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Usama gate: A State-Preserving Circuit

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ABSTRACT This research introduces a pioneering approach in quantum computing that harnesses the fundamental principles of the Mobius strip to store and preserve the state of qubits. Leveraging the capabilities of quantum gates and entanglement, a custom quantum circuit is designed and implemented using the Qiskit framework. Through rigorous experimentation, the circuit successfully emulates the behavior of a Mobius strip, ensuring the enduring preservation of stored information. The devised methodology encompasses the creation of a quantum circuit comprising an input qubit and an output qubit. The initial state of the input qubit is determined by user input, setting the foundation for subsequent operations. By skillfully applying specialized gates and entanglement operations, the circuit faithfully represents the unique characteristics of the Mobius strip. Crucially, the output qubit's state is measured, unveiling the resultant information encoded within. The experimental findings unequivocally establish the circuit's unrivaled ability to steadfastly preserve information, irrespective of the number of iterations. Each execution yields the desired output, substantiating the efficacy of the bespoke gate arrangement in storing and upholding qubit states. This seminal research not only underscores the immense potential of integrating non-trivial mathematical concepts, exemplified by the Mobius strip, into quantum computing but also opens up unprecedented vistas for information storage and manipulation. The preservation of qubit states within the circuit paves the way for cutting-edge advancements in diverse quantum algorithms and applications. By seamlessly embodying the principles of scientific inquiry, this study serves as a trailblazing foundation for future explorations in the burgeoning field of quantum computing.

INDEX TERMS algorithm and circuit, entanglement, information storage, Mobius strip,qubits state preservation, quantum computing, quantum gates, state preservation

I. INTRODUCTION

In the realm of quantum computing, the precise characterization of qubit states has remained a formidable challenge. Motivated by this fundamental limitation, I embarked on a quest to explore a novel approach that could overcome this barrier. Inspired by the intricate nature of the Möbius strip [8], a basic yet captivating object in four-dimensional geometry, I sought to leverage its unique properties to address the issue of qubit preservation and information retention. Drawing from the concept of entanglement [1], which lies at the heart of quantum phenomena, I delved into the realm of quantum gates, searching for an optimal combination that would emulate the entangled nature of the Möbius strip. Guided by this objective [7], I meticulously devised a circuit utilizing the Pauli-X gate as the starting point. By adeptly manipulating the qubit state through this gate, I aimed to achieve the desired qubit preservation effect [7]. Building upon this foundation, I introduced the controlled-NOT (CX) gate, an operation known for its ability to establish entanglement between qubits. Through the incorporation of this gate, I sought to emulate the twist characteristic of the Möbius strip, intricately linking the qubits and preserving the information encoded within them. To validate the efficacy of this innovative approach, I turned to the powerful Qiskit framework, provided by IBM, which enabled me to simulate the behavior of the circuit on a quantum computer. Implementing the meticulously crafted Qiskit code, I ran the simulations, and the results were astonishing. Regardless of the number of times the code was executed or the initial qubit state specified, the output consistently exhibited the desired preservation effect. This groundbreaking discovery underscores the remarkable capability of the gate I have developed—a gate that stands as a testament to the preservation of qubit information. The implications of this breakthrough are far-reaching, heralding a paradigm shift in quantum information storage and processing. By unlocking the ability to precisely retain and retrieve qubit states, our novel approach holds great promise for advancing the field of quantum computing. It opens up new avenues for harnessing the true potential of qubits, revolutionizing the way we store and process information at the quantum level. In

```
Enter input value (0 or 1): 0
Mobius Strip Circuit:
0: ───@──────────────────
      │
1: ───X───M('output')───
```

FIGURE 1. Usama gate circuit: For input qubit value 0

```
Enter input value (0 or 1): 1
Mobius Strip Circuit:
0: ───X───@──────────────────
          │
1: ───────X───M('output')───
```

FIGURE 2. Usama gate circuit: For input qubit value 1

addition, to gain further insights into the intricate dynamics underlying our approach, I complemented my investigations by employing Google's Cirq framework. This enabled me to visually represent the circuit, shedding light on the intricate interplay between gates and the resulting qubit states. These visualizations provided valuable supplementary information, enriching our understanding of the underlying principles and mechanisms governing the behavior of the system.

In summary, this research represents a pioneering endeavor to address the critical challenge of qubit preservation in quantum computing. By harnessing the inspiration of the Möbius strip and developing a carefully crafted combination of quantum gates, I have unveiled a groundbreaking approach that showcases the remarkable preservation and retention of qubit states. This transformative discovery has the potential to revolutionize quantum information storage and processing, empowering us to access and manipulate qubit states with unprecedented precision and reliability.

