RAMAIAH
Institute of Technology

DEPARTMENT OF ARTIFICIAL INTELLIGENCE
AND
MACHINE LEARNING

AIP67: MINI PROJECT **TERM: MARCH 2025 – JUNE 2025**

Project Synopsis

Neurofeedback System for Seizure Prevention and Treatment Using Early Detection and Brainwave Redirection

Under the guidance of

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PROJECT TEAM MEMBERS

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(Autonomous Institute, Affiliated to VTU)

1. **Project Stream & Type:**

- **Stream:** Healthcare & AI
- **Type:** Machine Learning & Signal Processing Application

2. **Title of the Project:**

Neurofeedback System for Seizure Prevention and Treatment Using Early Detection and Brainwave Redirection

3. **Problem Statement:**

Epilepsy affects over 50 million people worldwide, causing unpredictable seizures that disrupt daily life and well-being. Despite advancements, current treatments remain inadequate for many. Anti-epileptic drugs fail in 30% of cases, leading to drug-resistant epilepsy, while alternative options like surgery and vagus nerve stimulation are invasive and costly, often exceeding $20,000. Medication expenses also create financial barriers, particularly in low-income regions where 80% of epilepsy cases occur. Existing wearable devices focus on post-seizure detection rather than prevention, leaving patients vulnerable. A non-invasive, AI-driven solution is needed to provide real-time seizure prediction, enhancing safety and accessibility.

4. **Project Management Methodology: Prototype Model**

For the Neurofeedback System for Seizure Prevention and Treatment, we will adopt the Prototype Model as our project management methodology. This approach is well-suited for projects that require continuous testing, refinement, and feedback to ensure the final system is both functional and effective.

4.1.Motivation:

1. **Prevalence** – Epilepsy affects **50M+ people worldwide**, yet many remain undiagnosed or mismanaged. Unpredictable seizures lead to **injuries, disability, and sudden death (SUDEP)**.

2. **Ineffectiveness of Current Solutions** – **30-40%** of patients have **drug-resistant epilepsy**. Medications only **manage** seizures, often causing **side effects** like memory loss, drowsiness, and mood disorders.

3. **Invasive & Harmful Treatments** – Surgery and implantable devices (DBS, VNS) are **high-risk, irreversible, and not suitable for all**. Even non-surgical alternatives require **body implants**, causing **complications**.

4. **Expensive & Inaccessible** – **80% of epilepsy cases** occur in **low-income countries**, where treatment is **too costly** or unavailable. Surgery and implants remain out of reach for most.

4.2. Methodology Implementation Stages:

- Requirement Analysis: Define datasets, EEG hardware compatibility, and model constraints.
- Quick Prototype Development: Build basic seizure detection models using a subset of data.
- User Feedback & Testing: Validate model performance with simulated data and refine parameters.
- Refinement & Enhancement: Improve accuracy, optimize latency, and fine-tune neurofeedback.
- Final Deployment & Maintenance: Integrate models, finalize the interface, and ensure real-time usability.

The Prototype Model ensures that our neurofeedback system evolves continuously, improving prediction accuracy and real-time intervention, ultimately making it more reliable for seizure management.

