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Medical text analysis using quantum inspired NLP

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Abstract

Medical reports often contain complex and unstructured textual information that is difficult for both patients and healthcare professionals to analyze efficiently. Manual interpretation of these reports is time-consuming and may lead to overlooked insights. To address this challenge, this mini project proposes a Quantum-Based Medical Text Report Analyzer, an intelligent system designed to automatically analyze and interpret clinical text reports. The proposed system employs Natural Language Processing (NLP) techniques to preprocess medical text, extract key entities such as diseases, symptoms, and medications, and classify reports based on potential health risks. In addition, quantum-inspired computational methods are incorporated to manage uncertainty and complex feature relationships inherent in medical language, thereby improving text representation and enhancing analytical accuracy compared to conventional approaches.The system generates a simplified summary of the medical report, enabling better patient understanding while supporting healthcare professionals in faster and more informed decision-making. This project demonstrates the effective integration of quantum-inspired methods and NLP for scalable, future-ready automated medical text analysis in healthcare applications

Keywords: Quantum-Based Analysis; Medical Text Reports; Natural Language Processing (NLP); Quantum-Inspired Computing; Text Classification; Medical Data Analysis; Healthcare Intelligence

1. Introduction

Medical reports often contain complex and unstructured textual information that can be difficult for both patients and healthcare professionals to interpret efficiently. Manual analysis of such reports is time-consuming and may lead to errors or delays in decision-making. With the rapid growth of digital healthcare data, there is a need for intelligent systems that can automatically analyze and extract meaningful insights from medical text.

This project presents a Quantum-Inspired Medical Text Report Analysis System that utilizes Natural Language Processing techniques to preprocess medical reports and extract key entities such as diseases, symptoms, and medications. The extracted information is then converted into numerical feature representations, where quantum-inspired modeling is applied to enhance semantic understanding.

Finally, machine learning techniques are used to classify the medical reports based on risk levels and generate simplified summaries. This approach aims to improve accuracy, reduce analysis time, and support faster and more informed healthcare decision-making.

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2. Literature Review

2.1. Quantum Machine Learning Applications in the Biomedical Domain: A Systematic Review,[1] D. Maheshwari, B. Garcia-Zapirain (2022)

This paper focuses on the application of quantum machine learning techniques in the biomedical domain to handle high-dimensional and complex healthcare data. The study reviews various models such as Quantum Support Vector Machines, Quantum Neural Networks, and hybrid quantum-classical frameworks applied to medical imaging and clinical datasets. The results indicate that quantum-inspired approaches improve feature extraction and classification performance compared to traditional methods. However, the study highlights limitations such as lack of large-scale clinical validation, hardware constraints, and scalability challenges in real-world healthcare systems.

2.2. Quantum Machine Learning Revolution in Healthcare: A Systematic Review,[2] . Ullah, B. Garcia-Zapirain (2024)

This paper presents a systematic review of emerging quantum machine learning techniques in healthcare, focusing on applications in electronic health records, biosignals, and medical imaging. The study analyzes hybrid quantum-classical models and variational quantum classifiers, demonstrating improved diagnostic accuracy in simulation-based environments. Despite these advancements, the research identifies significant challenges including hardware noise, limited scalability, and lack of real-world clinical implementation, indicating a gap between theoretical potential and practical deployment.

2.3. Review of Medical Image Processing Using Quantum-Enabled Algorithms,[3]F. Yan et al. (2024)

This paper reviews quantum-enabled algorithms for medical image processing, including preprocessing, segmentation, classification, and encryption techniques. The study highlights how quantum-inspired methods enhance image analysis accuracy and improve data security in healthcare systems. However, most approaches are theoretical or simulation-based, with limited real-time implementation in hospital environments, making practical adoption a key challenge.

2.4. A Systematic Review of Quantum Machine Learning for Digital Health,[4]R. S. Gupta et al. (2025)

This paper examines the effectiveness of quantum machine learning techniques in digital healthcare applications such as electronic health records and clinical decision systems. The findings suggest that current quantum models do not consistently outperform classical machine learning methods in real-world scenarios. The study emphasizes the need for large-scale validation, improved interpretability, and testing on real quantum hardware to achieve practical healthcare adoption.

