Voice Controlled Car System

Ekin Karasan and Driss Hafdi

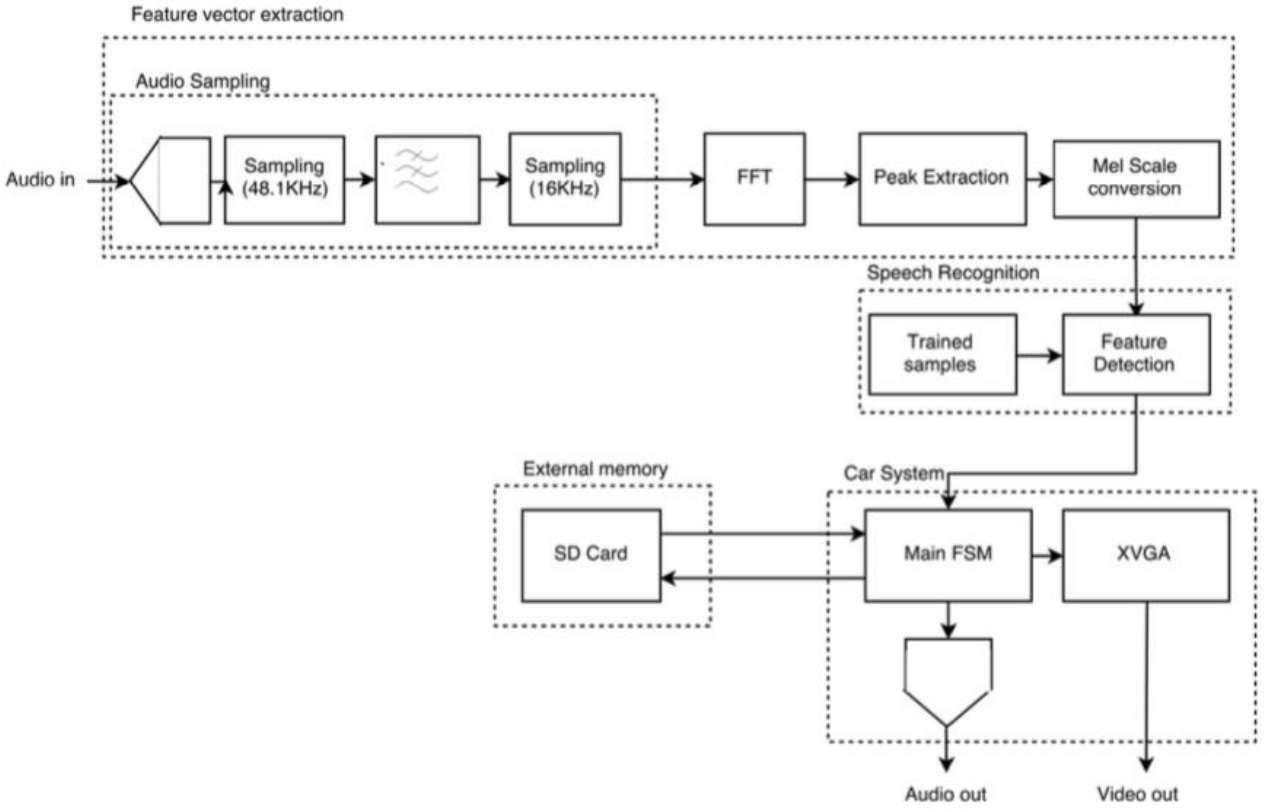
Objectives and Motivation

- Explore speech recognition algorithms and their hardware implementation.
- Detect a set of about 5 pre-recorded commands.
- Implement communication between the FPGA and an SD card in order to be able to output songs and the appropriate graphics.

Design Overview

- Sample and store the command as spoken by the user.
- Perform a FFT on the recording and extract a feature vector.
- Compare the feature vector with that of the training samples and obtain the desired command.
- Input the command into the main Car system FSM and adjust the audio and video output accordingly.

