

# Milestone 1: Problem Definition & Literature Review

## 1. Problem Definition & Objectives

The objective of our project is to build a **Multimodal AI Medical Assistant** that integrates **speech, vision, and text** data to support healthcare practitioners and patients.

- **Speech:** Transcribe patient descriptions, extract symptoms, urgency, and emotional tone.
- **Text:** Process doctor's notes, prescriptions, and medical literature using a domain-specific LLM.
- **Vision:** Analyze medical images (X-rays, MRI, CT scans) to detect potential abnormalities. (extension to first phase of the project)
- **Fusion:** Combine all three (or two) modalities into a unified representation that enables reasoning.
- **Output:**
  - **For doctors:** Structured, detailed diagnostic summary.
  - **For patients:** Simplified explanation in plain English.

**Objective Summary:** Provide an AI assistant that reduces diagnostic time, supports clinical decision-making, and improves patient understanding.

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## 2. Literature Review

### Existing Solutions:

- **Speech-to-Text & Symptom Extraction:** Tools such as the *Google Medical Speech-to-Text API* and *ClinicalBERT* can transcribe and extract symptoms from spoken inputs.
- **Medical Imaging (CV):** CNN and Transformer-based models (e.g., *CheXNet*, *MedViT*) achieve state-of-the-art performance in X-ray and MRI classification tasks.
- **Medical Text (LLMs):** Models such as *BioBERT*, *PubMedBERT*, and *MedPaLM* are fine-tuned on medical corpora to provide clinical reasoning.

- **Multimodal Models:** Recent research (e.g., *BioViL*, *MedCLIP*) explores combining vision and text but often excludes patient speech as an input.

#### Baselines & Benchmarks:

- **CheXpert** and **MIMIC-CXR** datasets for imaging benchmarks.
  - **i2b2** clinical NLP dataset for text-based symptom/diagnosis extraction.
  - **Wav2Vec2 + ClinicalBERT** pipelines for speech-to-symptom baselines.
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### 3. Gaps & Opportunities

- Most existing systems are **unimodal** (focus on speech or vision or text), not integrated.
- Few models provide **patient-friendly explanations**; most are designed only for doctors.
- Current multimodal approaches do not effectively combine **speech, vision, and medical text** into a unified diagnostic reasoning framework.
- Opportunity to design a system that:
  - Uses **multimodal embeddings** for richer diagnostic context.
  - Delivers **dual outputs** (doctor-oriented & patient-oriented).
  - Improves **accessibility** in telemedicine and resource-limited settings.