Project Proposal

Title: AI-Driven Mental Disorder Detection via Facial Expression Analysis

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Project Overview:

The increasing prevalence of mental disorders such as depression, anxiety, and PTSD highlights the urgent need for early detection and intervention. Facial expressions are key indicators of emotional states, and advancements in deep learning enable automated analysis of these expressions to assess mental health conditions. This project aims to develop an AI-powered system that detects mental disorders using facial expression analysis. By leveraging state-of-the-art deep learning models and real-time processing, the system will provide a cost-effective and accessible tool for preliminary mental health screening.

Research Questions & Objectives:

- **Primary Research Question:** How accurately can facial expressions predict mental health disorders?
- **Secondary Research Questions:**
    - Can multi-modal learning (text + image data) enhance model performance? (To be integrated if time permits or after the basic model is ready.)
    - What deep learning architectures are most efficient for real-time emotion detection?
    - How can ethical concerns such as bias and privacy be addressed in the development and deployment of the system?

Objectives:

1. Develop a deep learning model to classify facial expressions and correlate them with mental health disorders.

2. Achieve high accuracy (85%+ benchmark) in detecting disorders such as depression, anxiety, and PTSD.
3. Build a user-friendly web application for real-time facial expression analysis.
4. Compare the performance of traditional CNNs (e.g., EfficientNet-B4) with modern architectures like Vision Transformers (ViT).
5. Explore temporal analysis using a hybrid CNN-LSTM model for video-based emotion classification.

Methodology:

Dataset:

- **Primary Dataset:** AffectNet (1M+ facial images labeled for emotions).
- **Augmentation:** Synthetic image generation using GANs (Generative Adversarial Networks) to balance the dataset and address potential biases (to be explored if needed).

Preprocessing:

- Use **Mediapipe Face Detection** for accurate facial landmark extraction.
- Convert images to grayscale, normalize, and resize (224x224) for uniform processing.
- Perform feature extraction on key facial regions (eyes, mouth, eyebrows) to enhance emotion classification.

Model Selection:

1. **Base Model:** EfficientNet-B4 (pretrained for better accuracy and efficiency compared to VGG16).
2. **Alternative Model:** Vision Transformer (ViT) for advanced feature extraction (to be explored after base model completion).
3. **Temporal Analysis:** Hybrid CNN + LSTM model for video-based analysis (to be integrated after successful static image classification).

Emotion Classification Strategy:

- **Positive (Normal):** Happy, Neutral, Surprised.
- **Negative (Potential Disorder):** Fear, Disgust, Sad, Angry.

- **Final Classification:** Depression, Anxiety, PTSD (based on emotional patterns).

Prediction of Mental Health Risk:

- Analyze engagement levels and expression patterns over time to assess disorder severity.
- Use machine learning classifiers (e.g., K-Nearest Neighbor (KNN) or Random Forest) to refine predictions based on emotional trends.

Implementation & Deployment:

- **Frontend:** React.js for UI (developed using Visual Studio Code).
- **Backend:** Firebase (Cloud Functions for model inference, Firestore for storing results).
- **Deployment:** Free-tier Firebase Hosting + TensorFlow.js for real-time processing.

Evaluation Metrics:

To ensure the model's effectiveness and reliability, the following evaluation metrics will be used:

Primary Metrics:

1. Accuracy: Measures the proportion of correctly classified instances out of the total instances.
2. F1-Score: Balances precision and recall, especially useful for imbalanced datasets.
3. AUC-ROC (Area Under the Receiver Operating Characteristic Curve): Evaluates the model's ability to distinguish between classes.
4. Precision: Measures the proportion of true positive predictions out of all positive predictions.
5. Recall (Sensitivity): Measures the proportion of true positives correctly identified out of all actual positives.

Expected Outcomes:

- A highly accurate mental disorder detection model with a benchmark accuracy of 85%+.
- A web-based AI system capable of analyzing real-time facial expressions.
- A comparison of traditional CNNs (e.g., EfficientNet-B4) vs. modern Transformer models (e.g., ViT) for efficiency and performance.
- A functional prototype demonstrating the potential for real-world mental health screening.

Tentative Project Timeline:

Week	Task
1-2	Data Preprocessing & Augmentation (GANs to be explored later if needed).
3	Implement Face Detection (Mediapipe).
4-5	Train EfficientNet-B4 (Baseline Model).
6	Explore Vision Transformer (ViT) for Advanced Feature Extraction.
7	Develop CNN-LSTM Hybrid Model (if static model works successfully).
8-9	Web App Development (React + Firebase, VS Code).
10	Model Optimization & Testing.
11	Deployment & Final Report Submission.

Significance & Future Applications:

This project has the potential to revolutionize mental health screening by providing a quick, cost-effective, and accessible tool for preliminary diagnoses. It can be integrated into telehealth platforms, school counseling programs, and workplace wellness initiatives.

Future Enhancements:

- Integrate **voice analysis** and **textual sentiment analysis** for a multi-modal AI system.
- Expand the dataset to include diverse cultural and demographic groups to reduce bias.
- Collaborate with mental health professionals for clinical validation and refinement of the model.

Resources Needed:

- **Computing Resources:** Google Colab / Kaggle GPUs for model training (free-tier).
- **Dataset:** AffectNet (publicly available).
- **Development Tools:**
    - Firebase Free-tier for hosting and backend.

- Visual Studio Code (VS Code) for React.js frontend development.

Reference Paper: Hussein et al. (2023) "Automated Detection of Human Mental Disorders". Journal of Electrical Systems and Information Technology.

Ethical Considerations:

- Ensure user consent for facial data collection and comply with data protection regulations (e.g., GDPR, HIPAA).
- Address potential biases in the dataset and model to ensure fair and accurate predictions for all demographic groups.
- Implement robust security measures to protect sensitive user data.

Conclusion:

This project aims to build a highly efficient, AI-powered mental health detection tool leveraging deep learning on facial expressions. By integrating state-of-the-art models, real-time processing, and cloud deployment, the system ensures practical applicability and ease of use. The project not only addresses a critical global issue but also paves the way for future advancements in multi-modal mental health assessment.