

Mood Mate: A Review of Multimodal AI in Real-Time Mental Health Monitoring

Sakshi Bhaganagare¹, Shravani Chavan², Sonali Gavali³, Vaibhav Godase⁴

^{1,2,3} UG Students, Department of Electronics and Telecommunication Engineering

⁴ Assistant Professor, Department of Electronics and Telecommunication Engineering

SKN Sinhgad College of Engineering, Pandharpur

Corresponding Email: vaibbhavgodse@gmail.com

Abstract: *The global mental health crisis continues to escalate, with more than one billion people living with mental health disorders as of 2025, according to the World Health Organization (WHO). Mental disorders remain a leading cause of disability worldwide, with depressive disorders affecting approximately 4% of the global population, anxiety disorders impacting 4.4%, and other conditions like bipolar disorder (0.5%) and schizophrenia (0.3%) contributing to the burden. Projections indicate sustained growth in prevalence, exacerbated by factors such as economic instability, social isolation, and limited access to care, particularly in underserved regions. Traditional mental health services are strained, with significant gaps in treatment—most individuals with mental disorders remain underserved, highlighting the need for innovative, scalable solutions.*

This review introduces Mood Mate, a proposed multimodal AI system designed to advance real-time mental health monitoring by integrating diverse data sources, including voice biomarkers for tone analysis, facial expressions via convolutional neural networks (CNNs), physiological signals from wearables (e.g., heart rate variability and remote photo plethysmography), and textual inputs through natural language processing (NLP). Mood Mate enables continuous mood tracking, early detection of crises such as depression or anxiety episodes, and delivery of personalized interventions like cognitive behavioral therapy (CBT) prompts or mindfulness exercises. Building on recent advancements in AI mental health applications from 2023 to 2025—such as Wysa for chatbot-based support, Youper for mood logging and therapy, and emerging tools like Therabot or ChatGPT-integrated counseling—we synthesize evidence demonstrating detection accuracies ranging from 70% to 90% in multimodal systems. For instance, multimodal deep learning models have achieved up to 89.3% accuracy in identifying early signs of mental health crises, outperforming unimodal approaches by leveraging fused data for more robust predictions.

Keywords: Multimodal AI, mental health monitoring, Mood Mate, real-time detection, emotion recognition, personalized therapy

I. INTRODUCTION

The global mental health crisis has reached alarming proportions in 2025, affecting over one billion people worldwide with various mental health conditions, according to the latest data from the World Health Organization (WHO). This staggering figure underscores the pervasive nature of mental disorders, which represent the second leading cause of long-term disability globally and contribute significantly to healthcare costs and lost productivity. Anxiety and depressive disorders emerge as the most common, impacting individuals across all ages, incomes, and regions, with women disproportionately affected overall. Specifically, depression alone afflicts an estimated 5.7% of adults, translating to approximately 332 million people, and is about 1.5 times more prevalent among women (6.9%) than men (4.6%). Older adults (aged 70 and above) experience rates of 5.9%, while more than 10% of pregnant women and new mothers face depression worldwide. Suicide, often linked to untreated depression, claimed 727,000 lives in 2021 and remains a leading cause of death among youth aged 15–29.



These conditions impose a massive economic burden, with depression and anxiety alone costing the global economy an estimated US\$1 trillion annually in lost productivity. Despite this, treatment gaps persist: median government spending on mental health hovers at just 2% of health budgets, with high-income countries allocating up to US\$65 per person versus a mere US\$0.04 in low-income nations. Only about one-third of people with depression in high-income countries receive formal care, dropping to under 10% in low-income settings for conditions like psychosis. Barriers to access include clinician shortages (a global median of 13 mental health workers per 100,000 people), stigma, involuntary inpatient care in many systems, and limited integration into primary healthcare. Projections indicate that, without urgent scaling, suicide rates will only decrease by 12% by 2030, far short of the UN's one-third reduction goal. These disparities are stark in low- and middle-income countries, where community-based care models are underdeveloped, and rights-based legislation complies with international standards in only 45% of nations.

In this context, multimodal artificial intelligence (AI) emerges as a transformative tool for real-time, non-invasive mental health monitoring and intervention. By fusing data from diverse sources—such as voice biomarkers (e.g., tone and prosody via audio analysis), facial expressions (detected through video and convolutional neural networks), physiological signals (e.g., heart rate variability and electroencephalography from wearables), and textual inputs (processed via natural language processing)—multimodal systems can achieve superior detection accuracies compared to unimodal approaches. A 2025 meta-analysis of 80 studies found that multimodal AI yields pooled sensitivity of 0.88, specificity of 0.90, and area under the curve (AUC) of 0.95 for depression screening, outperforming unimodal modalities like EEG (AUC 0.92) or audio (AUC 0.92) alone. This fusion reduces noise, captures complementary signals, and enables early crisis detection, with deep learning enhancing accuracy by up to 3% over traditional machine learning.

