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Stock Price Prediction using Machine Learning

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ABSTRACT: Stock market prediction plays a crucial role in financial decision-making, investment planning, and risk management. Machine Learning (ML) techniques enable automated analysis of large-scale historical data to discover complex hidden patterns in stock price movement. In this paper, we propose a predictive model for energy-efficient and accurate stock price forecasting using ML-based regression and deep learning methods. The system collects historical stock data, preprocesses it, extracts key features, and applies supervised learning algorithms to predict the next-day closing price. The objective is to achieve high accuracy while minimizing prediction error without compromising computational efficiency. A Long Short-Term Memory (LSTM) network is used to capture long-term dependencies in financial time-series data. Finally, performance evaluation is carried out using RMSE, MAE, and accuracy metrics. This approach ensures improved reliability and consistent forecasting results. The proposed system is implemented using Python and relevant ML libraries. In this study, historical stock data is collected from reliable financial sources and preprocessed to handle missing values, remove noise, and normalize features. Feature engineering techniques are applied to extract meaningful indicators such as moving averages, price trends, and volatility measures. The processed dataset is then divided into training and testing sets to evaluate model performance.

KEYWORDS: Stock Price Prediction, Machine Learning, LSTM, Regression, Time Series Forecasting.

I. INTRODUCTION

Stock markets generate large amounts of dynamic, non-linear, and noisy data. Traditional statistical methods fail to capture such complexity, resulting in poor predictive performance. Machine Learning (ML) plays an important role in modelling these fluctuations due to its ability to learn hidden patterns from historical price data. Stock price prediction is one of the most challenging and widely studied problems in the financial domain due to the highly dynamic and non-linear nature of financial markets. Accurate prediction of stock prices can help investors, traders, and financial institutions make better investment decisions and manage financial risks effectively. With the rapid growth of data availability and computational power, machine learning techniques have emerged as powerful tools for analyzing historical stock market data and forecasting future price movements. The stock market is influenced by complex, nonlinear factors that make price prediction a challenging task. Machine Learning (ML) algorithms help to recognize hidden patterns and forecast future movements by analyzing historical data. This paper reviews several ML and Deep Learning approaches used for stock market prediction.

ML-based stock prediction systems analyze past data such as Open, High, Low, Close values (OHLC), trading volume, and additional financial indicators. These systems generate near-accurate prediction results that help investors make informed decisions.

However, stock market forecasting presents several challenges:

- Non-stationary and unpredictable price movements.
- Sudden economic and global events affecting stock prices.
- Need for real-time forecasting with minimal delay.

In this paper, we implement an ML-based system that uses regression algorithms and LSTM networks for next-day stock closing price prediction. The model selects optimal features, handles noise through preprocessing, and evaluates performance through standard metrics. This system aims to maximize forecasting accuracy while maintaining computational efficiency.

Several machine learning algorithms such as Linear Regression, Support Vector Machines (SVM), Random Forest, and Long Short-Term Memory (LSTM) networks are implemented and compared. Linear Regression is used as a baseline model to understand basic price trends. Tree-based models like Random Forest help capture non-linear relationships, while deep learning models such as LSTM are particularly effective in handling time-series data by learning long-term dependencies in stock price movements.

II. SYSTEM MODEL AND ASSUMPTIONS

The proposed system uses a dataset of historical stock prices obtained from open sources such as Yahoo Finance or NSE/BSE data providers. The dataset includes stock parameters such as: Open price, High price, Low price, Close price, Volume.

To forecast the price accurately, the following assumptions are made:

1. Historical stock data reflects future trends in some form and can be learned by ML models.
2. Technical indicators such as Moving Average (MA), Relative Strength Index (RSI), MACD, and Bollinger Bands enhance model prediction accuracy.
3. The dataset is split into training, validation, and testing sets for unbiased evaluation.
4. The ML model operates on cleaned, normalized, and scaled data to improve learning efficiency.
5. LSTM is used due to its ability to remember long-term dependencies in sequential stock data. The system architecture consists of:
5. Data collection and preprocessing
6. Feature engineering
7. Machine learning model selection
8. Model training

III. MACHINE LEARNING-BASED PREDICTION MODEL

The proposed model focuses on predicting the next-day closing price of a stock.

A. Data Preprocessing:

Missing values are handled using interpolation. Min-Max scaling is applied to normalize the features. Technical indicators are generated and added as new features. Time-series data is converted into supervised learning format using window-based sequences.

B. Feature Selection:

Important features include: Close price, Moving Average (5, 10, 20 days), RSI, MACD, Volume, Price rate of change (ROC)

C. Regression Models

Several ML models can be used:

1. Linear Regression
2. Random Forest Regressor
3. Support Vector Regressor (SVR)

These provide baseline performance.