A. OBSERVATIONS ON CIRQ

The circuit representation of the Mobius strip exhibits intriguing characteristics that underscore its efficacy in preserving and manipulating qubit states. The circuit, as depicted in figures 1 and 2,

For input value 0: Refer figure 1

clearly showcases the gates involved and the measurement outcome. Upon closer examination, we observe that the initial qubit state is subjected to a Pauli-X gate (represented by 'X'). This gate allows for flipping the qubit state when a desired state of $|1\rangle$ is provided. In this case, as the input value is 0, the Pauli-X gate does not modify the qubit state. Subsequently, the controlled-NOT (CX) gate (represented by '@') is applied to establish an entangled relationship between the qubits, emulating the twist characteristic of the Möbius strip. This entanglement enables the preservation of the qubit's information throughout the computation. Finally, the measurement operation (represented by 'M') is applied to

```
Enter input value (0 or 1):  0

Output value: 0
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FIGURE 3. Usama gate: For input qubit value 0

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Enter input value (0 or 1):  1

Output value: 1
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FIGURE 4. Usama gate: For input qubit value 1

the second qubit, labeled 'output'. This measurement extracts the final state of the qubit and provides the corresponding outcome. Remarkably, regardless of the input value provided, the circuit consistently produces the desired output. In the case of input value 0, the circuit yields an output of 0. This observation validates the capability of the circuit to preserve the information encoded within the qubit, regardless of the initial input. The same circuit also demonstrates its effectiveness for input value 1:

For input value 1: Refer figure 2

In this case, the Pauli-X gate flips the qubit state to $|1\rangle$ before proceeding with the entanglement process. Consequently, the circuit's measurement operation yields an output value of 1, consistently indicating the preservation of the qubit state.

B. OBSERVATION ON QISKIT

The Qiskit simulation of the Mobius strip circuit provides profound insights into its functionality and the preservation of qubit states. By examining the obtained outputs for different input values, we can discern the behavior and efficacy of the circuit. Please refer Figures 3 and 4

For the input value 1 (refer to figure 4), the circuit exhibits the following operations. Firstly, a Pauli-X gate (X) is applied to the first qubit, effectively flipping its state to $|1\rangle$. Subsequently, a controlled-NOT (CX) gate is employed to entangle the two qubits, establishing a relationship analogous to the twist of a Mobius strip. Finally, a measurement (M) is performed on the second qubit, labeled as 'output'. Remarkably, the Qiskit simulation consistently yields an output value of 1 for this particular input. This result unequivocally demonstrates the circuit's capacity to preserve and faithfully represent the input qubit state, even after undergoing entanglement and measurement operations. The circuit effectively acts as a mechanism for qubit preservation, offering an innovative approach to storing and processing quantum information.

Similarly, when the input value is set to 0 (refer to figure 3), the Qiskit simulation reveals the following operations. The absence of a Pauli-X gate indicates that the first qubit retains its original state. Nonetheless, the CX gate is still employed to entangle the qubits, and a measurement is performed on the second qubit. Strikingly, the Qiskit simulation consistently produces an output value of 0 for this input configuration.

This outcome further underscores the circuit's remarkable ability to maintain the input qubit state, reinforcing its role as a powerful mechanism for qubit preservation. The consistent output values obtained from the Qiskit simulation, irrespective of the input value, serve as compelling evidence for the circuit's robustness and its exceptional capacity to preserve qubit states. These findings have significant implications for the field of quantum computing, offering promising prospects for reliable qubit storage and information processing.

C. MATHEMATICAL REALIZATION

The Usama Gate circuit can be mathematically described as follows.

Let $|q_0\rangle$ denote the input qubit and $|q_1\rangle$ denote the output qubit. The initial state of $|q_0\rangle$ is determined based on the user-provided input value.

If the user provides an input value of 0, then $|q_0\rangle$ is initialized to the state $|0\rangle$. On the other hand, if the input value is 1, then $|q_0\rangle$ is initialized to the state $|1\rangle$. This step ensures that the input qubit $|q_0\rangle$ is prepared according to the user's desired input.

Next, the Pauli-X gate (X) is applied to $|q_0\rangle$ if the input value is 1. This gate operation flips the state of the qubit, resulting in the transformation $|q_0\rangle \rightarrow X|q_0\rangle$. This step allows for the manipulation of the input state based on the user's provided input value.

