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INTELLIGENT DETECTION OF STOCK MARKET ANOMALIES FOR OPTIMIZED INVESTMENT DECISION

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ABSTRACT: The rapid growth and intricacy of the Indian stock market have called for newer and more advanced tools to monitor and control market aberrations in real time. The project intends to create an anomaly detection system based on machine learning algorithms to identify aberrations in real-time stock market data. The system collects data from credible financial sources like the National Stock Exchange (NSE), Bombay Stock Exchange (BSE), and Alpha Vantage APIs and, in real time, examines real price movements and technical indicators like moving averages, volatility indicators.The platform employs unsupervised machine learning methods, Autoencoders and Isolation Forests, to detect anomalies without exploiting pre-labeled training data. Isolation Forests identify outliers by recursively partitioning the data, and autoencoder employ neural networks to tag deviations in terms of reconstruction errors. The learned models, utilizing historical market data, recognize patterns deviating from typical market behavior that enable the detection of activities such as market manipulations unusual price movements and liquidity.

KEYWORDS: Stock market anomalies, Anomaly detection, Market manipulations, Real-time monitoring, Smart investment, Isolation forest, LSTM autoencoder.

I. INTRODUCTION

The Indian equities market has seen extremely rapid growth in the recent past, driven by enhanced participation by retail and institutional investors, enhanced technology, and the extensive use of algorithmic trading. The rapid growth is calling for the identification and neutralization of market anomalies that may result from fraud, technical errors, economic uncertainty, or other unexpected causes. Traditional methods of identifying anomalies are greatly reliant on rule-based systems or human judgment, which are not capable of identifying sophisticated and dynamic market patterns in real-time.

Machine learning and more so unsupervised learning algorithms, presents a possible solution for identifying anomalies in stock market data. By studying enormous amounts of real-time financial data, machine learning systems can identify patterns and outliers without the need for any set of predefined rules. This project will be built to develop an anomaly detection system that is strong using the most advanced machine learning models, Isolation Forests and Autoencoders, to identify abnormal stock market activity efficiently.

II. LITERATURE SURVEY

[1] Detection of Anomaly stock prices based on time series deep learning model - Yingying zhang, Yujie wang, and Yanjun Li.
Summary: This paper presents a deep learning model based on time series LSTM to detect unusual behavior in the Chinese stock market.
[2] Time Contextual Anomaly for Detecting Market Manipulation in Stock Market - Koosa Golmohammadi, Osmar, R Zaiane.
Summary: The paper proposes a prediction based contextual anomaly detection (CAD) method for complex time series, aiming to detect market manipulation in the stock market.
[3] Stock Fluctuation Anomaly Detection Based on Wavelet Modulus Maxima - Yinging Zhang, Yujie wang, and Yanjun li.

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Summary: The study focuses on detecting anomalies in stock fluctuation using wavelet modulus maxima. The approach captures the singularities of stock price movements, aiding in the identification of anomalies.

[4] Anomaly Detection on Big Data in Financial Market - Andrea Dal Pozzolo, Olivier Caelen, Yann-Ael le borgne.

Summary: The paper applies a standard set of anomaly detection techniques, including nearest neighbours, clustering, and statistical approaches, to big data in financial market.

[5] Anomaly Detection in Financial Data using Deep Learning – Kubra sefa dedebek feyza, Yildirim Mehmet Ulvi Simsek.

Summary: This paper provides a comparative analysis of various deep learning models for anomaly detection in financial data, highlighting their effectiveness in identifying outliers in stock market datasets.

EXISTING SYSTEM

Current financial market anomaly detection depends on rule-based systems, statistical methods, and a few machine learning models. Rule-based and statistical approaches often struggle to keep up with changing, complex market conditions, resulting in many false positives. Existing machine learning systems like Isolation Forests and Autoencoders can identify anomalies, but they might not provide real-time responses, hybrid integration, or effective feature engineering. These shortcomings limit the ability to quickly and accurately identify market manipulations, sudden price changes, and liquidity problems.

PROPOSED SYSTEM

The proposed system uses unsupervised machine learning models, Isolation Forests and LSTM Autoencoders, along with technical indicators for real-time stock market anomaly detection. It fetches live data from NSE, BSE, and Alpha Vantage APIs, preprocesses it, and detects unusual patterns, price shifts, or manipulations instantly. A responsive dashboard for visualizes anomalies and sends alerts to traders, analysts, and regulators. This setup helps with proactive risk management, fraud prevention, and better market stability through timely and accurate detection.

