Lab 2 Report

Applications of Quantum Information Processing

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Q1[1]

(a)

alice_bits = [0,0,0,1]

if we use the qasm_simulator, bob_bits will always identify with alice_bits [0,0,0,1]

BER = 0%

SER = 0%

```
BER = 0.00%
SER = 0.00%
```

The relation between BER and SER is the same, 0%.

(b)

alice_bits = [0,1,0,1], on real devices

BER = 6.592%

SER = 12.402%

```
BER = 6.592%
SER = 12.402%
```

We can see that the SER is approximately twice of BER.

Using the mathematical analysis, the probability of a bit corrected transmitted is $1 - $ BER. A system contains 2 bit string. The transmission between two bits is independent. Hence the probability of a system corrected transmitted is $(1-BER)^2$. $\mathrm{SER} = 1 - (1-BER)^2 = 2BER - BER^2$, which is approximately 2BER when BER is small. For the more accurate calculation of SER = $2BER - BER^2$ = 12.75%, which is 0.99% from the real SER. By comparison, SER = 2BER = 13.184%, which is 6.3% from the real SER.

Q2[2]

Prepare for initial state(From Lab1 1(h))

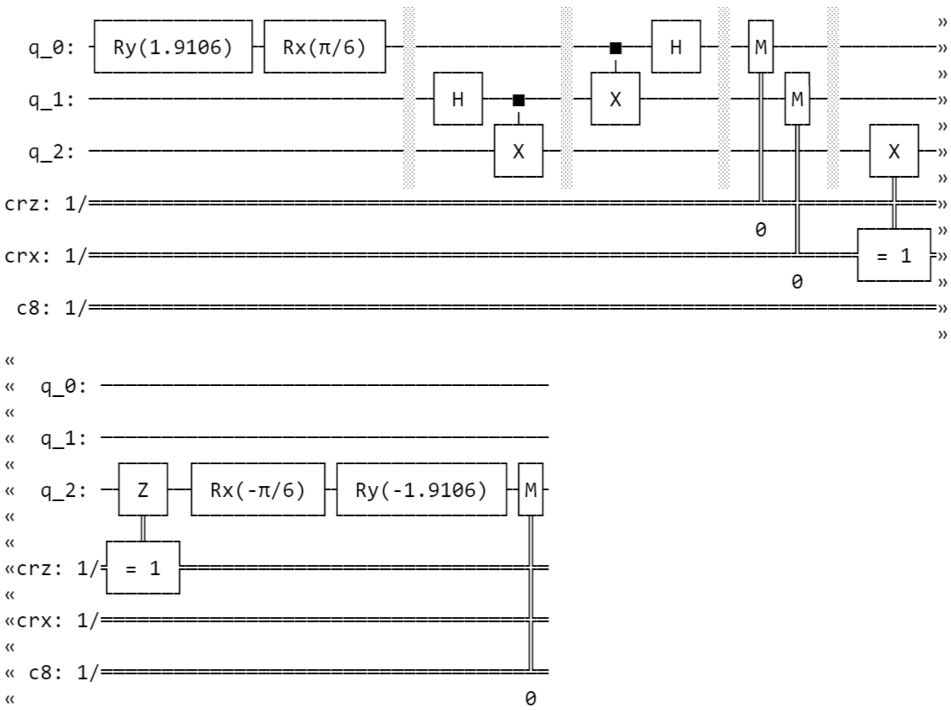
(i)