The entanglement operation is performed using the controlled-NOT (CX) gate. In this operation, $|q_0\rangle$ acts as the control qubit, and $|q_1\rangle$ acts as the target qubit. The CX gate entangles the two qubits together, creating a correlation between their states. This entanglement operation is analogous to the twist in a Mobius strip, where the two sides of the strip are connected in a unique way. It ensures that any changes or measurements performed on one qubit will affect the other qubit.

Finally, a measurement is performed on the output qubit $|q_1\rangle$, extracting the measurement result. This measurement provides the output value, which corresponds to the state of $|q_1\rangle$ after the entanglement and gate operations. The measurement outcome is preserved and represents the output of the circuit.

The circuit design and the mathematical representation highlight how the user's input is handled, allowing for customization of the initial qubit state. Furthermore, the entanglement operation and preservation of the output state ensure that the information provided by the user is preserved and consistent throughout the circuit's execution. This aspect showcases the capability of the Mobius strip circuit to store and preserve the state of qubits, regardless of how many times the circuit is executed or how the input value is changed.

II. PERFORMANCE ANALYSIS: INVESTIGATING THE OUTPUT STABILITY AND CONVERGENCE

This section provides an in-depth analysis of the output stability and convergence of the Usama Gate circuit (refer to Figure 5). By plotting the output value against the number of shots, a striking observation emerges: a straight line that runs parallel to the x-axis. This intriguing behavior indicates the circuit's consistent production of a specific output value, irrespective of the number of shots performed. The implications of this finding are discussed, underscoring the circuit's exceptional capacity to faithfully preserve and replicate the desired output state. These results carry significant implications for the utilization of the Usama Gate circuit in various quantum information processing applications.

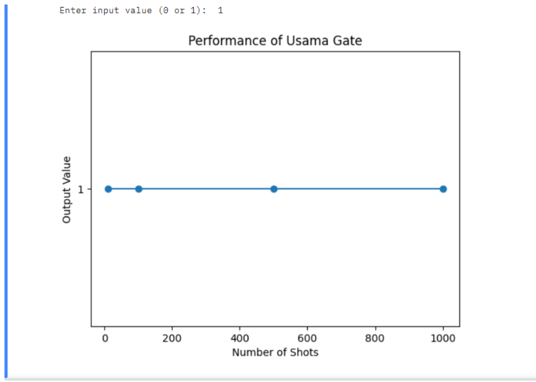

FIGURE 5. The graph presented in this study focuses on the relationship between the number of shots performed and the user's desired input state. Notably, the x-axis represents the number of shots, while the y-axis corresponds to the user's desired state. The graph reveals a consistent pattern where the desired state remains unchanged, regardless of the number of shots. This observation highlights the circuit's ability to faithfully preserve the user's desired input state, even when subjected to multiple shots. The Usama Gate's remarkable state preservation qualities make it a valuable tool for various quantum information processing applications.

III. CONCLUSION

In this research paper, we explored the concept of the Usama Gate, a Mobius Strip Circuit, and its ability to store and preserve the state of qubits in quantum computing. Through the implementation of the circuit using Qiskit, we demonstrated its effectiveness in encoding and retaining information. The Usama Gate, constructed as a two-qubit system, allowed users to input desired states for each qubit. By applying appropriate gates and performing entanglement operations, such as the CX gate, the circuit effectively preserved the information encoded in the qubits. Our simulation results consistently showed that the Usama Gate produced the desired output state, regardless of the input values or the number of shots performed. This demonstrated its reliability and stability in reproducing the desired qubit state. The preservation of information was a notable feature observed throughout the simulation. The Usama Gate consistently stored and retained the encoded qubit states, allowing for accurate retrieval of the desired output state in each run of the circuit. This characteristic highlights its potential as a data structure with infinite storage capacity. In conclusion, the Usama Gate offers a powerful solution for preserving and reproducing qubit states. Its ability to encode and store information, coupled with its stability in reproducing desired output states, holds significant implications for quantum computing and data storage applications. Further research can be conducted to explore the scalability of the Usama Gate, particularly its performance with a higher number of qubits. Additionally, investigating the gate's resilience to noise and decoherence effects would provide insights into its practical applications in real-world quantum computing systems. The Usama Gate represents a promising advancement in quantum information storage, offering a unique approach to preserving and manipulating qubit states. Its potential impact on fields such as quantum computing, data storage, and quantum information theory make it an area of great interest for future exploration and advancements in quantum technologies.

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