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FDIP FA Report

Hemifacial Spasm : A Silent Twitch With a Neurological Cause

1. Problem Statement

Hemifacial Spasm is a rare neurological disease or disorder characterized by involuntary, irregular contractions of muscles on one side or in some cases it may be seen on both side of the face. It's not life threatening, the condition affects patient's life, social confidence and daily functioning. Current treatments like Botox toxin injection and MVD ,(i.e, Microvascular Decompression) gives temporarily or permanent solutions, highlighting the need for awareness of this rare disorder, research and patient-friendly solutions.

2. Motivation

My primary motivation for investigating Hemifacial Spasm is deeply personal. My father lives with this condition, and I have witnessed firsthand its profound impact on daily life, emotional well-being, and social interactions. This personal connection fueled my desire to move beyond a passive understanding and undertake a project that combines my academic field Information Technology with a pressing real-world medical challenge.

3. Objectives

a. To study the cause, symptoms and the treatments for the hemifacial spasm.
b. To review the existing treatments, their effectiveness and limitations.
c. To leverage my technical skills to propose and demonstrate a novel, computational approach for analyzing facial features, with the future potential to aid in objective assessment and monitoring of HFS.

4. Introduction

Hemifacial Spasm is a neurological disorder/disease which arises due to compression of the facial nerve, because of an adjacent blood vessel. The condition mainly starts with twitching around the eye and then spreads to other facial muscles. It leads to the psychological distress, social embarrassment and functional problems in speech, vision. Treatments like Botox injections provides the temporarily relief while MVD surgery provides a long-term solution. However, awareness of such type of condition remains low among the people.

5. Literature Survey

Sr. No.	Study Title	Author(s) & Year	Methodology	Key Features	Research Gaps Identified

1	Applying a deep convolutional neural network to monitor the lateral spread response during microvascular surgery for hemifacial spasm	Kim et al., 2022	Deep neural network on intraoperative EMG images from 50 patients (3,674 images)	100% accuracy on test set; equivalent to human technologists performance	Limited to intraoperative monitoring only; requires specialized EMG equipment; small dataset from single center; not applicable for pre-surgical diagnosis
2	Facial Asymmetry Classification in Neurological Disorders: Integrating Computer Vision and Machine Learning	Ranjan et al., 2024	Computer vision and ML algorithms for stroke and peripheral facial paralysis	88% accuracy in distinguishing facial impairments	Limited to stroke and facial palsy; does not specifically address hemifacial spasm; lacks real-time detection capability
3	Deep Learning-Based Assessment of Lip Symmetry for Cleft Lip Patients	Rosero et al., 2025	Transformation-based approach using control subjects instead of patient data	Addresses privacy concerns by not using patient images for training	Requires frontal images only; performance depends on non-patient data; may not capture real patient variability; limited to lip symmetry assessment
4	Human vs. Machine Learning Based Detection of Facial Weakness	Aldridge et al., 2022	Facial landmark extraction on publicly available videos	Better performance than paramedics in laterality detection	6% video exclusion due to landmark detection failure; heterogeneous dataset quality; overrepresentation of severe cases; insufficient for subtle asymmetry detection
5	Facial expression deep learning algorithms in the detection of neurological disorders	Yoonesi et al., 2025	Meta-analysis of CNN-based facial expression recognition	89.25% pooled accuracy across 28 studies	High variability across different neurological conditions; requires standardized data collection protocols; limited generalizability across demographics

6. Methodology

To address the challenge of objective HFS assessment, I designed and implemented a dual-branch deep learning pipeline that leverages facial asymmetry analysis - a key clinical indicator of hemifacial spasm.

Core Technical Approach

1. Data Preprocessing and Face Analysis

- **Face Detection :** Implemented using MediaPipe, which accurately detects and crops facial regions from the input images, ensuring consistency in alignment and scale.
- **Hemispheric Splitting :** Each cropped facial image was split vertically into left and right halves, enabling hemisphere-wise feature comparison.

