**LAB 2: FIR Filters**

**1. Watch the video linked on the Moodle website:**

Overview of FIR and IIR Filter Designs

**2. Review Section 3.1 and 3.2 in the textbook, play with the Graphic Equalizer, the Notch Filter, and the Audio Effects Applications.**

(1) Graphic Equalizer

Operate with A1(LPF), A2 A3 A4 (BPF) and A5(HPF)

(2) Notch/Bandpass Filter

Adjust the Q value and center frequency

(3) Audio Effects

Play with echo/Chorus/Flanger/Tremelo…etc

Hint: We are going to make our own echo/flanging/chorus effect by CCS for the final project, then you will know how these audio effects are working.

**3. Create your own Filter by MATLAB (Two methods to generate you own .c and .h files)**

**(1) Method 1**: use FIR2C.m (Provided on the course Moodle: FIR Matlab to C Filter generator)

**a. Type in ‘fdatool’ in the command window**

**b. Design your filter:**

Response Type: Low Pass

Design Method: FIR: Equiripple

Filter Order: 30th

Frequency Specification: Fs=48kHz

Set the Pass/Stop frequency you want to make your filter sound great.

Then click the ‘Design Filter’ button.

**c. Go to File-Export:**

Export to a workspace as coefficients, record the Variables names: Num. Export the workspace.

**d. Download the FIR2C.m (FIR Matlab to C generator) from the course Moodle**

Save it to a new folder, and set the Matlab directory to that new folder.

**e. Using the FIR2C to generate a .c file and a .h file**

I. Open the FIR2C.m in the MATLAB

II. In the Command window, type in the FIR2C(‘Filename’,’Varname’, Coefficients, Length of the coefficients) as the example mentioned in the FIR2C.m

Note:

**Filename** can be whatever you want.(Better be FIR30th)

**Varname** (Variable names) should be the same as the Numerator name (Num) that your export in the workspace.

**Coefficients** is a 1xN vector, Set it as B.

**Length of Coefficients** is the length of the vector.

**f. Now you get your .c and .h file for your 30th order FIR filter. Save it somewhere for later use.**

**(2) Method 2**: Use fdatool in the MATLAB, and get the c/h files manually

**a. Set the MATLAB directory to a new folder.**

**b. Type in ‘fdatool’ in the command window**

**c. Design your filter:**

Response Type: Low Pass

Design Method: FIR: Equiripple

Filter Order: 30th

Frequency Specification: Fs=48kHz

Set the Pass/Stop frequency you want to make your filter sound great.

Then click the ‘Design Filter’ button.

**d. Go to Targets-Generate C Header**

Set the Numerator as B, Set the Numerator length as BL

**e. Generate the C files**

**f. Now you are getting a fdacoefs.h file in your folder.**

**g. Go to your folder, and open it.** Compare it with your c. file and .h file you just created by FIR2C.m. You will find this **fdacoefs.h** is a combination of the normal .c and .h files. If you want to use this, you have to manually separate it into a single .c and a single .h file.

**4. Start a CCS project for your 30th order FIR filter**

**(1) Follow every single steps of creating a new CCS project (From Lab Talk-Thru)**

Check the CCS file from the first week, go through all steps before debug.

Please include all files that are needed to your new project **expect two files:**

ISRs.c and Startup.c

**(2) Add new files to your project**

a. Go to Book3rdEdition\code\Chapter 03\ccs\FIRrevB. Add Startup.c and FIRstereo\_ISRs.c to your project

b. Add both of the .c and .h files you just created for the 30th order FIR filter to your new CCS project

**c. Modify the FIRstereo.ISRs.c to:**

Make the right channel talk through and the left channel implement the filter you just designed

**5. Start a CCS project for your 98th order FIR filter**

**(1) Follow every single steps of creating a new CCS project**

Check the CCS file from the first week, go through all steps before debug.

Please include all files that are needed to your new project expect two files:

ISRs.c and Startup.c

**(2) Add new files to your project**

a. Go to Book3rdEdition-code-Chapter 03-ccs-FIRrevD. Add Startup.c and FIRmono\_ISRs.c to your project

b. Add both of the .c and .h files for the 98th order FIR filter (Provided in the Moodle on the website) to your new CCS project

**c. Modify the FIRmono.ISRs.c to:**

Get rid of all coding errors you may have, make it run smoothly. Check the circular buffer structure. Read the circular buffer structure in the textbook, try to understand how it works.

**6. Homework Assignment (Things you need to submit)**

**(1) A text/word/pdf file explaining why the brute force method does not work in high order FIR filtering.**

**(2) The whole project for Part 4**

**(3) The whole project for Part 5**