AUTOMATIC STROKE RECOVERY RATE PREDICTION SYSTEM

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Keywords:

Stroke Recovery, Machine Learning, Pose Estimation, Keystroke Dynamics, Mouse Movement Analysis, XGBoost, Random Forest, Rehabilitation Monitoring, MediaPipe, FastAPI.

Introduction:

Stroke is one of the leading causes of long-term disability worldwide, occurring when blood flow to a region of the brain is interrupted, depriving brain cells of oxygen and nutrients. Stroke survivors may experience difficulty moving their limbs, speaking, or performing basic daily activities. Continuous evaluation and structured therapy are indispensable for promoting recovery, yet traditional methods are limited in their frequency, objectivity, and accessibility.

Traditional clinical assessment scales such as the Fugl-Meyer Assessment (FMA), Barthel Index, and NIHSS require frequent hospital visits, are subjective, and miss subtle improvements between evaluations. To address these limitations, this project proposes an **Automatic Stroke Recovery Rate Prediction System**. The system uses machine learning algorithms combined with multimodal user interaction data — including webcam-based pose estimation, keystroke dynamics, and mouse drag-and-drop behavior — to assess rehabilitation progress without requiring specialized medical sensors.

ML models trained on structured feature datasets — including **XGBoost, Gradient Boosting, and Random Forest** — learn patterns linked to motor improvement, identify recovery trends, predict recovery scores (0–100), and classify recovery levels (Excellent / Moderate / Poor) with high accuracy. The system eliminates the need for manual assessments and specialized equipment, making stroke rehabilitation monitoring more accessible, efficient, and cost-effective.

Objectives:

1. To develop an AI-driven stroke recovery assessment system that predicts motor performance and recovery levels using natural computer interaction data.
2. To integrate multimodal data sources — mouse movement, keystroke dynamics, and webcam-based pose estimation — for comprehensive motor movement analysis.
3. To design feature extraction methods that capture key metrics like tremor intensity, reaction time, movement smoothness, and trajectory accuracy for detailed motor assessment.

4. To build an accessible and user-friendly platform for patients, therapists, and caregivers, supporting real-time feedback, progress tracking, and continuous rehabilitation monitoring in home and clinical settings.

Methodology:

The project follows a structured development approach:

- **Data Acquisition:** Capture real-time user interaction data through three channels — webcam (MediaPipe pose landmarks), keyboard (keystroke timing: dwell time, flight time), and mouse (trajectory, drag-and-drop behavior).
- **Feature Extraction:** Compute key metrics from raw data including joint angles, movement velocity, limb symmetry (pose); typing speed, error rate, consistency (keystroke); cursor speed, path deviation, tremor frequency (mouse).
- **Model Training:** Train ML models on structured feature datasets using Random Forest (mouse/keystroke difficulty), XGBoost Classifier (recovery class: Excellent/Moderate/Poor), and XGBoost Regressor (recovery score 0–100).
- **System Architecture:** React.js frontend with MediaPipe integration for real-time data capture and visualization; FastAPI Python backend for REST API services, model inference, and session management.
- **Database & Progress Tracking:** Store all session data, extracted features, and prediction results securely; generate recovery trend reports and longitudinal performance dashboards for therapists.
- **Testing & Evaluation:** Validate model accuracy, system responsiveness, and usability across home and clinical environments; apply RandomizedSearchCV for hyperparameter tuning to optimize model performance.

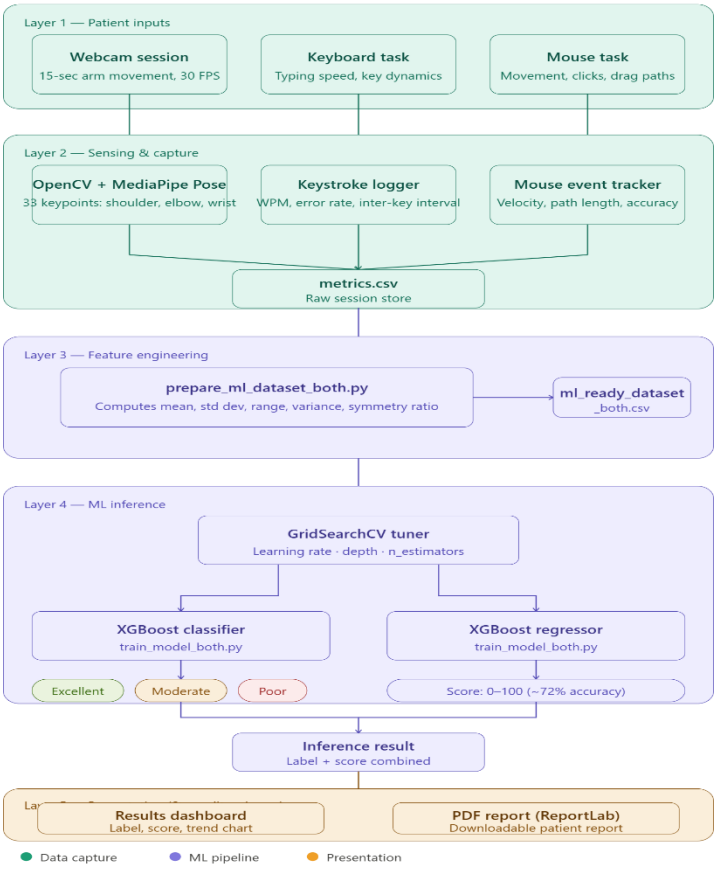

Figure 1: Architecture of the Project

Result and Conclusion:

The Automatic Stroke Recovery Rate Prediction System successfully demonstrates an objective, non-invasive approach to post-stroke rehabilitation monitoring. The system integrates three data modalities — webcam-based pose estimation, keystroke dynamics, and mouse movement analysis — to compute a comprehensive motor recovery score.

The XGBoost Classifier achieves approximately 72% classification accuracy in categorizing recovery levels (Excellent / Moderate / Poor), while the XGBoost Regressor generates continuous recovery scores. The React + FastAPI web-based architecture ensures real-time feedback and scalability across clinical and home environments, enabling early detection of motor improvement or stagnation and supporting data-driven, personalized therapy planning.

References:

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Future Scope:

The future scope of this project includes:

1. Integration of wearable sensor data (IMUs, smart bands) to complement webcam-based analysis with accelerometer and gyroscope measurements for more precise limb movement and tremor tracking.
2. Development of a personalized rehabilitation recommendation engine that suggests customized exercise routines, difficulty levels, and session durations based on each patient’s historical performance and recovery trends.
3. Development of an advanced therapist dashboard with predictive analytics, early-warning alerts for stagnation or regression, and real-time exercise correction guidance for remote deployment in telemedicine platforms.