Skin Cancer Detection with Data Security using Federated Learning and Blockchain Technology

An AI-Driven, Privacy Preserving Healthcare Framework

Secure AI for skin cancer detection

Integrating AI, Federated Learning, and Blockchain, this project provides a secure and accurate system for early skin cancer detection. The model uses CNNs for classification and employs federated learning for privacy-preserving training across institutions.

Blockchain ensures secure and transparent data sharing, creating a decentralized healthcare AI ecosystem.

Deep learning and secure data-sharing for skin cancer detection

Skin cancer is one of the most common cancers worldwide. Early detection saves lives, but traditional methods are slow and expensive.

This project uses deep learning and secure data-sharing technologies to accelerate diagnosis and improve accessibility.

Traditional vs AI-Based Detection

Comparing dermatologist expertise with AI technology for skin cancer detection.

01

AI technology

Uses CNN models to automatically classify lesion images into different types of skin cancer.

02

Key advantages

AI detection is faster, more accessible, and scalable for healthcare in both rural and urban areas.

03

Traditional methods

Requires specialized dermatologist expertise, invasive biopsy procedures, and time-consuming laboratory analysis.

System Architecture Overview

The system combines CNN-based deep learning for classification, Federated Learning for data privacy, and Blockchain for secure collaboration among institutions.

Dataset (HAM10000)

• Dataset: 10,015 dermatoscopic images. • Classes: Melanoma, Basal Cell Carcinoma, Squamous Cell Carcinoma, Benign Lesions.

Multiple diagnostic categories

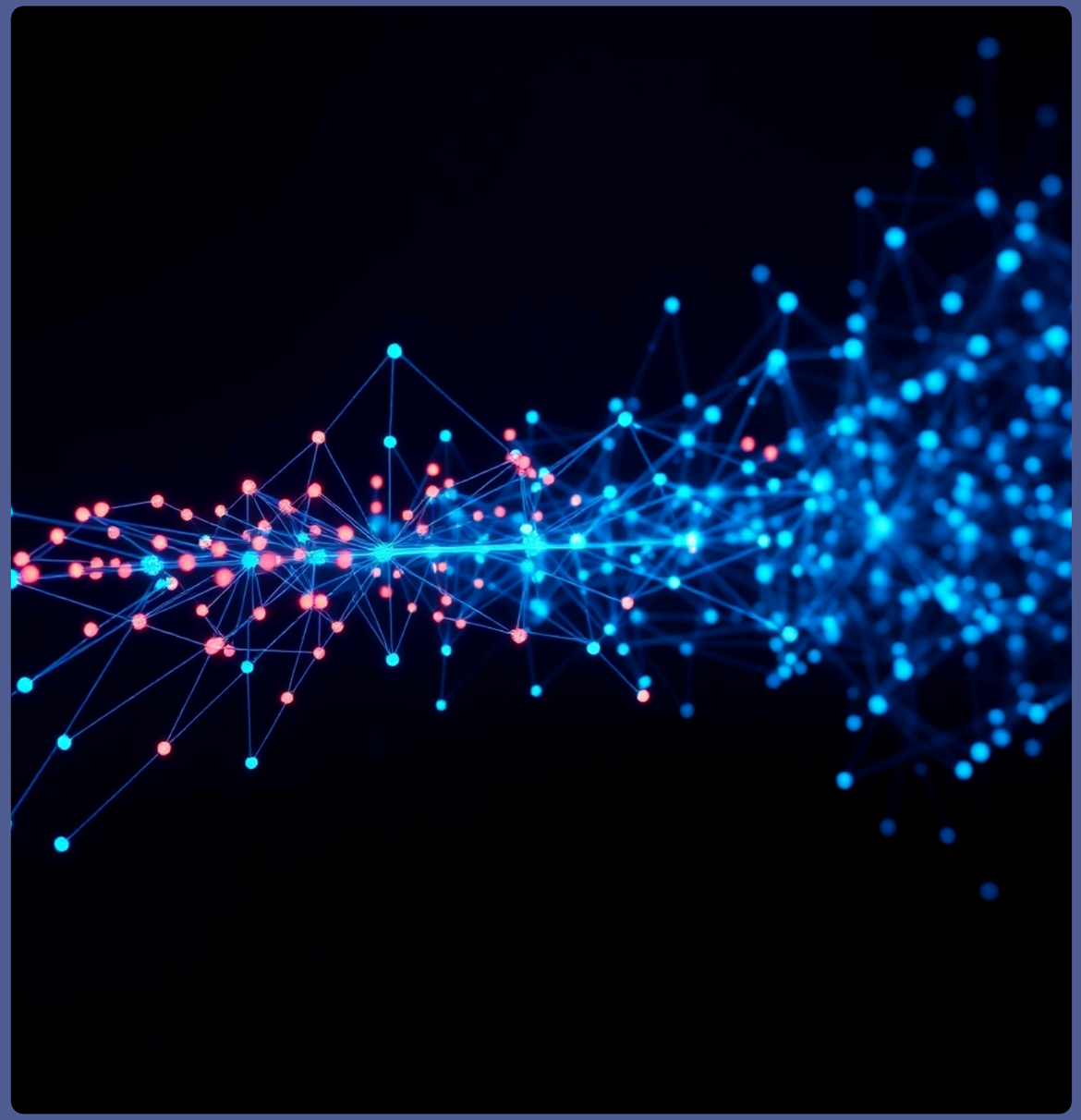
Includes four distinct classes: Melanoma, Basal Cell Carcinoma, Squamous Cell Carcinoma, and Benign Lesions for comprehensive skin cancer research.

