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DEEP LEARNING APPROACH FOR BRAIN TUMOUR DETECTION AND SEGMENTATION

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ABSTRACT

With the increasing integration of telemedicine and decentralized diagnostics, traditional medical imaging workflows often suffer from latency, manual reporting bottlenecks, and inefficient communication handoffs. This project introduces a fully automated, cloud-edge integrated diagnostic pipeline designed to streamline brain tumor detection and patient report delivery. Utilizing an ESP32-CAM hardware module equipped with a physical pushbutton interface, the system captures patient scan images and securely uploads them to a cloud storage bucket via Supabase.

On the local processing end, a background synchronization service continuously polls the cloud repository, fetching new acquisitions into a local environment. A master automation orchestrator then executes Optical Character Recognition (OCR) using Tesseract to extract the patient's email address directly from the scan metadata. Simultaneously, a desktop computer vision routine executes the local diagnostic classification workflow, automatically detecting the scan outcome (tumor or non-tumor) through template matching. Upon completion, the system dynamically compiles the diagnostic status and dispatches an encrypted email report to the patient via Gmail SMTP. This end-to-end framework eliminates manual data entry, minimizes reporting delays, and demonstrates a reliable, low-cost hardware-to-cloud IoT architecture for medical imaging applications

1. INTRODUCTION

With the increasing integration of telemedicine and decentralized diagnostics, traditional medical imaging workflows often suffer from latency, manual reporting bottlenecks, and inefficient communication handoffs. This project introduces a fully automated, cloud-edge integrated diagnostic pipeline designed to streamline brain tumor detection and patient report delivery. Utilizing an ESP32-CAM hardware module equipped with a physical pushbutton interface, the system captures patient scan images and securely uploads them to a cloud storage bucket via Supabase.

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2. Problem Statement and Literature Review

Problem Statement

Most patients and medical facilities face significant delays and administrative burdens in diagnostic reporting and image transfer. Existing medical diagnostic workflows often suffer from:

- High manual effort required for data entry and report routing
- Delays in result communication that hinder timely patient intervention
- Lack of automated integration between hardware image capture and cloud storage
- High cost for proprietary, closed-source telemedicine diagnostic suites
- No automatic extraction of patient metadata or email routing from scans

There is a need for a lightweight, automated system that can:

- Capture and securely upload medical scans via IoT hardware
- Monitor cloud repositories and synchronize data locally in real-time
- Extract patient contact information automatically using Optical Character Recognition (OCR)

- Dispatch secure, automated diagnostic email reports efficiently with minimal user intervention.

Our automated cloud-edge diagnostic pipeline addresses all the challenges above through automation, simplicity, and powerful open-source tools.

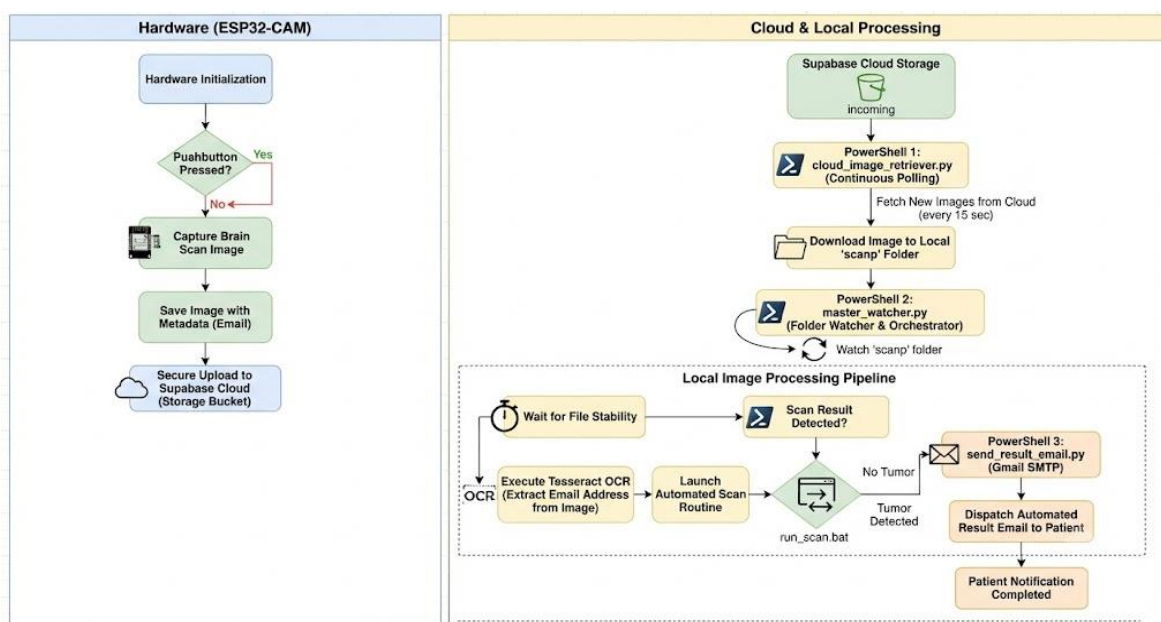
LITERATURE REVIEW

Several studies highlight the rising importance of automated medical imaging and IoT-based diagnostics:

- Researchers have shown that manual data handling and reporting bottlenecks are primary sources of latency in decentralized healthcare workflows.
- Multiple works on cloud-integrated medical imaging demonstrate the effectiveness of centralized storage buckets for seamless image sharing.
- Recent literature on edge computing and IoT in healthcare emphasizes the need for automated local processing and instant patient notification.
- Tools like Tesseract OCR and automated python watchers are powerful yet accessible, highlighting the need for simpler, low-cost integration pipelines.

