

Chapter 8

Simulation of Bloch Sphere for a Single Qubit

Harsha Vardhan Garine
BML Munjal University, India

Atul Mishra
BML Munjal University, India

Anubhav Agrawal
BML Munjal University, India

ABSTRACT

The Bloch sphere is a generalisation of the complex number z with $|z|^2 = 1$ being represented in the complex plane as a point on the unit circle. The goal of the research is to create a simulation that can be used to visualise a Bloch sphere of a single quantum bit, also known as a Qbit. QISKIT (developed by IBM) is an open-source lab for education in the realm of quantum computing, and is used to test and validate this simulator. This study made use of both quantitative and qualitative methods of investigation.

INTRODUCTION

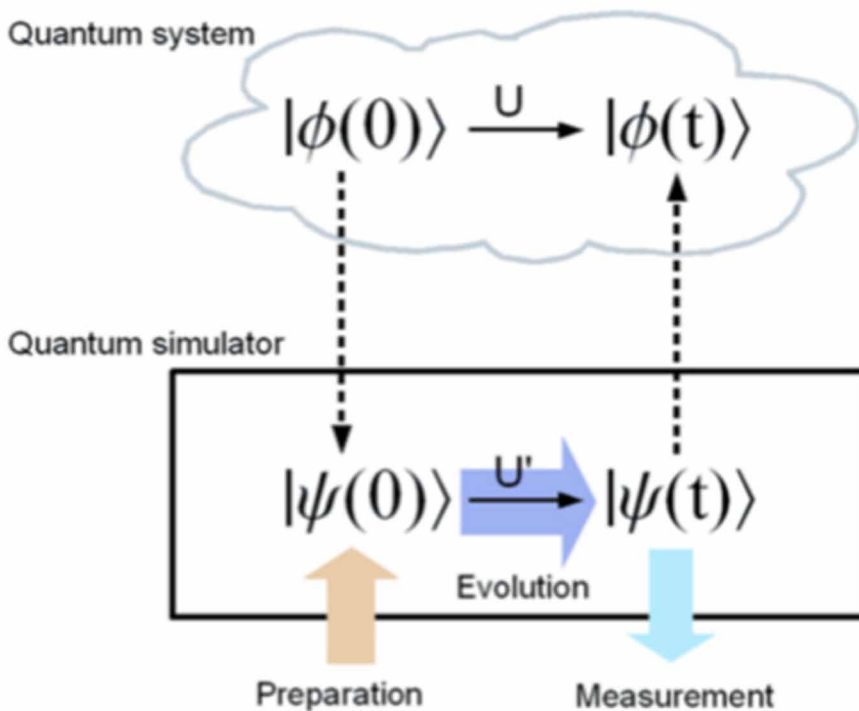
A bit is the fundamental unit of a computer. The essential component allows data to be stored in binary numbers, either 0 or 1. In a similar vein, the smallest unit of a quantum computer capable of storing information is referred to as a quantum bit, or in short, a qubit, for short. It has a complicated two-level mechanical system with two states, $|1\rangle$ and $|0\rangle$, divided into two categories. In the same way, that information stored in a classic bit may be updated to meet our requirements, data

DOI: 10.4018/978-1-7998-9183-3.ch008

or data recorded in a quantum bit can likewise be modified within the confines of quantum mechanics. Different gates, such as XOR, OR, and more, are used in digital electronics to change data and transport bits of information, among other things. In the quantum world, we have a variety of gates to choose from. To better understand how these gates function and how the qubit interacts with gates, we must first understand a few mathematical concepts such as complex numbers, matrices, and vectors. This is analogous to a simulation problem in that it is necessary to comprehend and visualize the process. It is possible to tackle this difficulty by modeling and simulating the procedure. Refer to Figure 1 for a visual understanding of how a physical quantum device is simulated on a real quantum simulator.

This is a discrete event simulation, which means that the outputs are fixed for the specified set of input parameters. The work (which is either one of $|1\rangle$ or $|0\rangle$) is determined by the probability of achieving the desired results. Please keep in mind that this project will only be able to replicate a single qubit at this time. It is possible to simulate several qubits as well.

Figure 1. A simulator of a real quantum computer



13 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/simulation-of-bloch-sphere-for-a-single-qubit/300520

Related Content

Tunable Attenuator Based on Hybrid Metal-Graphene Structure on Spoof Surface Plasmon Polaritons Waveguide

Aymen Hlaliand Hassen Zairi (2022). *Technology Road Mapping for Quantum Computing and Engineering* (pp. 154-164).

www.irma-international.org/chapter/tunable-attenuator-based-on-hybrid-metal-graphene-structure-on-spoof-surface-plasmon-polaritons-waveguide/300522

Quantum Image Cryptography of Gingerbreadman Map by Using Pixel Shuffling

Shilpa M. Satreand Bharti Joshi (2025). *Harnessing Quantum Cryptography for Next-Generation Security Solutions* (pp. 467-494).

www.irma-international.org/chapter/quantum-image-cryptography-of-gingerbreadman-map-by-using-pixel-shuffling/362597

Exploring Models, Training Methods, and Quantum Supremacy in Machine Learning and Quantum Computing

Arvindhan Muthusamy (2023). *Principles and Applications of Quantum Computing Using Essential Math* (pp. 22-36).

www.irma-international.org/chapter/exploring-models-training-methods-and-quantum-supremacy-in-machine-learning-and-quantum-computing/330437

Quantum Computing for Dengue Fever Outbreak Prediction: Machine Learning and Genetic Hybrid Algorithms Approach

Dhaya Chinnathambi, Srivel Ravi, Mohammed Abdul Matheenand Saravanan Pandiaraj (2024). *Quantum Innovations at the Nexus of Biomedical Intelligence* (pp. 167-179).

www.irma-international.org/chapter/quantum-computing-for-dengue-fever-outbreak-prediction/336151

Blockchain Solutions, Challenges, and Opportunities for DNA Classification and Secure Storage for the E-Healthcare Sector: A Useful Review

Garima Mathur, Anjana Pandey and Sachin Goyal (2023). *Handbook of Research on Quantum Computing for Smart Environments* (pp. 453-473).

www.irma-international.org/chapter/blockchain-solutions-challenges-and-opportunities-for-dna-classification-and-secure-storage-for-the-e-healthcare-sector/319882