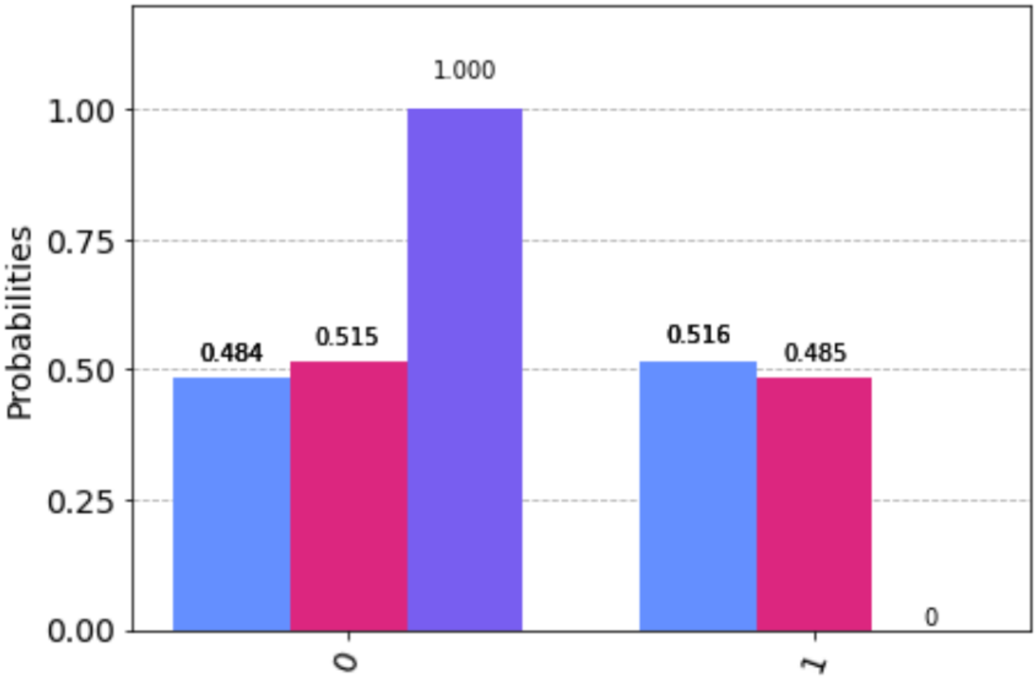
$|\psi\rangle$B = $[0.55768-0.21132i, 0.78868-0.14943i]$

$|\psi'\rangle$B = $[0.55768-0.21132i0.78868-0.14943i]$

$|\langle\psi|\mathrm{B}|\psi'\rangle\mathrm{B}|^2 = 1$

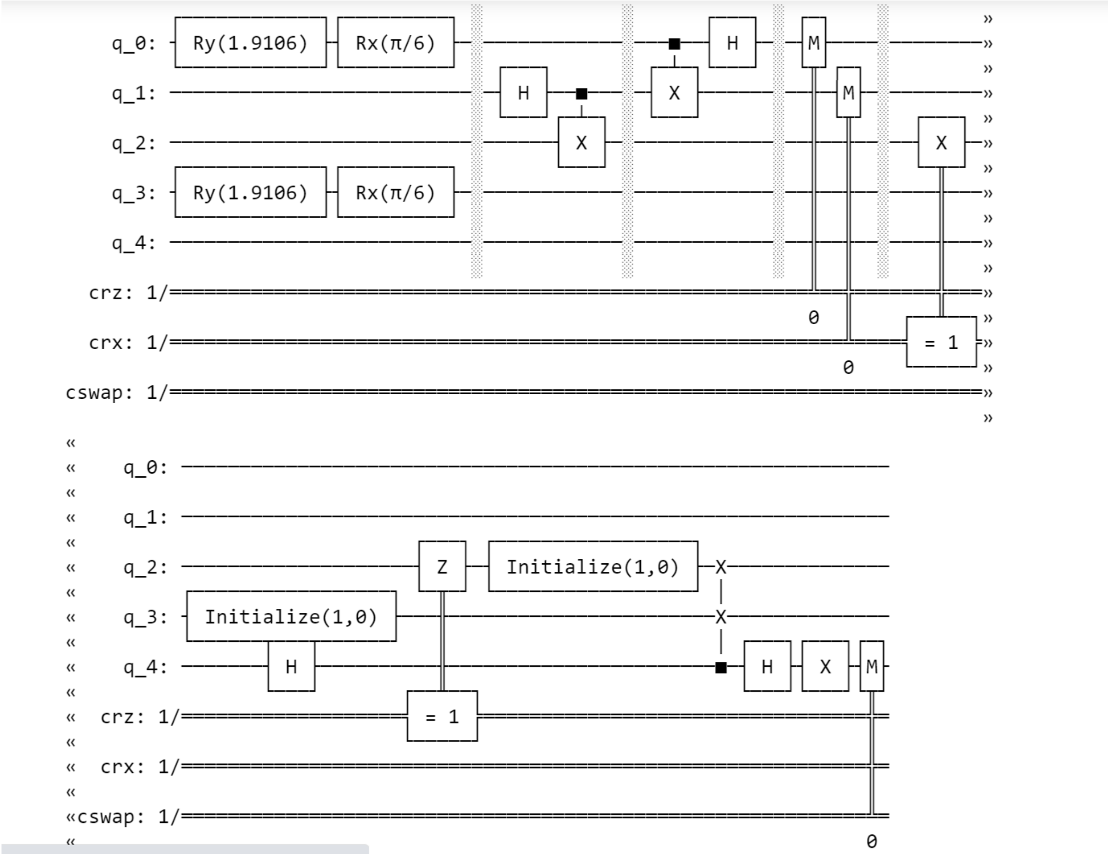
(ii)