2. Dual-Branch Neural Network Architecture

Input : Two separate input streams were designed for left and right halves of the face.

Backbone Network : Used EfficientNetV2-B0, pre-trained on ImageNet, as a feature extractor for both branches to capture detailed texture and structural information.

Asymmetry Encoding:

The model computes the absolute difference between the feature vectors of both halves, then concatenates them with original features to form a comprehensive asymmetry representation.

3. Training Strategy

Two-Stage Training Process:

Stage 1: Backbone layers frozen; only new top layers trained for 5 epochs.

Stage 2: Partial fine-tuning of the EfficientNet backbone for an additional 3 epochs to refine feature learning.

Class Weighting : Addressed dataset imbalance between normal and spasm classes using weighted loss computation.

Evaluation Metrics : Model performance was tracked using accuracy, loss, and confusion matrix for both training and validation sets.

7. Results and Analysis

Processed Images :

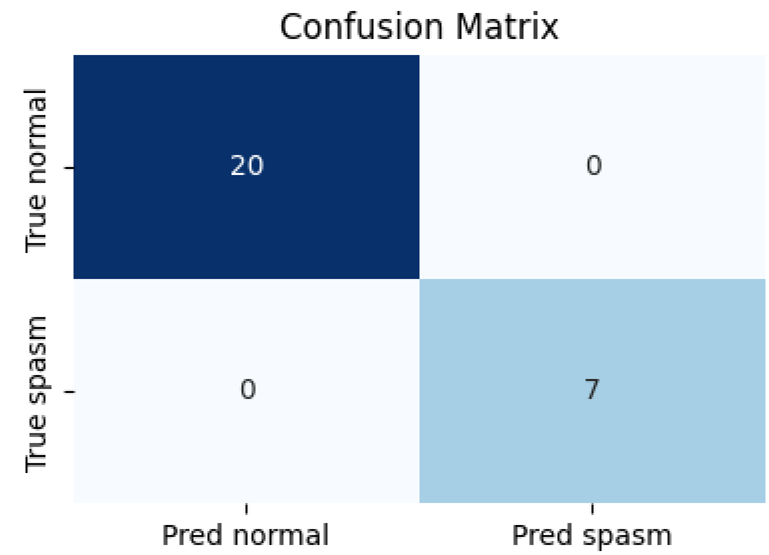
After Training the model

Test metrics:
- loss: 0.0011
- compile_metrics: 1.0000

Derived metrics:
- F1: 1.0000
- ROC AUC: 1.0000
- PR AUC: 1.0000

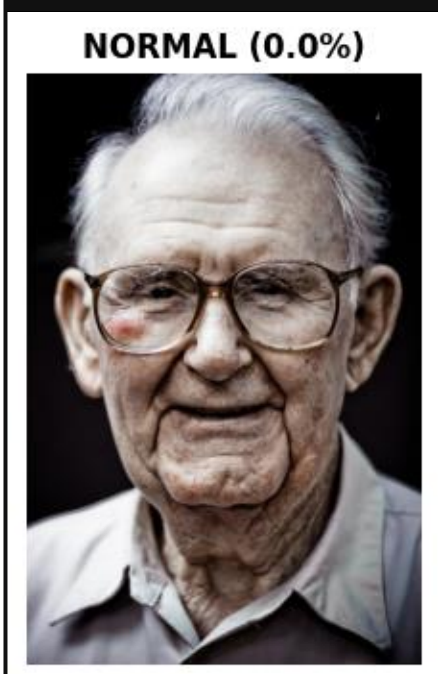
Classification report:

	precision	recall	f1-score	support
normal	1.0000	1.0000	1.0000	20
spasm	1.0000	1.0000	1.0000	7
accuracy			1.0000	27
macro avg	1.0000	1.0000	1.0000	27
weighted avg	1.0000	1.0000	1.0000	27



