E91 Depolarization Noise

August 30, 2021

[1]:
```python
import numpy as np

# Importing standard Qiskit libraries
from qiskit import QuantumCircuit, transpile, Aer, IBMQ
from qiskit.tools.jupyter import *
from qiskit.visualization import *
from ibm_quantum_widgets import *
from qiskit.providers.aer import QasmSimulator

# Loading your IBM Quantum account(s)
provider = IBMQ.load_account()
```

[4]:
```python
from qiskit import QuantumCircuit, execute, Aer
from qiskit.visualization import plot_histogram
import qiskit.providers.aer.noise as noise

# Error probabilities
res = []
r1=0.001
r2=0.01
while(r1 < r2+0.001 ):
    res.append(r1)
    r1 += 0.001

print(res)

for i in range(len(res)):
    prob_1 = prob_2 = float(res[i])
    print(prob_1)
    # Depolarizing quantum errors
    error_1 = noise.depolarizing_error(prob_1, 1)
    error_2 = noise.depolarizing_error(prob_2, 2)

    # Add errors to noise model
    noise_model = noise.NoiseModel()
    noise_model.add_all_qubit_quantum_error(error_1, ['u1', 'u2', 'u3'])
    noise_model.add_all_qubit_quantum_error(error_2, ['cx'])
```

```python
print(noise_model)
# Get basis gates from noise model
basis_gates = noise_model.basis_gates

from qiskit.tools.monitor import backend_monitor
from qiskit import *
from qiskit.visualization import plot_histogram
from random import randrange, seed, sample
from sys import argv, exit
import random

#data = int(input('ENTER LENGTH OF BIT STREAM (example 5 For 10110):'))
data=1
###########################################################################
print('|00>')
h=0
#h=int(input())
def bit_stream(p):
    key1 = ""
    for i in range(p):
        temp = str(random.randint(h,h))
        key1 += temp
    return(key1)

bitstream= bit_stream(data)
digits = [int(x) for x in str(bitstream)]
###########################################################################
#print('List of Bit Stream to transfer over Quantum Channel')
#print(digits)
print('\n')
#n = len(digits)
n=1
###########################################################################

bob_bits=[]
from random import choice
#m=0
for i in range(n):
    #m=m+10
    #print("No of identity Gate:",m)
    if digits[i] == 0:
        q = QuantumRegister(2, 'q')
        c = ClassicalRegister(2, 'c')
        qc = QuantumCircuit(q, c)
        #qc.x(0)
        #qc.x(1)
        qc.h(0)
```

```
            qc.barrier()
            qc.cx(q[0], q[1])
            qc.barrier()
            for j in range(10):
                qc.id(1)
                qc.barrier()
            qc.x(0)
            #qc.barrier()
            qc.x(1)
            qc.barrier()
            qc.measure(q[0], c[0])
            qc.measure(q[1], c[1])

                    # Perform a noise simulation
            result = execute(qc, Aer.get_backend('qasm_simulator'),
                             basis_gates=basis_gates,
                             noise_model=noise_model).result()
            counts = result.get_counts(qc)
            plot_histogram(counts)
            #print(qc)
            bits = (result.get_counts(qc))
            #print(bits)
            #itemMaxValue = max(bits.items(), key=lambda x : x[1])
            #print(itemMaxValue)
            print(bits.get('00'))
            print('\n')
            print("===========================================================")
```

```
[0.001, 0.002, 0.003, 0.004, 0.005, 0.006, 0.007, 0.008, 0.009000000000000001,
0.010000000000000002]
0.001
NoiseModel:
  Basis gates: ['cx', 'id', 'u1', 'u2', 'u3']
  Instructions with noise: ['cx', 'u1', 'u3', 'u2']
  All-qubits errors: ['u1', 'u2', 'u3', 'cx']
|00>


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===========================================================
0.002
NoiseModel:
  Basis gates: ['cx', 'id', 'u1', 'u2', 'u3']
  Instructions with noise: ['cx', 'u1', 'u3', 'u2']
  All-qubits errors: ['u1', 'u2', 'u3', 'cx']
```

```
|00>


511


============================================================
0.003
NoiseModel:
  Basis gates: ['cx', 'id', 'u1', 'u2', 'u3']
  Instructions with noise: ['cx', 'u1', 'u3', 'u2']
  All-qubits errors: ['u1', 'u2', 'u3', 'cx']
|00>


509


============================================================
0.004
NoiseModel:
  Basis gates: ['cx', 'id', 'u1', 'u2', 'u3']
  Instructions with noise: ['cx', 'u1', 'u3', 'u2']
  All-qubits errors: ['u1', 'u2', 'u3', 'cx']
|00>


497


============================================================
0.005
NoiseModel:
  Basis gates: ['cx', 'id', 'u1', 'u2', 'u3']
  Instructions with noise: ['cx', 'u1', 'u3', 'u2']
  All-qubits errors: ['u1', 'u2', 'u3', 'cx']
|00>


519


============================================================
0.006
NoiseModel:
  Basis gates: ['cx', 'id', 'u1', 'u2', 'u3']
  Instructions with noise: ['cx', 'u1', 'u3', 'u2']
  All-qubits errors: ['u1', 'u2', 'u3', 'cx']
```

```
|00>


512


==========================================================
0.007
NoiseModel:
  Basis gates: ['cx', 'id', 'u1', 'u2', 'u3']
  Instructions with noise: ['cx', 'u1', 'u3', 'u2']
  All-qubits errors: ['u1', 'u2', 'u3', 'cx']
|00>


505


==========================================================
0.008
NoiseModel:
  Basis gates: ['cx', 'id', 'u1', 'u2', 'u3']
  Instructions with noise: ['cx', 'u1', 'u3', 'u2']
  All-qubits errors: ['u1', 'u2', 'u3', 'cx']
|00>


524


==========================================================
0.009000000000000001
NoiseModel:
  Basis gates: ['cx', 'id', 'u1', 'u2', 'u3']
  Instructions with noise: ['cx', 'u1', 'u3', 'u2']
  All-qubits errors: ['u1', 'u2', 'u3', 'cx']
|00>


523


==========================================================
0.010000000000000002
NoiseModel:
  Basis gates: ['cx', 'id', 'u1', 'u2', 'u3']
  Instructions with noise: ['cx', 'u1', 'u3', 'u2']
  All-qubits errors: ['u1', 'u2', 'u3', 'cx']
```

