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Stock Price Prediction using GRU and Dashboards

M Pallavi[1], Anjali Koduru[2], Dedeepya Ande[3], Neyyila Navaneeth Kumar[4], Kola Swarnalatha[5]
[1, 2, 3, 4, 5]*Department of Computer Science and Engineering [AI-ML], Gayatri Vidya Parishad College of Engineering (A), Visakhapatnam, Andhra Pradesh, India*

Abstract: ***This research focuses on predicting stock prices using Gated Recurrent Units (GRUs), a type of Recurrent Neural Network (RNN) that effectively captures sequential dependencies in time series data. The model leverages historical stock data and presents results using interactive dashboards in Power BI, enhancing decision-making and interpretability for stakeholders. The study evaluates the accuracy and efficiency of GRU-based models against traditional approaches, demonstrating improved forecasting capabilities. Additionally, the research explores the impact of various hyper-parameters on model performance and compares GRU with other deep learning architectures, such as LSTMs, to determine the optimal approach for financial time series forecasting. The system's ability to detect trends, mitigate noise, and provide real-time insights makes it a valuable tool for investors and financial analysts. Furthermore, this study examines real-world applications, industry adoption, and the scalability of GRU-based predictive models in financial markets, ensuring robust performance across varying market conditions.***
Keywords: Stock Price Prediction, GRU, Power BI, Machine Learning, Financial Forecasting, Deep Learning, Time Series Analysis

I. INTRODUCTION

Stock price prediction plays a crucial role in financial decision-making, enabling investors, analysts, and traders to make informed choices regarding market movements. Accurate predictions can help mitigate financial risks, optimize investment strategies, and enhance portfolio management. However, stock markets are highly volatile, influenced by factors such as global economic conditions, investor sentiment, interest rates, inflation, and geopolitical events. This complexity makes stock price forecasting a challenging yet essential task. Traditional statistical models, such as Autoregressive Integrated Moving Average (ARIMA) and Exponential Smoothing, rely on linear assumptions and fail to capture intricate, non-linear patterns in financial data. These limitations have driven the adoption of advanced machine learning techniques that can better model complex dependencies and trends within time series data. Gated Recurrent Units (GRUs) have emerged as a powerful deep learning approach specifically designed to process sequential data efficiently. Unlike basic Recurrent Neural Networks (RNNs), which suffer from vanishing gradient issues, GRUs utilize gating mechanisms to selectively retain and update relevant information over long sequences. This enhances the model's ability to learn temporal dependencies and recognize critical market patterns, making GRUs well-suited for stock price prediction. This research integrates GRU-based predictive models with Power BI, a business intelligence tool that provides interactive dashboards for enhanced visualization and analysis. The combination of GRU's predictive capabilities and Power BI's real-time analytics ensures greater transparency, interpretability, and usability for financial professionals. Investors can leverage these insights to gain a deeper understanding of stock trends, identify potential investment opportunities, and respond proactively to market fluctuations.

II. LITERATURE SURVEY

A. Traditional Stock Prediction Methods

Historically, stock market forecasting has relied on statistical models such as ARIMA (Autoregressive Integrated Moving Average), Moving Averages, and Exponential Smoothing. These methods are limited by their linear assumptions and often fail to capture complex relationships between stock prices and external economic factors. For instance, the study in **[1]** discusses the limitations of ARIMA in modeling non-linear patterns, which can lead to suboptimal predictions in volatile markets.

B. Machine Learning in Stock Prediction

With advancements in artificial intelligence, machine learning models have gained traction for financial forecasting. Algorithms such as Decision Trees, Random Forests, and Support Vector Machines (SVM) have been employed for stock price prediction. However, these models lack the ability to learn temporal dependencies, making them less effective for time-series forecasting, as highlighted in **[2]**.

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Deep learning models, such as Recurrent Neural Networks (RNNs), Long Short-Term Memory networks (LSTMs), and Gated Recurrent Units (GRUs), have significantly improved stock prediction accuracy by capturing complex sequential patterns. The study in **[3]** provides a comparative analysis of GRU and LSTM models, demonstrating that GRUs not only offer computational efficiency but also maintain comparable accuracy to LSTMs, making them a suitable choice for financial applications. Additionally, the ability of GRUs to selectively retain relevant information from past sequences enhances their predictive capability, allowing for better modeling of stock price movements. Reference **[4]** emphasizes the advantages of GRUs in handling time-series data, particularly in financial contexts where capturing trends and patterns is crucial.

