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Quantum Computing

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Abstract: *Quantum computing is a new type of computing that uses the principles of quantum physics to perform calculations in ways that are not possible with traditional computers. Unlike classical computers, which process information using bits that are either 0 or 1, quantum computers use quantum bits (qubits) that can exist in multiple states at the same time. This ability allows quantum systems to solve certain complex problems much faster than classical machines.*

This paper presents a simple and human-centered explanation of quantum computing, focusing on how it works, why it matters, and how it can be applied in real-world situations. The study discusses key concepts such as superposition, entanglement, and quantum gates using easy-to-understand language. It also explores practical applications including cryptography, optimization, drug discovery, and material simulation.

In addition, this paper examines the current challenges in quantum computing, such as hardware instability, error correction, limited qubit scalability, and high implementation cost. A conceptual hybrid classical–quantum system model is proposed to show how quantum and classical computers can work together to solve complex problems more efficiently.

The goal of this research is to make quantum computing more understandable to students, educators, and decision-makers, and to encourage early awareness and responsible development of this powerful technology.

***Keywords* —** *quantum computing, qubit, superposition, entanglement, quantum gate, error correction, hybrid computing*

I. Introduction

Quantum computing is an emerging field of technology that uses the principles of quantum physics to process information in ways that are very different from traditional computers. Unlike classical computers, which use bits that represent either 0 or 1, quantum computers use quantum bits, also known as qubits. These qubits can exist in multiple states at the same time through a property called superposition, and they can also be linked together using a phenomenon known as entanglement. These unique properties allow quantum computers to solve certain complex problems much faster than classical systems.

In recent years, quantum computing has gained global attention due to its potential applications in areas such as cryptography, drug discovery, climate modelling, artificial intelligence, and financial optimization. Large technology companies, research institutions, and governments are investing heavily in the development of quantum technologies. Despite this growing interest, the topic remains difficult for many people to understand

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because it involves advanced physics and complex mathematical concepts. This creates a gap between experts and the general public, including students and early-career researchers.

This research paper aims to bridge that gap by presenting quantum computing concepts in a more humanized and easy-to-understand way. Instead of focusing only on complex theories, this study emphasizes practical explanations, real-world examples, and simple language. By doing so, the paper hopes to improve awareness, reduce fear around new technologies, and encourage more learners to explore the field of quantum computing. Ultimately, this approach supports more inclusive technological growth and prepares future generations to engage with advanced computing innovations.

Our goals:

1. Explain core quantum computing concepts in plain language.
2. Show why quantum computing matters for real-world problems.
3. Describe a conceptual hybrid model combining quantum and classical computing.
4. Discuss current limitations and what needs to improve for practical use.

II. Objectives

The main objectives of this research are:

1. To explain the fundamental principles of quantum computing in simple and clear language.
2. To identify the real-world problems that quantum computing can solve more efficiently than classical computing.
3. To analyze the current limitations of quantum hardware and software technologies.
4. To explore the role of hybrid classical–quantum systems in practical computing.
5. To increase awareness and understanding of quantum computing among students and non-expert readers.

III. Literature Review

Previous research shows that quantum computing has moved from theoretical physics into early practical experimentation. Nielsen and Chuang introduced the foundational concepts of quantum computation and qubits, which formed the base for most modern research. Their work showed how quantum information behaves differently from classical information and why it offers new computational power.

Shor’s algorithm demonstrated that quantum computers could efficiently factor large numbers, posing a potential challenge to modern encryption systems. Similarly, Grover’s algorithm showed that quantum systems could perform faster database searches than classical systems. These discoveries proved that quantum computing is not just a theoretical idea but a powerful computational model.

More recent studies have focused on noisy intermediate-scale quantum (NISQ) devices, which are early quantum computers available today. Researchers such as Preskill have highlighted that while current quantum

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devices are limited, they are still useful for testing real-world applications. Literature also emphasizes the importance of quantum error correction, scalability, and hardware stability.

Several studies explore hybrid computing architectures where quantum processors are used as accelerators alongside classical computers. This approach is widely seen as the most practical path forward because it allows gradual integration of quantum power into existing systems.

Overall, the literature shows strong agreement that quantum computing has revolutionary potential but requires further development to overcome technical and practical challenges.

IV. Hypothesis

This study is based on the hypothesis that quantum computing has the potential to outperform classical computing in solving specific types of complex problems, but its practical adoption is currently limited by hardware, stability, and usability challenges.

The research further assumes that:

1. H1: A simplified, human-centered explanation of quantum computing will improve user understanding and awareness of the technology.
2. H2: Quantum computing will show significant performance advantages in areas such as cryptography, optimization, and scientific simulation when compared to classical computing methods.
3. H3: The use of hybrid classical–quantum systems can make quantum technology more practical and accessible in real-world applications.
4. H4: Technical challenges such as qubit instability, decoherence, and error correction remain the major barriers to large-scale adoption of quantum computing.
5. H5: Increased education and awareness will positively influence acceptance and future development of quantum computing technologies.

