Project Brief: Clinical Interoperability & DICOM Integration

Developer: Gabriel "Gabe" Casillas

Core Objective: To bridge the gap between legacy medical imaging standards and modern web-based healthcare ecosystems through automated data transformation and AI-driven clinical decision support.

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1. The Data Evolution: From Legacy to Modern

This project demonstrates the complete lifecycle of clinical data, moving from siloed, "old-fashioned" formats to high-accessibility web standards.

Phase A: DICOM Legacy to DICOMweb (PS3.18)

- **The Challenge:** Traditional DICOM files are often trapped in heavy, binary formats with 16-bit hex tags (e.g., 0010,0010 for Patient Name).
- **The Solution:** We implemented a **DICOMweb JSON Model** transformation. By mapping these hex tags into a lightweight JSON structure, the imaging metadata becomes instantly readable by modern web applications without losing clinical integrity.

```
const gabeMockStudy = {
  '00100010': { Value: [{ Alphabetic: "CASILLAS, GABE" }] },
  '00080060': { Value: ["MR"] },
  '00081030': { Value: ["BRAIN W/O CONTRAST"] },
  '00080020': { Value: ["20260227"] },
  '0020000D': { Value: ["1.2.840.113619.2.203.4.2147483647"] }
};
```

Phase B: HL7 v2 Ingestion

- **The Protocol:** We built a live listener for **HL7 v2 ADT (Admission, Discharge, Transfer)** messages.
- **The Impact:** This simulates a real hospital feed. When a patient like "DOE, JOHN" is admitted via a curl command (simulating an EMR trigger), the system captures the PID (Patient Identification) segment and syncs it to a cloud-based **Firestore** database.

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2. The Orchestration: Mapping to FHIR R4

The "heart" of the project is the transformation of disparate data into a unified **FHIR (Fast Healthcare Interoperability Resources)** resource.

- **Resource Type:** ImagingStudy.
- **Transformation Logic:** Our mapping engine takes the **DICOMweb** metadata and the **HL7** admission data to create a single, validated FHIR object.
- **The Result:** This provides a 360-degree view of the patient's imaging encounter, ready for enterprise-wide consumption.

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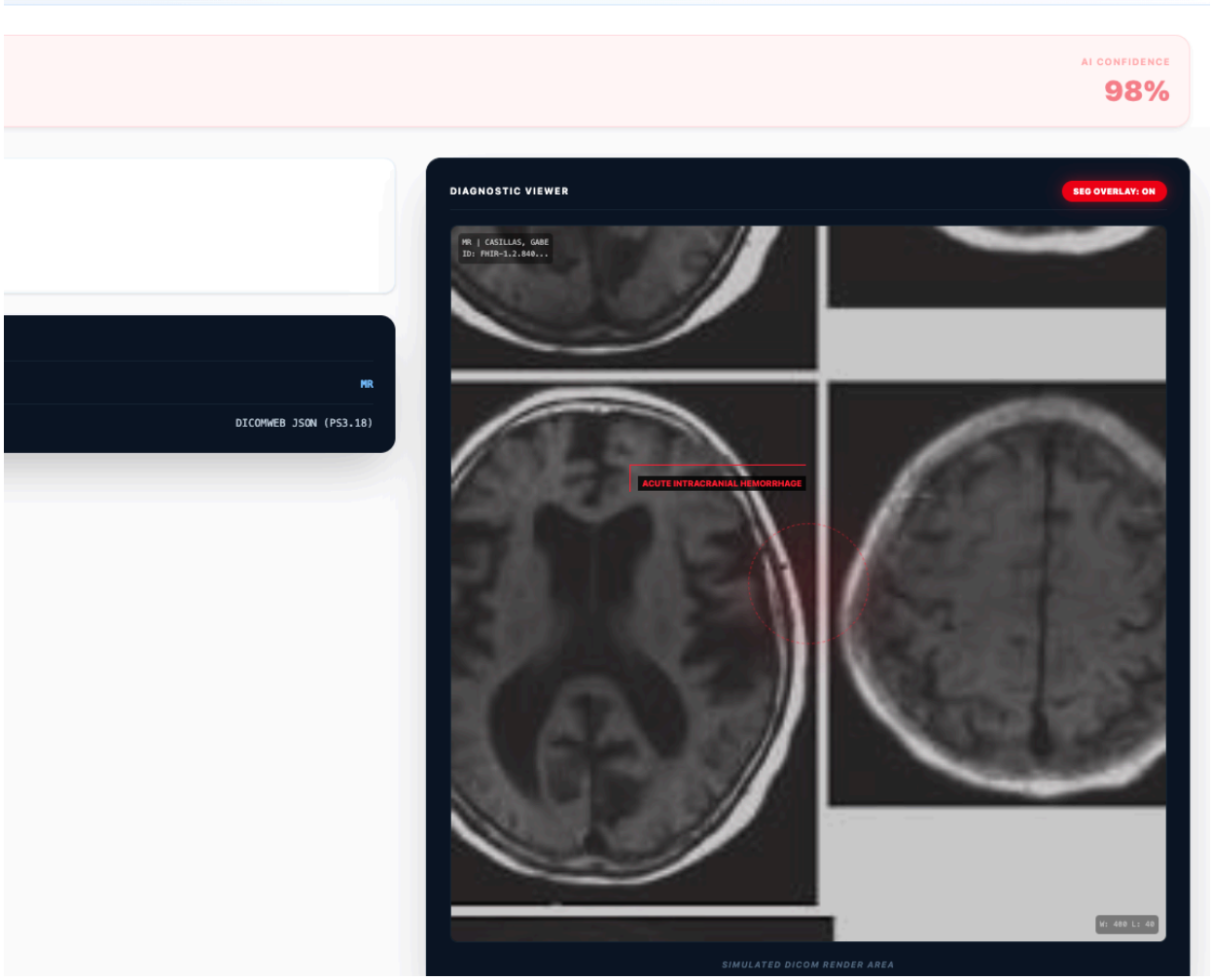
3. Real-World Application: AI & DICOM SEG Pathway

To demonstrate future-ready clinical workflows, we integrated an **AI Logic Controller** that monitors the transformation pipeline.

The "Critical Finding" Trigger

- **Anomaly Detection:** In the mock study for **Gabe Casillas**, the AI identifies a specific metadata pattern and triggers a **Critical Machine Vision Alert**.
- **Real-World Resemblance:** The system detects an "Acute Intracranial Hemorrhage" with **98% confidence**.
- **The SEG Pathway:** In a production environment, this triggers a **DICOM SEG (Segmentation)** object. Our EMR Portal allows a clinician to toggle an **AI Overlay** directly on the brain MRI, visually confirming the AI's finding.



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4. Enterprise EMR Portal Capabilities

The final output is a high-fidelity **Mock EMR Dashboard** that serves as the clinician's single source of truth:

- **Dynamic Workqueue:** Real-time patient updates via Firebase.
- **Interactive Diagnostic Viewer:** Toggleable AI overlays for clinical validation.
- **Interoperability Log:** Transparency into the HL7 $\rightarrow$ FHIR mapping process.

🛠️ Technical Stack

- **Framework:** Next.js 14 (App Router)
- **Database:** Google Firebase (Firestore & Hosting)
- **Standards:** HL7 v2, DICOM PS3.18, FHIR R4
- **Intelligence:** Custom Machine Vision Logic Controller