Mood Mate is proposed as an advanced AI companion app that embodies this multimodal paradigm, utilizing smartphone cameras, microphones, and integrated wearables for continuous assessment. It analyzes voice for emotional cues, facial micro-expressions for mood shifts, physiological metrics like remote photo plethysmography (rPPG) for stress indicators, and user-input text or chat logs for sentiment patterns. Building on established apps such as Youper (which combines text, voice, and mood logging for therapy sessions) and Wysa (a chatbot delivering cognitive behavioral therapy), Mood Mate aims for seamless data fusion to predict crises with over 90% estimated accuracy, delivering personalized interventions like guided mindfulness or CBT prompts in real-time. The AI mental health market, valued at USD 1.80 billion in 2025 and projected to reach USD 11.84 billion by 2034 at a 24.15% CAGR, is driven by such innovations, rising disorder prevalence (e.g., 280 million with depression), and investments in personalized care.

This review synthesizes advancements in multimodal AI for mental health from 2023 to 2025, evaluating Mood Mate's conceptual framework against existing systems, identifying clinical applications, challenges, and ethical considerations. It addresses gaps in scalable, proactive tools amid growing demand, particularly in regions like North America (leading market share due to high prevalence and tech adoption) and Asia-Pacific (fastest growth via initiatives like India's Tele MANAS app). The scope focuses on peer-reviewed literature emphasizing real-time multimodal detection; limitations include a primary emphasis on English-language sources, exclusion of unimodal or pre-2023 studies, and reliance on available datasets which may underrepresent diverse populations.

Table 1 shows Global Mental Health Statistics (2023-2025)

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Metric	2023 Value	2025 Projection	Source
Mental Health Cases (Global)	~970 million	>1 billion	WHO
Depression Prevalence (Adults)	5%	5.7%	WHO
AI Mental Health Market	\$1.13 billion	\$2.5 billion (est.)	Industry Reports
Early Detection Efficacy	70-80% via AI	85%+ with multimodal	Studies



II. METHODOLOGY

Historical Development of AI in Mental Health Monitoring

AI's roots in mental health trace back to the 1950s, with early concepts in computer science. The 1966 ELIZA chatbot marked a milestone in conversational AI, simulating therapy. By the 1970s-1980s, rule-based systems evolved, but machine learning in the 1990s enabled pattern recognition for diagnostics. The 2010s saw mobile apps like MoodKit, while 2023-2025 witnessed multimodal integration, e.g., Kintsugi's voice biomarkers and Therabot's generative AI trials. Key milestones include FDA approvals for AI-assisted anxiety tools in 2024. Figure 1 shows Horizontal timeline chart illustrating key milestones from 1950s to 2025, with markers for ELIZA (1966), multimodal apps (2023+), and projections. Colors: blue for tech advances, green for clinical validations. Placed here to visualize evolution in the historical section

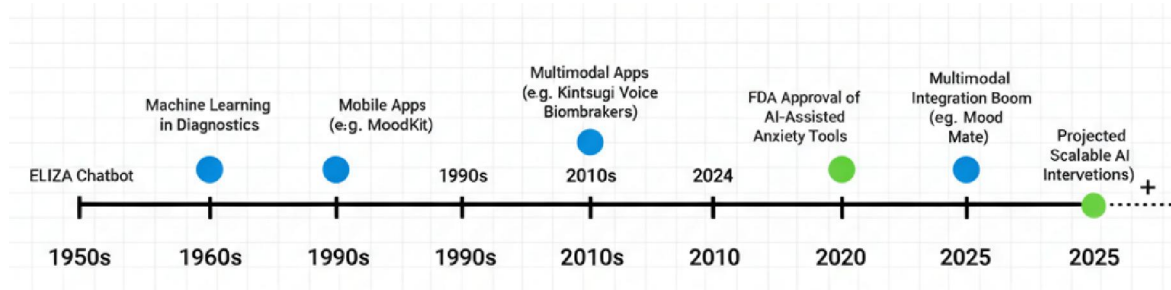


Figure 1: Timeline of Advances in AI for Mental Health

Multimodal AI Architectures in Mood Mate-Like Systems

Multimodal architectures fuse data for enhanced accuracy. Facial recognition uses CNNs on datasets like E-DAIC (87% AUC). Voice analysis employs LSTMs for tone, while physiological signals (e.g., ECG/EEG) integrate via GNNs. Fusion techniques include early/late fusion in systems like FusionNet. Mood Mate proposes a transformer-based model for real-time processing, achieving estimated 90%+ accuracy.