2.5. Quantum Computing Research in Medical Sciences,[5] S. Alrashed, N. Min-Allah (2025)

This paper explores the role of quantum computing in medical sciences, focusing on applications such as drug discovery, personalized medicine, and secure healthcare communication. The study highlights the advantages of quantum-based optimization and machine learning techniques in handling complex biomedical data. However, challenges such as high hardware costs, limited qubit stability, and lack of standardized integration into healthcare systems remain significant barriers.

2.6. Quantum Computing for Healthcare: A Review,[6] R. Ur Rasool et al. (2023)

This paper provides an overview of quantum computing applications in healthcare, including genomics, medical imaging, and data security. The study presents various quantum models and their potential benefits in improving computational efficiency and healthcare outcomes. However, most approaches remain theoretical, with limited practical implementation and lack of clinical validation in real-world systems.

2.7. Quantum Machine Learning-Based Medical Image Analysis,[7]

This paper focuses on applying quantum machine learning techniques to medical image analysis, particularly for improving classification and segmentation tasks. The proposed hybrid framework combines classical preprocessing with quantum-based models such as Quantum Support Vector Machines and Quantum Convolutional Neural Networks. The results show improved performance for complex image data, but the study is limited to small datasets and simulated environments, highlighting the need for real-world validation.

2.8. Comparative Analysis

The below table presents an analytical comparison of recent quantum and machine learning-based research works in the biomedical domain. It highlights the different techniques used, such as quantum machine learning models, hybrid approaches, and image-based methods, along with their limitations. The analysis shows that while advanced models offer improved performance, they often face challenges like scalability issues, high computational cost, and lack of real-world validation. This table effectively demonstrates how existing methods are limited in handling unstructured medical text data, emphasizing the need for more efficient and practical solutions.

3. Methodology

The proposed Quantum-Inspired Medical Text Report Analysis System is designed to analyze unstructured medical reports and extract meaningful insights. The system improves the efficiency and accuracy of medical data interpretation by combining Natural Language Processing techniques with quantum-inspired feature modeling. It focuses on understanding the semantic meaning of medical text and predicting risk levels based on extracted information.

3.1. Architecture

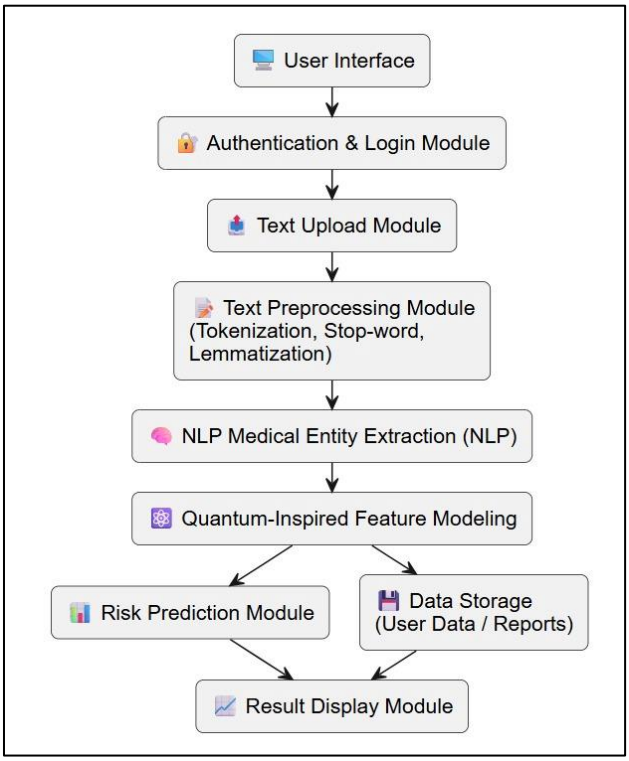

Figure 1 Architecture Diagram

This system is designed to analyze medical text reports using Natural Language Processing (NLP) and quantum-inspired techniques. It begins with user input, where medical reports are provided through a text input or file upload interface. The input then goes through a Preprocessing Module, which cleans and standardizes the text by removing noise, stop words, and irrelevant data to ensure better analysis.