Research quality standards

Selected for its size, diversity, and research-standard quality, making it ideal for developing reliable dermatological diagnostic models.

Comprehensive image collection

Contains 10,015 high-quality dermatoscopic images, providing a substantial dataset for skin lesion analysis and classification.



Architecture

Convolutional Neural Network (CNN)

Input → Convolution Layers → Pooling → Dense Layers → Output

- Softmax layer outputs
- Feature learning
- Dense layers integrate
- Model architecture

Federated Learning for healthcare data privacy

FL allows training across multiple hospitals without sharing raw patient data.

01

Institutional training

Each hospital trains a local model on their own data, sharing only model weights instead of raw patient records.

02

Collaborative learning

Enables creation of a comprehensive global model through institution collaboration without compromising data security.

03

Privacy preservation

Protects sensitive patient information while enabling collaborative model training and ensuring HIPAA/GDPR compliance.

Blockchain Integration

Blockchain stores federated model updates immutably and securely for transparent AI training.

Enhanced transparency

Every model update is visible to all network participants, enabling complete auditability and verification of the collaborative training process across distributed systems.

Decentralized trust

By eliminating the need for central authorities, blockchain creates a tamper-proof AI ecosystem where participants can collaborate with confidence in data integrity.

Immutable secure storage

Blockchain technology provides a permanent record of federated model updates that cannot be altered or compromised, ensuring data security throughout the AI training process.

Workflow

System Workflow

Local CNN models train on collected data, allowing each hospital to develop machine learning capabilities tailored to their specific patient populations.

Model updates are shared via Federated Learning, enabling hospitals to collaborate effectively without exposing sensitive patient information.

Blockchain records updates for transparency, creating an immutable ledger of all model changes and contributions from participating institutions.

Performance

Results & Evaluation of image processing system

Balanced between accuracy and real-time performance for clinical use.

Clinical utility balance

Optimized algorithms provide ideal trade-off between diagnostic accuracy and speed for medical applications.

Processing efficiency

System delivers results within 1-3 seconds per image, meeting clinical timing requirements.

Baseline CNN performance

Initial convolutional neural network models achieved 80-85% accuracy on diagnostic images.

Transfer learning advantages

Implementing ResNet and EfficientNet models significantly improved accuracy to 90-95%.

Data Security Framework for Healthcare AI

Secure, transparent, and privacy-preserving AI system for healthcare.

01

Blockchain Technology

Provides tamper-proof security and integrity for all healthcare data and AI model transactions.

02

Combined Approach

Creates a comprehensive system that balances security, transparency, and patient privacy in healthcare AI applications.

03

Federated Learning

Enhances privacy by processing data locally, eliminating the need to share raw patient information.

Benefits

Advantages Over Traditional Diagnosis

The solution is both **cost-effective** and **non-invasive**, eliminating expensive procedures while providing comfortable experiences for patients seeking diagnosis.

Rural healthcare facilities can implement this scalable technology, bringing advanced **diagnostic capabilities** to previously underserved communities and regions.

Medical professionals experience **reduced workload** as the system handles routine cases, allowing doctors to **focus resources** on more complex patient needs.

Roadmap

Future Enhancements for healthcare innovation

Add XAI, use transfer learning, implement blockchain and expand globally

Global expansion

Expanding services to create a comprehensive global healthcare network reaching patients worldwide.

Multi-platform deployment

Developing and deploying cloud and mobile applications for seamless access across different devices.

Advanced AI capabilities

Adding Explainable AI and Transfer Learning models to improve accuracy and transparency in healthcare diagnostics.

Blockchain integration

Implementing smart contracts on blockchain to ensure secure, transparent patient data management and transactions.

Conclusion

This project delivers a secure, AI-driven approach for skin cancer detection. Federated Learning preserves privacy, Blockchain ensures trust, and CNN enables accurate classification. The integration of these technologies creates a robust framework that maintains patient confidentiality while providing healthcare professionals with reliable diagnostic tools.

The system represents the future of collaborative, secure, and scalable medical AI. By allowing multiple institutions to contribute to model development without sharing sensitive data, our approach addresses ethical concerns while advancing medical capabilities. The system represents the future of collaborative, secure, and scalable medical AI.