Audio Files Comparison with Wavelet Transform

BY

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A REPORT

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Faculty of Information and Communication Technology

(Kampar Campus)

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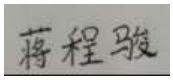

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Date: **07/09/2023**

FACULTY/INSTITUTE* OF ___ Information and Communication Technology___

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Date: ____05/09/2023___

SUBMISSION OF FINAL YEAR PROJECT /DISSERTATION/THESIS

It is hereby certified that _____***JIANG,CHENGJUN***_____ (ID No: __***20ACB00714***__) has completed this final year project/ dissertation/ thesis* entitled "_____ **Audio Files Comparison with Wavelet Transform**_____" under the supervision of ___**Mr. Lee Heng Yew**___ (Supervisor) from the Department of ____ **Computer and Communication Technology**_____, Faculty/Institute* of ___ **Information Communication Technology**____.

I understand that University will upload softcopy of my final year project in pdf format into UTAR Institutional Repository, which may be made accessible to UTAR community and public.

Yours truly,

__**Jiang,ChengJun**__
(*Student Name*)

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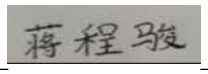
Signature : _____  _____

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Date : ____05/09/2023_____

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Finally, I really appreciate my parents and family's love and support . They encouraged me from start to finish. They are my strongest backing. I would have been unable to do it without their support.

ABSTRACT

This is a project development-based project, a signal processing project, the purpose is to design a program that uses continuous wavelet transform (CWT) to achieve the recognition of audio similarity, mainly used to identify the similarity between audio with different file names or different audio formats Spend. Today, a piece of music in the world may have many instruments, some played by piano, some saxophone, some even synthesized by software... Or, a song has other covers in different languages, sometimes English, sometimes It's Chinese, sometimes Japanese. Nowadays, people often download many songs to listen to, but sometimes they download the same song repeatedly in different folders, sometimes give them different names, sometimes download the same song but in different formats. So the goal of this project is to find the same or similar songs, i.e. songs with the same name but different formats, or songs with different names and formats but actually the same format, and songs with the same music but played or sung by different instruments/languages.

This project will compare their similarities in MATLAB.

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LIST OF SYMBOLS

Ψ	Psi

LIST OF ABBREVIATIONS

WT	Wavelet Transform
DWT	Discrete Wavelet Transform
CWT	Continuous Wavelet Transform
STFT	short-time Fourier transform
RAM	Random Access Memory
PCM	Pulse Code Modulation

Chapter 1

Introduction

1.1 Problem Statement

Nowadays, especially in China, some music software has the function of recognizing music, which is more useful. They can sing or recognize the music played outside and match to the most similar song at last. But they also have many drawbacks. Most of the audio contrast software on the market is integrated in some music software, which can only be used after downloading and registering.

In the works of the predecessors, it is generally only possible to perform simple audio recognition, such as recognizing the same song in different formats or the same format with different names, and most of them can only recognize pure music.

In addition, none of them can recognize files. They can only recognize music based on the sound collected by the microphone of their mobile phone, which is easily influenced by the environment and other factors. And in these music recognition functions, if the identified music is very similar or is suspected of plagiarism, it will lead to confusion of music recognition, resulting in the normal recognition of music. All in all, the functions of these software can only identify and find similar songs, and must register an account before use, or even open VIP membership. Comparing music similarity is also a function that these software do not have, making these software Limited.

1.2 Motivation

There are many kinds of music, such as symphony, rock, DJ rock, and music synthesized with software, etc. There are also songs sung in different languages in different countries. Some music can recall people's childhood memories, but they can't remember what the song is called. Now there are some mobile music software on the market that can recognize music, but they all have great limitations. So this project is to develop a way to compare music in different audio files name or in different audio formats, and show their similarity by percentage, so as to visually judge the similarity between the audio to achieve user's purpose.

Most of the predecessors' works can only recognize pure music, but my goal is to be able to recognize both pure music and songs with vocals.

1.3 Objectives

This project purpose is to develop a music file similarity comparison program that can identify different names, or different formats, or different names and different formats, but all are the same music, and display the results in the most intuitive way.

1.4 Project Scope

Usually there are many music files in a personal computer. The scope of this project is to find out those audio files with different names, different formats, or different names and different formats but actually the same music, and finally display the results with similarity.

1.5 Contributions

The contribution of this project is to supplement the music comparison function of existing software and to verify that it is possible to compare audio files using CWT method. This project can achieve functions that are not available by the mainstream music software on the market at present, such as uploading files for identification, showing the similarity between audio, etc.

1.6 Report Organization

Specifics about this report are described in the sections that follow. The first is to introduce the project, including problem statements, project motivation and contributions. The second chapter reviews some relevant backgrounds such as related software. Then, the Chapter 3 describes the system implementation and evaluation. Then, Chapter 4 describes the system design, including the use case, system component and activity diagram. Finally, Chapter 5 summarizes the project and recommended.

Chapter 2

Literature Review

This part involves the methods of comparing audio files studied by predecessors, the introduction of CWT and DWT, and some software/functions that have been applied to relevant audio recognition technologies.

2.1 Previous work on Audio Files Comparison

2.1.1 Audio Compression by Using Discrete Wavelet Transform

Speech is a weapon used to convey information from one person to another, with a bandwidth of 4 kHz. The increased usage of multimedia communication necessitates the optimal use of transmission bandwidth, storage space, and electricity. To avoid the repercussions, we must compress data, and this work takes a beginner's approach to evaluating and compressing the speech signal. PCM was the primary audio encoding technique used in the past, however it lacks a mechanism for redundancy reduction. The majority of signals in the world are non-stationary, and for best results, they should be examined without any assumptions that signals are linear and stationary for Fourier analysis. The introduction of wavelets has revolutionised signal analysis, which is used to evaluate both linear and non-stationary signals. Due to the time changing nature and sudden shift in frequencies of the human voice production system, speech is a non-stationary random process. Non-stationary signals are distinguished by transient fluctuations in frequency. Wavelets' key localization property, combined with their time-frequency resolution properties, makes them well suited for coding voice signals. Speech compression is critical in today's environment since bandwidth is restricted due to advances in multimedia technologies. [1]

2.2 Common methods in Wavelet Transform

2.2.1 WT

The wavelet transform is a mathematical method for analysing data whose features change with scale. The properties of signals can be frequency, transitory, or steadily varying patterns over time. Edges and textures are examples of image features. The To solve the inadequacies of the Fourier transform, the wavelet transform was created. Fourier analysis requires dividing the data into sinusoidal waves of a specific frequency, whereas wavelet analysis divides the signal into scaled and shifted versions of the wavelet.