C. Integration of Machine Learning with Power BI

The integration of machine learning-based forecasting models with business intelligence tools like Power BI enhances real-time financial analysis by providing dynamic visualization and interactive data exploration. Reference **[5]** discusses how such integrations allow investors to visualize stock trends effectively and conduct scenario-based simulations. This combination ensures accessibility, interpretability, and practical usability for financial professionals. Moreover, the research in **[6]** explores the scalability and effectiveness of deep learning models for financial time series analysis, indicating that the combination of GRUs with visualization tools like Power BI can lead to better decision-making processes in finance.

III. EXISTING SYSTEM

The existing systems for stock price prediction primarily use traditional statistical methods and basic machine learning algorithms, relying on historical price data and fundamental indicators. However, these approaches have significant limitations that affect their accuracy and effectiveness. Traditional methods, such as ARIMA (Autoregressive Integrated Moving Average), analyze historical data to forecast future values. These models assume linearity and stationarity, which often do not hold true for stock prices that exhibit non-linear patterns and volatility. As noted in [1], ARIMA can fail to capture sudden market shifts influenced by external factors. Similarly, moving averages and exponential smoothing techniques help identify trends but do not account for complex interactions between market variables, leading to inaccuracies in volatile conditions. Machine learning approaches, such as Decision Trees and Random Forests, model stock prices based on historical data and financial indicators. While Random Forests are more robust, they may struggle with temporal dependencies inherent in time-series data, as highlighted in [2]. Support Vector Machines (SVM) are also used for classification in stock prediction, but they require careful tuning and are sensitive to kernel choices, limiting their adaptability to the dynamic nature of stock movements. These systems face challenges, including an inability to capture non-linear patterns, a lack of real-time processing, and inadequate incorporation of external factors like news events and market sentiment. This oversight can lead to poor predictive performance, especially during high volatility. Thus, the limitations of existing systems highlight the need for advanced predictive models that can handle non-linear relationships and incorporate real-time data. The proposed system utilizing GRUs aims to address these challenges by leveraging deep learning techniques to enhance forecasting accuracy and provide real-time insights through interactive dashboards.

A. Disadvantages

1) Limited ability to capture complex relationships between stock prices and external factors.
2) High error rates due to market volatility and sudden price fluctuations.
3) Lack of real-time processing capabilities, limiting practical usability for traders and analysts.

IV. PROPOSED SCHEME

The proposed stock price prediction system integrates GRU-based predictive models with Power BI for real-time data visualization. The methodology consists of four primary components:

1) Data Preprocessing: Handling missing values and normalizing stock prices for consistency.
2) Feature Engineering: Techniques like Simple Moving Average (SMA) and Relative Strength Index (RSI) are applied to extract insights from historical trends.
3) Model Execution: The pre-trained GRU model analyzes stock price trends, classifying upcoming trends based on detected patterns, such as price spikes and volatility indicators.
4) Model Execution: The trained GRU model processes stock data securely, generating real-time forecasts. Alerts can be generated for investors if significant price movements are detected.
5) Dashboard Visualization: An interactive dashboard in Power BI allows investors and analysts to view real-time stock price forecasts, including live stock price charts, market trend analysis, risk assessment metrics, and exportable reports.

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V. ADVANTAGES

1) Privacy-Preserving AI Model Training: The GRU model analyzes stock market trends without exposing user-sensitive data.
2) Real-Time Data Processing: Efficient retrieval and processing of stock data ensure up-to-date forecasting.
3) Automated Trend Detection: The system detects high-impact stock movements based on AI-driven pattern recognition.
4) Investment Strategy Optimization: Facilitates data-driven decision-making, enabling investors to refine trading strategies based on forecast accuracy.

