Breast Cancer Computer-Aided Detection

AI-Powered Mammography Analysis by QuData

Abstract

Mammography is one of the most effective methods for early detection of breast cancer, significantly increasing the chances of successful treatment. However, interpreting mammographic images can be a complex task that requires a high level of expertise from radiologists. The **AI-Powered Mammography Analysis by QuData** with **BI-RADS** classification leverages state-of-the-art neural network architectures to analyze mammographic images efficiently. The system is designed to detect breast abnormalities, classify lesions, and assist in the identification of potential pathologies.

With its high reliability and accuracy, the system enhances the efficiency of mammogram interpretation, reduces the workload on radiologists, and provides crucial support in regions with limited access to specialized medical professionals. This technology contributes to the continuous advancement of breast cancer diagnostics by integrating deep learning methods into the BI-RADS classification system.

The AI-Powered Mammography Analysis is a service developed within **QuMed** – a dedicated initiative of QuData, focused on applying artificial intelligence in medicine. QuMed develops AI-driven solutions for medical image analysis, diagnostic enhancement, and workflow optimization in healthcare institutions.

Service Overview

The **AI-Powered Mammography Analysis by QuData** provides medical institutions with an AI-driven tool for analyzing mammograms using the **BI-RADS (Breast Imaging Reporting and Data System)** scale.

The service fully integrates with **PACS (Picture Archiving and Communication System)** for seamless storage, retrieval, and transmission of analysis results.

1. Key Features

High Accuracy. Our AI algorithms detect abnormalities with an accuracy comparable to leading radiologists. The system automatically analyzes mammographic images and assigns a BI-RADS score (1-5) to indicate the likelihood of malignancy.

Speed. The analysis is completed within seconds, significantly reducing the turnaround time for mammogram assessments and enabling faster decision-making.

Compatibility. The system supports DICOM standards for data exchange, ensuring seamless integration with existing PACS-based medical information systems and imaging equipment.

Detailed Reports. The service generates structured, in-depth reports that include BI-RADS evaluations alongside annotated images for radiologists to review.

AI-Driven Innovation. Utilizing advanced machine learning and artificial intelligence, the model assesses mammographic images and assigns BI-RADS classifications based on detected patterns, enhancing diagnostic accuracy and consistency.

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2. Target Audience and Use Cases

The AI-Powered Mammography Analysis by QuData is designed for various medical institutions and professionals who require advanced AI-driven assistance in mammographic interpretation.

Medical Institutions:

- Diagnostic centers and clinics specializing in mammography
- Multispecialty hospitals with radiology departments
- Oncology centers
- Private medical offices equipped with mammography devices

Medical Professionals:

- Radiologists seeking a second opinion for complex cases
- Oncologists using mammography results for treatment planning
- Junior radiologists who can use the system as a training tool
- Medical personnel in remote areas with limited access to qualified specialists

Key Use Cases:

1. Primary Screening:
    - Automated analysis of routine mammographic examinations
    - Rapid preliminary assessment to prioritize high-risk cases
2. Decision Support:
    - Providing a second opinion to confirm diagnoses
    - Assisting in the detection of subtle abnormalities
    - Reducing the likelihood of missing pathological changes
3. Workflow Optimization:
    - Automated pre-processing and classification of images
    - Prioritization of urgent cases
    - Reducing time spent on routine analysis of normal scans
4. Telemedicine:
    - Enabling remote access to expert mammography analysis
    - Supporting healthcare facilities in underserved regions
    - Facilitating fast consultations for complex cases

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3. Service Architecture

PACS Integration: The QuData's service seamlessly integrates as an external PACS system, receiving **DICOM** (Digital Imaging and Communications in Medicine) images through standardized protocols. This ensures compatibility with existing medical imaging infrastructure.

Data Workflow:

1. A physician's workstation or a hospital's PACS system connects to QuData's PACS via standard DICOM protocols and transmits mammography images.
2. The QuData's system processes the images using advanced AI algorithms to generate a BI-RADS classification.
3. The analyzed results, including the BI-RADS score and any relevant annotations, are sent back to the PACS or other medical systems for clinician review and decision-making.

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4. Technical Details

QuData's AI-powered solution is built on deep neural networks (DNN), specifically convolutional neural networks (CNN), which are optimized for medical image processing. The system follows a multi-stage processing pipeline:

1. **Preprocessing**: Image enhancement and normalization to improve analysis accuracy. The system also verifies metadata tags to ensure compatibility.
2. **Segmentation**: Identifying and isolating key areas of interest within the mammogram for further examination.
3. **Classification & Evaluation**: Analyzing image features and assigning a BI-RADS category (1–5) based on detected patterns.
4. **Report Generation**: Producing a structured report that includes BI-RADS assessment and highlighted pathological findings.

5. **Integration**: The service operates via the **DICOM** protocol and is compatible with **PACS** servers. This ensures seamless deployment and interoperability with existing medical imaging systems across different manufacturers.

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5. Technical Documentation

Integration with PACS

Healthcare facilities must integrate QuData's AI-Powered Mammography Analysis with their PACS system using DICOM interfaces. This integration enables seamless image upload and retrieval of results.

To establish the connection, QuData provides:

- ➔ PACS Server IP Address
- ➔ Communication Port
- ➔ AE Title (Application Entity Title) of our PACS server

In return, the user must provide:

- ➔ IP addresses for authorized client stations
- ➔ AE Title of the client workstations

Once integrated, the hospital's PACS system or workstation transmits DICOM mammography files via the **C-STORE** command to QuData's PACS. Our system receives the images in DICOM format, processes the metadata, and extracts key patient and study information.

DICOM Tags Used:

Patient ID (0010,0020)
Study Date (0008,0020)
Series Description (0054,0220)

The QuData's service utilizes a pre-trained deep learning model to analyze DICOM images and identify breast tissue patterns. The AI model detects features such as tumors, calcifications, and asymmetries and matches them against known BI-RADS patterns for classification.

BI-RADS Assessment Criteria:

BIRADS 1 : Negative
BIRADS 2 : Benign findings
BIRADS 3 : Probably benign
BIRADS 4 : Suspicious abnormality
BIRADS 5 : Highly suggestive of malignancy

Next, using the **C-FIND** command, the user can locate the processed image by **Patient ID** and retrieve it using the **C-MOVE** command. Once the transfer is complete, QuData's service will send the image to the user's system and then delete it from our servers. If the user's system does not retrieve the results within **24 hours**, they will be automatically deleted from our side.

If storing the results on our server is required, the **C-GET** operation can be used to retrieve images from PACS.

To verify the service's availability, the user's workstation should send a **C-ECHO** command.

Response Time:

Image Processing Time: On average, 10–15 seconds per image.

Scalability: The system supports multiple simultaneous requests and dynamically scales based on workload.

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6. Deployment & Security

Cloud-Based Solution. The service is hosted on a secure cloud platform with automatic scaling to handle varying workloads efficiently.

Data Encryption. All transmitted data is encrypted using HTTPS, while DICOM images are stored with AES-256 encryption for enhanced security.

Compliance. The service complies with HIPAA and GDPR regulations, ensuring the secure processing of patient data and maintaining confidentiality.

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7. Future Enhancements

Multimodal Support: Expansion of the service to support additional types of medical imaging for cancer detection.

EHR Integration: Seamless integration with Electronic Health Records (EHR) systems to streamline and automate patient workflows.