Wavelet, as opposed to sinusoidal waves, is a fast-decaying wave oscillation. As a result, the wavelet may represent data at different scales. Depending on the application, different wavelets can be utilised. Transients typically disturb the piecewise smoothing behaviour of signal of audios, financial data of time series, and biological signals. Similarly, photos frequently feature smoothing sections that are uniform and segmented, separated by transients that appear as edges. Smooth regions and transients in signals and images can be represented sparsely using a wavelet transform. [2]

A Wavelet is a time-localized wave-like oscillation. Wavelets have two basic properties: scale and position. The scale of a wavelet determines how "stretched" or "squished" it is. A location is a point in time. [3]

2.2.2 CWT

Time-frequency transform includes continuous wavelet transform, which is suitable for non-stationary data. When the frequency domain representation of the signal changes with time, signal instability will occur. The CWT is similar to another transform -- the short-time Fourier transform (STFT). STFT generates local frequency analysis by using a fixed window. whereas CWT tiles time-frequency planes using variable-size windows. With time, the window becomes broader, making it ideal for low frequency phenomena, and smaller, making it suited for high frequency phenomena. Transient behaviour, fast changing frequency, and slow changing behaviour can all be analysed using the continuous wavelet transform..[4]

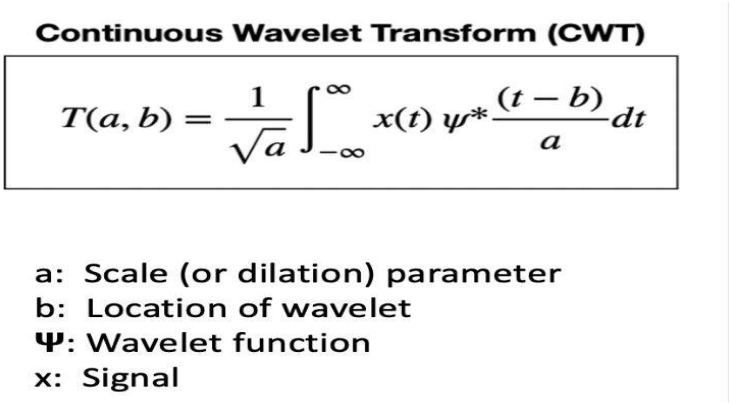

Figure 2.2.2 Formula of CWT

2.2.3 DWT

The discrete wavelet transform (DWT) is a transform that decomposes a given signal into many sets, each is a time series coefficient that describes the signal's time evolution in the related frequency band.[5]

2.3 Some Software

2.3.1 Netease Cloud Music

NetEase Cloud Music, a NetEase music product, is the output of NetEase Hangzhou Research Institute. Online music services focus on song lists, social networking, large brand recommendation, and music fingerprints, relying on professional artists, DJs, friends' recommendations, social functions. It focuses on discovery and sharing through music lists, DJ shows, social networks and geolocation.[6]

NeteaseCloud can use the function of “listening to songs and recognizing songs”, which can identify the released songs, humming, and speaking lyrics, improving the accuracy of music recognition.[7]

Figure 2.3.1 NetEase Cloud Music “listening to songs and recognizing songs”

2.3.2 QQ Music

Similar to Netease Cloud Music, QQ Music is also a music software, QQ Music is a music streaming media platform affiliated to Tencent Music Entertainment Group.[8]

Similarly, QQ Music also has the function of "listening to songs and recognizing songs" similar to Netease Cloud Music.

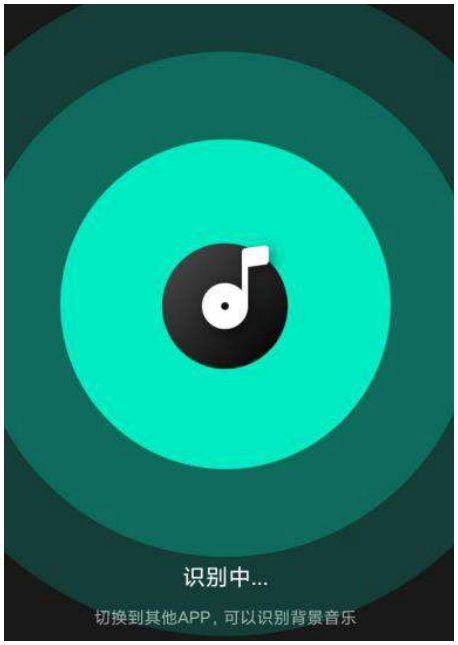

Figure 2.3.2 QQ Music “listening to songs and recognizing songs”

CHAPTER 3

SYSTEM IMPLEMENTATION AND EVALUATION

3.1 Test Case And Result

In this section, the audio content and results of all tests up to the time of writing will be displayed in the form of a table.

