Classification of time signals by CNN using spectrogram

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# Introduction

Convolutional neural network (CNN) is a deep learning algorithm used to process the data of image. It is commonly used in computer vision as a classification technique to distinguish different objects. On the other hand, spectrogram is a representation method used to present three-dimension measured signals in two-dimensional diagram.

Based on the dataset provided by Professor Pech in the module Computational Intelligence at Frankfurt University of Applied Sciences (FRA-UAS), the goal of this project is to classify the reflected signals of different objects using CNN and spectrogram.

# Literature Review

## Gabor Transformation

Based on the provided dataset which is the set of analog signals in time domain, Gabor transform is used to convert them to time-frequency representation. Basically, Gabor transform filters the signals with a Gaussian window and Fourier Transform will be then applied to the filtered signals. The following formula is the applied filter as discussed:

Em chiu thua :’( Giup em cho nay voi, hong hieu gi :v

As the time increases, the signal dataset is acquired with the corresponding time from the window length until it reaches the end of the window. The whole process will generate the spectrogram of the signals to be used later as the training set, and also to test the model accuracy.

## Convolutional Neural Network

The concept of neural network or artificial neural network is commonly known as a combination of different layers connected to each other to make decisions based on different types of input. Biologically speaking, the neural network is a technique that mimics approximately how a brain functions. Each layer contains various nodes acts as a system of neurons that can interconnect between layers. Besides, dependent on the importance of each specific neuron, or node, a factor called weight is introduced to bias for the purpose of the system. These layers are commonly known as the hidden layer.

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On going...

(Viet Nguyen)

# Methodology

## Overview

## Gabor Transform and Creation of Spectrogram

(Toan Truong)

## Convolutional Neural Network configuration

(Toan Truong)

## Graphical User Interface GUI

(Hai Pham)

A user-friendly GUI was created to implement the experiment of Gabor transform as well as CNN classifier. The app is named “GUI.mlapp”. The figure below shows the GUI of this project.

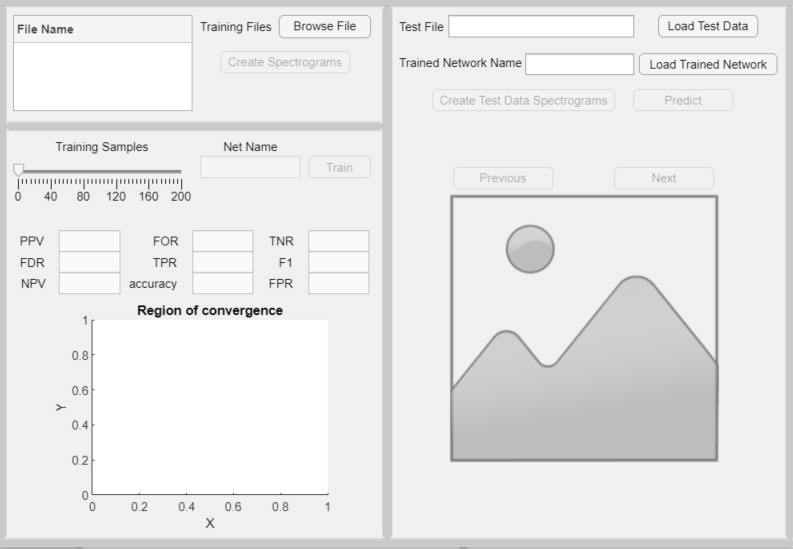
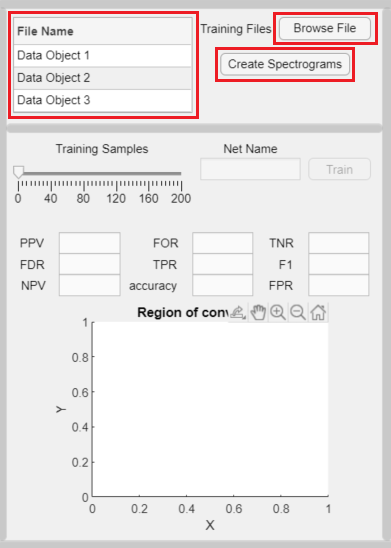


