Summer Fellowship Report

On

Scilab and Xcos

Submitted by

Vishesh Vinod Munghate

Under the guidance of

Prof. Kannan M. Moudgalya
Chemical Engineering Department
IIT Bombay
Mentors
Ms. Rashmi Patankar
Ms. Vineeta Gharvi
Mr. Rupak Rokade

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Acknowledgment

I wish to express my sincere gratitude to Prof. Kannan M. Moudgalya, head of FOSSEE team, IIT Bombay for giving me the opportunity to work with the FOSSEE team for contributing towards the development of free and open-source software.
I would like to thank Ms. Vineeta Gharvi and Mr Rupak Rokade. Their help, stimulating suggestions and encouragements helped me co-ordinate and successfully complete my project.
I would also like to thank my mentor- Ms. Rashmi Patankar. Her exemplary guidance, constant encouragement, and careful monitoring throughout the internship shaped my project to be be perfect.

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1. Introduction

1.1 FOSSEE And Its Aim

FOSSEE (Free and Open Source Software in Education) project promotes the use of free and open-source tools to improve the quality of education in our country. They aim to reduce dependency on proprietary software in educational institutions. They encourage the use of FOSS tools through various activities to ensure that commercial software is replaced by equivalent FOSS tools. They also develop new FOSS tools and upgrade existing tools to meet requirements in academia and research. Incorporated to FOSSEE program, this fellowship's main aim is to introduce students to the FOSS in various engineering fields and to become a part of this big community.
I was selected for this fellowship on the basis of the screening task submitted by me. As a part of this fellowship, I got to work on Scilab. I successfully completed two case studies-: **Audio Signal Processing** and **Vehicle Number Plate Recognition** in Scilab.
I also got work in the TextBook Companion Project(TBC). The project required me to code examples of textbooks in Xcos.

1.2 Scilab

Scilab is a free and open-source, cross-platform numerical computational package and a high-level, numerically oriented programming language. It can be used for signal processing, statistical analysis, image enhancement, fluid dynamics simulations, numerical optimization, and modelling, simulation of explicit and implicit dynamical systems and (if the corresponding toolbox is installed) symbolic manipulations.

1.3 Xcos

Xcos is a graphical editor to design hybrid dynamical systems models. Models can be designed, loaded, saved, compiled and simulated. Xcos provides functionalities for modeling of mechanical systems (automotive, aeronautics. . .), hydraulic circuits (dam, pipe modeling. . .), control systems, etc.

2. Case Study 1

2.1 Abstract

The purpose was to gain a deep understanding of how signals are processed in a computer environment. My case study involved the study and analysis of digital signals. I have used a logic based approach built upon mathematical concepts.