Table 3.1 Test Case And Result

Audio 1	Audio 2	Bias, time bias	Result
Chinese.wav	Chinese.ogg	0,0	100%
Chinese.wav	Japanese.wav	70000,0	89.6%
Faster Than Light.wav	Faster Than Light1.wav	0,0	100%
Faster Than Light+3.wav	Faster Than Light.wav	0,time*Fs+8000	97.6%
international(live).wav	international(rock).wav	0,0	84.2%
AuferstandenausRuinen(piano)	AuferstandenausRuinen(live)	0,0	84.9%
Jasmine Flower(live).wav	Jasmine Flower(game).wav	5000,0	83.7%
Faster Than Light.wav	Faster Than Light.mp3	0,0	91.1%
Korean.wav	Japanese.wav	24000,0	83.6%
Faster Than Light mix.mp3	Faster Than Ligh.mp3	0,0	84.3%
Faster Than Light.wav	Japanese.wav	0,0	0%
Faster Than Light.wav	Chinese.wav	0,0	0%
Faster Than Light.wav	Japanese.wav	95000,0	0%
Faster Than Light.wav	Korean.wav	0,0	0%
Faster Than Light.wav	Faster Than Light.flac	0,0	100%
international(rock).wav	Jasmine Flower(game).wav	0,0	0%
international(live).wav	Jasmine Flower(live).wav	0,0	0%

3.2 Limitations

Although the program has made significant progress and breakthroughs compared to FYP1, and can compare songs in different languages, instruments, and formats, the program still has limitations. First of all, although this program can compare files in audio formats such as wav, flac, ogg, etc., it cannot get results well for files in mp3 format. For example, as shown in Section 3.1, I used "Faster Than light" for comparison, the similarity results of wav, ogg, and flac are all 100%, but using the mp3 format for comparison, the similarity is 91.1%, I judge that this is because the audio files in the mp3 format are compressed , while audio files in other formats are lossless or low-loss formats, so files in mp3 format cannot be compared very well. The second is user-friendliness. The program requires people who have a certain MATLAB or programming foundation to operate. The third is that the program needs better hardware support. If the hardware performance is weak, the results cannot be obtained smoothly and quickly, and even the system/software will crash and fail to run. Finally, the program will be affected by the audio quality. If one file has a good audio quality, but the other file has a poor audio quality, it may also cause errors in the results of comparison.

In addition, I found that the results obtained by my program similarity are all above 80%, and there is no example below 70%. This may be a problem caused by my calculation method, which can only identify "known to be the same song" ", if part of the audio file is similar, for example, there are similar fragments in "1812 Prelude" or "Marseillaise", the ideal result may have a similarity of 20-30%, but the program can only obtain more than 80% similarity value, there is no doubt that this is a limitation.

CHAPTER 4

System Design

4.1 Hardware

The only hardware used in this project is my personal laptop. MATLAB will be used to run the project. For some reason my last laptop was broken and no longer usable, so replaced the one I was using during FYP1.

Table 4.1 Details of Laptop

Parts	Details
Model	Colorful X15 A23
Processor	Intel Core i5-13500H
System	Windows 11 professional workstations vision 22H2
Graphic	NVIDIA GeForce RTX4060 8GB
RAM	DDR4 32GB
Hard Disk	NVME 512GB SSD +2TB NVME SSD +1TB SATA SSD

4.2 Software

4.2.1 MATLAB

Before developing the program, I need to install MATLAB in my laptop, which is the development software that needs to be used at present. However, when installing MATLAB, I encountered some problems. During the process of installing MATLAB 2022 and testing the program, my laptop would occasionally blue screen for unknown reasons, which made it impossible to run normally. Therefore, I reinstalled MATLAB 2021.

MATLAB is a commercial mathematics software developed by MathWorks in the United States. it can do many things in many domains. [9].

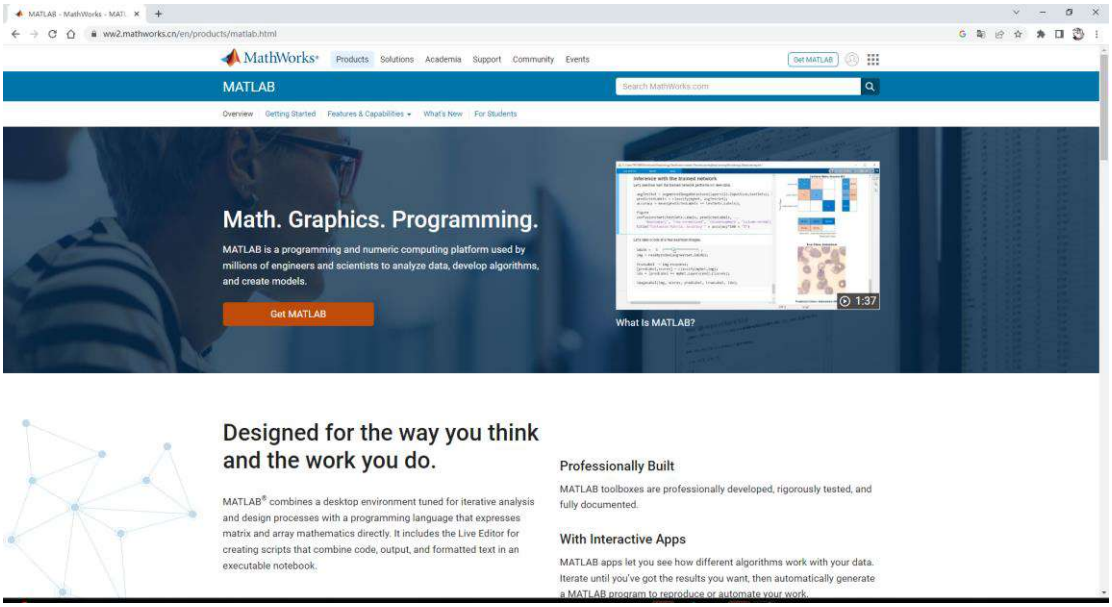

Figure 4.2.1 Web of MATLAB

4.2.2 Audacity

Audacity is a easy to use, open source, cross platform music software that is easy to use, multi track audio recording and editing. It can be used on all major operating systems.[10]

Figure 4.2.2 Audacity

4.3 Use Case Diagram and System Components

In this system, the user can mainly perform operations as shown in Figure 4.3: First, open MATLAB, and the user can freely import audio to be compared (must be at least two), in this example, we use faster than light and example of the same song but with a three second blank time added. The user fills in the song information (file name, song format) in the MATLAB program, fill in "Faster than Light+3.wav" and Faster than Light.wav" here. Then start running the program, the system is mainly divided into four parts , audio setting, data preprocessing part, CWT conversion operation part, result generation part. The first part is mainly to set the audio program, and in the second part, it is necessary to debug the bias value or time bias value according to the generated image. In this example Among them, the bias value here is 0, and the time bias is set to 8000. The third part is CWT conversion. The CWT part of the audio depends on MATLAB itself for calculation. Here I use the "amor" method for wavelet transformation. The last part is the result, of which Three pictures are generated (can be set here, but it is not recommended to generate too many pictures), representing the absolute value of the CWT captured by the two audio files being analyzed. The y-axis stand for frequency, and the x-axis stand for time. The number of generated images can be controlled by "num". The value set here is “3”, but if too many values are set, MATLAB may crash.

