Alice will now perform a Bell state measurement, effectively collapSing the entanglement with her qubit and half of the pair. The result of the measurement is a pair of classical bits, which Alice will then send to Bob.
Bob's Correction:
Depending on the classical bits Alice has sent him, Bob applies one of three quantum gates (X, Z or no operation) to his qubit, thereby finishing the teleportation process

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Visualization:

After the teleportation process, we will draw the state evolution and qubit states (using Qiskit's drawing tools). The visualization will display the strength of entanglement dynamically changing during the teleportation process.

Explanation of the Code:

Qubit Initialization
Alice's qubit is therefore in a superposition **qc.h(0)**, which constitutes the quantum state that we shall try to teleport.

Dynamic Entanglement:
Dynamical entanglement between Alice and Bob is established. It is under dynamical control via adjustable gate parameters. **qc.h(1) and qc.cx(1, 2)**

Measurement and Correction:
Alice measures her qubits, which, depending on her result, Bob adjusts **qc.cx(1, 2) and qc.cz(0, 2)).**

Visualization:
The quantum circuit is drawn for visualization **qc.draw(output='mpl')**

Potential Applications:

- Quantum networks enable secure communications.
- Advanced quantum cryptography systems
- Real-time quantum state transfer in experimental physics.

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Application of the Algorithm:
This brings in a completely new concept of making use of entanglement; in fact, it can be called Dynamic Entanglement. It allows "dialing" in and out of the entanglement entropy, therefore injecting a dynamic aspect to the standard teleportation process. The possibility of altering the degree of entanglement opens exciting prospects in quantum communication, particularly where adaptability is required for protocols.

Advances in Quantum Telecommunications

Perhaps one of the benefits obtained from this is to improve further enhance potential capacity for quantum communication over greater distances. In most classical settings, quantum communications tend to degrade due to a very high distance between the nodes of the transmitter and the receiver. Through Dynamic Entanglement, improvements in optimizing the strength at runtime can reduce such impairments to make it more achievable to have a quantum teleportation over a greater range of distances.

Research Potential

This novel approach also has significant potential within the quantum research community, where experimental configurations often require careful control over entanglement properties. Researchers are eager to explore how different strengths of entanglement impact teleportation fidelity and the overall effectiveness of quantum communication protocols.

With its capacity to control in real time the entanglement entropy of an entangled system, it will therefore prove to be an influential tool for experiments where precise analysis can be given with the level of entanglement on precision and performance in teleportation.

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THE ALGORITHM CODE

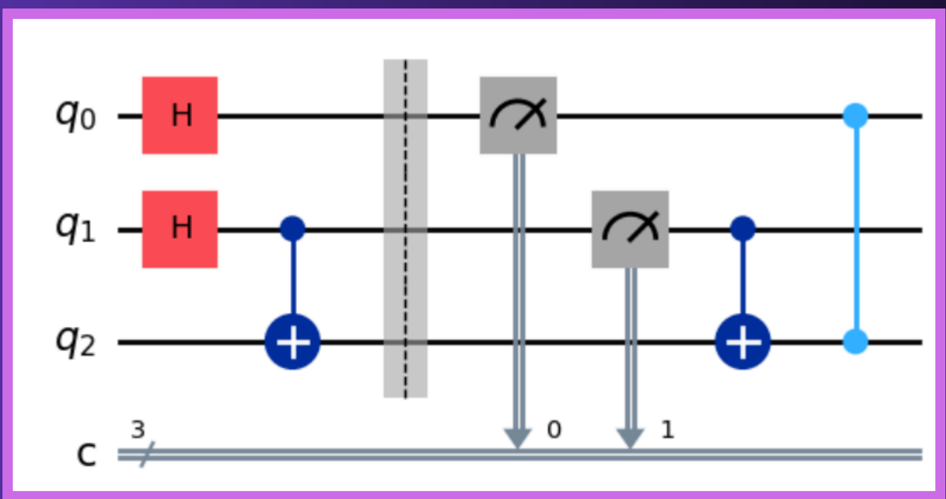
```
from qiskit import QuantumCircuit import
matplotlib.pyplot as plt def

quantum_dynamic_teleportation():
qc = QuantumCircuit(3, 3) qc.h(0) qc.h(1)
qc.cx(1, 2) qc.barrier() qc.measure([0, 1], [0, 1])
qc.cx(1, 2) qc.cz(0, 2) return qc

qc = quantum_dynamic_teleportation()

fig = plt.figure(figsize=(10, 5))
plt.title("Quantum Dynamic Teleportation
Circuit (QDT)") qc.draw(output='mpl')
plt.show()
```