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|00>
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514
```

```
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[9]:

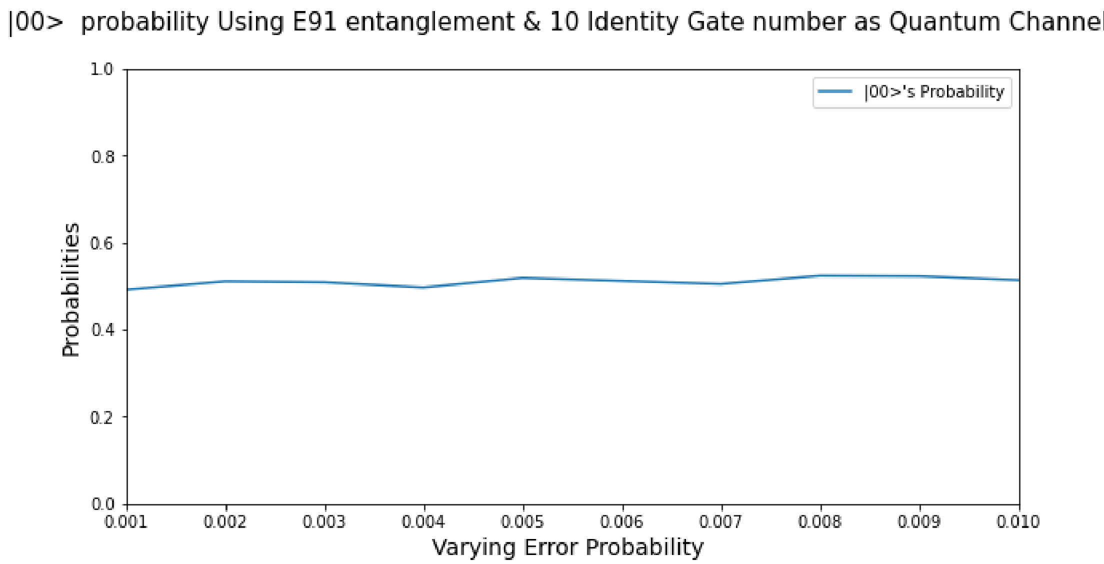
```python
import matplotlib.pyplot as plt
from matplotlib.ticker import (AutoMinorLocator, MultipleLocator)

fig, ax = plt.subplots(figsize=(10, 5))
fig.suptitle('|00>  probability Using E91 entanglement & 10 Identity Gate␣
 ↪number as Quantum Channel',fontsize=15)

# naming the x axis
plt.xlabel('Varying Error Probability ',fontsize=14)
# naming the y axis
plt.ylabel('Probabilities',fontsize=14)
# giving a title to my graph
# Set axis ranges; by default this will put major ticks every 25.
#ax.set_xlim(0, 300)
#ax.set_ylim(0, 1)
ax.set_xlim(0.001, 0.01)
ax.set_ylim(0, 1)
fig = plt.figure(figsize=(8,5))
# line 2 points
y2 = [0.492,0.511,0.509,0.497,0.519,0.512,0.505,0.524,0.523,0.514]
x2 = [0.001, 0.002, 0.003, 0.004, 0.005, 0.006, 0.007, 0.008, 0.009, 0.01]
# plotting the line 2 points
ax.plot(x2, y2, label = "|00>'s Probability")
#ax.axes.xaxis.set_ticks([])
# show a legend on the plot
ax.legend()
```

[9]:

```
<matplotlib.legend.Legend at 0x7f548c15a580>
```




```
<Figure size 576x360 with 0 Axes>
```

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[ ]:
```