In the first part, if the song is not pure music, you need to change the bias value. For example, when comparing "mang zhong" audio, the bias needs to be changed according to the graph. You can also add audio playback code if desired.

The second and third parts are the main part of the program, which is the data preprocessing and CWT transformation processing part. In MATLAB, there are many WT (wavelet transform) methods, such as 'amor', 'morse', 'bump', etc. Here I choose 'amor' as WT. Here Euclidean distance is used to compare audio.

The third part is to generate charts and result calculations to display the comparison results more intuitively and allow users to see the differences intuitively.

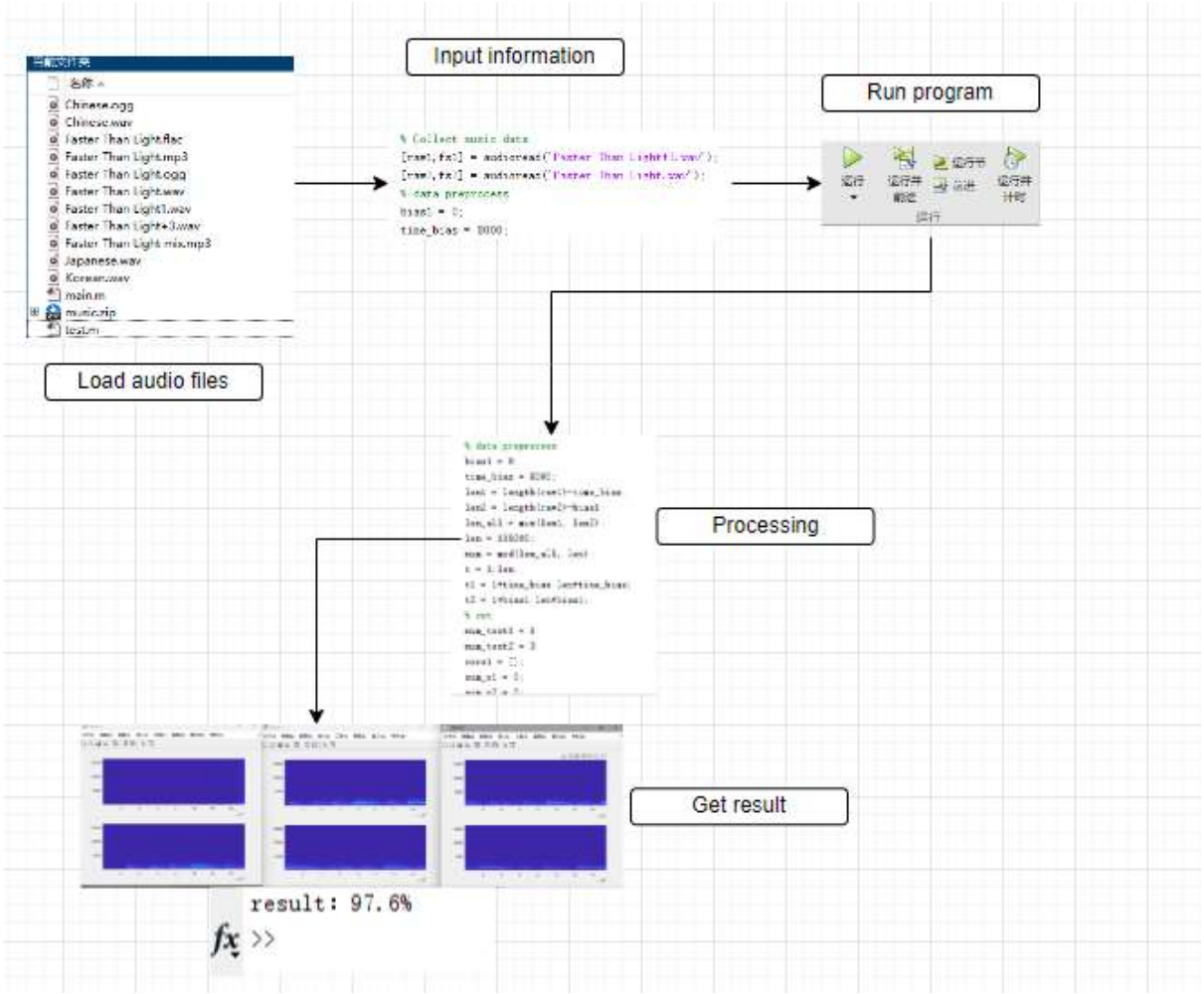

Figure 4.3 Diagram of System

4.4 Activity Diagram

Figure4.4 below shows that here I use the “Mang zhong” Chinese version as an example to compare wav and ogg files, and both bias and time bias are set to 0. The user enters the name and file format of the compared songs, sets the number of generated charts to 3, and the similarity result after running is 100%. It can be concluded that the two songs are completely the same song.