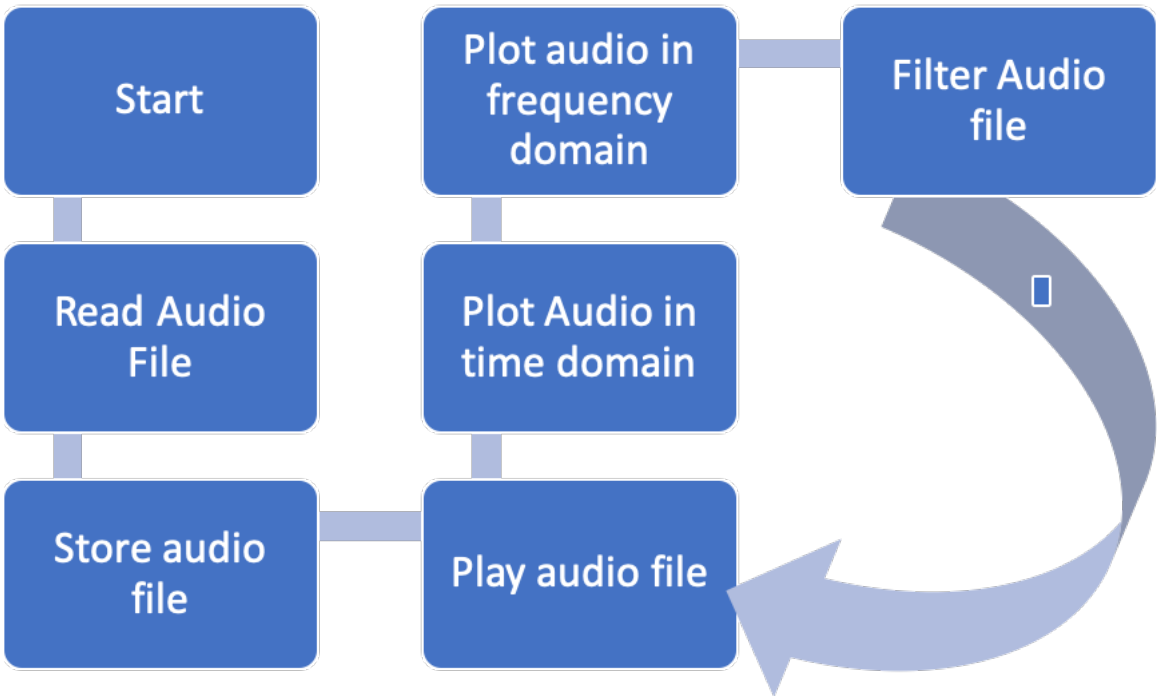
2.2 Problem Statement

An audio file is given. Read the file. Analyse it in time domain and frequency domain. Make a scilab gui based equalizer which can perform the following operations:-
1.read the audio file
2.play the audio file
3.show the input signal in time and frequency domain
4. design five filter(one low pass, one high pass, three band pass)
5.filter the input signal
6.display the filtered signal in frequency domain

2.3 Approach

A GUI(Graphical User Interface) is made. The interface helps in selecting and playing audio files, passing the signal through various filters(low pass, high pass, band-pass). The Amplitude vs frequency and Amplitude vs time plots are also displayed, for both input and output signals. The filters are made with help of convolution function. And the graphical analysis is done by using the fft(fast fourier transform) and analyze functions.