Block Diagram



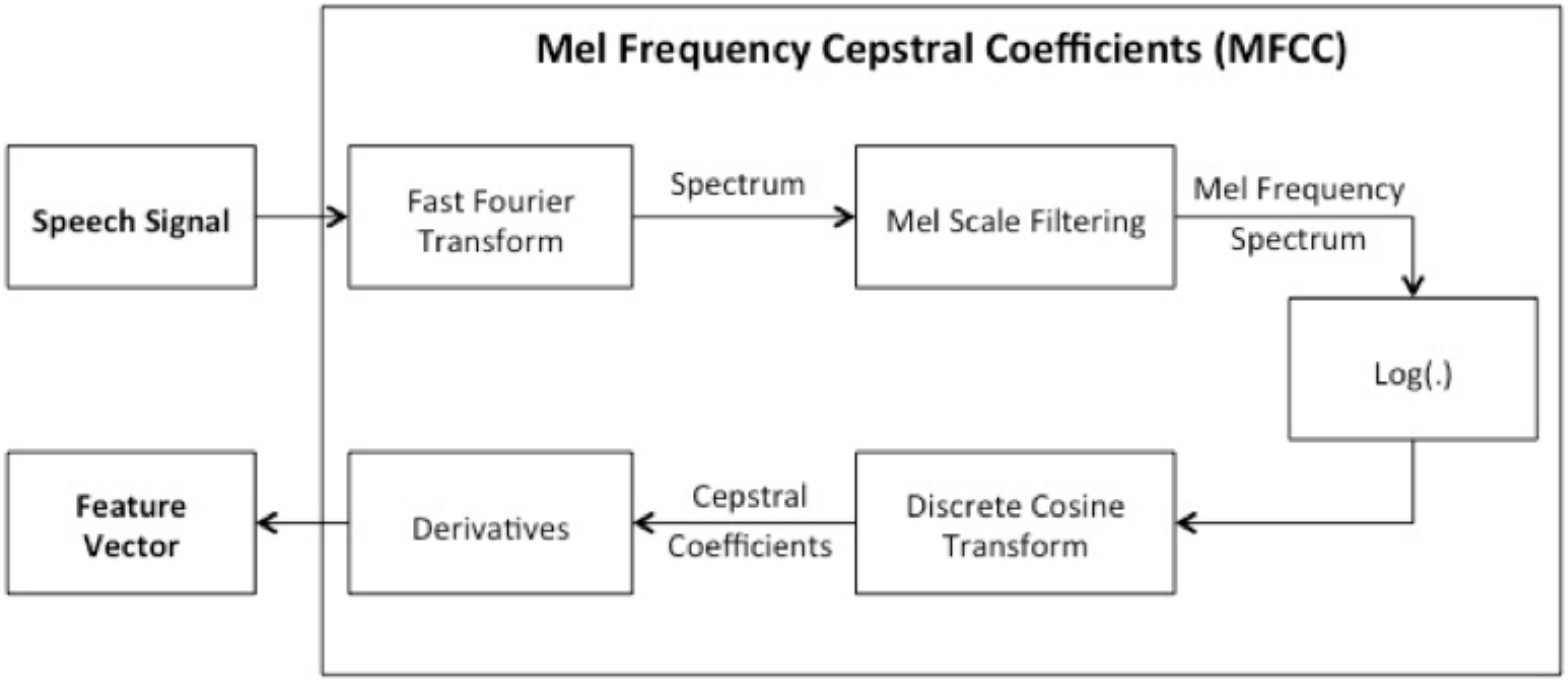
Audio Sampling module

- Sample the audio signal from the XADC at any frequency above 40KHz (Nyquist rate for sound).
- Anti-aliasing filter and downsample to 16KHz
- Store each 10ms window of our audio signal in a BRAM.

Feature Extraction Module

- Obtain an FFT for each 10ms window of our incoming audio signal.
- For each FFT obtain the 10 frequencies with the highest intensity and arrange the frequencies in increasing order.
- Convert the frequencies to mel scale.
- Concatenate the vectors for each of the windows to obtain the feature vector.