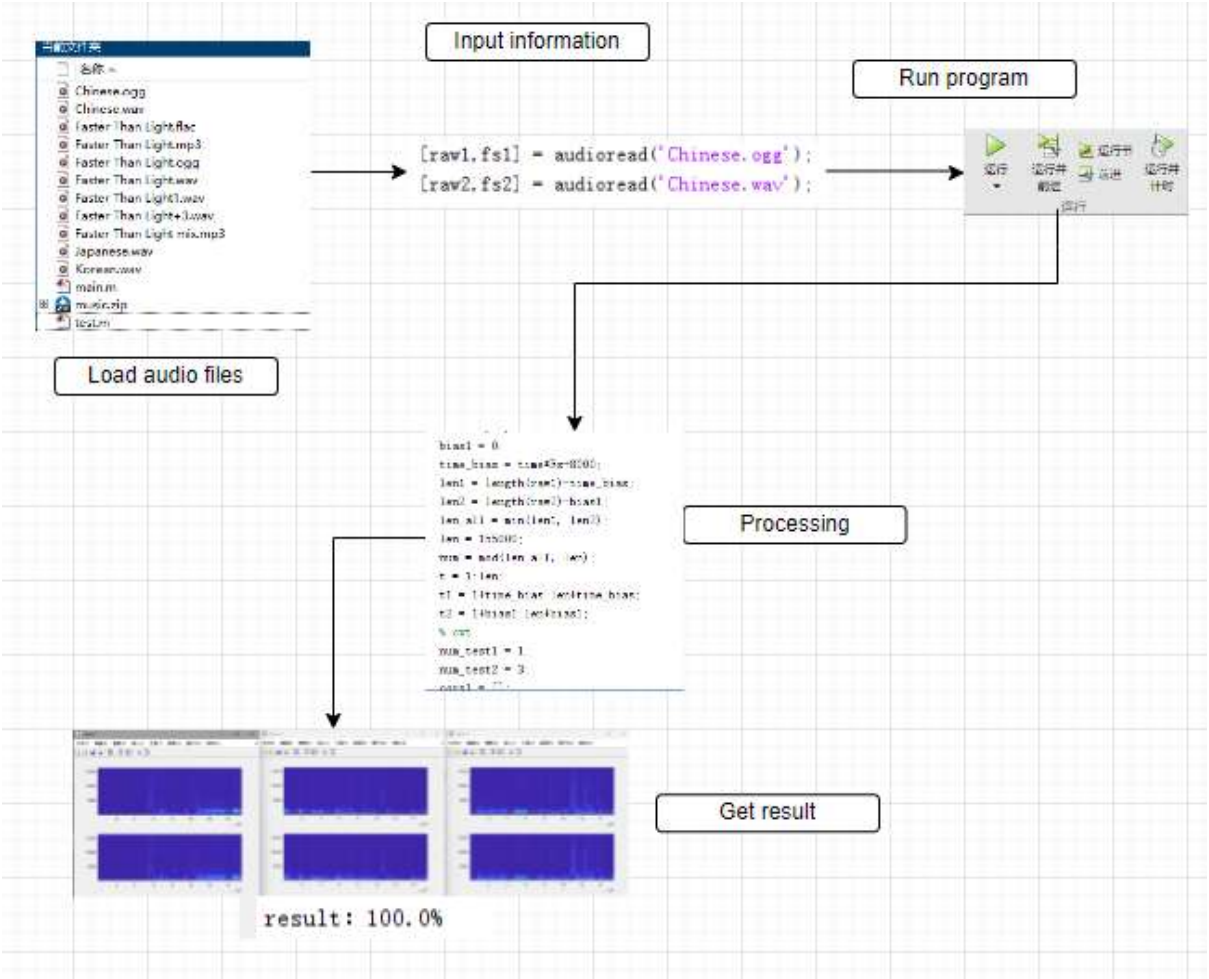

Figure 4.4 Activity Diagram Case 1

Figure 4.5 below shows that here I use the “Mang Zhong” Chinese version and the Japanese version as an example, the format of the two audio files is wav, set bias to 70000, and set time_bias to 0. The user enters the name and file format of the compared songs, sets the number of generated charts to 3, and the similarity result after running is 89.6%. From this, it can be concluded that the two songs are basically the same song, with only differences in background music/language or musical instruments.

