Application Example

Vivaldi Sound Recognition Embedded Suite

"The world of sounds is full of useful information and sound event classification is becoming a powerful solution in many domains: from predictive maintenance to home automation, from robotics to intelligent cities applications."

Overview

Today, non-structured data management can be integrated in the embedded application providing wide inference capabilities to the device, without the need to communicate with the cloud.

Machine learning drives the change to the creation of distributed-AI IoT architectures where narrow AI skills lead to the design of smarter, faster and safer devices based on STM32 microcontrollers.

ST has created a tool called the STM32Cube.AI to do that optimizing DNNs for a microcontroller.

Product

The Vivaldi platform takes advantage of the most successful kinds of machine learning algorithms that automate decision making by generalizing from known examples and exploits the STM32Cube.AI potential to create a customized embedded suite that **brings automatic recognition of sound events and audio analytic capabilities to your application** based on STM32 target.

The world of sounds is full of useful information and **sound event classification** is becoming a powerful solution in many domains: predictive maintenance, smart cities applications, intelligent transportation systems, robotics or security and home safety automation.

The Vivaldi platform enables your device to extract meaning from audio and to autonomously take important decisions based on a pre-trained deep neural network.

Use cases

- **Physical Event Recognition**
- **Predictive Maintenance**
- **Key word Spotting**
- **Biometric Voice Authentication**
- **Sound Event Classification**

Vivaldi for intelligent cities

Proposed Solution
The Vivaldi for Intelligent Transportation Systems (ITS) purpose is to highlight the opportunities made available by the enabling of hearing capabilities in the world of embedded systems, smart sensors and IoT.

Huge potentials exploit whenever your device is given the power to hear.

In this embodiment the Vivaldi platform is deployed to monitor a particular sound event: the **Doppler effect** of a flowing vehicle.

The aim of the Vivaldi for ITS is to collect real time statistics about urban traffic by counting the number of cars passing by.

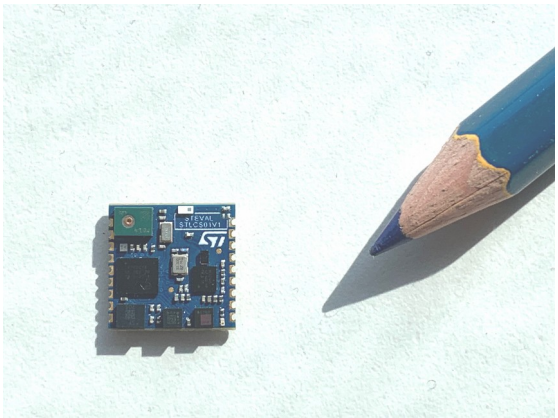
This kind of product is intended to be installed by the side of the street and it is suitable for traffic lights networks optimization and vehicles throughput maximization.

The target hardware is the **Sensortile module** from STMicroelectronics, which holds small and cheap sensors and an ultra low power MCU based on ARM Cortex-M4 architecture, featuring 1Mb of Flash and 128Kb of SRAM. Preprocessing and classification execution together take less than 0.5s.

It is known that using raw audio samples to feed a neural network is not feasible in terms of model's accuracy and dimensions.

Therefore audio is preprocessed to extract an MFCCs (Mel-frequency Cepstral Coefficients) matrix, which stands as input to the classification algorithm.

Lastly, a CRNN (Convolutional Recurrent Neural Network) model was selected due to its well-known high accuracy reached in the tasks of audio stream analysis, such as key word spotting or sound event classification.



Technical Overview

Small, cheap and energy saving components such as MEMS sensors and low power MCUs from the STM32 series perform the full sequence:

- audio sampling
- pre-processing and feature extraction
- classification based on a pre-trained NN

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