2.4 Flowchart



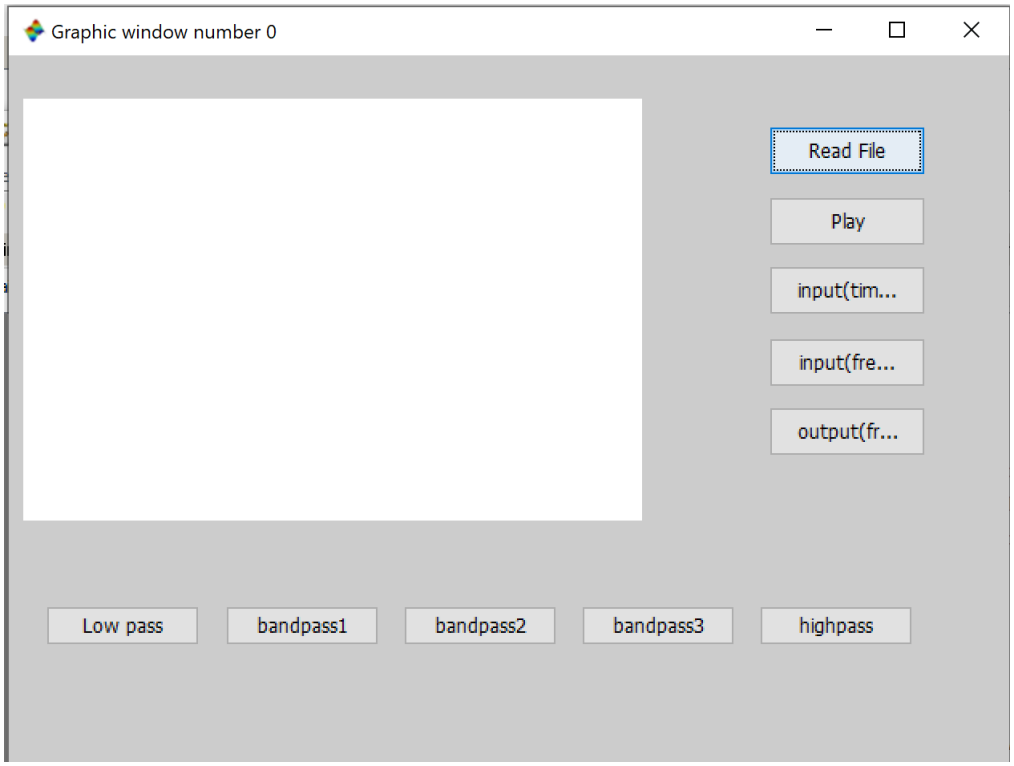


Figure 2.1: Graphical User Interface

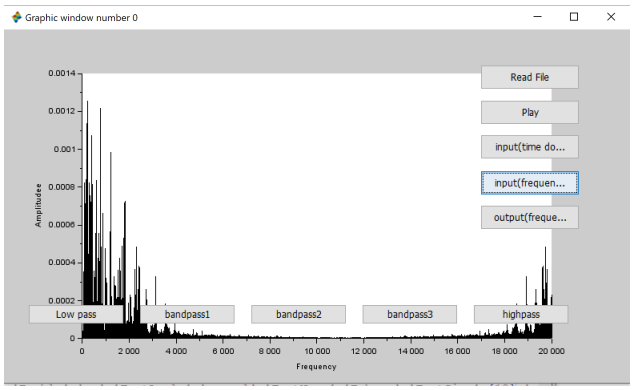


Figure 2.2: Frequency Plot of input signal

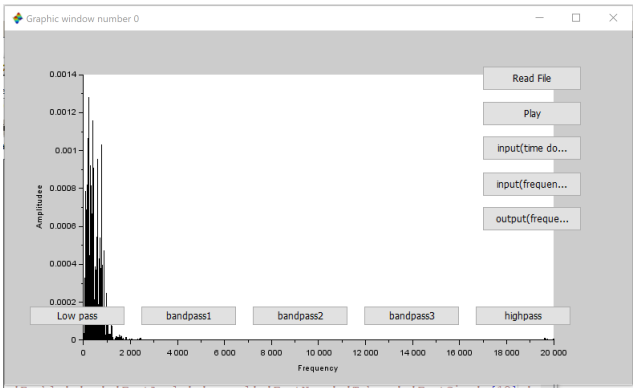


Figure 2.3: Lowpass filter

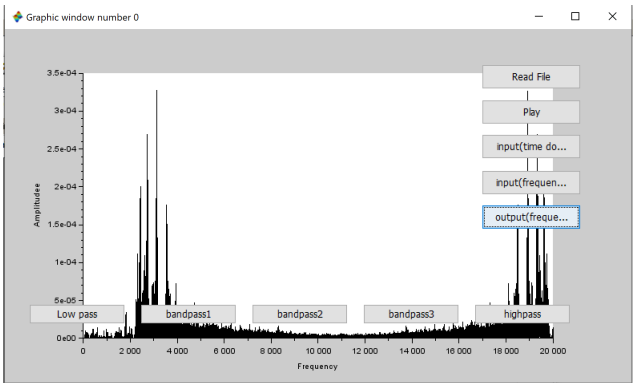


Figure 2.4: Bandpass filter(2000-3000 Hz)

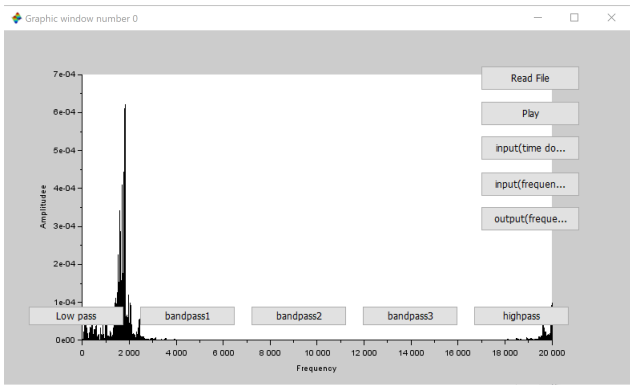


Figure 2.5: Bandpass filter(3000-4000 Hz)