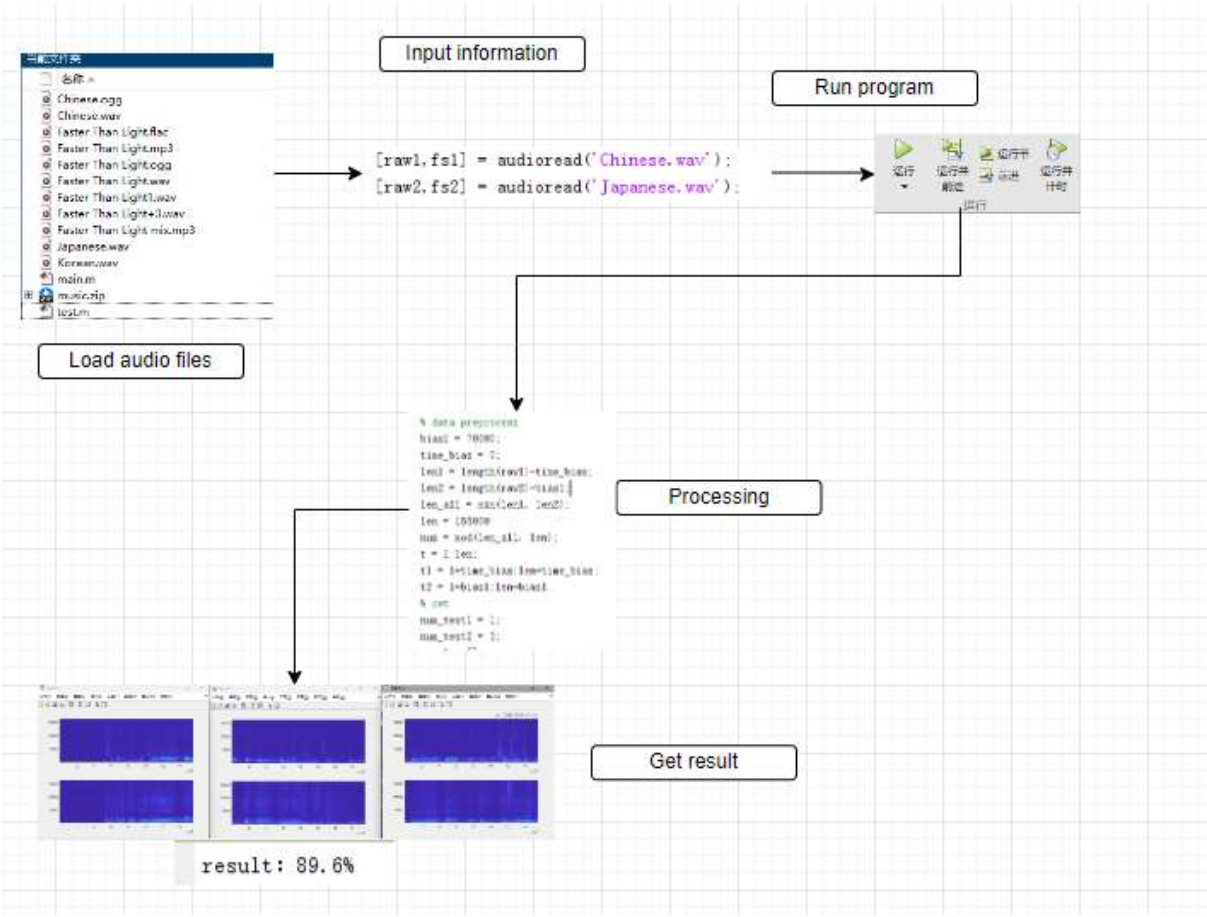

Figure 4.5 Activity Diagram Case 2

Figure4.6 below shows that here I use the “Mang zhong” Korean version and the Japanese version as an example, the format of the two audio files is wav, set bias to 24000, and set time bias to 0. The user enters the name and file format of the compared songs, sets the number of generated charts to 3, and the similarity result after running is 83.6%. From this, it can be concluded that the two songs are basically the same song, with only differences in background music/language or musical instruments.

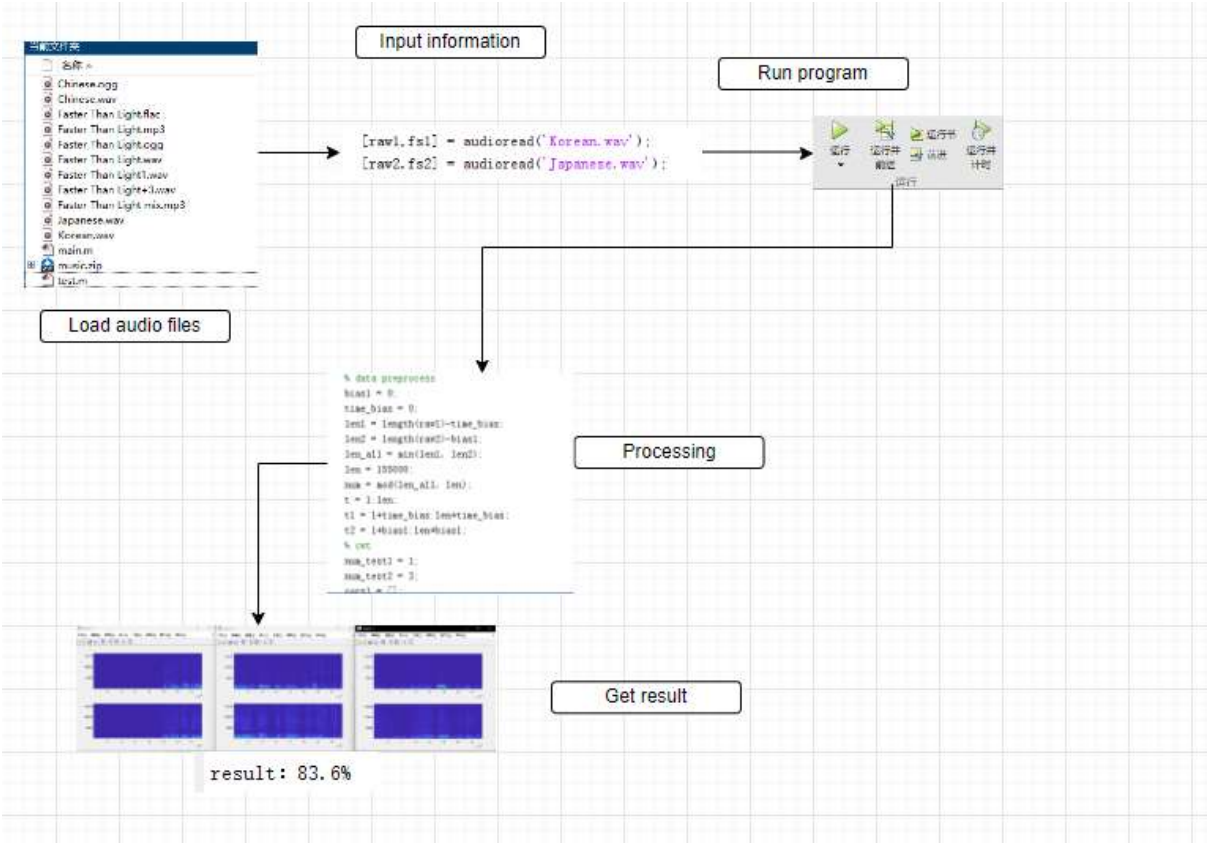

Figure 4.6 Activity Diagram Case 3

Figure4.7 below shows that here I use Faster than light as an example, in this example, only the name is changed, and other parameters are not changed. One name is "Faster than light" and the other is "Faster than light1". Both audio files are in wav format, bias is set to 0, and 0 is set to 0. The user enters the name and file format of the compared songs, sets the number of generated charts to 3, and the similarity result after running is 100%. From this, it can be concluded that the two songs are the same song, but differ in name.