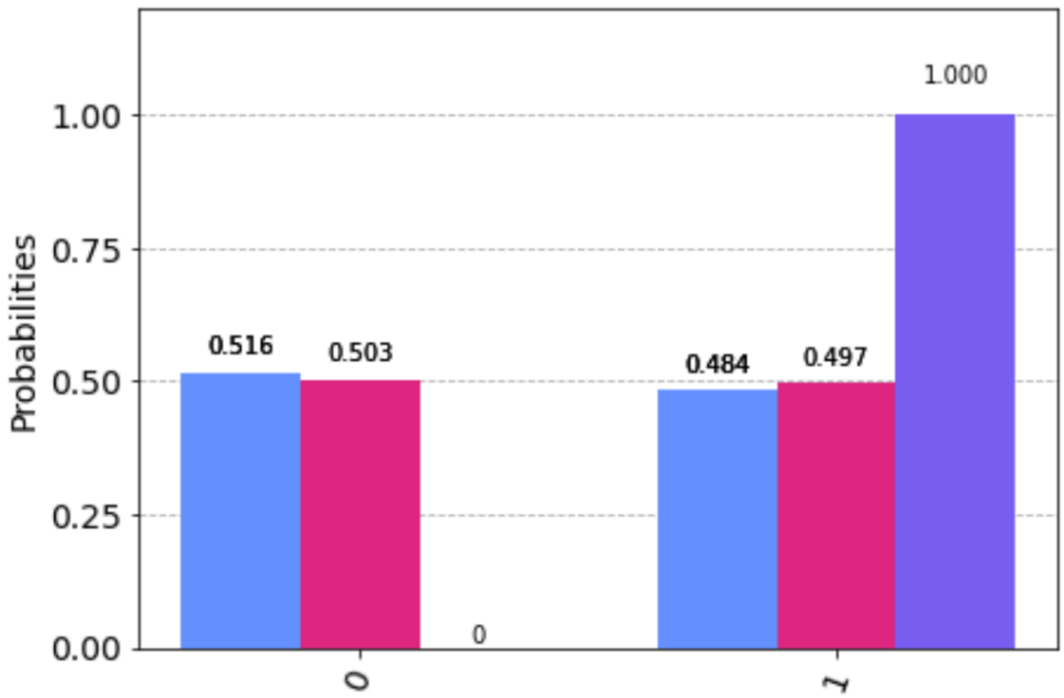




The measurement is to the third classical bit, which is 100% 0 state.

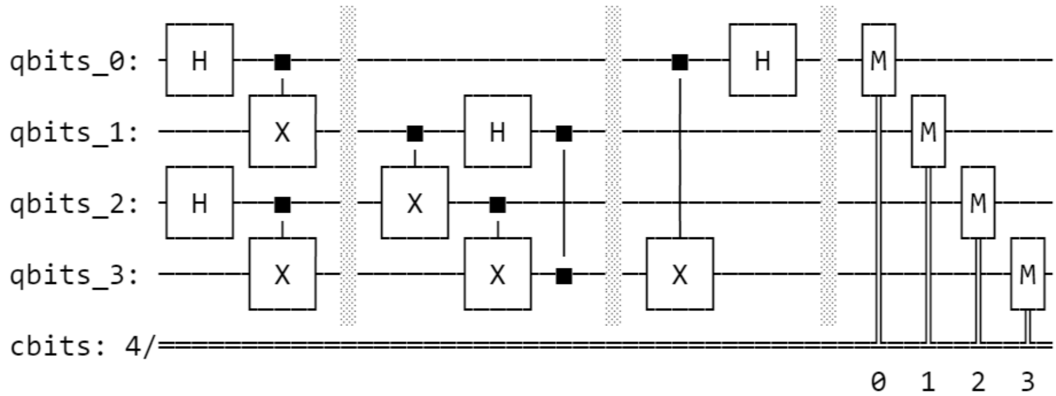
(iii)