III. SYSTEM ARCHITECTURE

The system architecture for the “Anomalies Detection in Stocks for Improved Decision Making” project is structured as a layered framework. This design allows for scalability, modularity, and real-time performance. At the top is the Presentation Layer (User Interface), which serves as the main interaction point for traders, analysts, regulators, and financial institutions. This layer includes a responsive web dashboard built with HTML, CSS, JavaScript, and Bootstrap, making it accessible on various devices. Users can enter stock symbols, view live price movements, anomaly points, and detailed performance metrics.

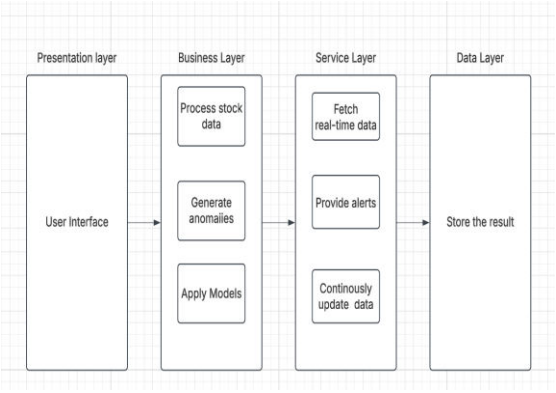

Fig 3.1 System Architecture

IV. METHODOLOGY

The “Anomalies Detection in Stocks for Improved Decision Making” project uses a structured, multi-phase, data-driven machine learning approach This method ensures the accurate identification of irregularities in financial markets in real time. The first phase is data collection. It starts by gathering live stock market data from reliable sources such as the National Stock Exchange (NSE), Bombay Stock Exchange (BSE), and Alpha Vantage API. These APIs provide

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both historical and real-time data, including open, high, low, and close prices, along with traded volumes. This data forms the basis for detecting anomalies. The process is automated to maintain continuous data acquisition without manual input. This guarantees timely updates for immediate analysis. Once the data is fetched, the data preprocessing phase cleans, standardizes, and makes raw market data suitable for machine learning models. In this step, missing values are handled using imputation techniques like forward filling or by removing incomplete entries. Non-numeric or corrupted entries are corrected or filtered out to keep the data intact.

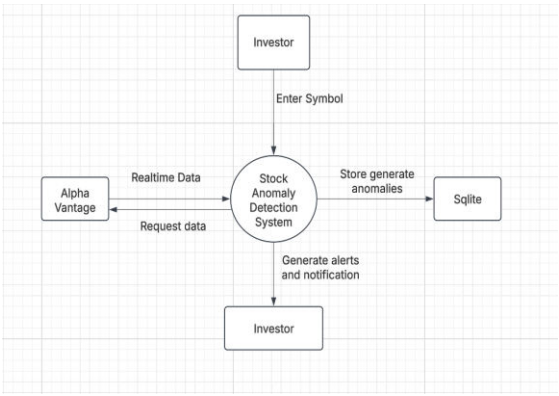

Fig 4.1 Tracking Ways

IV. DESIGN & IMPLEMENTATION

The system design features a four-layer structure: the Presentation Layer, Business Layer, Service Layer, and Data Layer. The Presentation Layer acts as a responsive web-based dashboard that uses HTML, CSS, JavaScript, and Bootstrap.

It gives users real-time visualizations, stock data charts, and anomaly indicators. Users can input stock symbols, request analyses, and see historical anomalies in graphical form. The Business Layer, built in Python with Flask, takes care of data processing, feature engineering, and model execution. It connects the user interface with the backend logic, handling incoming data requests and sending them through the detection pipeline.

The Service Layer handles external API communications. It consistently fetches live market data and keeps the data stream running smoothly. It also manages the alert system and regularly updates the dataset to keep the model accurate. The Data Layer stores historical market data, logs of detected anomalies, and records of user interactions. SQLite serves as the main storage engine because of its lightweight and fast performance. Future scalability is planned with PostgreSQL or cloud-hosted databases for larger deployments.

