Quantum Teleportation

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1 Quantum Teleportation

Quantum teleportation is used to “teleport” the state of one qubit to another without making a copy of the state.

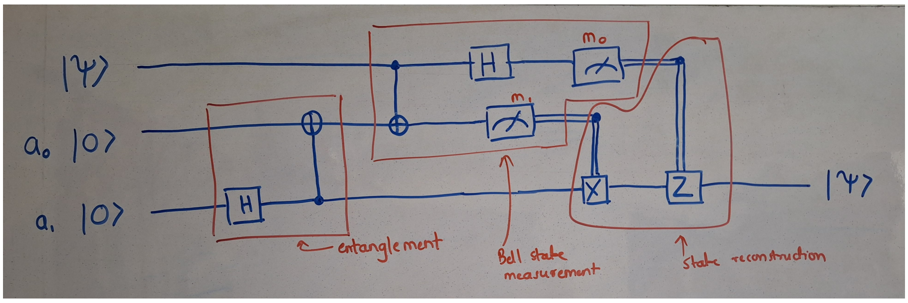

Figure 1: Teleportation circuit

In this, first we need two entangled qubits. These are a_0 and a_1 in the above circuit. These are entangled using the Hadamard gate and CNOT gate as shown in the circuit above. The qubit state to be teleported is in $|\psi\rangle$ from Alice to Bob. The qubits $|a_0\rangle$ and $|\psi\rangle$ are with Alice while $|a_1\rangle$ is with Bob.

The qubits $|\psi\rangle$ and $|a_0\rangle$ are then measured in the Bell basis and the measured values are stored in m_0 and m_1 respectively. Bob uses these values and applies $Z^{m_0}X^{m_1}$ to his qubit $|a_1\rangle$ to get the state $|\psi\rangle$. Thus, the state in $|\psi\rangle$ has been teleported to $|a_1\rangle$.

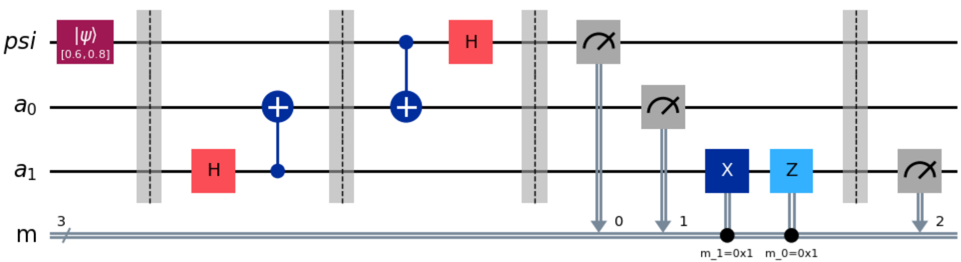

Figure 2: Teleportation circuit drawn using Qiskit

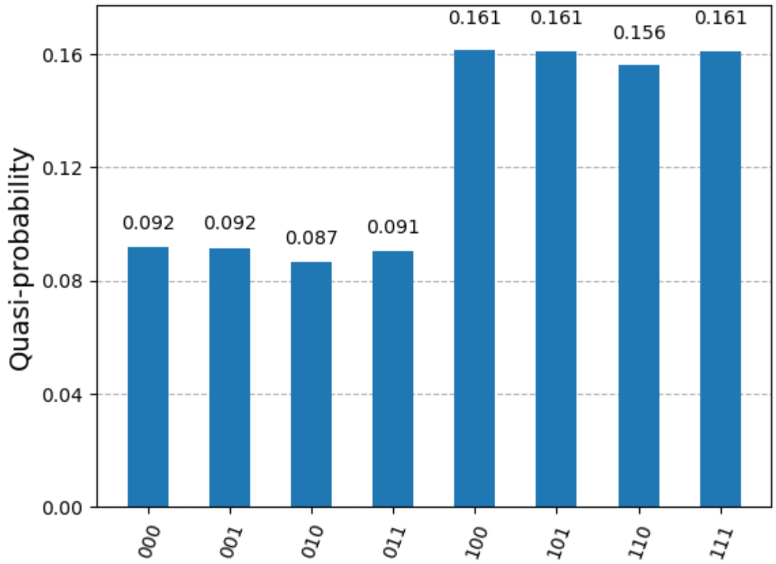

Figure 3: AER plot

The first bit in the registers is for a_1, i.e Bob's bit. We have to find the state of this qubit at the end of this circuit. So we find out the probabilities of a_1 being 0 and 1 which turn out to be very close to 0.36 and 0.64 respectively. Thus, a_1 is in the state $0.6\,|0\rangle + 0.8\,|1\rangle$. This is the state of the qubit which we wanted to teleport from Alice to Bob. This shows that we have done it successfully.

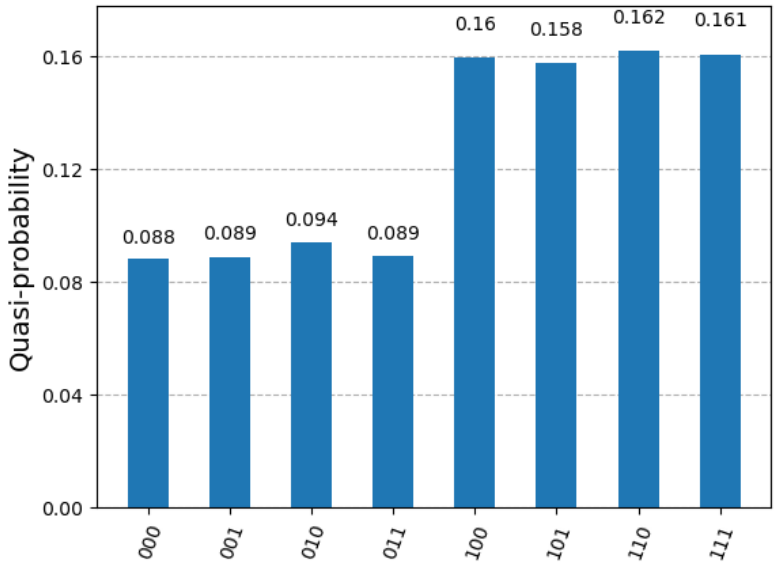

Figure 4: Histogram of the qubit states generated by running the circuit on IBM quantum computer for 8192 shots

With 8192 shots, the state of $|a_1\rangle$ still is very close to the original state of $|\psi\rangle$. Even though a quantum computer is might have noise which would give errors in the result, increasing the number of shots seems to make the result more accurate.