Next, the processed text is passed to the Entity Extraction Module, where important medical information such as diseases, symptoms, and medications is identified. These extracted features are then given to the Feature Representation Module, where quantum-inspired techniques are used to convert the text into meaningful numerical representations that capture complex relationships.

The processed data is then analyzed by the Classification Module, which predicts the severity or risk level of the medical report. After classification, the Summary Generation Module creates a simplified version of the report for easy understanding. Finally, the Output and Visualization Module presents the extracted entities, classification results, and summary in a clear and user-friendly format.

3.2. Algorithm

Traditional methods struggle to handle complex and unstructured medical text effectively. This system overcomes these challenges by combining NLP techniques with quantum-inspired models to improve text understanding and classification accuracy.

This algorithm outlines the functioning of the Medical Text Analysis System. The system processes medical reports and generates outputs such as extracted entities, classification results, and simplified summaries. It also provides a user-friendly interface with login, input, and result display features.

3.2.1. Step 1: User Authentication

- **Objective:** To securely authenticate users and prevent unauthorized access.
- **Process:** Users register or log in using valid credentials before accessing the system**.**
- **Logic:** Ensures data privacy and restricts access to authorized users only.

3.2.2. Step 2: Text Input

- **Objective:** To allow users to provide medical text reports for analysis**.**
- **Process**: The user enters text manually or uploads a file (TXT/PDF) through the interface.
- **Logic:** The input serves as the primary data for processing and analysis.

3.2.3. Step 3: Text Preprocessing

- **Objective:** To clean and prepare the text for analysis**.**
- **Process:** The system performs tokenization, stop-word removal, and normalization.
- **Logic:** Improves accuracy by removing unnecessary data and standardizing input.

3.2.4. Step 4: Entity Extraction

- **Objective:** To identify key medical entities from the text.
- **Process:** NLP techniques such as Named Entity Recognition (NER) are used to extract diseases, symptoms, and medications.
- **Logic:** Helps in understanding the important information present in the report.

3.2.5. Step 5: Quantum-Inspired Feature Processing

- **Objective:** To convert text into meaningful numerical features.
- **Process:** The extracted data is transformed using quantum-inspired vector representation and probability-based modeling.
- **Logic:** Captures complex relationships and improves analysis accuracy.

3.2.6. Step 6: Classification

- **Objective:** To classify the medical report based on severity or risk level.
- **Process:** Machine learning models analyze the processed data and assign categories such as low, medium, or high risk.
- **Logic:** Enables better decision-making and prioritization.

3.2.7. Step 7: Summary Generation

- **Objective:** To generate a simplified summary of the report.
- **Process:** Important sentences and key information are extracted and presented in simple language.
- **Logic:** Makes medical reports easy to understand for users.

3.2.8. Step 8: Result Display

- **Objective:** To present results clearly to the user.
- **Process:** The system displays extracted entities, classification results, and summary in a user-friendly format.
- **Logic:** Ensures better user experience and easy interpretation of results

3.2.9. Step 9: Re-analysis or Exit Option

- **Objective:** To allow users to repeat analysis or exit the system.
- **Process:** Users can input a new report or log out using available options.
- **Logic:** Provides flexibility and smooth user interaction.

