FACIAL EMOTION RECOGNITION SYSYTEM

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April 1, 2024

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Introduction

- Integrating AI and deep learning into embedded systems has enabled advancements in Facial Emotion Recognition (FER) for various applications.
- Practical deployment of FER systems faces challenges, particularly in resource-constrained environments like edge devices.
- Developing deployable FER models optimized for ultra-low power embedded systems is essential.
- Successful deployment of this model will unlock new possibilities for human-computer interaction, mental health monitoring, and consumer behavior analysis.

Motivation

- Facial Emotion Recognition(FER) plays a major role in:
- Improving human-computer interaction, allowing dynamic system responses based on user emotions.
- Monitoring and assessing mental health conditions through facial emotion analysis.
- Analyze consumer reactions for targeted and effective advertising for marketing strategies.
- The increasing demand, interest, and adoption of facial emotion recognition systems was the motivation to delve into this subject for our study.

Literature Survey

Paper Title: Light-FER: A Lightweight Facial Emotion Recognition System on Edge Devices (Sensors 2022)[5]

Description: The paper introduces Light-FER, a variant of the Xception model, aimed at improving accuracy and addressing resource limitations in FER systems. Light-FER is optimized for deployment on edge devices like the NVIDIA Jetson Nano, demonstrating its effectiveness in scenarios with restricted computing resources.

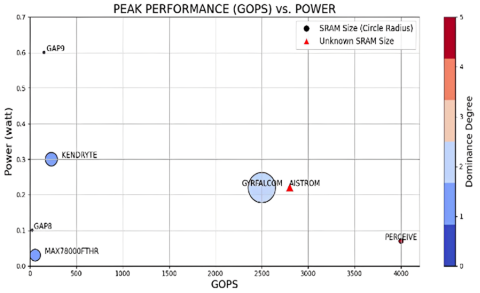
FER Model	Test Accuracy
Light-FER	69%
VGG-Net	Around 60%
ResNet-50	Around 60%
CNN	Around 60%

FER Model	Parameter	Computati -onal Cost	Memory Usage
Light-FER	Optimized	Low	3.1%
Other Models	Varies	High	12%

Literature Survey

Paper Title: Wildlife Species Classification on the Edge: A Deep Learning Perspective. (ICAART 2024)[6]

Description: This paper introduces an energy-efficient system designed for real-time animal species classification to support wildlife conservation efforts. Seven new ultra-low-power embedded processors, mainly for neural network inference and training, have been analyzed. Trained DNN models are deployed on the MAX78000FTHR board for real-time inference.



Model	Image Size	Accuracy [%]	F1 score [%]
VGG-6	64x64	82.88	80.05
	96x96	83.12	82.4
	180 x 180	84.45	82.67
VGG-8	64x64	81.55	79.67
	96x96	86.67	85.93
	180 x 180	88.12	86.53

Literature Survey

Paper Title: Face Identification Using MAX78000 (2020) [1]

Description: This study presents a detailed guide on implementing Face Identification (FaceID) on the MAX78000 platform, focusing on three main stages: face extraction, face alignment, and face identification. The datasets used for training the FaceID model, such as VGGFace-2 and YouTubeFaces, as well as the creation of a custom dataset named MaximCeleb for evaluating the model's performance.

	Maximceleb Dataset			
	Female		Male	
	MTCNN+FACENET	AI85FACEID	MTCNN+FACENET	AI85FACEID
ACCURACY (%)	94.4	78.9	94.4	88.9

Problem Statement and Objectives

Problem Statement

Develop a deployable Facial Emotion Recognition model on an ultra-low power embedded system.

Objectives

- Design of a Deep Neural network-based energy-efficient Facial Emotion Recognition Model.
- Development of the embedded system for the efficient deployment of the Facial Emotion Recognition Model.

Dataset Description[2]

- Benchmark dataset used: "Facial emotion recognition" from Kaggle.
- Dataset size: 56.51MB.
- Grayscale face images.
- The total images in the dataset are 35,914.
- The dataset consists of 7 classes. They are- happy, sad, disgust, angry, fear, neutral, and surprise.
- The size of each image is approximately 2KB.
- Testing images – 20.06
- Training images – 79.93

Figure: Sample images from the dataset

- **Data Preprocessing:** Balancing of the training dataset using the "Random Oversampling" method.
  The total number of train images after pre-processing is 50,505.