A. System Block Diagram

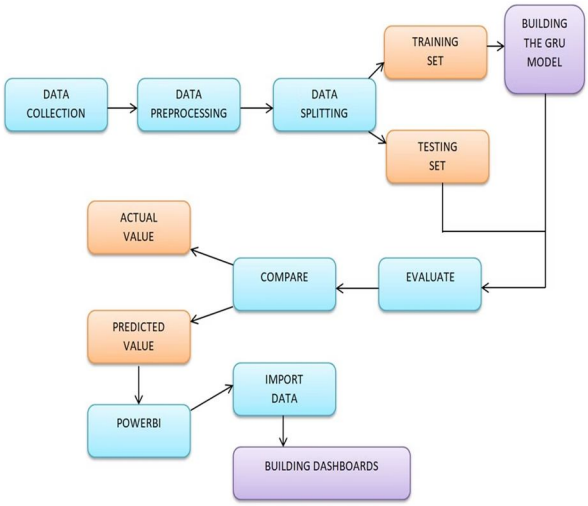


Fig: System Architecture

VI. OUTPUT SCREENS

1	Date	Actual Price	Predicted Price
2	31-03-2015	162.33	162.7879029
3	01-04-2015	160.62	163.3943199
4	02-04-2015	162.54	163.4553356
5	06-04-2015	162.8	163.9962693
6	07-04-2015	163.84	164.343139
7	08-04-2015	163.55	164.6312353
8	09-04-2015	162.47	164.7069994
9	10-04-2015	163.33	164.9714543
10	13-04-2015	164	165.0423107

Figure 1: Testing Data

1	Date	Predicted Price
2	03-01-2018	152.9587485
3	04-01-2018	152.2330924
4	05-01-2018	151.4237692
5	08-01-2018	150.6104606
6	09-01-2018	149.7889275
7	10-01-2018	148.9398439
8	11-01-2018	148.0511774

Figure 2: Future Predictions

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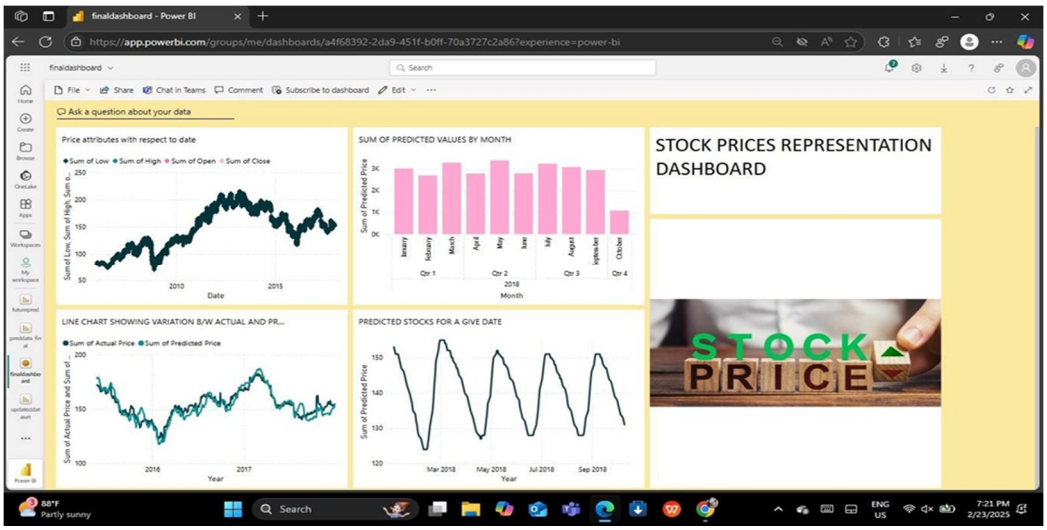