Figure [NUMBER] shows the GUI is divided into three sections:

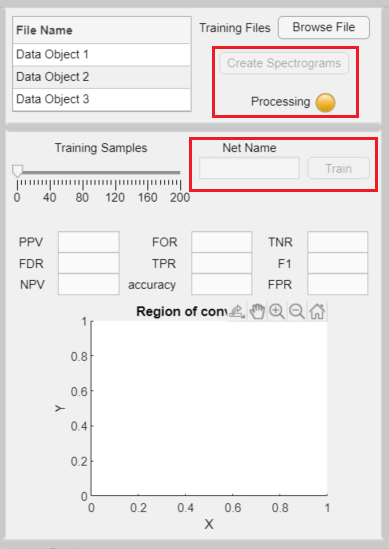
* The first section is located at the top left corner of the frame. This one is used for loading training data files and create spectrograms for each sample in the training data.
* The section which is used for training and validating the data is right under the first section.
* The last section is situated at the left panel of the GUI. This section indicates the predicted results of test data files.

The following is a short manual instruction in order to run the GUI application:

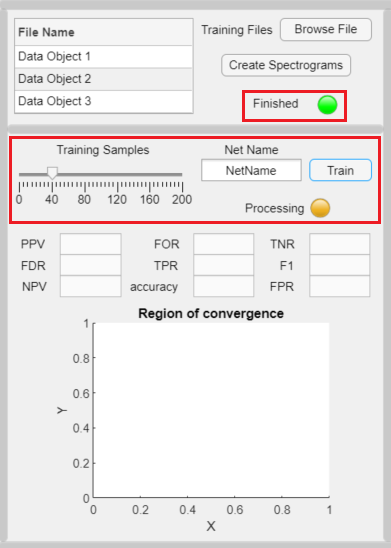
* ***Step 1***: First and foremost, user needs to load the training files by pressing the button “Browse File” as shown in figure [NUMBER]. Currently, the training dataset includes three files “Data Object 1”, “Data Object 2”, “Data Object 3” which are located inside folder “dataset”. User can choose one file, two files or three file files at the same time for training purpose. After choosing training files, the names of all chosen files are illustrated in the table to help the user can check it again.



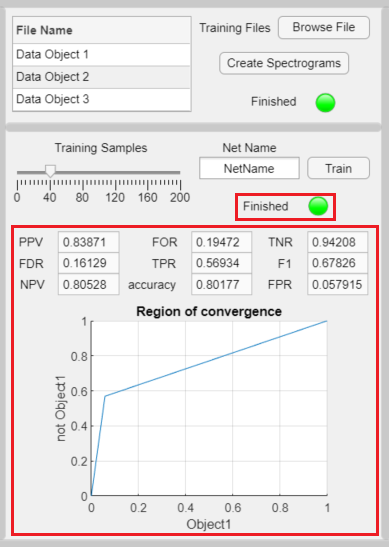
* ***Step 2***: Press the button “Create Spectrogram” to generate all spectrograms from the “Data Object” files. All the images are stored in folder “trainingData”, which is created automatically by Matlab. There is a LED in the lower area of the “Create Spectrogram” button to illustrate status of the process. As depicted in the figure [NUMBER], the LED shows orange and the status indicates “Processing” while the program is running. At this state, the “Net Name” field in section 2 is disabled.