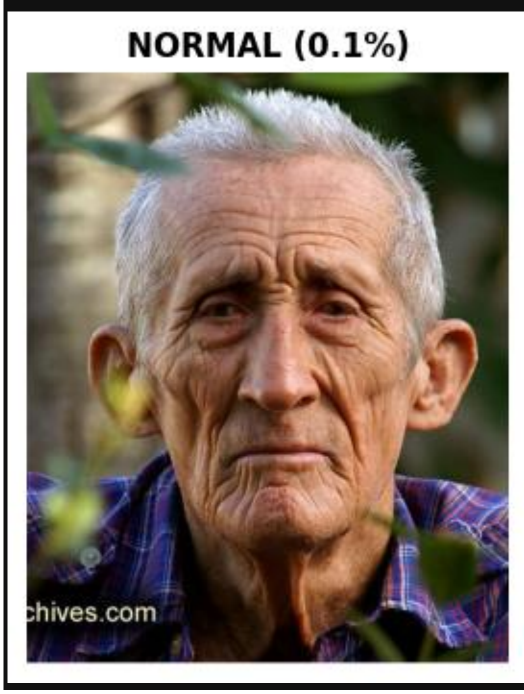
Final Predictions :

/content/dataset/test/normal/1 (1).jpeg
Prediction: NORMAL (prob=0.000)



/content/dataset/test/normal/1 (1).jpg
Prediction: NORMAL (prob=0.000)

/content/dataset/test/normal/1 (1).png
Prediction: NORMAL (prob=0.001)



/content/dataset/test/spasm/12.jpg
Prediction: SPASM (prob=0.994)

/content/dataset/test/spasm/13.jpg
Prediction: SPASM (prob=0.827)

8. Conclusion

The study on Hemifacial Spasm (HFS) provided deep insights into its neurological origin, symptoms, and currently available treatment options. Through a blend of medical research and computational experimentation, this project explored both the clinical understanding and technological possibilities for objective assessment of the disorder.

The comprehensive literature review revealed that Botox injections offer only temporary symptom relief, whereas Microvascular Decompression (MVD) remains the most effective long-term treatment option. However, limited awareness and accessibility highlight the need for broader educational and research efforts.

The proposed deep learning-based facial asymmetry analysis pipeline successfully demonstrated how image processing and AI can quantify subtle facial differences. Metrics such as intensity asymmetry and edge density showcased measurable indicators aligned with real clinical observations. These findings suggest that computational tools can assist neurologists in monitoring disease progression or evaluating treatment outcomes.

Overall, this study emphasized the importance of combining medical knowledge with artificial intelligence to create practical, patient-friendly solutions. Future research should focus on developing non-invasive, data-driven diagnostic tools, expanding datasets, and spreading awareness to improve early detection and patient care for Hemifacial Spasm.

8. References

[1] Kim, H., et al. (2022). Applying a deep convolutional neural network to monitor the lateral spread response during microvascular surgery for hemifacial spasm. *PLoS ONE*, 17(11): e0276378. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0276378

[2] Ranjan, P. & Lasala, T. (2024). Facial Asymmetry Classification in Neurological Disorders. *Semantic Scholar*. https://www.semanticscholar.org/paper/Facial-Asymmetry-Classification-in-Neurological-and-Ranjan-Lasala/e3c1ac475fd2a15c306441e9eff8fbb2aa7a7dc1

[3] Rosero, O., et al. (2025). Deep Learning-Based Assessment of Lip Symmetry for Cleft Lip Patients. *PMC*. https://pmc.ncbi.nlm.nih.gov/articles/PMC11909766/

[4] Aldridge, D., et al. (2022). Human vs. Machine Learning Based Detection of Facial Weakness. *PMC*. https://pmc.ncbi.nlm.nih.gov/articles/PMC9284117/

[5] Yoonesi, L., et al. (2025). Facial expression deep learning algorithms in the detection of neurological disorders. *PMC*. https://pmc.ncbi.nlm.nih.gov/articles/PMC12096636/

9. Github Repository Link :

https://github.com/ChinmayaKolhe/Hemifacial_spasm_Detection