MFCC Module (Alternative)



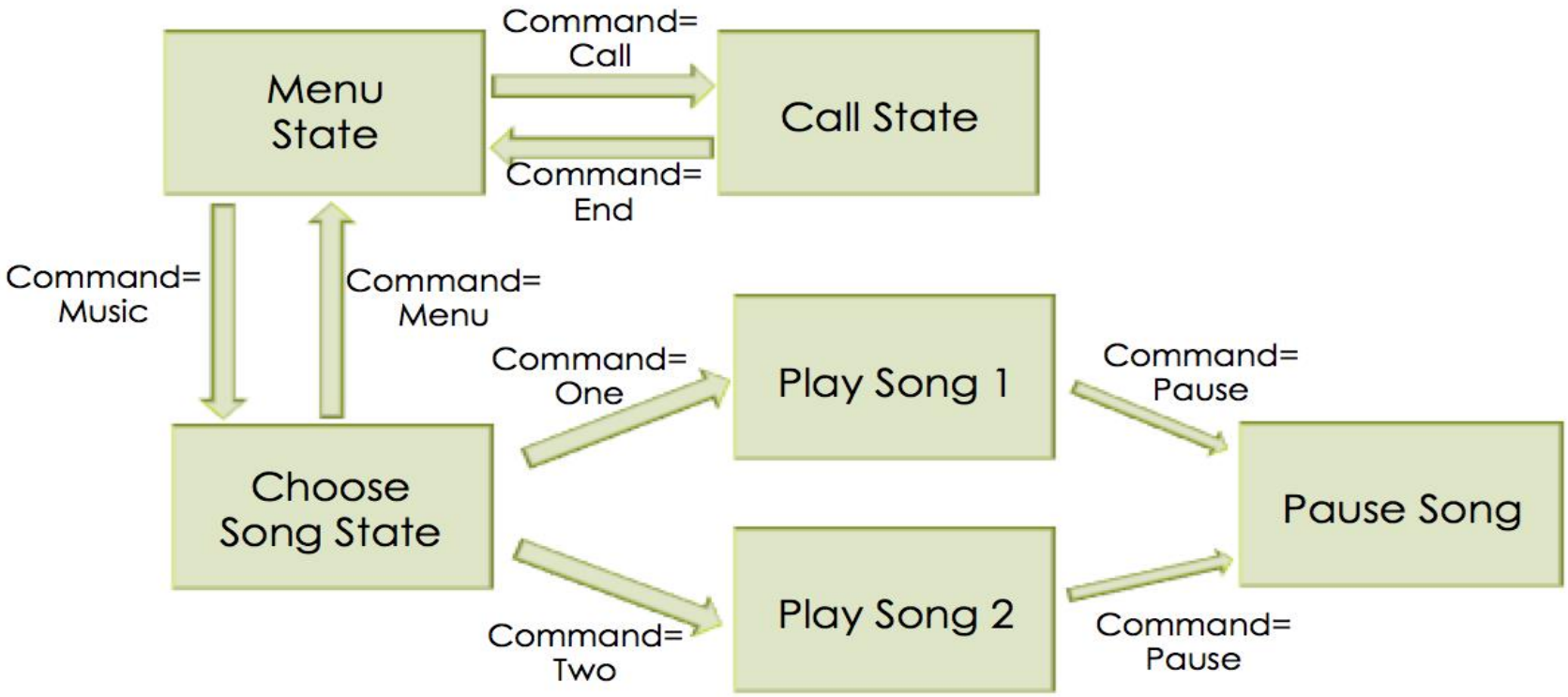
Feature Detection Module

- Compute the feature vector for each training sample using MATLAB.
- Hard-code the training sample's feature vector in a ROM.
- Compute the angle between the input feature vector and that of the training samples.
- (Alternative) Use a statistical model or the Dynamic time warp algorithm (DTW) to find the corresponding command.
- Output the command detected to the car system FSM.

Car System FSM

- Outputs the appropriate audio and video output based on the command interpreted by the speech recognition module.
- Pictures in bitmap format stored in an SD card will be displayed according to the state.
- Songs/Audio effects in wav format also stored in an SD card will be output to a DAC.

Car System FSM



Timeline

- **Week of 7th of November:** Implement and test the speech recognition algorithms on MATLAB
- **Week of 14th of November:** Audio Sampling Module, FFT, Car system FSM
- **Week of 21st of November:** Feature extraction module, Speech recognition module, SD card module
- **Week of 28th of November:** Working towards reach goals
- **Week of 5th of December:** Debugging
- **Week of 12th of December:** Debugging

Questions ?