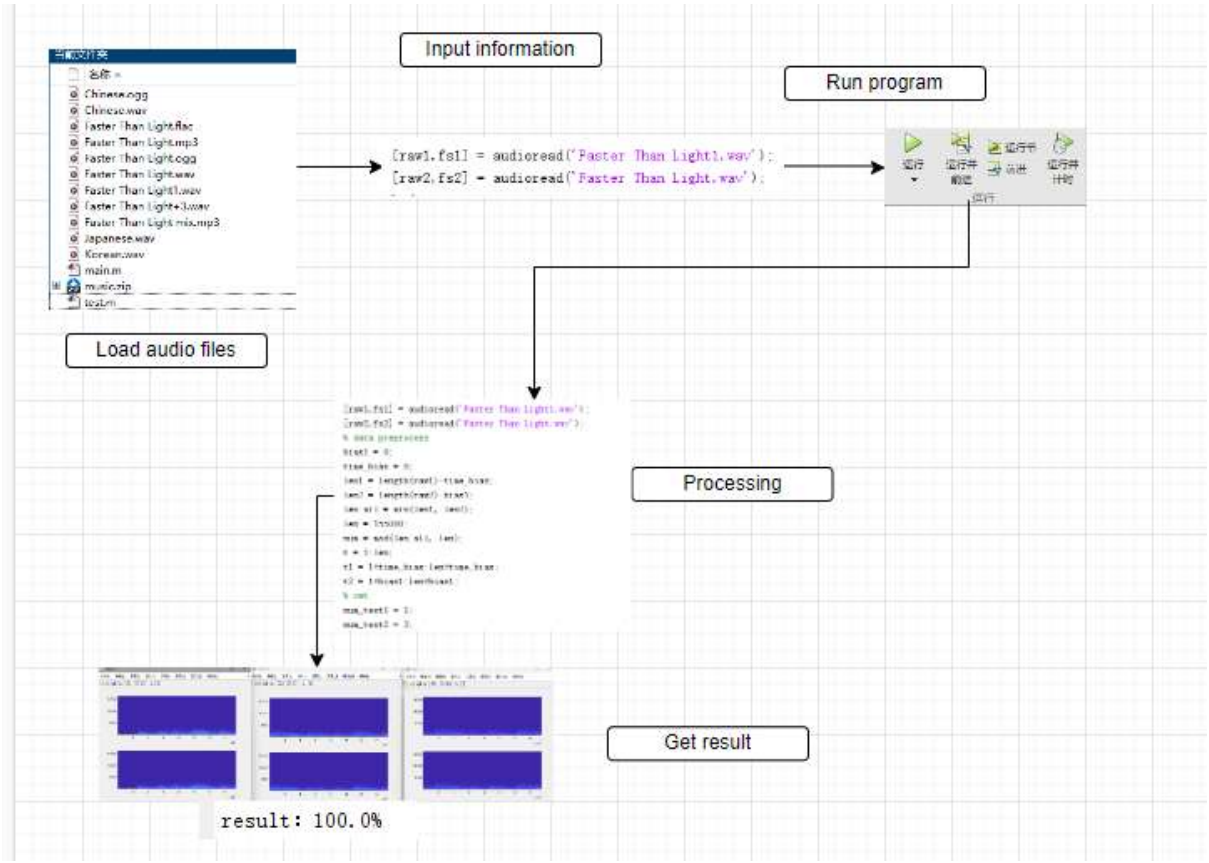

Figure 4.7 Activity Diagram Case 4

Figure4.8 below shows that here I use "Faster than light" and the Korean version of "Mang Zhong" as an example. In this example, two completely different pieces of music are selected. Both audio files are in wav format, bias is set to 0, and 0 is set to 0. The user enters the name and file format of the compared songs, sets the number of generated charts to 3, and the similarity result after running is 0%. From this, it can be concluded that there is no similarity between the two songs, and they are not a song at all.

