Summer Fellowship Report

On

Scilab Case Study and Xcos TBC

Submitted by

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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. My task was to implement the case studies **Audio Signal Processing** and **Computation of Distances Between Objects in an Image** in Scilab.
I also had to code examples of textbooks in Xcos as a part of the **TBC** project.

1.2 What is an open source software

The term "Open source" defines software whose source code is made publicly available.They are eligible for use and modification by users, developers subject to certain conditions. Some key points of "Open Source"
No need to buy Software
Large community (Users, developers, admin).
Many open sources like Blender are under the GNU Public License.

1.3 What is 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.

1.4 The Case Study

Two case studies were successfully completed. One dealt with Audio signal Processing and the other with Computaion of Distances between Objects in an image.

The first case study was submitted as a screening task. In the first case study, to develop an understanding of Scilab, a basic GUI was developed. It contained various functions such as play,combine two audio files, plot a Amplitude vs Time and Frequency vs Time graph. It also had an audio filter which could filter the audio based on the cut-off frequency provided.

The Second case study dealt with the computation of distances between multiple objects. If an image is selected the Scilab program for the case study first tries to segment the objects and the backgrounds using edge detection and thresholding. Once the image is segmented it labels the objects detected and gives the centroidal distances between the objects that are selected. The user can also provide a scale or keep a reference object such as five rupee coin to get the scale. The case study was validated physically by measuring the actual distances between the objects and the computed distances and the error found was very small.

1.5 Textbook Companion Project

The Textbook Companion Project (TBC) aims to port solved examples from standard textbooks using an open source software system, such as Scilab or Xcos. Any standard textbook can be used for this purpose.
For this Project one hundred examples from five textbooks were coded in Xcos, from various domains. Xcos is more intuitive to use than Scilab and can be easily accessed and used. On completion of the TBC project a peer review was performed for other fellow's Xcos codes.

2. Case Study 1

2.1 Abstract

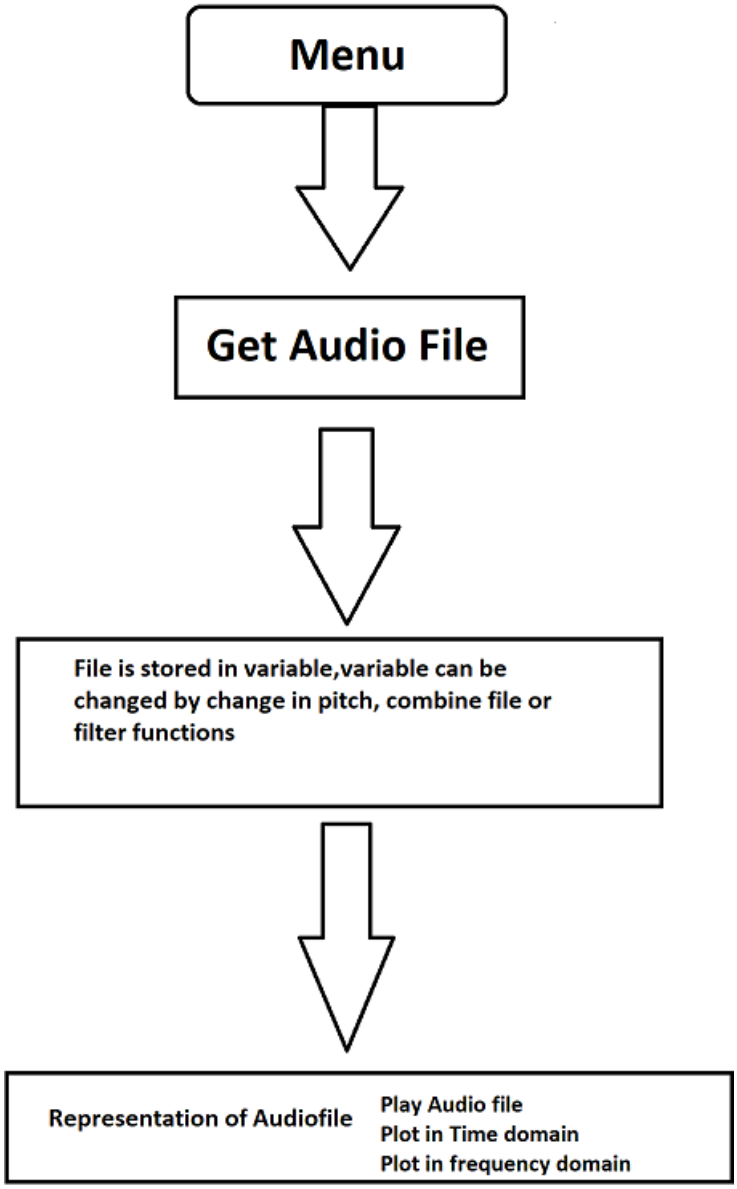
The case study had numerous aspects firstly a thorough understanding of Scilab and its way of handling of audio files is required. Secondly how an audio file is stored and concepts such as sampling rate are to be understood, the concept of digital filters is also essential in the case study. The case study is basically to study Audio Processing through Scilab concepts of Audio processing such as Frequency of the Audio file and filtration were implemented.

