Automatic Severity Grading System for Facial Palsy Using Video Analysis with a Selective Neural Network Model

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Introduction

- Facial palsy is a common neurological disorder, affecting 10 to 40 per 100,000 adults annually as Bell's palsy. The prevalence is even higher when considering central facial palsy caused by brain injuries or other neurological conditions. Traditional assessment relies on clinician-performed physical examinations, which are time-consuming and subject to inter-examiner variability.
- Recent studies have explored automated classification systems for facial palsy using facial landmarks.
- In this study, we developed an automatic facial palsy diagnosis system that provides severity grading based on the Sunnybrook Facial Grading System, utilizing MediaPipe Face Landmark detection and a selective neural network model.

Methods

- A total of 82 patients with either central or peripheral facial palsy were enrolled. Severity grading was based on the voluntary movement scale of the Sunnybrook Facial Grading System, and video recordings were obtained during assessments.
- The automatic diagnosis process involved the following steps: (1) facial landmark detection in evaluation videos using MediaPipe, (2) extraction of frames displaying maximal asymmetry during five specific voluntary movements—forehead wrinkle, gentle eye closure, open-mouth smile, snarl, and lip pucker, (3) calculation of asymmetry ratios by comparing affected and unaffected sides using landmark-based distance and area measurements, (4) training a selective neural network using the TabNet model, and (5) final prediction of severity scores for each voluntary movement using the trained model.

Standard Expressions	Unable to initiate movement/no movement	Initiates slight movement	Initiated movement with mild excursion	Movement almost complete	Movement complete	
Forehead Wrinkle (FRO)	1	2	3	4	5	☐
Gentle eye closure (OCS)	1	2	3	4	5	☐
Open mouth smile (ZYG/RIS)	1	2	3	4	5	☐
Snarl (LLA/LLS)	1	2	3	4	5	☐
Lip Pucker (OOS/OOI)	1	2	3	4	5	☐
	Gross Asymmetry	Severe Asymmetry	Moderate Asymmetry	Mild Asymmetry	Normal Symmetry	Total ☐

Figure 1. Voluntary movement scale of Sunnybrook Facial Grading System
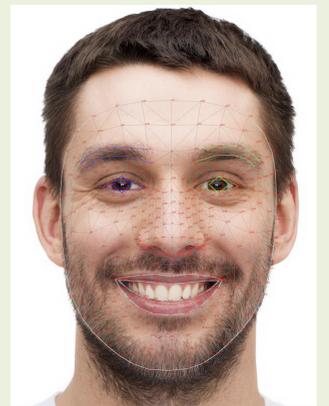
Figure 2. MediaPipe Face Landmark system

STEP 1 Video input

STEP 2 Facial landmark detection

STEP 3 Expression extraction

STEP 4 Feature extraction → Calculation of asymmetry ratio

STEP 5 AI model training → Severity classification

STEP 6 Prediction model selection

STEP 7 Final diagnosis
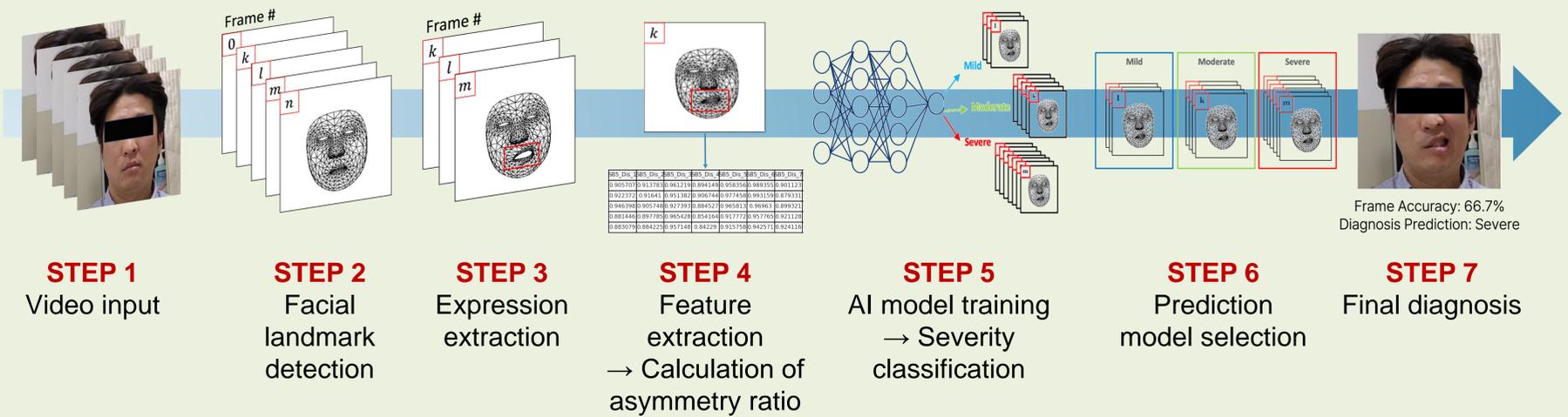
Frame Accuracy: 66.7%
Diagnosis Prediction: Severe