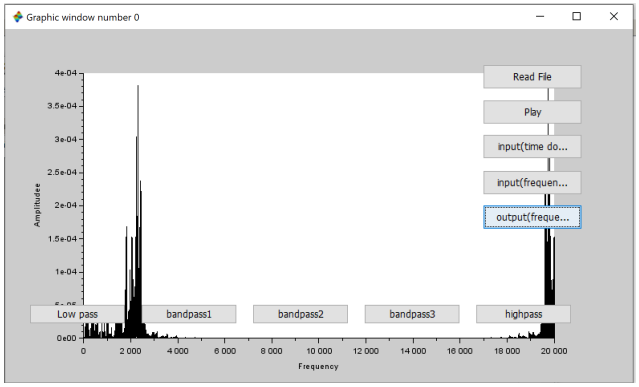


Figure 2.6: Bandpass filter(4000-5000 Hz)

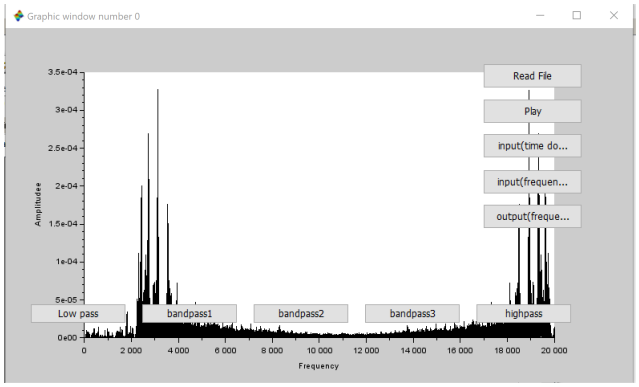


Figure 2.7: Highpass filter

3. Case Study 2

3.1 Abstract

The case study deals with how image processing concepts can be implemented in Scilab to get the number of a vehicle from its image. Mathematical concepts like convolution and correlation have been developed in a discrete system using matrices. These functions have been used to filter and prepare the image for extraction of the number plate. Finally, template matching , a method based on correlation has been used for recognizing the extracted characters.

3.2 Problem Statement

3.2.1 Problem

The back or the front RGB image of a car containing the number plate is given. Make a Scilab-based program which accurately gives the number of the vehicle as its output.

3.2.2 Method of approach

1)Extraction of Number Plate Location :- In this step the number plate is extracted by firstly converting RGB Image i.e., the captured image to gray-scale Image. Firstly the image is filtered to remove any noise present in the image. Then, mathematical morphology is used to detect the plate region and canny edge operator are used to calculate the threshold value. After this we get a dilated image. Then imfill function is used to fill the holes so that we get a clear binary image. This image is multiplied with the gray scale image so that we get only the number plate of the vehicle.

2)Segmentation :- Here bounding box technique is used for segmentation. The bounding box is used to measure the properties of the image region. The bounding boxes formed around characters are cropped so we get a cropped image of every character.

3)Recognition of characters by template matching :- Number plate recognition is now used to compare the cropped image of individual character against the complete alphanumeric database using template matching. The matching process uses

correlation coefficient as a measure of how well the image matches the template image.