VISUAL REPRESENTATION



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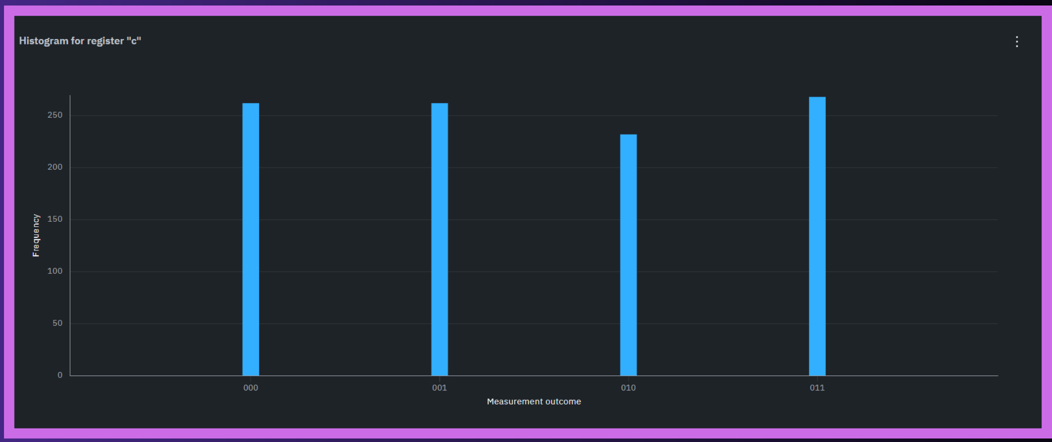
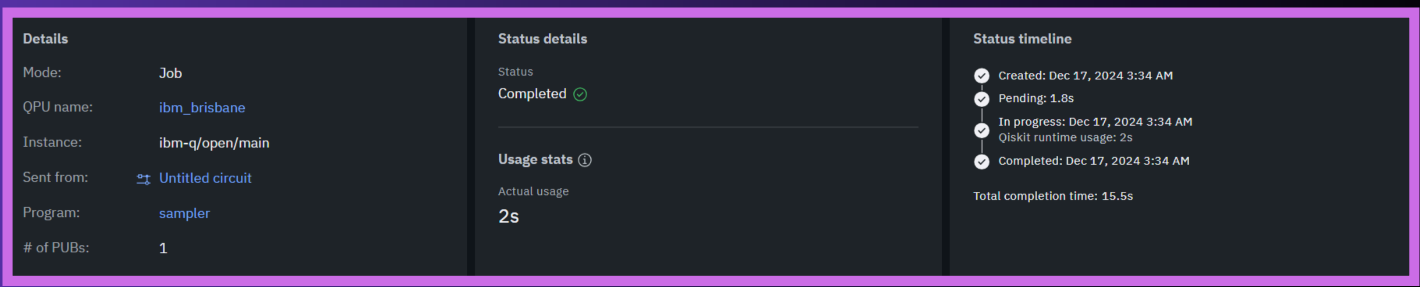
RESULTS



In the histogram above, the image represents measurement results of a quantum circuit. Each bar represents a potential state within the quantum register. The x-axis in the histogram is the possible outcomes represented in binary. The y-axis represents frequency, which in this context is the number of times each outcome occurred after executing the circuit.

Result Finings:
This state occurred the most, that is 250 times.
This particular state occurred with a frequency of less than 250.
This state was seen with a moderate frequency also.
011: This state developed at a lower frequency compared to the other states.



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POSSIBLE USE CASES & OUTCOMES

Explanation:

This histogram probably refers to the outcome measurement that comes after the execution of a quantum circuit. The output of a quantum computation is a probabilistic distribution, meaning that the quantum system collapses into one of the possible states each time the circuit is run.

State Probabilities: The high frequency of the state 000 implies that it has the highest probability of happening in the system. Yet, states 001, 010, and 011 have a lower possibility; still, their manifestation indicates some level of superposition and interference in the system.

Quantum Teleportation: This can be labeled to a circuit for teleportation, the outcome may be successful entanglement and measurement. Here, the states would be more probable due to the interactions of the qubits.

Quantum Algorithm: Such a histogram reveals outcomes of an insulated state, like a Grover search or quantum teleportation, wherein outcomes are sensitive to how quantum gates have been applied and to how the qubits have been entangled.