Face Detection

LATTICE SEMICONDUCTOR®

MODEL DETAILS

A lightweight model designed to detect face bounding boxes, estimate head pose, and identify basic facial landmarks. It is optimized for embedded and resource-constrained environments, delivering low latency and efficient computation.
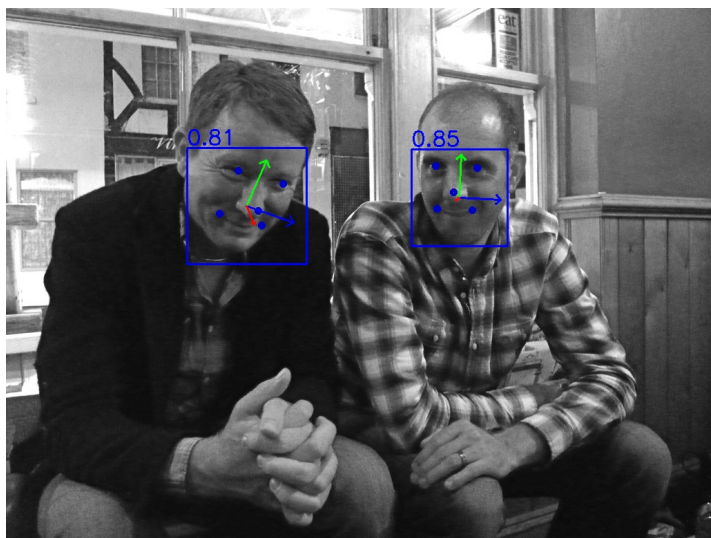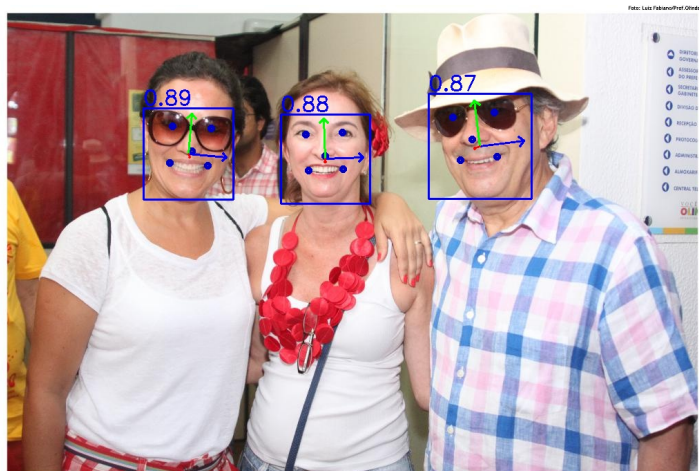

Figure 1: Face Detection Model Output.

MODEL SPECIFICATIONS

Inputs

- 256×144×1 grayscale image

Outputs

- Face bounding boxes
- 5 basic landmarks (right eye center, left eye center, nose tip, right mouth corner, left mouth corner)
- Head pose angles (pitch, yaw, roll)

Architecture

- Backbone: MobileNetv2-like model
- Head: SqueezeDet-style model

Parameters

- 469,496 (463,320 trainable, 6,176 non-trainable)

AUTHORS	Lattice Semiconductor	SOURCE CODE	Training Source Code
VERSION	fd_lnd_hp-fpga-8.1.0	TOOLCHAIN	LATTE
RELEASE	2025-12-18		LSCQuant

PERFORMANCE EVALUATION

Live Evaluation

Evaluations were performed on Lattice CLNX-33 FPGA and IMX219 camera, under a controlled, standardized environment to ensure consistency and reproducibility of results. While these conditions shaped the reported metrics, the model architecture is designed for flexibility, supporting potential deployment across a wide range of platforms, including non-FPGA environments.

- Scene Composition: Test scenes were limited to ≤ 5 individuals due to constraints on a smaller FPGA. However, the model is capable of handling significantly more faces when inference resources are less restricted.
- Illumination: Consistent performance was observed at lux levels above 15 under indoor conditions. Reliability decreases in darker environments (lux ≤ 15).
- Depth: Accurate face detection was maintained at distances from 30 cm up to 4 meters.

Offline Evaluation

The KPIs for the evaluation data are reported in Table 1. Categorical metadata for quantitative analysis were generated using Gender Classifier, Age Classifier, and Deep Face. Figure 2 illustrates the false negative rate by age, ethnicity and gender categories.

Table 1: Model performance across datasets.

| Output Category	Metric	Value	Dataset
Bounding Box	mIoU	0.817	OID V5 (2,880 images)
	F1 Score	0.966	OID V5 (2,880 images)
	False Positive Rate	3%	Lattice No-face dataset (29,358 images)
Head Pose	MAE Pitch	3.85 degrees	OID V5 + Lattice HP GT (2,880 images)
	MAE Yaw	4.19 degrees	OID V5 + Lattice HP GT (2,880 images)
	MAE Roll	3.48 degrees	OID V5 + Lattice HP GT (2,880 images)
Facial Landmarks	MAE	1.17 pixels	OID V5 + Lattice Landmarks GT (2,880 images)

(a) Age   (b) Ethnicity   (c) Gender
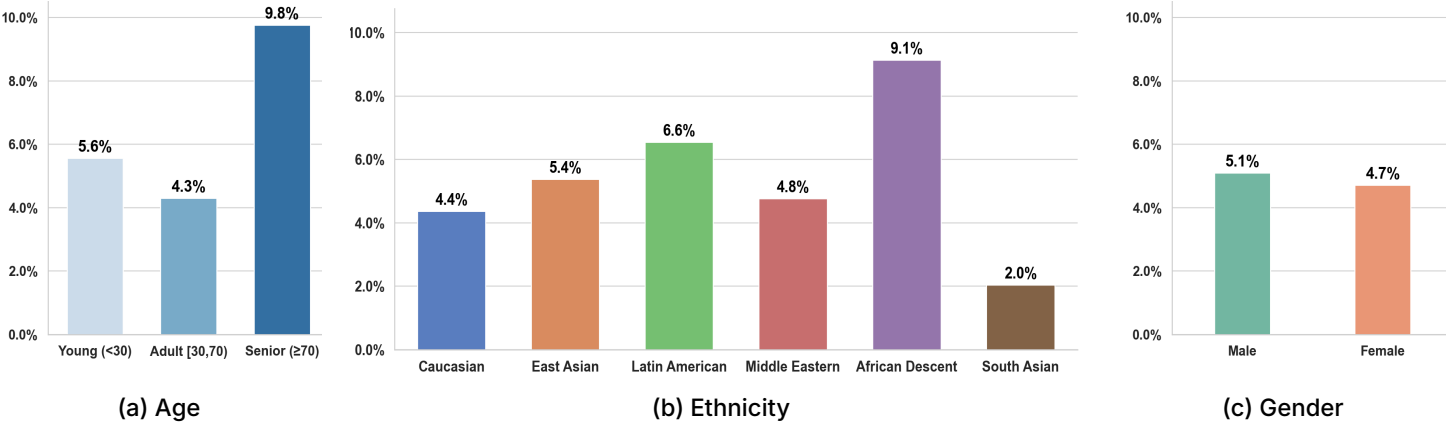
Figure 2: False Negative Rate by age, ethnicity, and gender categories.