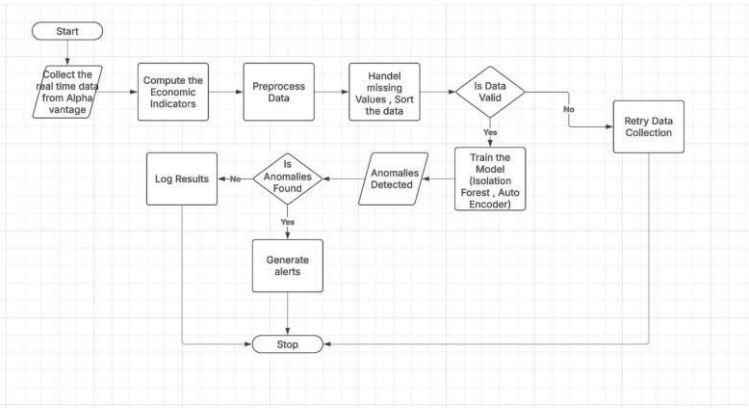

Fig 5.1 Flowchart Working

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VI. OUTCOME OF RESEARCH

The outcome of this research project shows that combining unsupervised machine learning models with real-time financial data streams can greatly improve the detection of anomalies in stock market behavior. By using Isolation Forest and LSTM Autoencoder algorithms, the system effectively identified unusual trading patterns, sudden price changes, and potential market manipulations with high accuracy. Adding technical indicators like moving averages, RSI, MACD, volatility, and rate of change improved the models' ability to distinguish between normal fluctuations and true anomalies.

The project resulted in a fully functional web-based platform. This platform gives traders, analysts, and regulatory authorities real-time anomaly detection capabilities. The dashboard features clear visualizations, including annotated price charts and model performance metrics, which help users interpret results quickly and make informed decisions. Real-time alert systems ensure that important market irregularities are addressed promptly, lowering the risk of financial loss.

Validation using historical data and synthetic anomalies confirmed the robustness and adaptability of the system. This research contributes to financial analytics by offering a scalable, cost-effective, and automated solution for market surveillance, improving transparency, and supporting proactive risk management in volatile market conditions.

VII. RESULT AND DISCUSSION

The results of this project show that the proposed anomaly detection system effectively identifies unusual stock market activities in real time, using Isolation Forest and LSTM Autoencoder models. Testing on historical and live data from NSE, BSE, and Alpha Vantage APIs demonstrated the system's ability to find significant anomalies like unusual price jumps, sudden drops, and abnormal trading volumes. Isolation Forest proved efficient at spotting a wide range of anomalies across various features, while the LSTM Autoencoder excelled at detecting changes in sequential patterns over time. The use of technical indicators like moving averages, RSI, MACD, volatility, and ROC improved model accuracy and reduced false positives compared to simpler statistical methods.

The dashboard interface provided clear visualizations, allowing for quick interpretation of where anomalies occurred and the patterns involved. Performance metrics and model comparison charts gave insight into the detection behavior. Real-time alerts ensured prompt responses to market irregularities, which is crucial for traders, analysts, and regulators. The discussion emphasizes that while each model has strengths; Isolation Forest for breadth and LSTM Autoencoder for detecting changes over time, their combined use creates a stronger detection system. This research confirms that machine learning-based, real-time anomaly detection can improve market transparency, assist in risk management, and lessen the impact of fraudulent or destabilizing trading activities.

Testing on multiple stock datasets, including Apple (AAPL) and SBI (SBIN.NS), showed that combining both models offered a complementary detection ability. For example, the Isolation Forest identified a wider range of anomalies, including short-term fluctuations. In contrast, the LSTM Autoencoder concentrated on longer-term deviations from normal patterns. Cross-validation showed that the models had moderate agreement, suggesting that combining them could further improve detection accuracy.

VIII. CONCLUSION

The "Anomalies Detection in Stocks for Improved Decision Making" project shows how machine learning techniques can improve financial market surveillance. It uses unsupervised algorithms like Isolation Forest and LSTM Autoencoder to identify irregularities in stock prices, trading volumes, and market trends without needing labeled training data. By integrating with real-time data sources such as NSE, BSE, and Alpha Vantage, it enables quick detection, allowing users to respond swiftly to market anomalies.The system has a layered design, smart feature engineering, and an easy-to-use visualization dashboard, making it practical and user-friendly. Technical indicators like moving averages, RSI, MACD, volatility, and ROC enhance model analysis and improve reliability. Testing with different stock datasets confirmed the system's reliability, as both models provided valuable strengths in detecting anomalies.

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