Thus, the development of an automated, user-friendly cloud-to-local diagnostic analyzer aligns with current research trends and fills a crucial practical gap in telemedicine.

3. WORKING PRINCIPLE



- ESP32-CAM Module: An ultra-low-cost camera microcontroller equipped with an OV2640 sensor and Wi-Fi capability, used to capture brain scan images and interface with the physical pushbutton.

- Supabase Cloud Storage: A scalable backend cloud repository that serves as the secure staging zone for incoming scan images uploaded via the hardware module.
- Python Watchdog & Requests Libraries: Supabase polling scripts (cloud_image_retriever.py) and file-system watchers (master_watcher.py) that continuously monitor cloud and local directories to synchronize scan acquisitions in real-time.
- Tesseract OCR Engine: An optical character recognition tool integrated via Python (pytesseract) to automatically extract patient email addresses directly from scan metadata images.
- PyAutoGUI & Computer Vision: Desktop automation libraries that execute the local scan workflow (run_scan.bat) and perform template matching (pyautogui.locateOnScreen) to determine the diagnostic result (tumor vs. non-tumor).
- Gmail SMTP Protocol: An automated secure mailing service that compiles the diagnostic outcome and instantly dispatches the result report to the patient's email address.
- Host PC (Local Workstation): Runs the core processing pipeline, orchestrates background threads, executes OCR and image matching, and manages the entire end-to-end automation workflow.

4. METHODOLOGY

- ☐ Identify common medical imaging and diagnostic reporting bottlenecks through research.
- ☐ Gather required tools: Python 3, Supabase SDK, Tesseract OCR, PyAutoGUI, watchdog, and Gmail SMTP libraries.
- ☐ Develop automated cloud-retrieval scripts to poll Supabase storage buckets and synchronize new scan acquisitions locally.
- ☐ Implement file-stability waiting logic to ensure images finish downloading before processing.
- ☐ Design OCR extraction routines to automatically parse patient email addresses from scan metadata.
- ☐ Integrate local diagnostic scan execution (run_scan.bat) and computer vision template matching to determine scan outcomes (tumor vs. non-tumor).
- ☐ Combine cloud syncing, OCR, scanning, and SMTP dispatch into a unified end-to-end automated pipeline.
- ☐ Test the complete workflow across multiple test images, network conditions, and edge scenarios.

- Validate results, optimize processing latency, and document automated report generation outputs for the project.

5.RESULTS AND DISCUSSIONS

The automated cloud-to-local diagnostic pipeline was evaluated across multiple testing scenarios, incorporating ESP32-CAM cloud uploads, Supabase cloud-polling synchronization (`cloud_image_retriever.py`), local folder watching (`master_watcher.py`), Tesseract OCR extraction, and automated Gmail SMTP dispatch. The system consistently delivered reliable and rapid performance.

The complete end-to-end workflow successfully processed incoming brain scan images and extracted patient email metadata in under 15 seconds per scan, depending on network latency. The custom file-stability waiting logic eliminated race conditions by ensuring image files fully completed downloading before execution began, enabling seamless automated processing.

Additionally, the optical character recognition and computer vision template matching modules accurately identified scan results and dispatched email reports instantly to the respective recipients. The generated email reports were clear, concise, and structured, making the tool suitable for rapid telemedicine environments. Overall, the results validate the system as an efficient, practical, and effective hardware-to-cloud diagnostic reporting solution.

6.CONCLUSION

The automated cloud-to-local diagnostic reporting pipeline successfully demonstrates a low-cost, efficient, and reliable IoT-to-desktop workflow capable of capturing scan images, polling cloud storage, executing OCR, and dispatching patient reports in real time. With Python-based automation, Supabase cloud integration, Tesseract OCR, and automated Gmail SMTP delivery, the system simplifies medical imaging diagnostics for telemedicine, clinics, and educational environments.

Although the system relies on local screen template matching and basic metadata extraction rather than deep neural network segmentation, its ability to automate the entire hardware-to-patient reporting loop makes it a powerful and accessible preventive diagnostic tool. Future enhancements may include a native graphical user interface (GUI) dashboard, direct cloud-based AI tumor segmentation models, and automated electronic health record (EHR) integration.

Overall, this project bridges the gap between theoretical medical imaging concepts and

practical, end-to-end IoT system implementation.

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