Approach

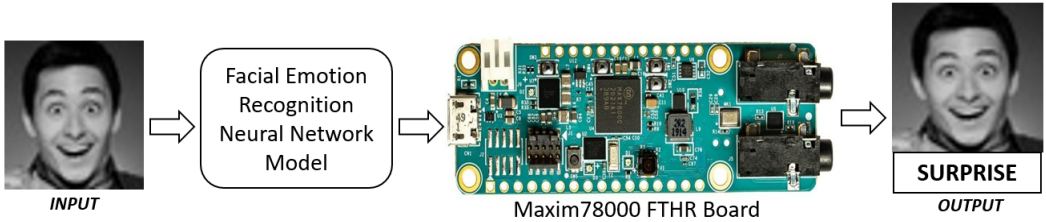


Figure: High level design for FER System

- Model Development: Design the model with PyTorch or TensorFlow-Keras.
- Training: Train with floating-point weights, then quantize for MAX78000 deployment.
- Model Evaluation: Assess quantized model accuracy using an evaluation dataset.
- Synthesis Process: Use the MAX78000 Synthesizer tool to generate optimized C code from ONNX files, YAML model description, and input data. The tool generates C code for loading weights, performing inference, and validating results.

Approach (contd...)

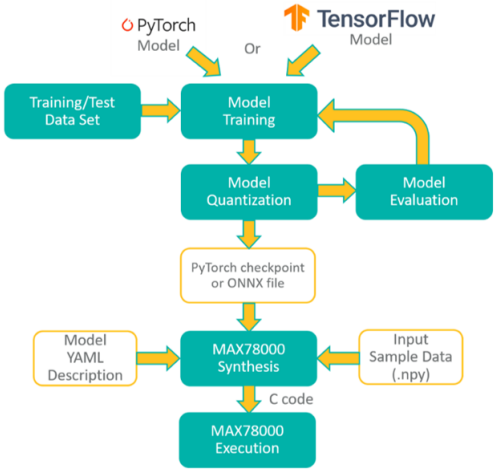
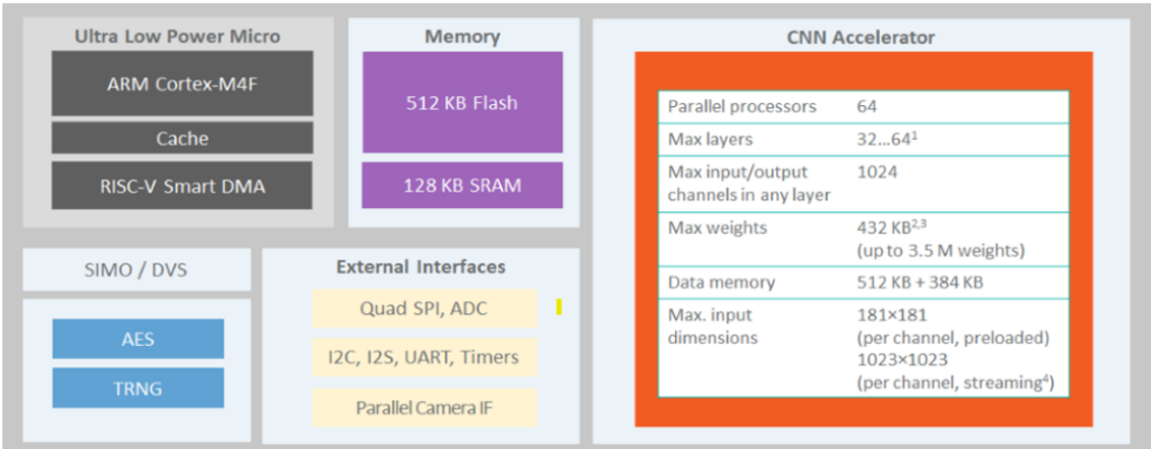


Figure: Flow diagram for Facial Emotion Recognition System

Development Board

MAXIM78000 FTHR BOARD:



Development Board (contd...)

MAXIM78000 FTHR BOARD:

1. Dual-Core Ultra-Low-Power Microcontroller
2. Power Management Maximizes Operating Time for Battery Applications
3. 12-Bit Parallel Camera Interface
4. The CNN engine also has 512KB of data memory.
5. Input Image Size up to 1024 x 1024 pixels
6. 52 General-Purpose I/O Pins.
7. 512KB Flash and 128KB SRAM.

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Thank You