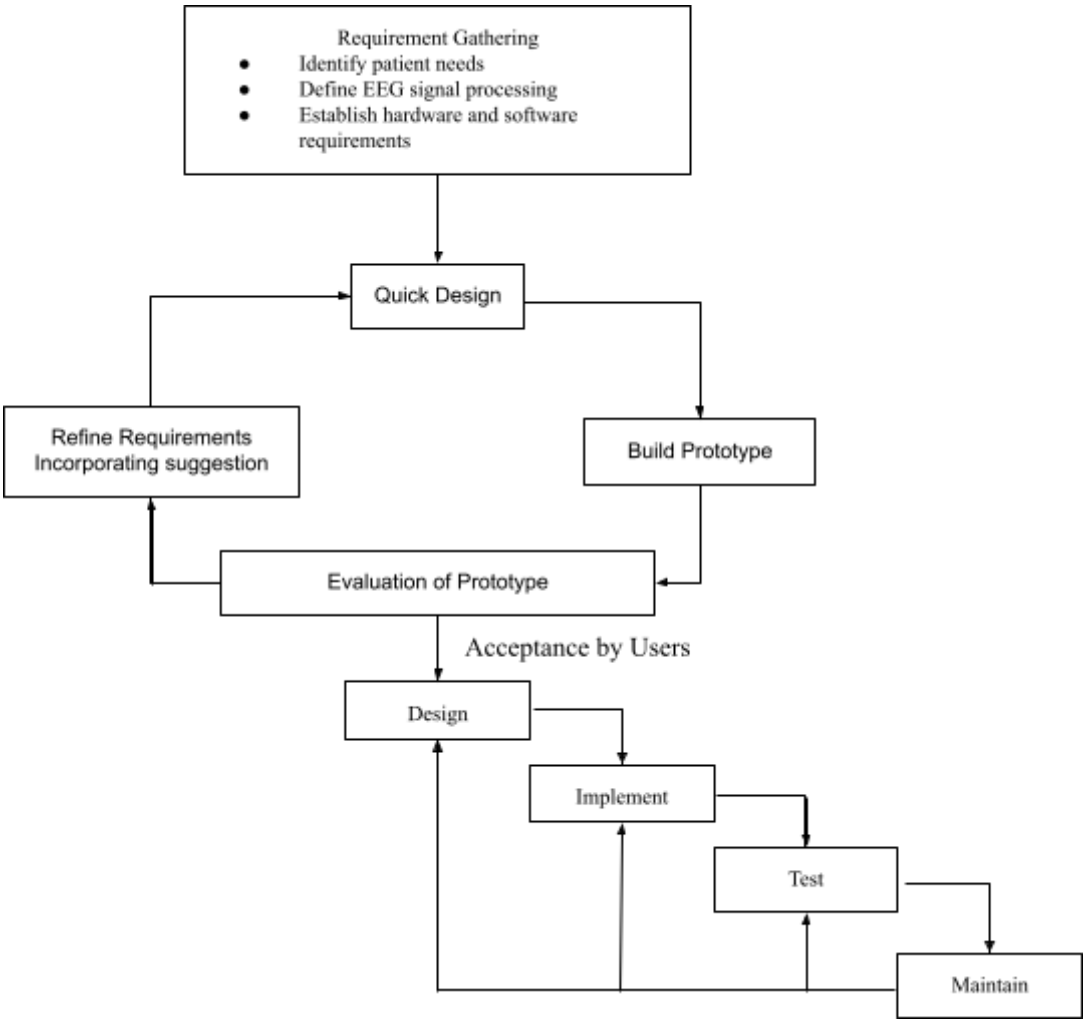

Fig.1. Prototype Model for Neurofeedback system

5. Objective & Scope of the Proposed Project

5.1. Objective:

The project aims to design and develop a real-time AI-powered seizure prediction and neurofeedback intervention system that enhances seizure management by:

- Predicting seizures in advance using EEG signal processing and AI models.
- Delivering neurofeedback interventions to stabilize brainwave activity and prevent seizures.
- Providing a wearable, non-invasive solution that is both affordable and accessible.

5.2. Scope:

1. AI-Based Seizure Prediction
2. Real-Time Neurofeedback Intervention
3. Wearable Integration & Usability
4. Cost-Effective & Scalable Solution

By addressing these objectives, this project will provide a groundbreaking shift in seizure management, offering a predictive, preventive, and accessible solution for patients worldwide.

6. Hardware & Software to be Used:

Hardware:

- Brain-Computer Interface (BCI): BrainSense One, OpenBCI Cyton, Muse 2.
- Processing Unit: High-performance GPU (NVIDIA RTX 3050)
- Storage & Connectivity: Cloud storage (AWS, Google Cloud), Bluetooth/Wi-Fi for real-time data transfer.

Software:

- EEG Signal Processing: MNE-Python, PyEDFlib.
- Machine Learning: TensorFlow, PyTorch, Scikit-Learn.
- Database & Cloud: PostgreSQL, Firebase, AWS S3, Google Cloud Storage.

7. Expected Outcome of the Proposed Project:

- Real-Time Seizure Prediction: AI-driven models will analyze EEG signals to detect seizure patterns before they occur, providing timely alerts.
- Non-Invasive Neurofeedback Interventions: The system will use brainwave modulation techniques to reduce seizure likelihood without requiring surgery or medication.
- User-Friendly Dashboard: A web and mobile interface will allow patients and caregivers to monitor real-time EEG data, receive alerts, and track historical trends.
- Cost-Effective Solution: Compared to expensive surgical procedures and long-term medication, this system will offer an affordable, accessible alternative for seizure management.

8. Contribution to Society

- Comprehensive Solution for All: Designed to cater to a wide range of epilepsy patients, including those who do not respond to medication, this system ensures that no patient is left without a viable management option.
- Enhanced Quality of Life: By providing early seizure warnings and neurofeedback-based interventions, the system helps epilepsy patients regain independence and reduce anxiety related to unpredictable seizures.
- Affordable & Accessible Solution: Unlike costly surgeries and lifelong medication, this system offers a budget-friendly alternative, making advanced seizure management accessible to low-income communities.
- Reduced Dependence on Invasive Treatments: Many existing solutions, such as brain surgeries and vagus nerve stimulation, are invasive and come with risks. **This** non-invasive approach minimizes medical complications while ensuring effective seizure control.
- Advancing AI-Driven Healthcare: By integrating EEG analysis, machine learning, and neurofeedback, the project contributes to the growing field of AI-based medical technologies, paving the way for more intelligent, real-time healthcare solutions.

9. REFERENCES

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