# BME 417: Team 19
# MedComAI: Clinical Communication Platform

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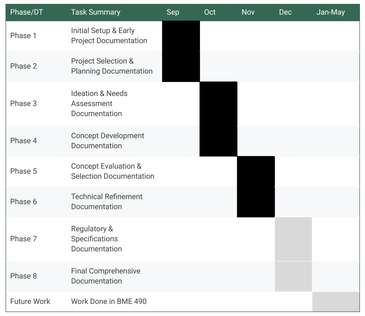
## Introduction

Healthcare professionals face increasing pressure to navigate complex, emotionally difficult conversations with patients, yet current training methods such as role-play or faculty feedback are subjective, costly, and unable to scale to the demands of modern clinical education. More than **53% of U.S. physicians report burnout [1]**, with communication-related stress cited as a major contributor, and **poor communication accounts for 30% of malpractice case**s [2]. Simultaneously, higher perceived clinician empathy significantly improves patient satisfaction and treatment adherence.

**Our mission is to create an AI-powered communication coach that delivers fast, objective, and personalized feedback to clinicians, empowering them to strengthen empathy, improve patient trust, and reduce burnout.**

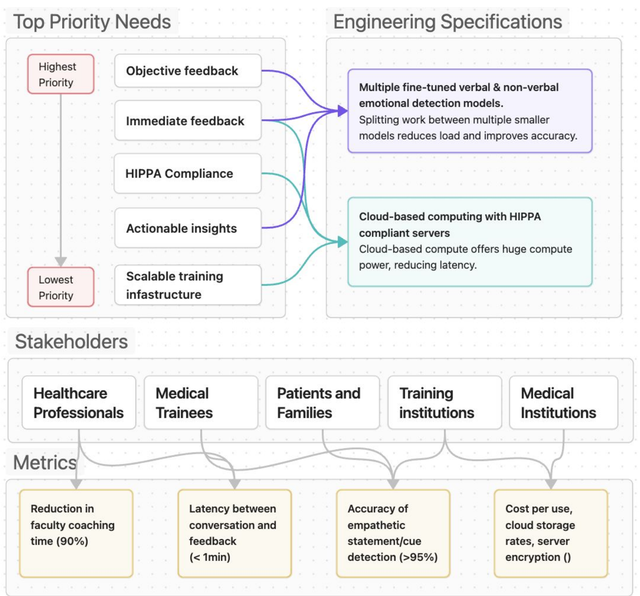
## Planning & Design Status




**Status: Preliminary Architecture**

- **Achievements:** Pipeline 1 (**Audio Analysis**) is functional. Pipeline 2 (**Feedback Generation**) classifies roles, behaviors, and generates reports.
- **Challenge Solved:** Qualitative insights using AI modules and an LLM.

## Design Inputs & Metrics




## Device Concept and Design

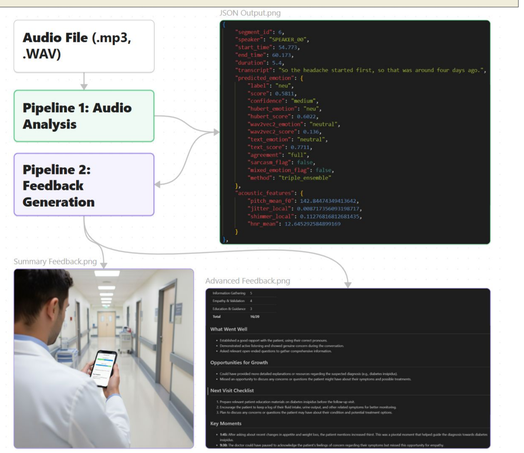
**Concept** Our tool analyzes clinical conversations—*what* was said and *how*—to generate actionable feedback.