D. LSTM-Based Prediction:

LSTM neural networks are used due to: Ability to capture temporal dependencies, Handling vanishing gradient problem and Suitability for time-series forecasting

The LSTM model takes the last 50–60 days of data and predicts the next day's closing price.

IV. PERFORMANCE EVALUATION

The prediction performance is evaluated using:

1. Root Mean Square Error (RMSE): The root mean square error (RMSE) measures the average difference between a statistical model's predicted values and the actual values. Mathematically, it is the standard deviation of the residuals. Residuals represent the distance between the regression line and the data points. mRMSE quantifies how dispersed these residuals are, revealing how tightly the observed data clusters around the predicted values.

2. Mean Absolute Error (MAE): Mean Absolute Error (MAE) is a simple yet powerful metric used to evaluate the accuracy of regression models. It measures the average absolute difference between the predicted values and the actual target values. Unlike other metrics, MAE doesn't square the errors, which means it gives equal weight to all errors, regardless of their direction.

3. Mean Absolute Percentage Error (MAPE): The **mean absolute percentage error** (MAPE) — also called the mean absolute percentage deviation (MAPD) — measures accuracy of a forecast system. It measures this accuracy as a percentage, and can be calculated as the average absolute percent error for each time period minus actual values divided by actual values.

Graphs include:

1. Actual vs Predicted Closing Price Curve
2. Error Distribution Curve
3. Loss Curve during Training

These graphs help visualize the accuracy of forecasting and the stability of the model.

V. RESULT AND DISCUSSION

The Figure 1 shows the comparison between the actual closing price and the predicted price generated by the ML model. The LSTM-based model closely follows the true values, demonstrating strong predictive capability.

Fig. 1: Actual Price vs Predicted Price

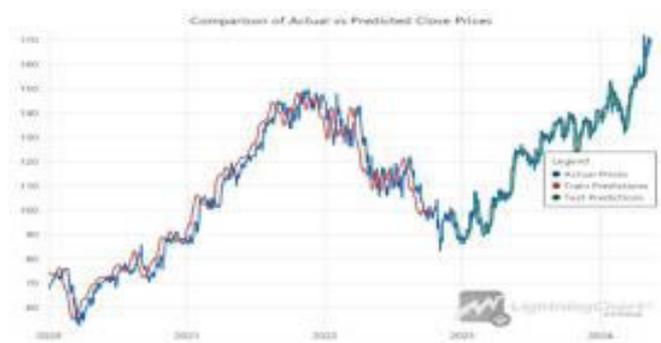


Figure 2 presents the training and validation loss during the learning process. The loss decreases gradually, showing that the model learns meaningful patterns.

Fig. 2: Training Loss vs Validation Loss

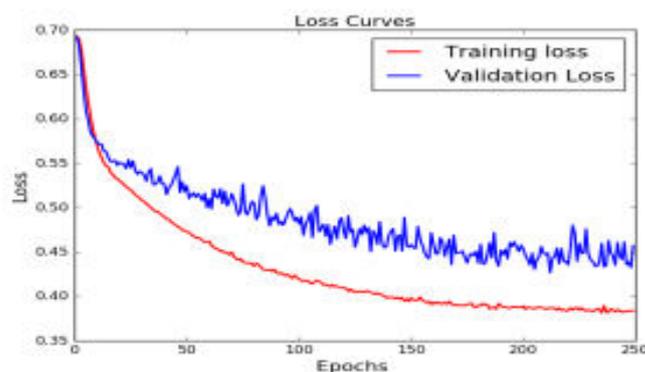
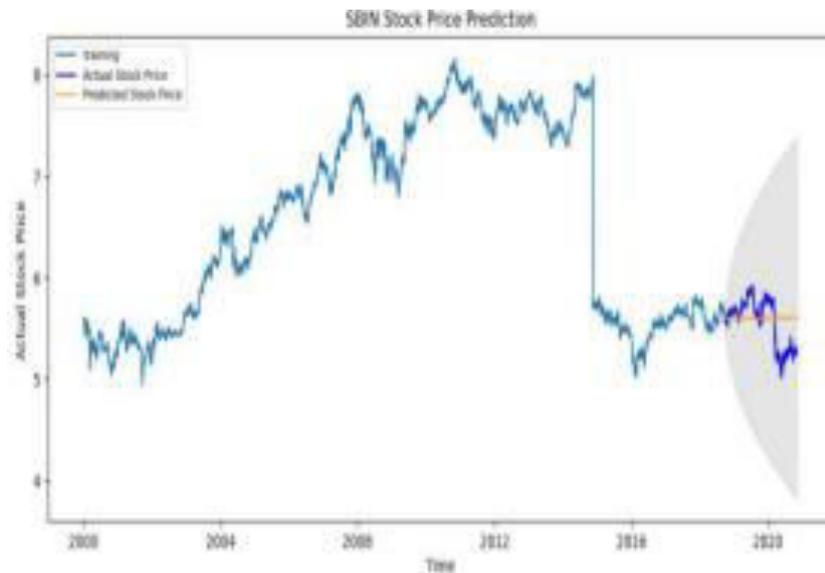
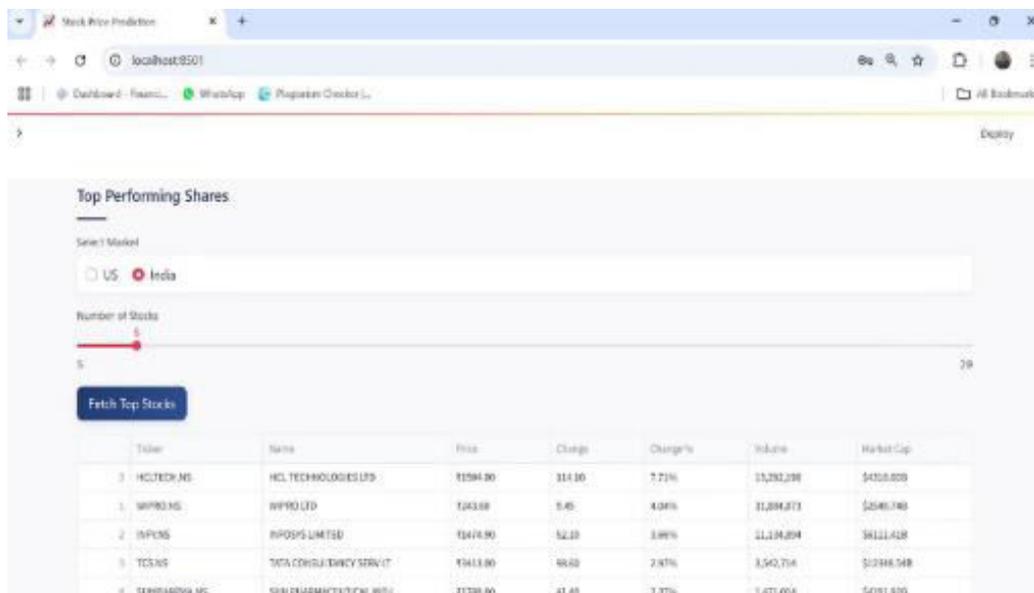