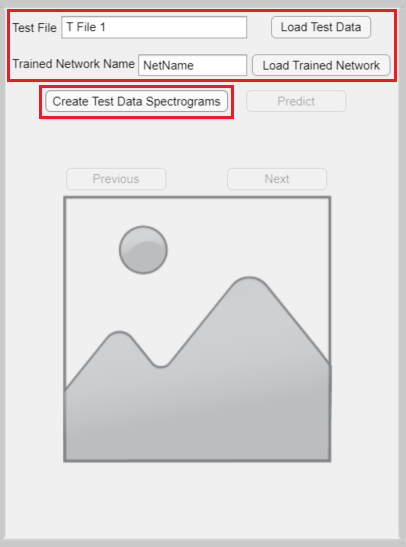
* ***Step 3***: After generating spectrograms, the LED changes to green and the status also alternates to “Finished”. There is also a notification to show that the process of creating images is finished. Then, the user moves to the second section for the training data purpose. Before pressing the “Train” button to start the training process, user must fill in the “Net Name” field as well as specify the “Training Samples” value using the slider as indicated in the figure [FIGURE]. A second orange LED with status “Processing” are also displayed.



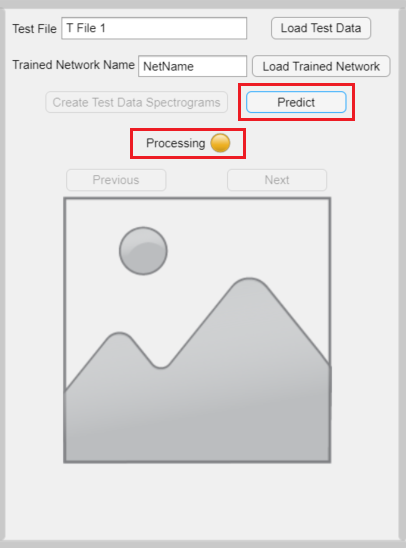
* ***Step 4***: The training process is done when the LED is green, and the status is “Finished”. The figure [NUMBER] illustrates the statistic validation as well as the graph region of convergence after the training process. The validation process also compels the data to have its label to generate the confusion matrix (pop up window) and the Region of Convergence (ROC). Validation needs a loaded CNN with appropriate resolution with respect to the images.



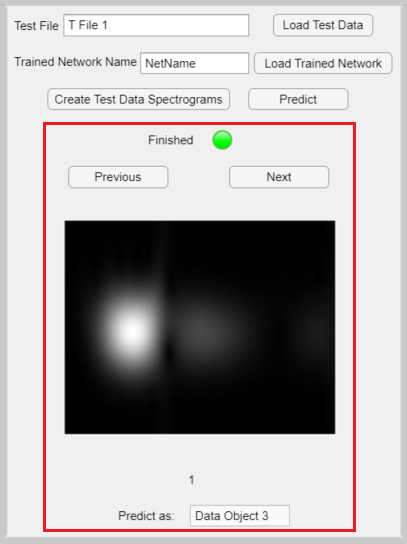
* ***Step 5***: Figure [NUMBER] shows the third section of the GUI. The “Test File” field requires the user to input the test .xlsx file, which is located in the “dataset” folder, by pressing the “Load Test Data” button. Then, the user presses the “Load Trained Network” button to load a trained network from the current directory, the name of the file “.mat” should be inputted. At the beginning, the “Create Test Data Spectrograms” is unable to press because there is no test data file. Therefore, the “Test File” and the “Trained Network Name” must be fulfilled to be able to proceed to the next step. Press the “Create Test Data Spectrograms” button when it is enabled.



* ***Step 6***: The data of test file is read into images under “testingData” folder, this data is then be loaded into the program. Eventually, the “Predict” button is able to be pressed. The predict process starts after the button is pressed and the third orange LED appears to show the “Processing” status as depicted in figure [NUMBER].



* ***Step 7***: Figure [NUMBER] depicts the result after the predict process is done. The LED turns to green and the status is “Finished”. The result pictures as well as the predict output are displayed in the lower area of the LED. The pictures can be browsed using the 2 buttons “Previous” and “Next”.



*NOTE*: If the user already has the trained network, step 1 to step 4 can be skipped and user can start directly at step 5 for the prediction purpose only. If the user only wants to train a new network, then please perform only step 1 to step 4 and ignore step 5, step 6 and step 7.

# Experiment

## Experiment’s result

(Riyad)

## Result on Given Test data

(Riyad)

# Conclusion

# Further Development

(Toan Truong)

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