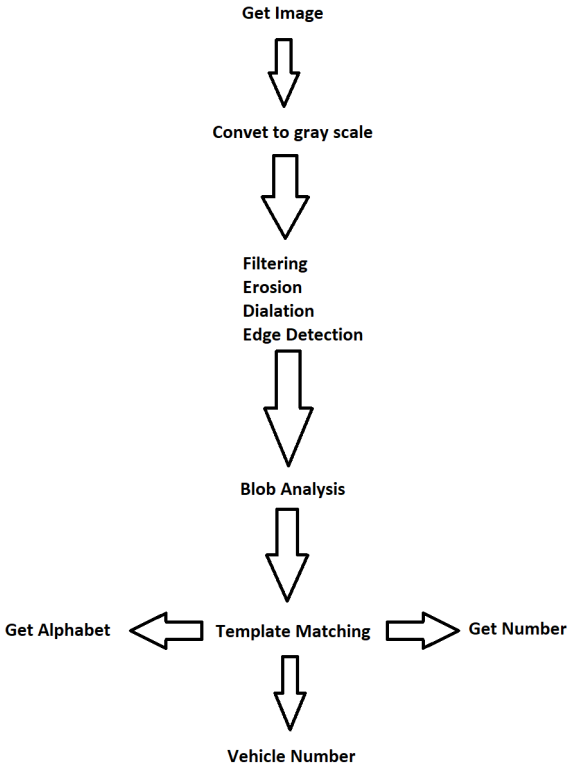
3.2.3 Problems Faced

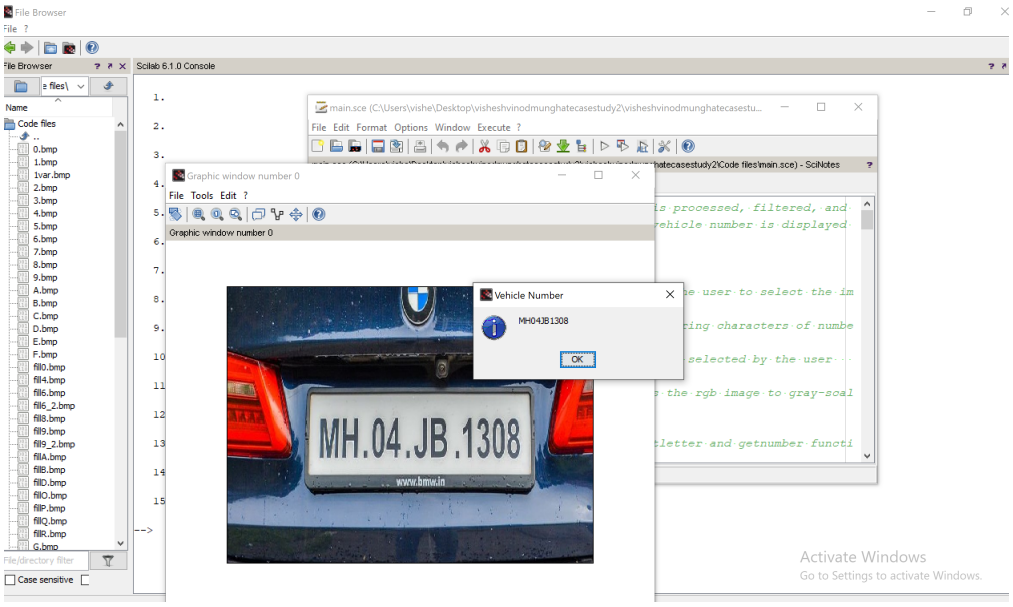
1) Every image has a different amounts of colour , intensity and contrast. Hence, the values used in thresholding and filtering do not work for all images. They have to be changed. This is observed especially in the case of white and black cars.

2) After an image has undergone filtering, erosion, dilation the characters themselves get a bit distorted. Hence during template matching, they are not recognized correctly.

3) There are also bounding boxes formed around features other than characters. To make sure that only the character bounding boxes are sent for template matching is a bit tricky. If this is not ensured, wrong results are obtained.

3.3 Flowchart





4. **Xcos TBC**

Five textbooks with at least twenty examples each were coded in Xcos. The books chosen were:-
1) Engineering Thermodynamics by **P. K. Nag**,
2) Concepts of Physics (Volume - 1) by **H. C. Verma**,
3) Fluid Mechanics by **Y. A. Cengel and J. M. Cimbala**,
4) Heat Transfer (In SI Units) by **J. P. Holman**,
5) Vector Mechanics for Engineers: Statics And Dynamics by **E. R. Johnston, D. F. Mazurek, P. J. Cornwell And E. R. Eisenberg**
Coding the textbook in Xcos is much easier albeit time consuming. Xcos is easier to understand as there are blocks instead of lines of codes which reduce the complexity of the code. In this numerous blocks such as the elementary blocks Summation Product LOGblock etc were used. To get the output the AFFICH block and CLOCKC were used.For graphs Cscope,MUX and GAINBLK were used. When these block are connected to each other in a specific way the desired output is obtained. In the code appropriate text and comments were added to enhance readability.

Once the code was completed a peer review was done. Codes were exchanged between the fellows and were reviewed to check for errors such as missing text or comments , wrong answers and whether proper standards and conventions were followed.
The errors were corrected as suggested by the reviewers and resubmitted.The review was done twice to ensure that there was no chance of errors in the code.

Reference

- https://www.scilab.org/
- https://scilab.in/Textbook/Companion_Project