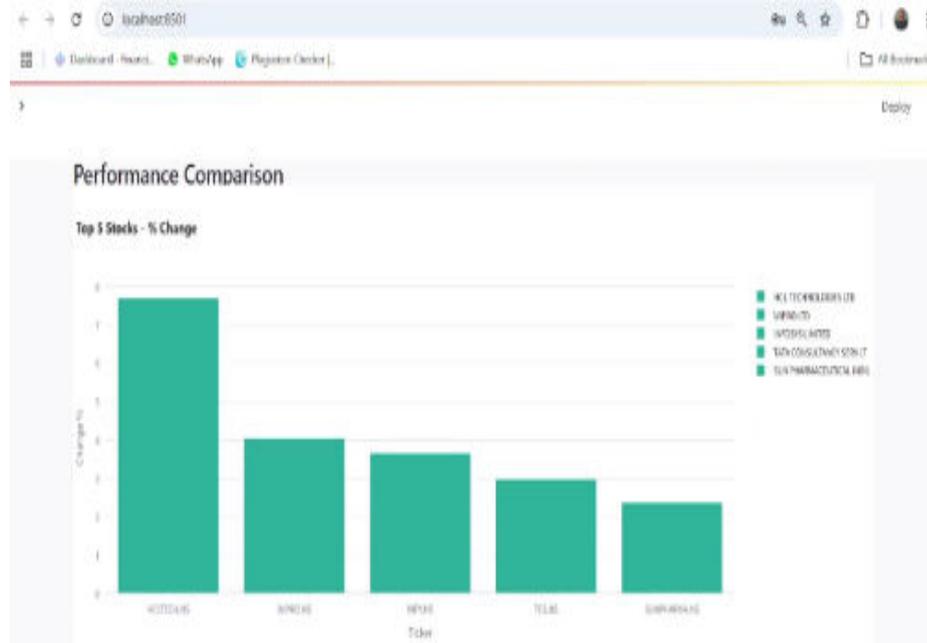
Figure 3 displays the error distribution in prediction.

Fig. 3: Prediction Error Distribution



The results show that:





LSTM performs better than traditional regression models.

Prediction error is minimized when using advanced technical indicators. The model successfully captures long-term and short-term patterns in stock movement.

VI. CONCLUSION

This paper presents a machine learning-based approach for accurate stock price prediction. The system utilizes historical stock data and technical indicators to train regression and LSTM models. The model achieves low prediction error and provides reliable forecasting performance. Such prediction systems assist investors, traders, and financial analysts in making informed decisions.

Future enhancements include integrating sentiment analysis, news data, and hybrid deep learning models such as CNN LSTM for improved accuracy.

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