Figure 3: Dashboard with Power BI

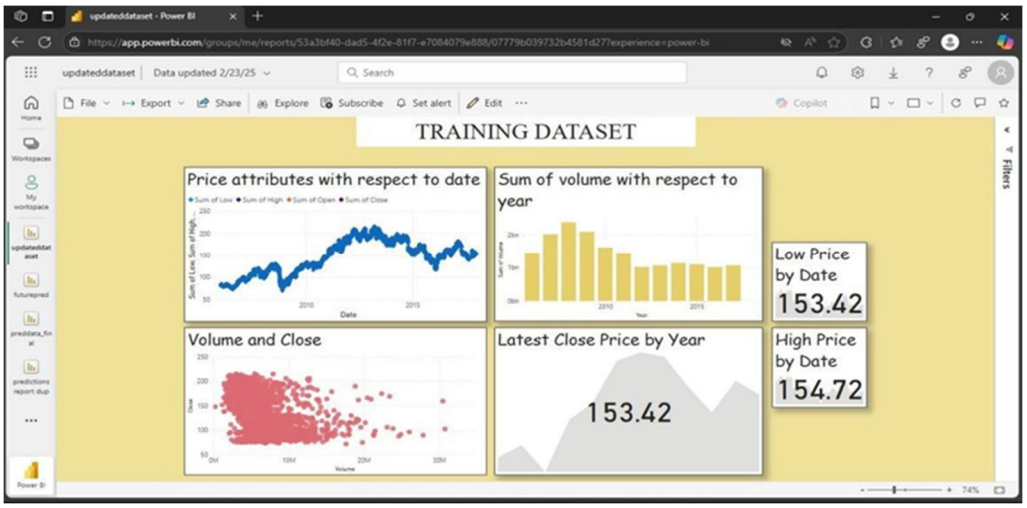


Figure 4: Training Dataset Visualization in Power BI

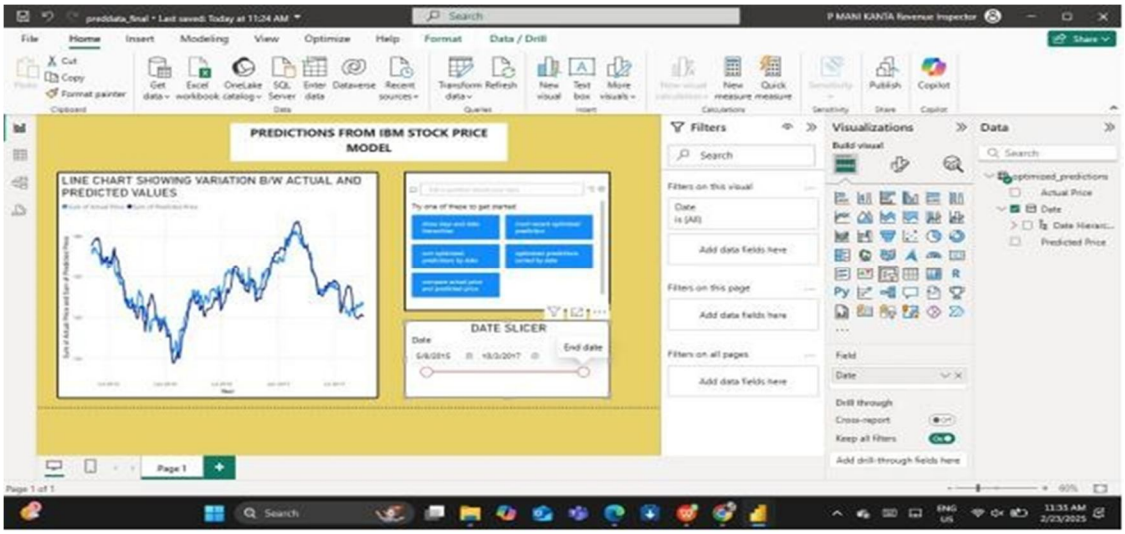