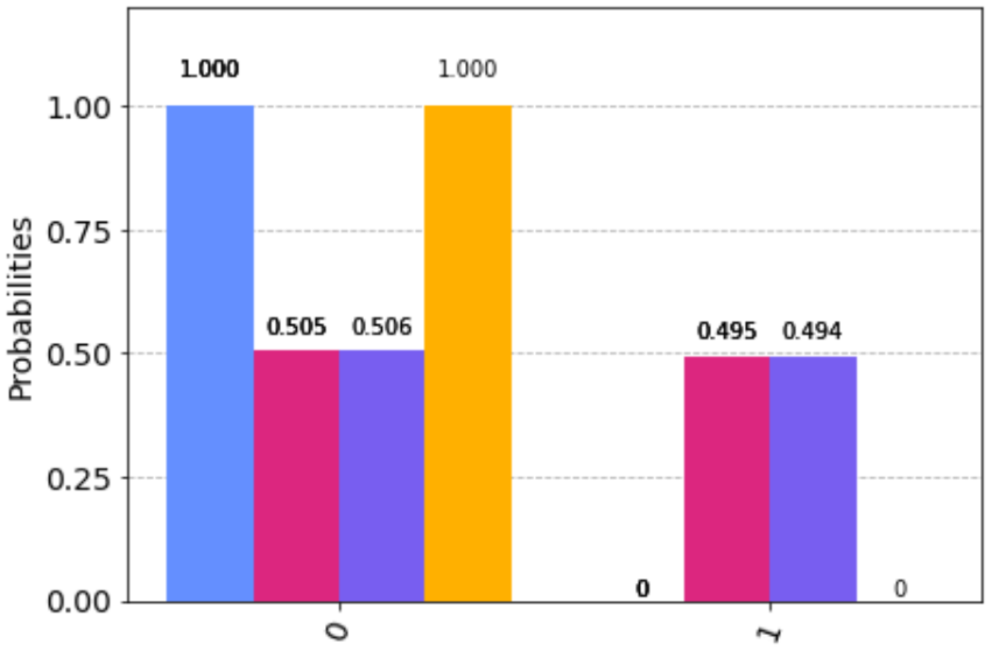
The measurement is to the third classical bit, which is 100% 1 state. The result means that the two qubit state is identical.

(b)[3]



We create a function to validate which state is |q0q3> and add the cnot gate between q[0] and q[3] and the h gate on q[0] for reversing the Φ^+ state to 00 state.

The result of |q0q3>



The result shows that the q[0] and q[3] are always 0. Hence, before reversing, we create an entangled state Φ^+ between Alice and Bob through Charlie.

Q3

(a)

```
correct percentage:  75.0 %
```

(b)

```
correct percentage:  85.8 %
```

Bonus

```
correct percentage:  67.30000000000001 %
```

```
correct percentage:  76.8 %
```

Appendix

Code: https://github.com/yuanchiachang/CommLab/blob/main/Lab1/src/Lab1.ipynb

Reference :

[1] https://qiskit.org/textbook/ch-algorithms/superdense-coding.html

[2] https://qiskit.org/textbook/ch-algorithms/teleportation.html

[3] https://github.com/SowmitraDas/Quantum-Repeater-using-Quantum-Circuits/blob/main/Elements%20-%20Entanglement%20Swapping.ipynb

[4]https://qiskit.org/textbook/ch-algorithms/quantum-key-distribution.html