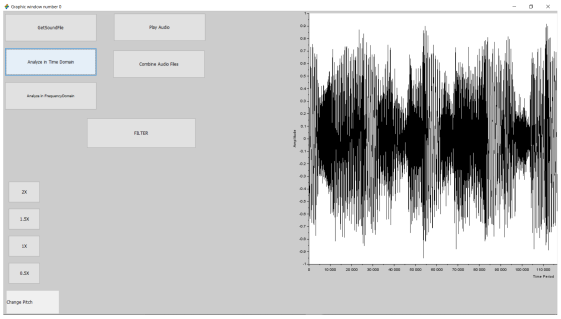
2.2 Problem Statement

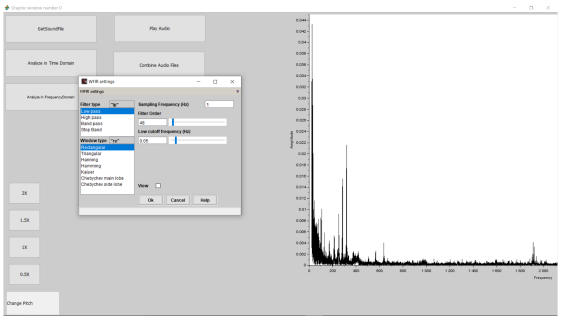
The project is to implement a GUI based system that can 1) Load an audio file and read it.
2) It should be able to play it without any distortions or at a different frequency.
3) It should be able to plot an Amplitude vs Time graph.
4) It should be able to plot an Amplitude vs frequency graph.
5) It should be able to combine at least 2 audio files.
6) It should be able to change the pitch of the audio file.
7) It should be able to filter any unwanted noise in the Audio.

2.3 Overview of the Program

In the figure the buttons displayed each have a function.
The first button Get file allows the user to browse through the directory and select the audio file of their choice.
The play button plays the audio file.
The buttons Analyze in Time and Frequency Domain plot the graphs Amplitude vs Time and Frequency vs Time respectively. The left hand figure showcases the graph of a sample audio in Time domain and the right hand figure of the frequency domain.


Menu
Get Audio File
File is stored in variable,variable can be changed by change in pitch, combine file or filter functions
Representation of Audiofile
Play Audio file
Plot in Time domain
Plot in frequency domain





The change pitch buttons change the pitch of the audio. It can be clearly heard when played or seen when compared on the graph with the original.
The combine audio file button combines two audio files. The audio file which is selected first will be the first part and the audio file selected after clicking on this button would be the second part.
The FILTER button shows the user a GUI based filter which the user can configure themselves.

3. Case Study 2

3.1 Abstract

In this case study an image consisting of multiple objects is taken and an attempt is made to find the centroidal distances between the objects. This requires the use of the IPCV toolbox in Scilab. Many functions from the IPCV toolbox were used. The Program is divided into two parts, one-part deals with the segmentation of the object and the other deals with detecting the objects and calculating their centroids and distances. The program is subdivided into functions for better control and readability. The program also has two modes one is the auto mode which detects images using edge detection and the other is the manual mode. The manual mode asks the user to threshold the grayscale image until only the objects are visible.

3.2 Problem Statement

The program in the case study must be able
1) To read the image.
2) To segment the image into objects and background.
3) To do multiple operations to the image to clean the image up.
4) To detect the objects and calculate their centroids.
5) To find the centroidal distances between the said objects.

3.3 Overview of the Program

The program asks the user to load an image. The program then asks for the mode of the program auto mode segments the image using edge detection and the manual mode using thresholding.