Figure 3. Development process of automatic severity grading system for facial palsy

Results

Table 1. Demographics

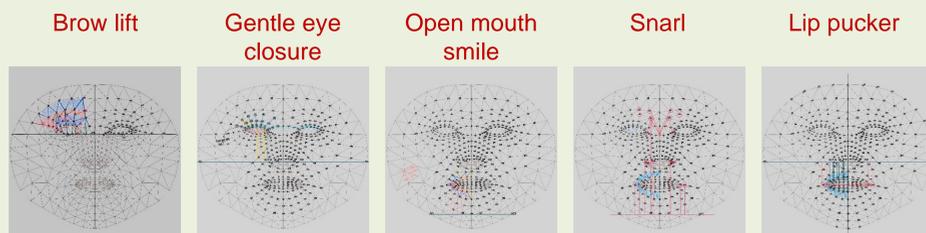| Features	N = 82
Sex, F:M	48:34
Age (years), mean ± SD	52.6 ± 14.9
House-Brackmann grading system	I, 10 (12.2%) II, 14 (17.1%) III, 16 (19.5%) IV, 13 (15.9%) V 26 (31.7%) VI, 3 (3.7%)

Brow lift · Gentle eye closure · Open mouth smile · Snarl · Lip pucker

Figure 4. Optimal parameter selection based on landmark-based distance and area measurements

Train model → Evaluate feature importance → Remove least important Features → Re-train model with remaining features → Repeat until desired number of features
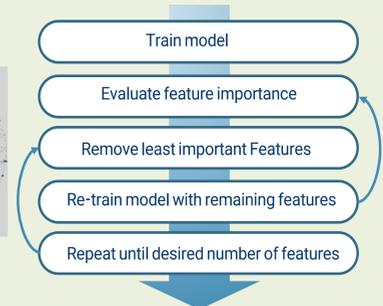
Figure 5. Selective Neural Network Model system

Table 2. Performance of a total of eight models

	Brow lift	Gentle eye closure	Open-mouth smile	Snarl	Lip pucker	Mean
TabNet	86.63%	83.09%	78.54%	61.45%	86.72%	83.87%
MLPs	73.09%	81.09%	68.72%	57.45%	76.90%	70.96%
TabPFN	80.54%	79.09%	70.54%	61.45%	80.54%	77.56%
CatBoost	82.54%	79.09%	70.54%	59.45%	80.54%	73.91%
XGBoost	80.54%	79.09%	72.90%	53.81%	78.72%	72.24%
LightGBM	82.36%	77.27%	70.90%	53.63%	79.27%	71.88%
RandomForest	75.78%	77.93%	71.20%	53.96%	74.43%	70.07%
SVM	76.90%	83.27%	70.54%	52.18%	78.54%	71.37%

Table 3. Accuracy of severity classification

	Brow lift	Gentle eye closure	Open-mouth smile	Snarl	Lip pucker	Mean
Severe vs. Mild	96.36%	90.72%	92.36%	94%	96.18%	93.9%
Severe vs. Moderate vs. Mild	94.18%	92.36%	84.36%	79.09%	94%	88.59%

Conclusion

- Our findings indicate that the developed selective neural network model achieves high accuracy in the severity assessment of facial palsy.
- This automated grading system has the potential to facilitate symptom monitoring and enhance patient self-management.