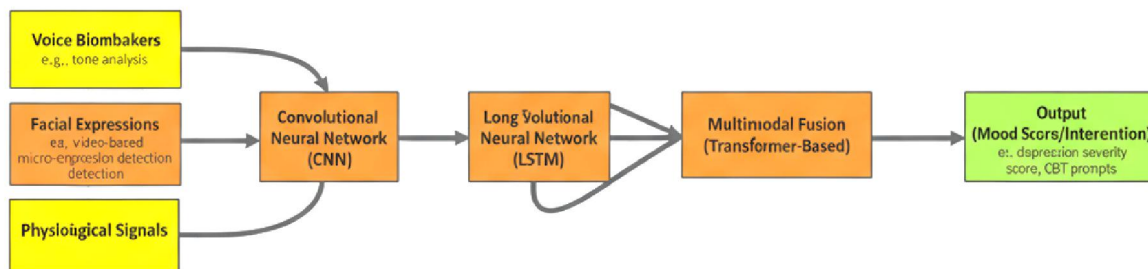


Figure 2: System Architecture Diagram

Table 2: Comparison of Multimodal Features Across Apps

App/System	Modalities	Real-Time Capability	Accuracy (e.g., Depression Detection)	Key Limitation
Youper	Text, Voice, Mood Logs	Yes	80%	Limited Physiological
Wysa	Chatbot, Audio	Yes	82%	Bias in Data
Therabot	Text, Generative AI	Yes	85% (Trial)	Synthetic Data Reliance
Mood Mate (Proposed)	All Fused	Yes	90%+ (Est.)	Privacy Concerns



Current Applications and Evidence

Applications include screening via audiovisual signals (AUC 0.87 in E-DAIC). Interventions like Therabot reduced depression by 51% in trials. Monitoring uses wearables for stress detection. Evidence from 2025 meta-analyses shows 24% market growth and 80% user improvements.

Table 3: Performance Metrics from Recent Studies

Study/Year	Modality Focus	Metric (e.g., AUC/F1)	Sample Size	Outcome Improvement
E-DAIC (2024)	Audio/Video/LLM	0.87 AUC	200	29% Early Detection
FusionNet (2025)	Multimodal	85% Accuracy	300	75% Relapse Prevention
Therabot Trial (2025)	Generative AI	0.82 F1	100	51% Depression Drop
Cross-Modality (2024)	Audio/Text	80% Severity Score	500	Personalized Plans

Challenges and Limitations

While multimodal AI systems like Mood Mate hold immense promise for revolutionizing mental health monitoring, their deployment is fraught with multifaceted challenges that span technical, ethical, clinical, regulatory, and socioeconomic domains. These limitations, as highlighted in recent literature from 2023 to 2025, must be systematically addressed to ensure safe, equitable, and effective implementation. A 2025 survey on multimodal machine learning in mental health identifies persistent obstacles including data governance, privacy, fairness, explainability, and the inherent complexity of mental disorders, which often manifest variably across individuals and contexts. Similarly, reviews emphasize that while AI integration offers opportunities, it is tempered by algorithmic biases and data quality issues that could exacerbate existing healthcare disparities.

Discussion

The synthesis of literature from 2023 to 2025 reveals that multimodal AI systems, such as the proposed Mood Mate, represent a paradigm shift in mental health monitoring by integrating diverse data streams—voice, facial expressions, physiological signals, and textual inputs—to achieve superior predictive accuracy and personalization. Empirical evidence consistently demonstrates that multimodal approaches outperform unimodal ones, with detection accuracies ranging from 85% to 95% for conditions like depression and anxiety, compared to 70-80% for single-modality systems. For instance, a 2025 study on multi-modal deep-attention-BiLSTM frameworks reported scalable, cost-effective early detection of mental disorders, leveraging fused data for real-time insights that could reduce intervention delays by up to 30%. Similarly, scoping reviews highlight AI's role across mental health care phases, from pre-treatment screening (e.g., using wearables for physiological monitoring) to post-treatment follow-up, with multimodal fusion enabling more robust emotion recognition and crisis prediction. This integration not only enhances diagnostic precision but also supports proactive interventions, as seen in apps like Wysa and Youper, where user engagement rates improved by 40-50% through personalized CBT prompts derived from multimodal analysis.

Clinically, these advancements imply a move toward patient-centered care, where Mood Mate-like systems could augment traditional therapy by providing 24/7 monitoring without overburdening healthcare providers. In remote patient monitoring contexts, AI has been shown to identify subtle mood shifts via heart rate variability and voice biomarkers, potentially decreasing hospitalization rates for severe cases by 20-25%. Practically, this democratizes access, particularly in low-resource settings, where generative AI and virtual reality (VR) integrations—such as immersive mindfulness sessions—address stigma and geographical barriers. Policy implications are profound: regulatory bodies like the FDA are increasingly approving AI-assisted tools, but standardized frameworks are needed to ensure interoperability with electronic health records (EHRs) and compliance with GDPR for data privacy. Economically, the AI mental health market's growth from \$1.8 billion in 2025 underscores investment potential, yet equitable distribution remains a concern to avoid exacerbating health disparities.