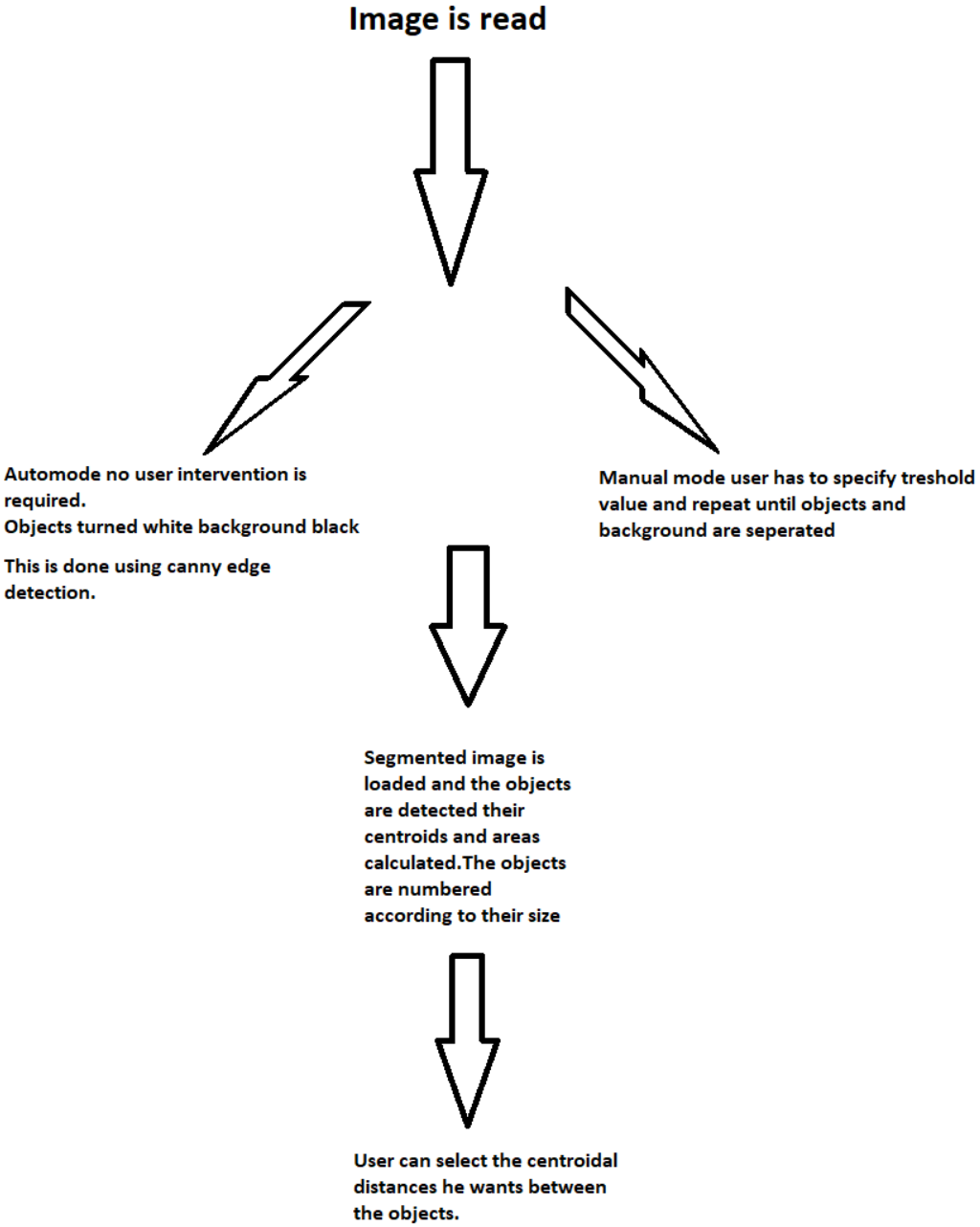


Image is read
Automode no user intervention is required.
Objects turned white background black
This is done using canny edge detection.
Manual mode user has to specify treshold value and repeat until objects and background are seperated
Segmented image is loaded and the objects are detected their centroids and areas calculated.The objects are numbered according to their size
User can select the centroidal distances he wants between the objects.

