TECHNICAL PROPOSAL

Project BeepBlip: Real-Time Affective Biofeedback & Interoceptive Offloading

Technical Proposal, Scientific Rationale & System Architecture

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Abstract

Project BeepBlip is an assistive technology designed to offload the cognitive processing of difficult emotions. By pairing continuous physiological and linguistic signals with custom auditory cues ("beep blips"), the system provides real-time interoceptive biofeedback. This document outlines the psychological mechanisms, system architecture, mathematical formulation, and development roadmap for a scalable emotion labelling engine.

1 Scientific Rationale: Why BeepBlip Works

The core premise of BeepBlip—that an external cue can offload the cognitive burden of recognizing and regulating difficult emotions—is supported by interconnected psychological and physiological theories:

- **The Interoceptive Gap:** Emotional awareness begins with interoception—the perception of internal bodily signals like heart rate and breathing. Many individuals experience low interoceptive accuracy (IAcc) or delays in conscious processing. BeepBlip acts as an auxiliary interoceptive monitor, providing objective feedback on physiological arousal before it manifests as behavioral dysregulation.
- **Cognitive Offloading & Executive Function:** Regulating a "hard emotion" requires significant executive functioning for continuous self-monitoring. By delegating state-tracking to an external algorithm, executive resources are freed to focus on active coping mechanisms.
- **The Power of Affect Labelling:** Assigning precise terms to affective states (emotional granularity) reduces anxiety and depression severity. BeepBlip's custom auditory cues serve as immediate, low-friction labels (e.g., a distinct pitch profile for irritation versus sadness).
- **Auditory Biofeedback:** Audio cues directly modulate the autonomic nervous system. Real-time auditory feedback offers a rapid modality for guiding user attention back to physiological equilibrium.

2 System Architecture

The system architecture transitions from continuous multimodal sensing to real-time auditory intervention.

2.1 Phase 1: Multimodal Sensing & Data Ingestion

- **Physiological Sensors:** Photoplethysmography (PPG) for heart rate variability (HRV) and Electrodermal Activity (EDA) for sympathetic nervous system arousal.
- **Linguistic Data (NLP):** Real-time text and voice stream analysis for sentiment and emotional vocabulary, providing cognitive context.

2.2 Phase 2: Real-Time Inference Engine

- **Signal Processing:** Raw sensor data is filtered and windowed (30-second sliding windows) to extract key metrics (e.g., RMSSD for HRV, peak frequency for EDA).
- **Machine Learning Classifier:** Models trained on the Russell Circumplex Model of Affect classify states across valence (pleasant/unpleasant) and arousal (calm/activated) dimensions.
- **Dynamic Thresholding:** Baselines adapt continuously to individual user physiology rather than relying on static population averages.

2.3 Phase 3: The BeepBlip Intervention

When emotional arousal breaches dynamic limits, an immediate auditory trigger T_a is dispatched. The auditory cue delivers a pre-conscious label to the user, enabling proactive self-regulation.

3 Mathematical Formulation

Let S_t represent the user's physiological and linguistic state vector at time t. The arousal metric $A(S_t)$ is evaluated against the dynamic threshold τ_{arousal}. The dispatch logic is formulated as:

$$T_a = \begin{cases} \text{AudioCue}(\text{HighArousal}), & \text{if } A(S_t) \geq \tau_{\text{arousal}} \\ \text{Null}, & \text{otherwise} \end{cases} \tag{1}$$

4 Feasibility Analysis & Development Roadmap

4.1 Development Schedule

Phase	Milestone Objectives	Timeline
Phase I	Prototype ingestion pipeline for PPG sensor data & basic NLP sentiment.	Month 1–2
Phase II	Train baseline multimodal classification model on arousal/valence datasets.	Month 3–4
Phase III	Integrate real-time low-latency audio cue dispatch engine.	Month 5
Phase IV	Field evaluation on interoceptive offloading efficacy.	Month 6

5 Conclusion

Project BeepBlip establishes a scalable architecture for automated affective feedback. By translating physiological dysregulation into immediate auditory signals, the system offers an intuitive, low-friction mechanism to support emotional regulation and reduce cognitive load.

No bad feelings. Only beep blips.