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Expanding PyAFAR: A Novel Privacy-Preserving Infant AU Detector

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***Abstract*— We enhance PyAFAR[1], an open source, Python-based library for facial action unit detection by introducing a privacy-protected infant AU detector. To prevent reconstruction of the training images, we train the infant AU detector by extracting histogram of gradients (HoG) features and using an efficient Light Gradient Boosting Machine (LightGBM) classifier. Models are trained with two large, well-annotated databases. The performance of our approach is comparable to previously developed deep models that have not been released due to privacy concerns. Our models are available for use and further fine-tuning, contributing to the advancement of facial action unit detection.**

I. Introduction

As infant faces differ greatly from those of adults, action unit (AU) detectors that are trained on adult faces generalize poorly to infant faces [7]. Although recent works have proposed deep learning-based infant AU detectors, they have not released their pre-trained models due to two privacy-related concerns. One, training images can be reconstructed from the neural networks [1] and consent to reveal those images is lacking. Two, encrypted neural networks are orders of magnitude slower during inference [5], limiting their applicability in real-world. We propose an extension of PyAFAR [2] with a privacy-protected infant AU detector trained on two databases (CLOCK for 9AUs and MIAMI for 4AUs, see AUC, F1, and negative agreement results in Table I). Our approach uses Histogram of Gradients (HoG) features to ensure privacy and trains a LightGBM model [3] which achieves state-of-the-art performance in several tasks and has a high speed during inference.

II. Software Description

PyAFAR is compatible with Windows, Linux, and MacOS platforms. It is fully developed in Python using other open-source libraries and is easy to use by non-programmers. It is the first publicly available tool to offer a privacy protected infant AU detector. Given an infant video, PyAFAR can detect faces, track 3D landmarks using Mediapipe [6], and perform face alignment using dlib [4]. After alignment, face images are resized to 112×112. HoG features are extracted using 2×2 cells per block, each having 8×8 pixels per cell and 9 orientations resulting in 6084 dimensional feature vectors. These features are used to train individual lightGBM classifiers per AU. The final output of our tool is customizable; it can be directly imported into user code and CSV and JSON files.

[1]Code will be available on: https://affectanalysisgroup.github.io/PyAFAR/

TABLE I
Performance of infant AU detector of PyAFAR

	CLOCK			MIAMI		
AUs	**AUC**	**F1 (PA)**	**NA**	**AUC**	**F1 (PA)**	**NA**
1	0.64	0.47	0.76	-	-	-
2	0.63	0.39	0.83	-	-	-
3	0.71	0.55	0.87	-	-	-
4	0.80	0.57	0.93	0.76	0.54	0.94
6	0.86	0.81	0.90	0.85	0.78	0.89
9	0.85	0.56	0.96	-	-	-
12	0.86	0.75	0.92	0.83	0.74	0.91
20	0.79	0.62	0.89	0.79	0.59	0.93
28	0.69	0.42	0.95	-	-	-

III. Demo Description

The demo will provide an opportunity to try the new infant AU detector module of PyAFAR. Laptops with software will be available. Conference attendees will be encouraged to test the features of the software by loading sample infant videos and analyzing the intermediate and final outputs including head pose and occurrence probabilities of 9 AUs. During the demo, information will be provided about the underlying privacy preserving methodology. The importance of the demo is that it will showcase the first publicly available system for AU detection in infants. Its anticipated impact within the community is to draw the attention of researchers in infant/child behavior analysis and ensure the adoption of a system that demonstrates superior generalization to infants compared to existing publicly available adult AU detectors.

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