**Key Features**

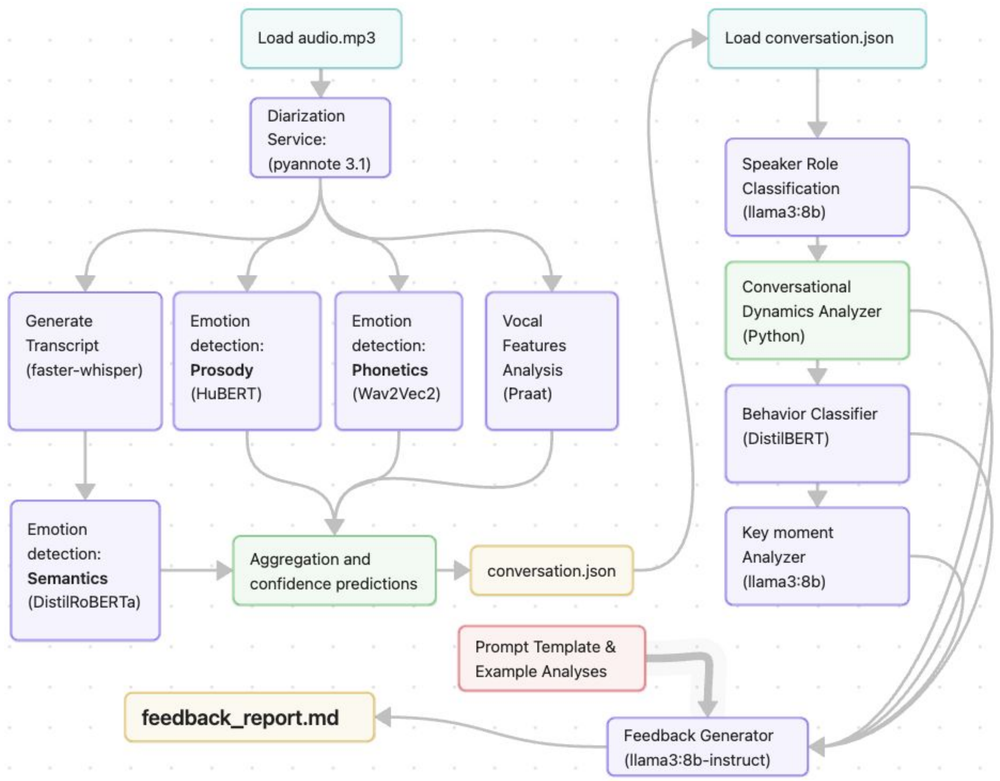
- **Audio Analysis:** Extracts transcription + emotion from conversations
- **Dual Feedback:** Provides instant summary (text/email) + detailed dashboard

**Impact**

- **Trainees:** Get immediate, actionable feedback.
- **Administrators:** Gain a scalable tool to track communication quality and training gaps.
- **Patients:** Benefit from improved provider communication.




## Product Architecture




**Diarization Model**

$$DER = \frac{Total\_Error\_Time}{Total\_Duration} = \frac{FA_{Time} + MS_{Time} + SC_{Time}}{Total\_Duration\_of\_Scored\_Speech}$$

**Automatic Speech Recognition (ASR) Model**

$$WER = \frac{Substitutions + Deletions + Insertions}{Total\_Words\_in\_Reference\_Transcript}$$

**Acoustic Feature Extraction Model**

$$R(\tau) = \int x(t) \cdot x(t+\tau) dt$$

$$F0 = \frac{1}{\arg\max_\tau R(\tau)} \text{ for } \tau \in [\frac{1}{P_{max}}, \frac{1}{P_{min}}]$$

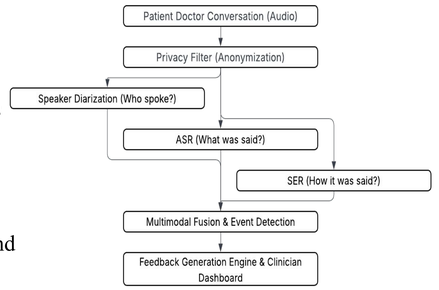
**Clinical Feedback & Analytics Model**

$$CFQ = U(A, S, T) = w_A A_{\text{pipeline}} + w_S S_{\text{feedback}} + w_T T_{\text{task}}$$

$$A_{\text{pipeline}} = (1 - \text{WER}) \times (\text{WF1}_{\text{Emotion}})$$

## Design for Manufacturing

- **Scalability:** Cloud-based infrastructure usable for an entire hospital.
- **Maintainability:** Modular system allows for easy updates
- **Deployment & Cost:** Mobile app for easy access. Model optimization will reduce computational costs.
- **Compliance:** Privacy filters and secure data handling on HIPAA-compliant servers.




## Final Product Specifications

| Category | Specification | Linked Customer Need |
|---|---|---|
| Feedback Latency | <5 sec | Immediate reflection |
| Diarization Accuracy | DER ≤ 6.6% | Trustworthy segmentation |
| ASR Accuracy | WER ≤ 15% | Reliable transcript |
| SER Accuracy | ≥90% | Emotional awareness |
| Empathy Detection | ≥95% precision | Improve empathetic speech |
| HIPAA Compliance | Full encryption + anonymization | Privacy, trust |
| Ensemble Architecture | 3-model fusion | Deeper communication insight |
| Acoustic Feature Stability | r ≥ 0.95 correlation | Accurate tone analysis |

## Future Work

1. **Refine & Validate:** Retrain models with clinical data; validate feedback against SME evaluations.
2. **Expand Behavior Library:** Enhance Behavior Classifier for skills like "Active Listening."
3. **Develop Interactive UI:** Build UI for audio recording, timeline exploration, and feedback review.
4. **Assess "End-of-Meeting" Analysis:** Optimize pipeline for near-immediate report generation post-meeting.

## Acknowledgements

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Scan for: References, Detailed Specifications, and Gantt Chart

Scan For: Supplemental Materials