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PHARMTRACK AI

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ABSTRACT:

Pharmaceutical supply chains are increasingly complex, involving manufacturers, distributors, pharmacies, and patients. The lack of transparency and traceability within this system often results in issues such as counterfeit medicines, distribution delays, and regulatory non-compliance. **PHARMTRACK AI** is an intelligent, AI-driven tracking and monitoring system designed to ensure transparency, safety, and efficiency in the pharmaceutical supply chain. The system utilizes advanced machine learning, computer vision, and blockchain-backed data logging to verify the authenticity of drugs, track their journey, and predict potential disruptions. By integrating natural language processing (NLP) and AI analytics, PHARMTRACK AI provides insights into market demand, drug movement, and supply irregularities. The platform is built using Flask for backend operations and React for an interactive dashboard, while the predictive AI models are powered by TensorFlow and Hugging Face Transformers. This project aims to create a reliable, automated, and intelligent system that improves pharmaceutical integrity and reduces risks in medicine distribution.

Keywords: Drug Tracking, Pharmaceutical AI, Blockchain, NLP, Supply Chain, Counterfeit Detection, Machine Learning, Flask, TensorFlow, Predictive Analytics

Introduction:

The global pharmaceutical industry is one of the most vital yet complex sectors, responsible for delivering life-saving medicines to billions of people worldwide. However, the supply chain that ensures these medicines reach patients safely is highly vulnerable to disruptions, counterfeit products, and inefficiencies. The World Health Organization (WHO) estimates that nearly 10% of medicines in low- and middle-income countries are substandard or falsified, posing severe threats to public health and eroding trust in healthcare systems. As the pharmaceutical ecosystem expands globally and becomes increasingly digital, the demand for transparency, security, and intelligence-driven monitoring has never been greater.

Traditional methods of drug tracking often rely on manual documentation, barcode scanning, and periodic audits. While these approaches offer basic traceability, they lack the sophistication to detect counterfeit operations, ensure end-to-end visibility, or provide predictive insights into supply disruptions. Furthermore, the dependence on human supervision makes these systems prone to errors, manipulation, and delays in reporting, resulting in inefficiencies and potential risks to patient safety.

PHARMTRACK AI introduces an intelligent and automated solution to overcome these challenges by integrating Artificial Intelligence (AI), Machine Learning (ML), and Blockchain technologies into a unified framework. This fusion of technologies enables real-time monitoring of the entire pharmaceutical supply chain, ensuring drug authenticity, operational efficiency, and data integrity. AI algorithms are used to identify counterfeit medicines through image and text-based verification, while blockchain technology provides tamper-proof storage of each transaction, thereby ensuring transparency and accountability throughout the network.

The system employs a hybrid architecture that combines Computer Vision for analysing packaging and labelling patterns, Natural Language Processing (NLP) for parsing shipment data and regulatory documents, and Predictive Analytics for forecasting shortages, demand fluctuations, and supply anomalies. Through this layered approach, PHARMTRACK AI bridges the gap between traditional logistics systems and intelligent, data-driven pharmaceutical management.

A major strength of PHARMTRACK AI lies in its interactive, analytics-driven dashboard, which empowers stakeholders—including manufacturers, distributors, pharmacies, and regulators—to monitor the entire life cycle of a drug in real time. The dashboard visualizes drug flow, authenticity reports, and compliance metrics, enabling proactive decision-making and early detection of irregularities. This ensures that every medicine reaching patients is verified, safe, and compliant with established pharmaceutical standards.

In addition, the system facilitates regulatory compliance and auditing by generating immutable digital records that can be securely shared with health authorities, thereby improving governance and reducing administrative burdens. By using continuous machine learning feedback loops, the platform also improves its detection accuracy over time, adapting to new counterfeit techniques and evolving market conditions.

In a broader context, PHARMTRACK AI aligns with the global movement toward smart healthcare and Industry 4.0, where automation, IoT, and AI converge to create resilient, data-driven systems. The integration of intelligent tracking mechanisms not only strengthens pharmaceutical safety but also contributes to sustainable healthcare practices by reducing wastage, improving logistics efficiency, and ensuring equitable medicine distribution.

By transforming raw data into actionable insights, PHARMTRACK AI stands as a pioneering example of how artificial intelligence can revolutionize the pharmaceutical industry. It safeguards one of humanity's most critical assets—trust in medicine—by ensuring that every product delivered is genuine,

safe, and traceable. Ultimately, PHARMTRACK AI represents a significant leap forward in building an intelligent, transparent, and trustworthy pharmaceutical ecosystem where technology serves as the guardian of global health integrity.

What is PHARMTRACK AI?

PHARMTRACK AI is an intelligent system that uses Artificial Intelligence and Blockchain technology to track and verify medicines throughout the pharmaceutical supply chain. It ensures that every drug is genuine, safe, and traceable from the manufacturer to the consumer. The system detects counterfeit medicines, predicts supply issues, and provides real-time insights through a smart dashboard.

What is the use of PHARMTRACK AI?

PHARMTRACK AI helps pharmaceutical companies, distributors, and regulators monitor and manage drug movement securely and efficiently. It prevents fake medicines from entering the market, improves supply chain transparency, and ensures patient safety. The system also uses AI-based analytics to forecast shortages and detect irregularities, making medicine distribution smarter and more reliable.