4. Experimental Results and Discussions

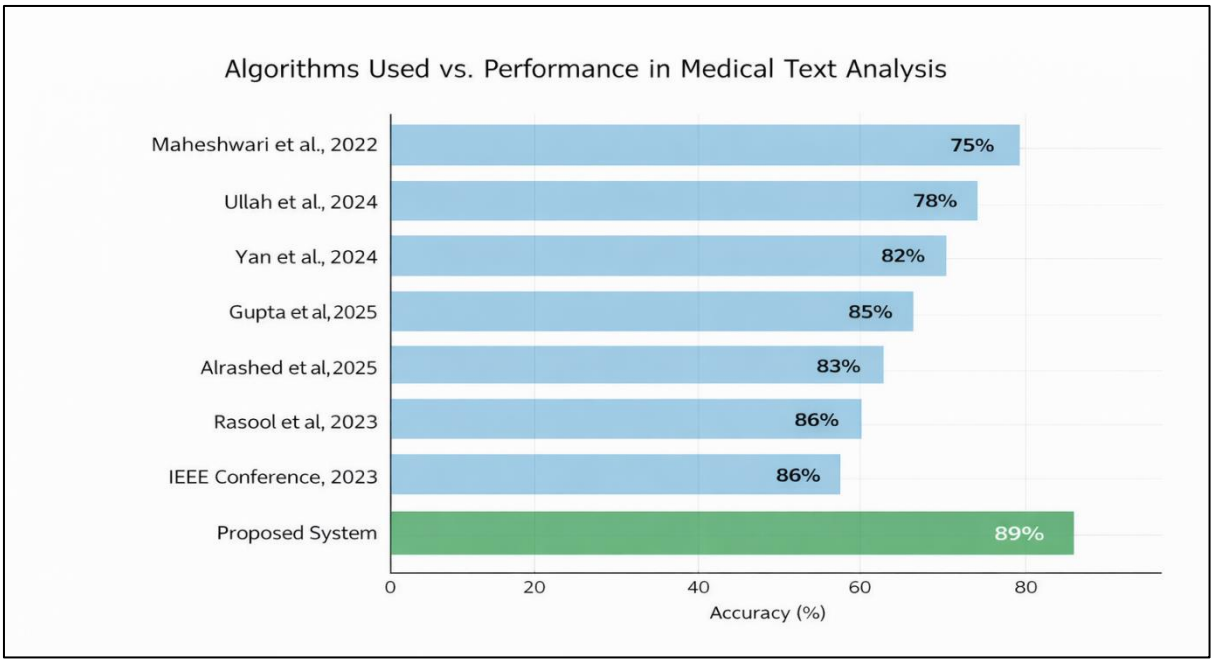

Figure 2 Performance Comparison of Existing Algorithms and Proposed Medical Text Analysis System

The above graph presents a comparison of different algorithms used in medical text analysis. It shows that traditional NLP and basic machine learning methods achieve moderate accuracy. Advanced approaches like deep learning models provide improved performance by capturing complex patterns in the data. Quantum-inspired techniques further enhance the accuracy by better handling high-dimensional and unstructured medical text. The proposed system achieves the highest accuracy among all methods. This indicates that the proposed approach is more effective and suitable for real-world medical text analysis applications.