Figure 5: Predicted Stock Values Visualization

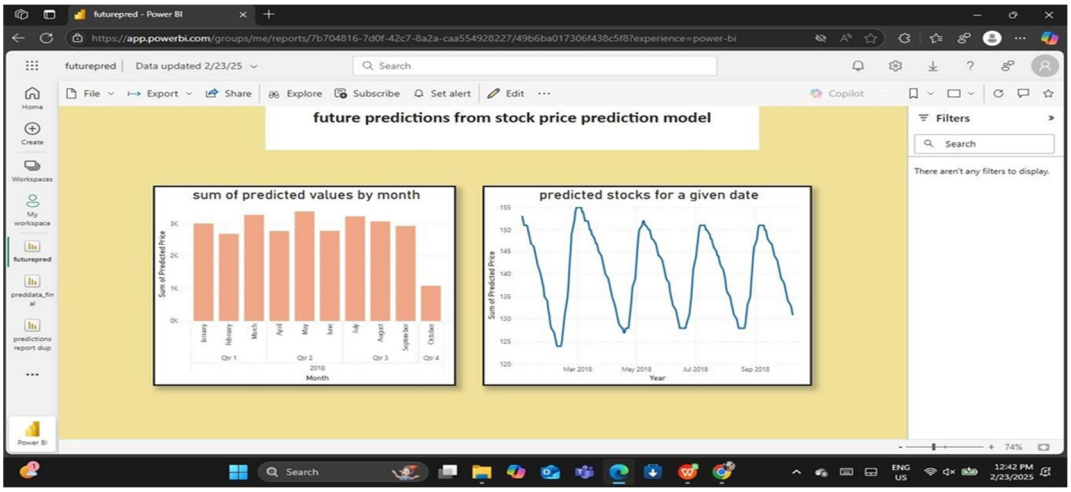


Figure 6: Future Stock Price Prediction

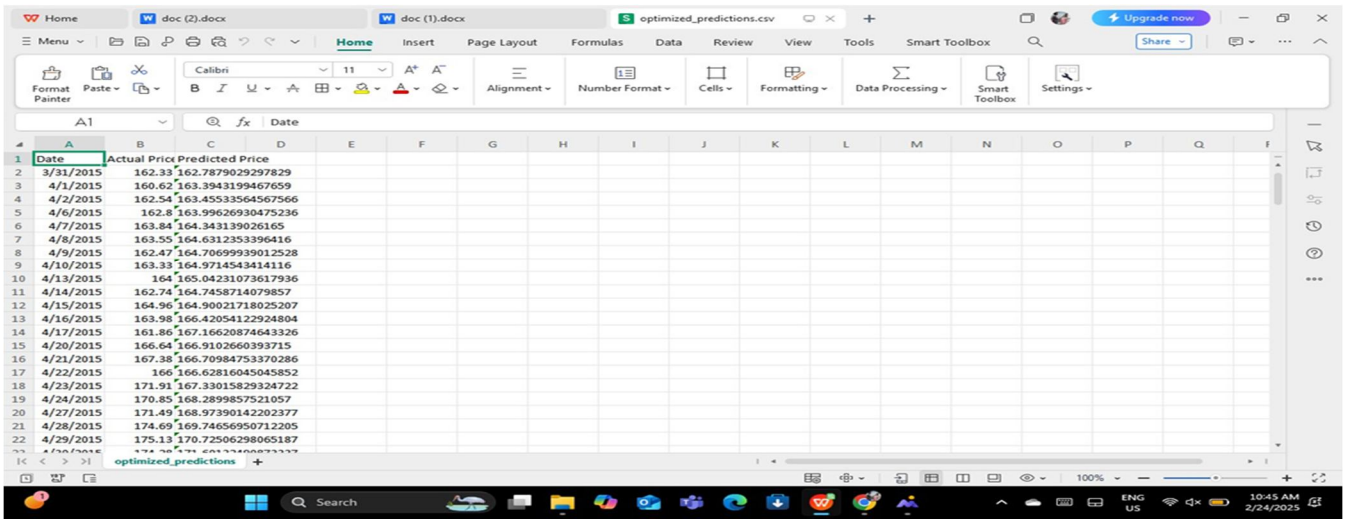


Figure 7: Predictions from the dataset for the year 2017