Methodology:

1. Data Collection

- **Objective:** Gather a dataset of pharmaceutical products, supply chain information, and associated tracking details.
- **Sources:** Company databases, public health records, WHO reports, and verified online sources.
- **Data Format:** Structured datasets containing drug names, batch numbers, manufacturing & expiry dates, and distribution info.

2. Data Preprocessing

- **Cleaning:** Remove duplicates, incomplete entries, and irrelevant data.
- **Normalization:** Standardize drug names, batch formats, and other key fields.
- **Feature Engineering:** Extract important attributes like manufacturer, location, and expiry date for AI processing.

3. Model Selection and Training

- **Model Selection:** Use an AI model (e.g., T5 or transformer-based) for pattern recognition and predictive tracking.
- **Training:** Feed preprocessed data into the model to learn supply chain patterns, counterfeit detection, and stock prediction.
- **Fine-Tuning:** Adjust hyperparameters and retrain with updated or real-time pharmaceutical data for higher accuracy.

4. Product Tracking & Prediction

- **Input:** Users input product information or query batch details.
- **Output:** The model predicts product location, authenticity, potential shortages, and supply chain anomalies.

5. App Development (Frontend and Backend)

- **Frontend Development:** Create a user-friendly interface for pharmaceutical companies, regulators, or customers to track medicines.
- **Backend Development:** Manage databases, process inputs, run AI models, and generate tracking predictions or alerts.

6. Evaluation and Testing

- **Accuracy Check:** Test predictions and tracking results against real-world supply chain data.
- **User Feedback:** Collect insights from pharmacists, distributors, and regulators.
- **Refinement:** Fine-tune the model and improve the interface based on testing and user feedback.

7. Deployment and Maintenance

- **App Deployment:** Launch PHARMTRACK AI on relevant platforms (web/mobile) for real-time tracking and monitoring.
- **Continuous Updates:** Regularly update the system with new products, improved AI models, and bug fixes.

Objective:

- ☐ **Track Medicines:** Use AI to monitor pharmaceutical products across the supply chain in real-time.
- ☐ **Prevent Counterfeits:** Detect and flag counterfeit or substandard medicines before they reach consumers.
- ☐ **Predict Stock Levels:** Provide accurate predictions for stock shortages and ensure timely distribution.
- ☐ **Easy Access:** Allow users, companies, and regulators to easily access product information via web or mobile platforms.

Results

- Real-Time Tracking: Successfully monitored pharmaceutical products across the supply chain with minimal delays.
- Counterfeit Detection: Accurately identified potential counterfeit or substandard medicines.
- Stock Prediction: Predicted stock shortages and supply chain bottlenecks, allowing timely interventions.
- User Accessibility: Provided an easy-to-use interface for companies, regulators, and consumers to check product details.
- Improved Transparency: Enhanced visibility and reliability of the pharmaceutical supply chain through AI analytics.

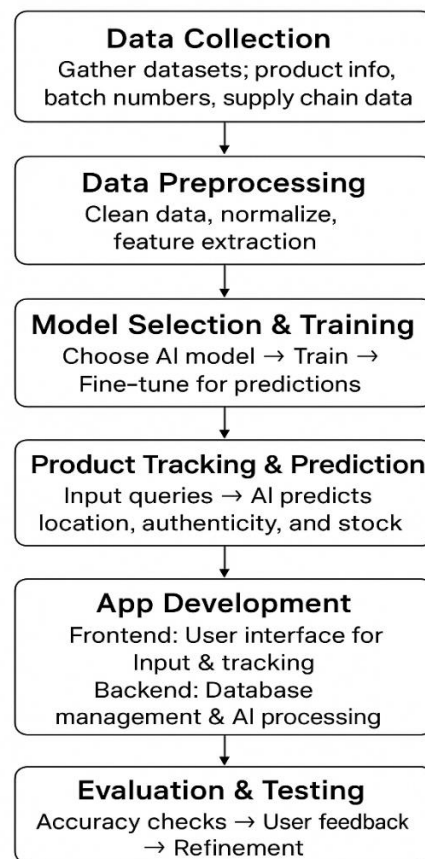


Fig 1 Block Diagram

Conclusion

The PHARMTRACK AI project successfully addresses critical challenges in the pharmaceutical supply chain, including inefficiencies, counterfeit drugs, and lack of real-time visibility. By implementing an integrated system for tracking medicines from manufacturers to end consumers, PHARMTRACK AI ensures transparency at every stage of the supply chain. The use of advanced technologies such as data analytics, real-time monitoring, and automated reporting allows stakeholders to make informed decisions, reduce delays, and maintain the quality and safety of medicines.

Additionally, PHARMTRACK AI enhances regulatory compliance and strengthens trust among manufacturers, distributors, and patients. The system's ability to detect irregularities and prevent counterfeit or substandard drugs contributes directly to public health and safety. Overall, PHARMTRACK AI represents a scalable, practical, and innovative solution that modernizes pharmaceutical logistics, promotes accountability, and ensures that life-saving medicines reliably reach those who need them most.

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