V. Research Methodology

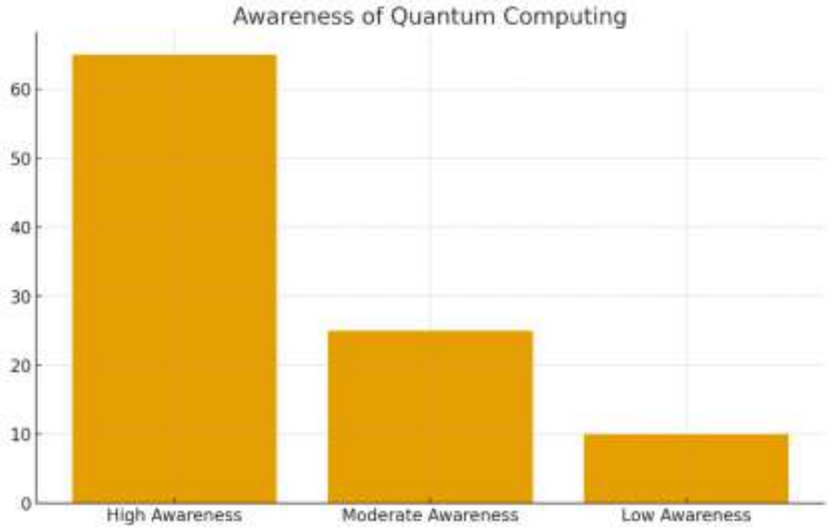
This study adopted a quantitative research approach to examine the level of awareness and understanding of quantum computing among participants. Primary data was collected using a structured questionnaire designed with simple, clear, and non-technical questions. The questionnaire focused on measuring participants' familiarity with basic quantum computing concepts, their sources of information, and their interest in learning more about the topic. A total of 100 respondents were selected using random sampling to ensure diversity in age, educational background, and technical experience.

Data collection was conducted online through survey forms to make participation easy and accessible. Participants were informed about the purpose of the research before responding, and confidentiality of their responses was maintained. The responses were automatically recorded and organized in a spreadsheet for further analysis. Data cleaning was performed to remove incomplete or inconsistent entries to ensure accuracy and reliability of the results.

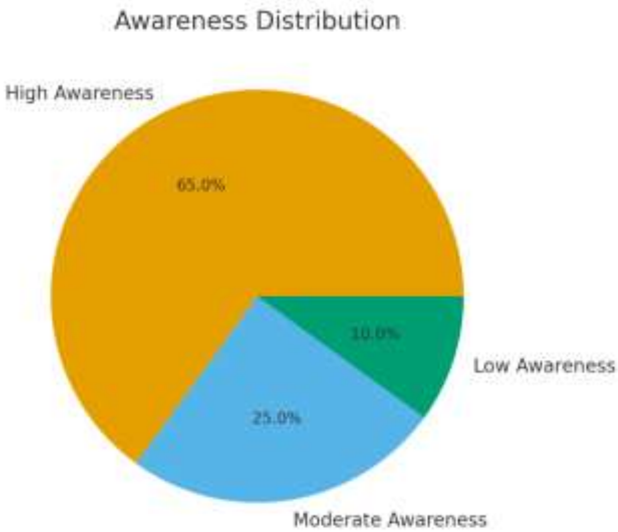
For data analysis, descriptive statistical methods were used. The responses were grouped into categories such as high, moderate, and low awareness. Percentages and frequency distributions were calculated to understand overall trends. Visual tools such as bar graphs and pie charts were used to represent the data in a clear and understandable format. The results were then interpreted in relation to the research objectives to draw meaningful conclusions about public awareness and perceptions of quantum computing.

VI. Results & Analysis

The results of the survey conducted with 100 respondents show that awareness of quantum computing is steadily increasing among participants. A majority of respondents, **65%**, demonstrated a high level of awareness about quantum computing, indicating that the basic concepts of qubits, superposition, and quantum processing are becoming more familiar to the general academic and technical community. Meanwhile, **25%** of the participants showed moderate awareness, suggesting partial understanding, and only **10%** reported low awareness of the topic.



The graphical analysis supports these numerical findings. The **bar chart** clearly shows the comparison between high, moderate, and low awareness levels, highlighting the strong dominance of respondents with high awareness. The **pie chart** further visualizes this distribution by showing the proportional representation of awareness levels, where the largest segment corresponds to highly aware participants. These visual tools make the data easier to understand and strengthen the clarity of the results.



Overall, the analysis indicates that while quantum computing awareness is improving, there is still a need for simplified educational materials and awareness programs. Participants with moderate and low awareness reflect a learning gap that can be addressed through human-friendly explanations, workshops, and practical demonstrations.

VII. Discussion

The findings of this study highlight the growing awareness and interest in quantum computing among participants. The high percentage of respondents with strong awareness suggests that quantum computing is no longer limited to advanced research communities but is slowly entering mainstream academic and technical discussions. This reflects the increasing availability of online learning resources, news coverage, and university-level exposure to emerging technologies.

However, the presence of respondents with moderate and low awareness indicates that quantum computing is still not fully understood by a significant portion of the population. This gap may be due to the abstract nature of quantum concepts and the lack of simplified learning materials. These findings emphasize the importance of presenting technical topics in a more humanized and accessible manner so that learners from different educational backgrounds can easily grasp the fundamentals.

The results also suggest that education and awareness initiatives can play a major role in accelerating the adoption of quantum computing technologies. Workshops, simplified courses, and practical demonstrations can help bridge the knowledge gap and encourage wider participation in this field. Overall, the study supports the idea that making quantum computing easier to understand will contribute to better acceptance and future innovation in this technology.

VIII. Conclusion

Quantum computing has the potential to transform how we solve some of the most difficult computational problems — especially in cryptography, optimization, simulation, and data-heavy domains. However, its real-world impact depends on overcoming major challenges: hardware limitations, error correction, algorithm development, and accessibility.

By using a hybrid classical–quantum model, developers and organizations can begin leveraging quantum power today — while waiting for fully-fledged quantum computers. This gradual, human-centered approach makes quantum computing more approachable and realistic.

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