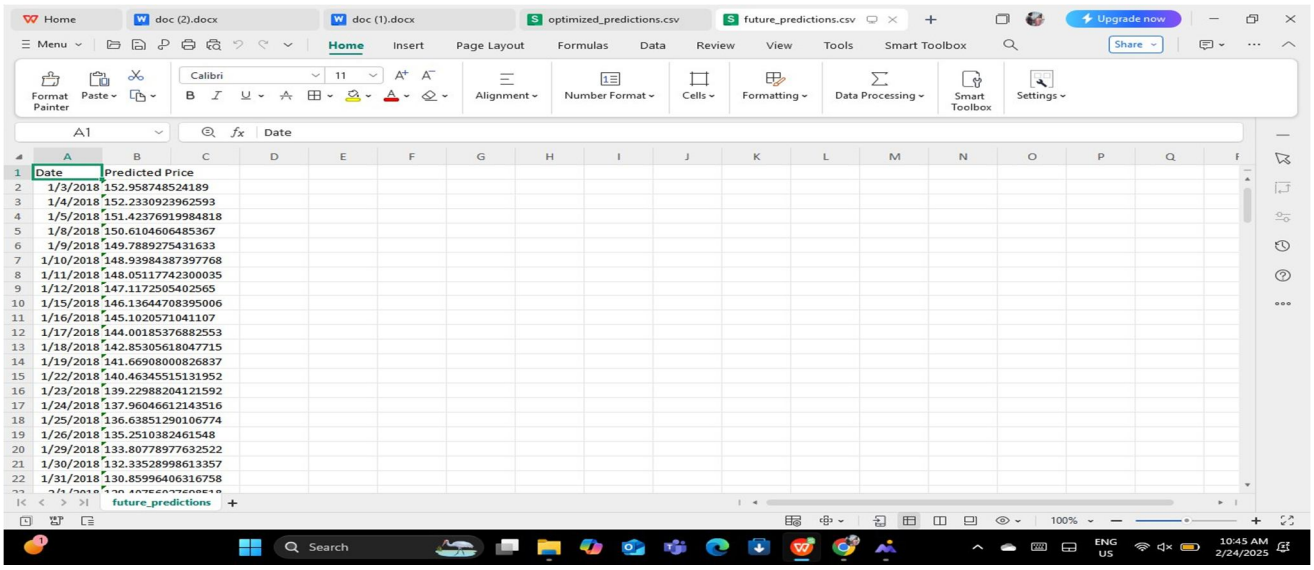


Figure 8: Predictions for the year 2018[Jan-Oct]

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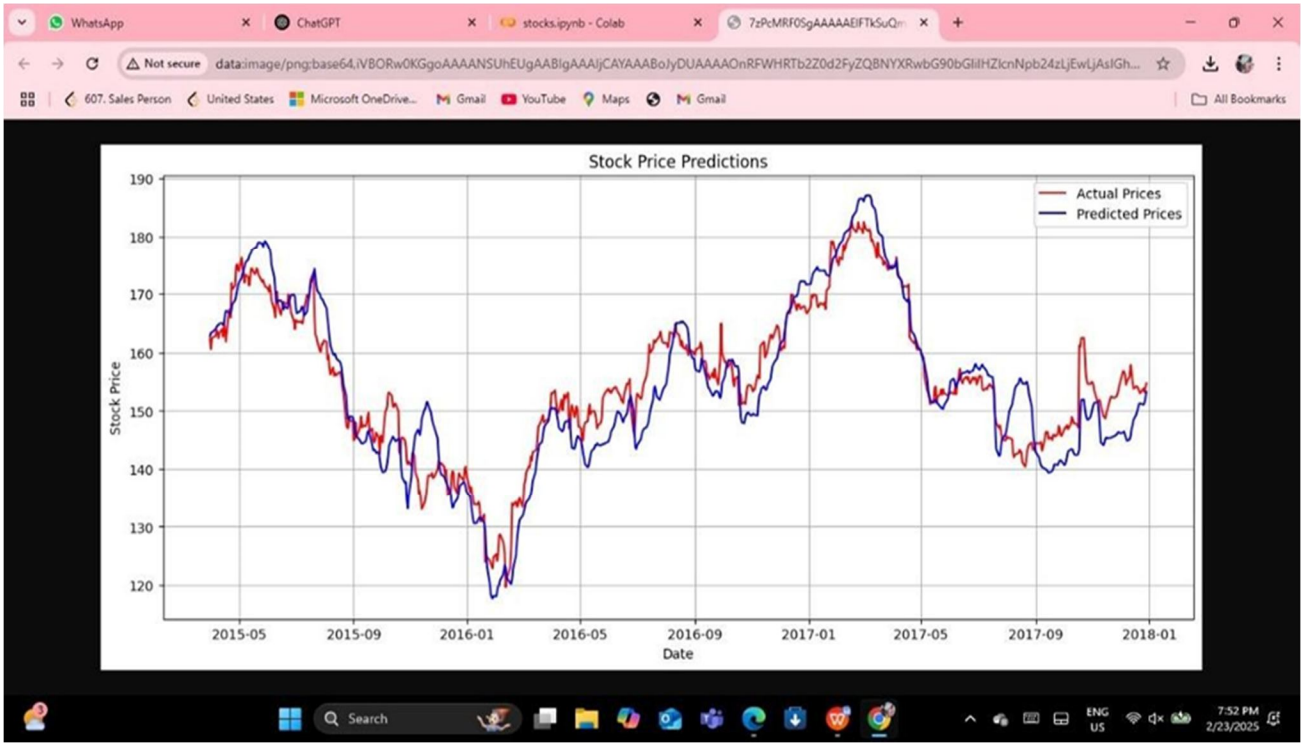