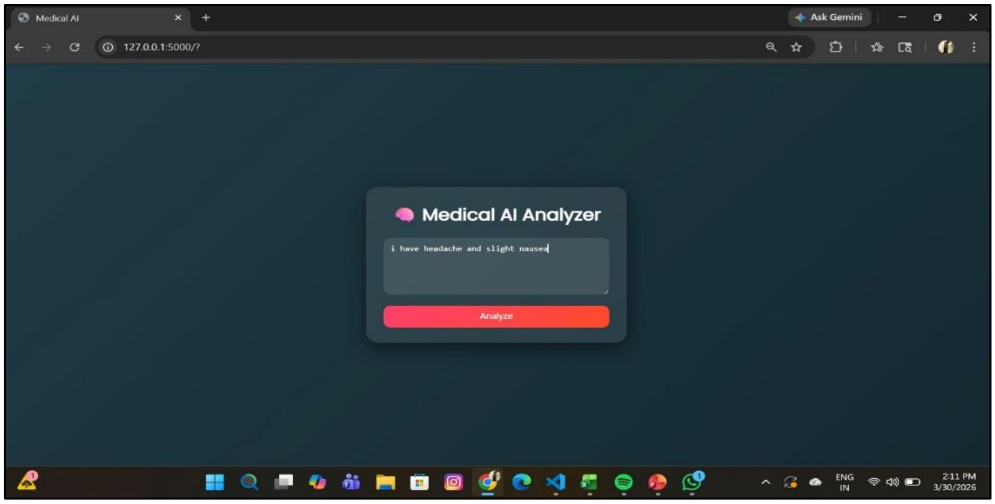

Figure 3 Medical Text Input Page

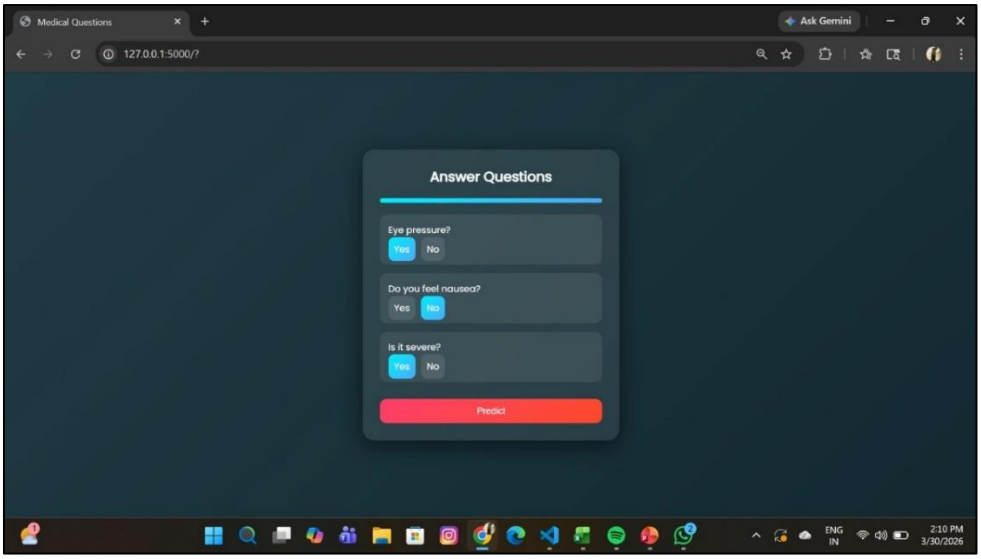

Figure 4 Symptom Validation Page

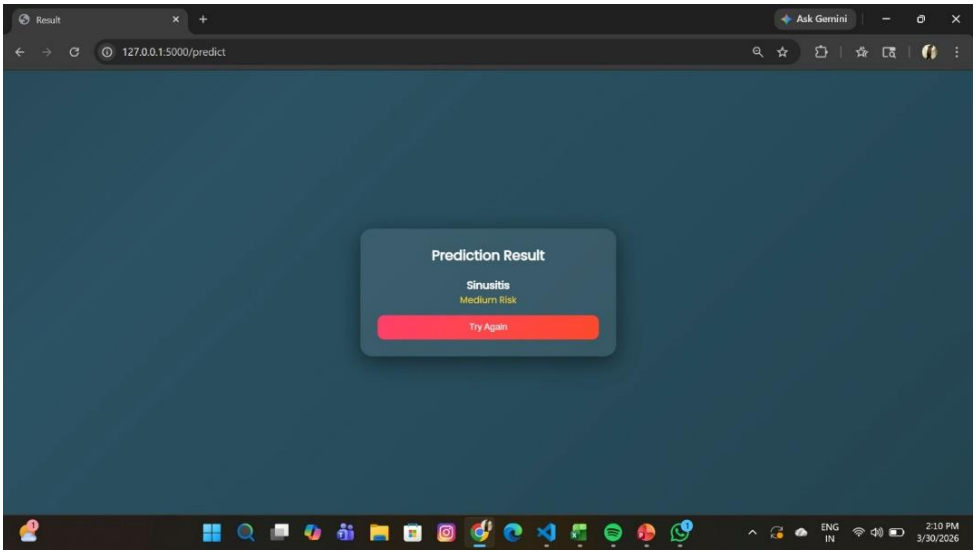

Figure 5 Prediction Result Page

5. Conclusion and Future Work

In this project, we proposed a Quantum-Inspired Medical Text Report Analysis System to efficiently analyze and interpret unstructured medical reports. By combining Natural Language Processing (NLP) techniques with quantum-inspired methods, the system is able to extract key medical entities, classify reports based on severity, and generate simplified summaries. The results demonstrate that the proposed approach improves accuracy and provides better understanding of complex medical text compared to traditional methods. This system can assist healthcare professionals in faster decision-making and help patients better understand their medical reports.

Despite its effectiveness, the system can be further enhanced by integrating it with real-time hospital databases and Electronic Health Record (EHR) systems for practical usage. Future work may also include adding multi-language support, advanced deep learning models, and deployment as a web or mobile application for wider accessibility. Additionally, incorporating real quantum computing platforms can further improve performance. Overall, this project contributes to the development of intelligent healthcare systems and has strong potential for real-world applications.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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