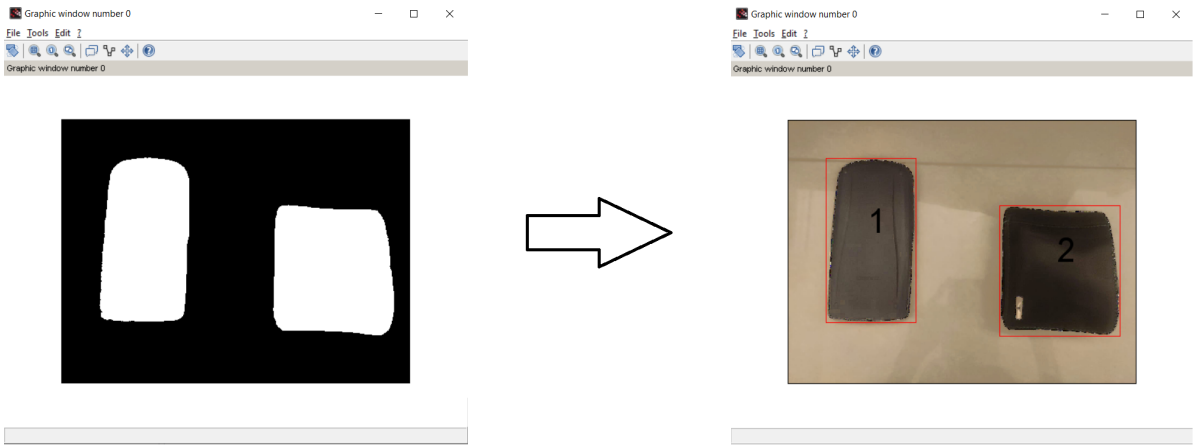


Figure 3.1: Segmentation then labelling the objects

The program then presents the user with the segmented image and asks the user to set the maximum number of objects in the image.This is to remove the noise in the image. The objects are then labelled with numbers to easily identify and mark them.
The user must set a scale in pixels/mm which the user must calculate.
Alternatively the user can place a circular object in the leftmost part of the image, the program would calculate the scale itself.

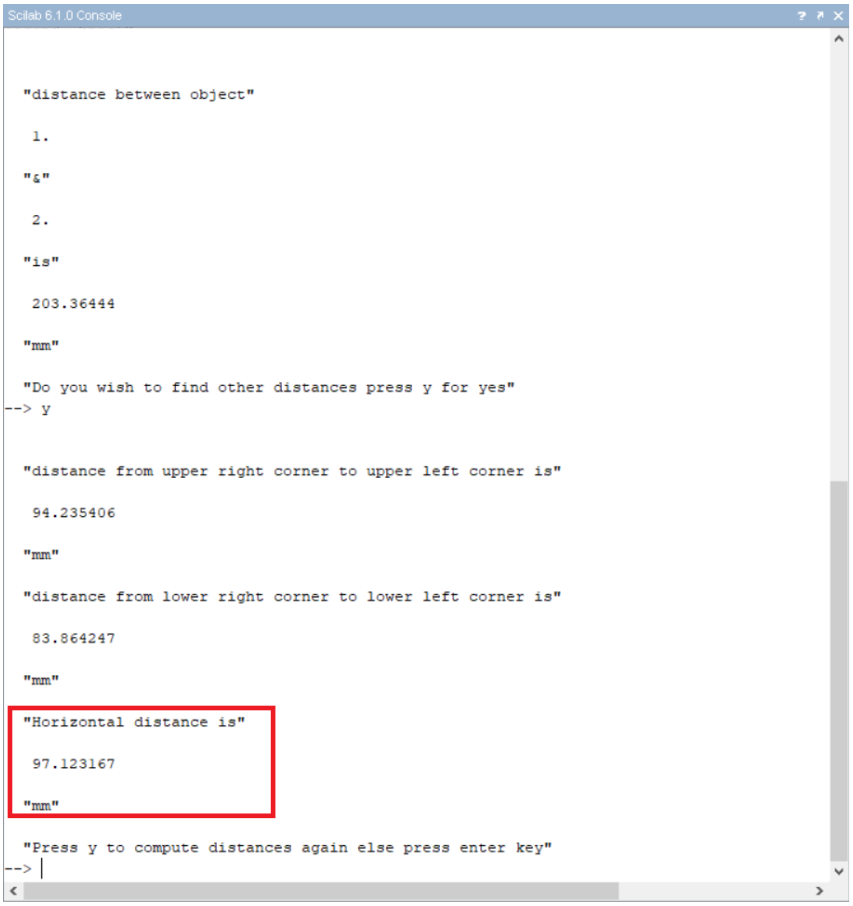


Figure 3.2: Console window displaying the answer

Once the scale has been calculated the user can choose the objects between which they want the distances to be computed. The user is presented with the centroidal distances and many more distances such as the horizontal distance. In this particular example the distance computed by the program is 97mm which just short of the actual 100mm of distance between the objects.

4. **Xcos TBC**

Five textbooks with at least twenty examples each were coded in Xcos. The books chosen were
Thermodynamics An Engineering Approach by **MA Boles and Yunus Cengel**,
Mechanics of Materials by **R C Hibbeler**,
Fluid Mechanics by **John F. Douglas**,
Concepts of Physics Volume 2 by **H.C Verma**,
Heat Transfer A Practical Approach by **Yunus A Cengel**
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 make the readability of the code easier.

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