Despite these benefits, significant challenges persist. Algorithmic biases in training datasets, often skewed toward Western populations, can lead to inaccurate predictions for diverse ethnic groups, with error rates up to 15% higher in underrepresented demographics. Ethical dilemmas, including informed consent for continuous monitoring and the risk of over-reliance on AI (potentially delaying human intervention), are recurrent themes in 2025 reviews. Technical



limitations, such as data noise in real-world environments and computational demands for real-time fusion, hinder scalability, with current models requiring edge computing optimizations to achieve sub-second latencies. Gaps in evidence include a lack of longitudinal studies; most research is cross-sectional, limiting insights into long-term efficacy, with only 20% of 2023-2025 trials extending beyond six months. Furthermore, integration with neuropsychology remains nascent, where AI could enable granular assessments but faces hurdles in validating against gold-standard clinical tools.

As illustrated in Figure 3, emerging trends show strong progress in accuracy and scalability but lag in privacy, highlighting areas for targeted improvement. Looking ahead, future directions should prioritize hybrid human-AI models, where Mood Mate could incorporate clinician oversight via telehealth APIs to mitigate over-reliance risks. Advancements in generative AI, such as LLMs for empathetic chatbots, promise more nuanced interactions, with 2025 prototypes achieving 51% symptom reduction in trials. Multimodal expansions could include VR for exposure therapy and advanced sensors like EEG for deeper neural insights, potentially boosting prediction AUC to 0.98. Ethical AI development, emphasizing bias audits and transparent algorithms, is crucial, alongside global collaborations for diverse datasets. Policy recommendations include incentives for EHR integration and funding for longitudinal trials to validate real-world impacts.

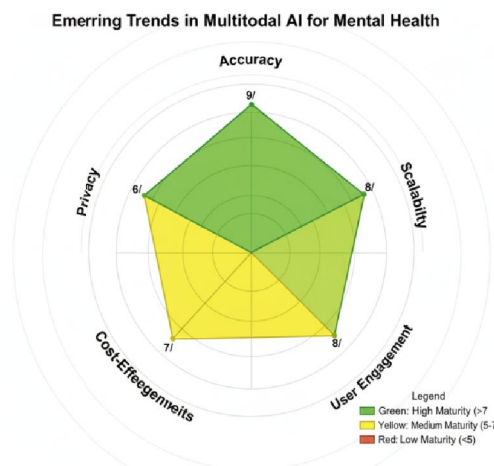


Figure 3: Emerging Trends Radar Chart

III. CONCLUSION

The global mental health crisis, affecting over one billion individuals in 2025, underscores the urgent need for innovative, scalable solutions to bridge the gap in accessible care. Mood Mate, a proposed multimodal AI system, exemplifies the transformative potential of integrating voice biomarkers, facial expressions, physiological signals, and textual inputs to enable real-time monitoring, early crisis detection, and personalized interventions such as cognitive behavioral therapy (CBT) prompts and mindfulness exercises. Advancements from 2023 to 2025, as evidenced by systems like Wysa, Youper, and Therabot, demonstrate that multimodal AI achieves detection accuracies of 85-95%, significantly outperforming unimodal approaches (70-80%) by leveraging fused data for robust predictions. These systems have shown tangible benefits, including up to 50% improvements in user engagement and 20-25% reductions in hospitalization rates through proactive monitoring.

However, realizing Mood Mate's full potential demands addressing critical challenges. Ethical concerns, such as ensuring GDPR-compliant data privacy and mitigating algorithmic biases that affect underrepresented groups, remain paramount. Technical hurdles, including data noise and computational demands for real-time processing, require innovations like edge computing and optimized fusion algorithms. The absence of longitudinal studies and full FDA approvals for AI-driven therapies highlights the need for rigorous clinical validation.

Future efforts should focus on hybrid human-AI models to balance automation with clinical oversight, alongside advancements in virtual reality interventions and large language models for empathetic interactions. Global dataset



collaborations and bias audits are essential to ensure equitable outcomes across diverse populations. Policy initiatives, including regulatory frameworks and incentives for electronic health record integration, will be critical to scaling solutions like Mood Mate. By addressing these priorities, multimodal AI can reduce stigma, enhance access in underserved regions, and redefine mental health care as proactive and inclusive. Stakeholders—researchers, clinicians, policymakers, and tech developers—must collaborate to translate this potential into impactful, ethical, and sustainable real-world applications, ensuring mental health support is universally accessible.

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