Figure 9: Plotting of predicted values against actual values

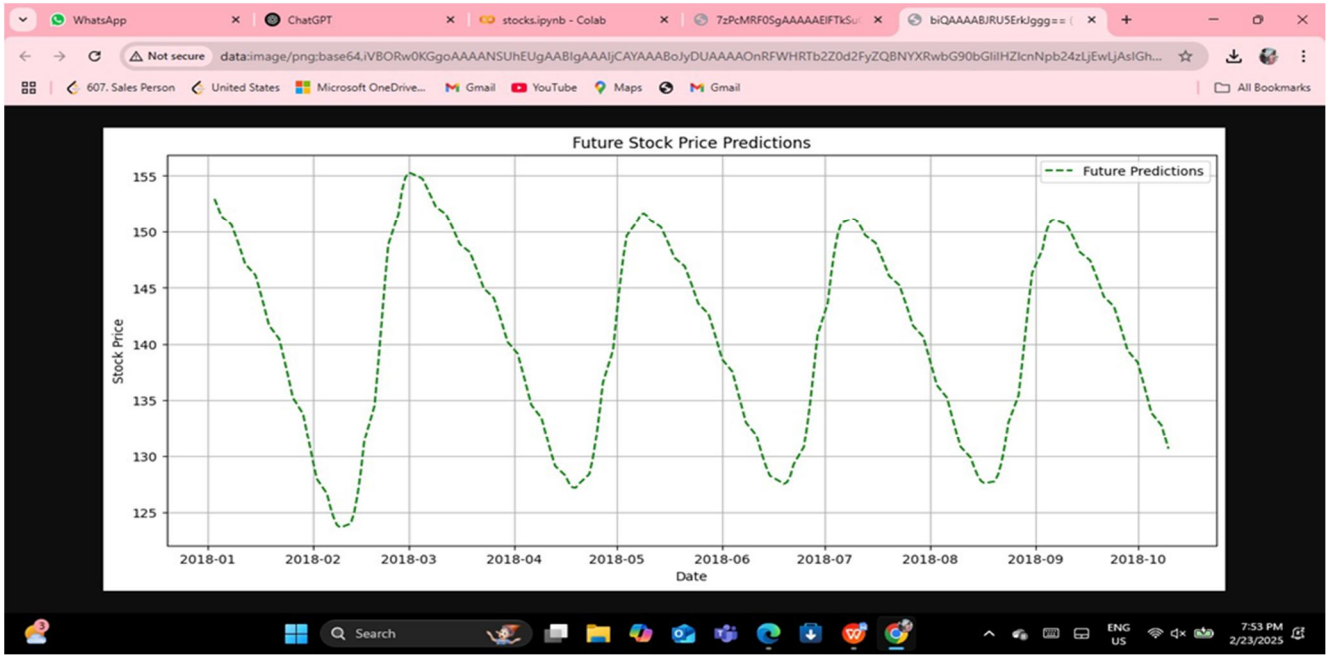


Figure 10: Plotting of future predicted values

VII. CONCLUSION

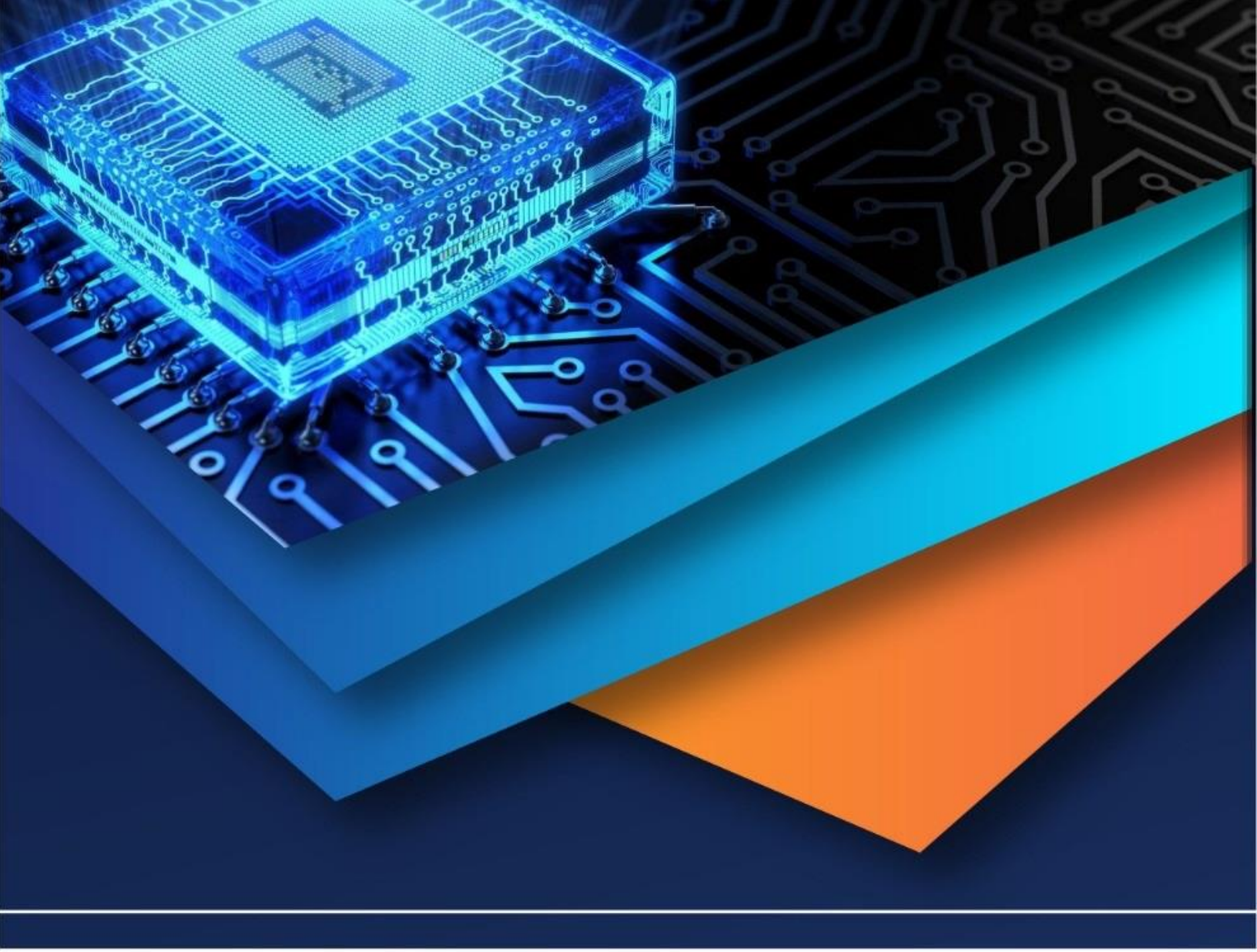
The proposed stock price prediction system using Gated Recurrent Units (GRUs) significantly improves upon traditional forecasting methods. By combining deep learning with real-time visualization through Power BI, the system enhances prediction accuracy and reliability. The GRU effectively captures complex temporal dependencies, outperforming conventional statistical models that struggle with non-linear patterns.

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This research highlights the value of incorporating external factors, such as market sentiment and economic indicators, into predictive models. The GRU's capability to process sequential data allows for a better understanding of stock price movements, aiding investors in making informed decisions. Additionally, real-time processing ensures access to current market information, supporting timely investment strategies. Interactive dashboards provide a user-friendly interface for visualizing trends and assessing risks, thereby enhancing decision-making. Future work should focus on optimizing the GRU model and exploring additional financial indicators. Overall, this research contributes to financial forecasting, offering a solid framework for future advancements.

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