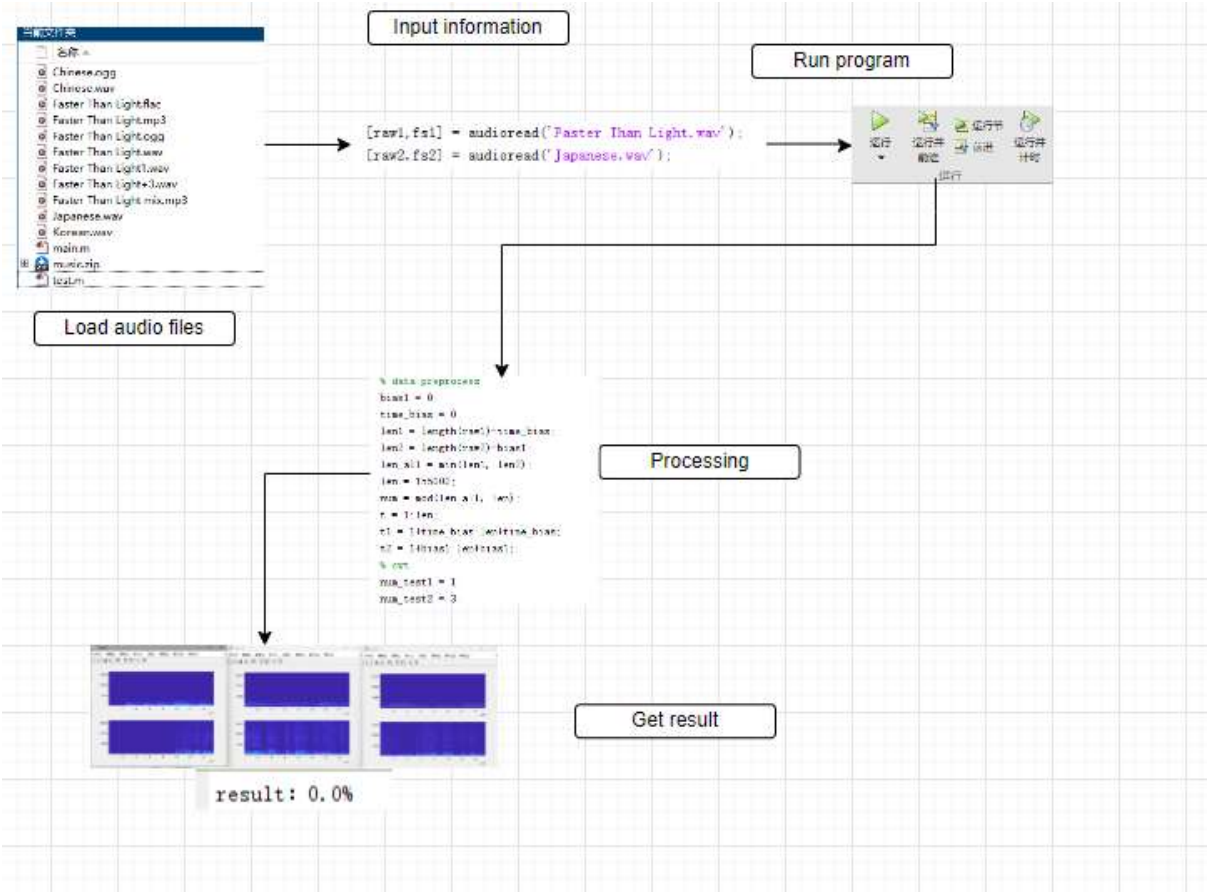

Figure 4.8 Activity Diagram Case 5

CHAPTER 5

RECOMMENDATION AND CONCLUSION

5.1 Conclusion

Audio comparison technology has developed rapidly in recent years, but it is basically embedded in some software or systems, and cannot identify files or similarities, only has the function of searching songs, and some embedded music software even requires VIP members to use. In addition, in the previous FYP of similar students, it was only possible to compare pure music in different formats, the same format or the same and different, but it was not possible to compare songs in different languages or different instruments. But my program can do all of the above. Although there are still some flaws, it may be a major breakthrough compared to the works of the predecessors. Whether it is rock music, Western music, symphony, piano music, or pop songs, the program can be compared. However, there are still some defects in this project. The limitations of the project have been mentioned in section 3.2. The main problems are the mp3 format, which is not very friendly to non-professional users, and has high requirements for hardware.

Although there were many difficulties with the preparation and procedure of the report, most of them could be solved. Thanks again to Mr.Lee Heng Yew, my supervisor, based on my many suggestions and help, helped me to solve the confusion and get new ideas.

5.2 Recommendation

In the future, it is necessary to improve the accuracy of audio recognition and solve the problem that MP3 files cannot be analyzed normally. It also needs to address issues that currently require knowledgeable people to debug. Because according to the current situation, sometimes the comparison of songs can be compared after importing, but sometimes it is necessary to adjust the two bias values to obtain a more accurate similarity value. The program also needs to be optimized to solve the freeze problem, otherwise the computer with low system configuration may not be able to run the program normally. Also, there are some unresolved issues. For example, the "game" version of the song "Jasmine Flower" was copied from the game

"Civilization 6", but if I use resources on the Internet, the results of comparing the two songs with the "live" version will be different. .The task is still arduous and cannot be relaxed. I also need to enrich my thoughts and learn more knowledge. "Knowledge is the key to the universe."

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y4S2	**Study week no.:1**
Student Name & ID:20ACB00714	
Supervisor: Mr. Lee Heng Yew	
Project Title: Audio Files Comparison with Wavelet Transform	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Gather information

2. WORK TO BE DONE

Conceive new ideas

Review FYP1

3. PROBLEMS ENCOUNTERED

N/A

4. SELF EVALUATION OF THE PROGRESS

N/A

Heng Yew

_____

Supervisor's signature

_____

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y4S2	**Study week no.:3**
Student Name & ID:20ACB00714	
Supervisor: Mr. Lee Heng Yew	
Project Title: Audio Files Comparison with Wavelet Transform	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Review FYP1

Conceive new ideas

2. WORK TO BE DONE

Write code

3. PROBLEMS ENCOUNTERED

N/A

4. SELF EVALUATION OF THE PROGRESS

N/A

Heng Yew

_____

Supervisor's signature

蒋程骏

_____

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y4S2	**Study week no.:5**
Student Name & ID:20ACB00714	
Supervisor: Mr. Lee Heng Yew	
Project Title: Audio Files Comparison with Wavelet Transform	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

N/A

2. WORK TO BE DONE

Write code

3. PROBLEMS ENCOUNTERED

There is no idea, there is too little information in this area, and there is no relevant software for reference.

4. SELF EVALUATION OF THE PROGRESS

anxious

Heng Yew

Supervisor's signature

蔣程駿

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y4S2	**Study week no.:7**
Student Name & ID:20ACB00714	
Supervisor: Mr. Lee Heng Yew	
Project Title: Audio Files Comparison with Wavelet Transform	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Write the code according to the ideas provided by the supervisor and optimize it

2. WORK TO BE DONE

Further improve the program

3. PROBLEMS ENCOUNTERED

N/A

4. SELF EVALUATION OF THE PROGRESS

Excited

Heng Yew

Supervisor's signature

蒋程骏

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y4S2	**Study week no.:9**
Student Name & ID:20ACB00714	
Supervisor: Mr. Lee Heng Yew	
Project Title: Audio Files Comparison with Wavelet Transform	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

The program is generally completed and the comparison of vocal songs has been implemented.

2. WORK TO BE DONE

Test more audio

3. PROBLEMS ENCOUNTERED

Computer damaged, waiting for new computer

4. SELF EVALUATION OF THE PROGRESS

Mixed joys and sorrows

Heng Yew

Supervisor's signature

蒋程骏

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y4S2	**Study week no.:11**
Student Name & ID:20ACB00714	
Supervisor: Mr. Lee Heng Yew	
Project Title: Audio Files Comparison with Wavelet Transform	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

The program has been completed and tested with many audio files, and different forms of comparison can be successfully performed and the similarity obtained

2. WORK TO BE DONE

Write reports and present procedures to supervisor

3. PROBLEMS ENCOUNTERED

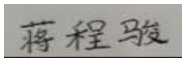
N/A

4. SELF EVALUATION OF THE PROGRESS

N/A

Heng Yew

Supervisor's signature



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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y4S2	**Study week no.:13**
Student Name & ID:20ACB00714	
Supervisor: Mr. Lee Heng Yew	
Project Title: Audio Files Comparison with Wavelet Transform	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

All has been done

2. WORK TO BE DONE

N/A

3. PROBLEMS ENCOUNTERED

N/A

4. SELF EVALUATION OF THE PROGRESS

From FYP2, I learned a lot and communicated with supervisor more frequently, I think it has improved a lot

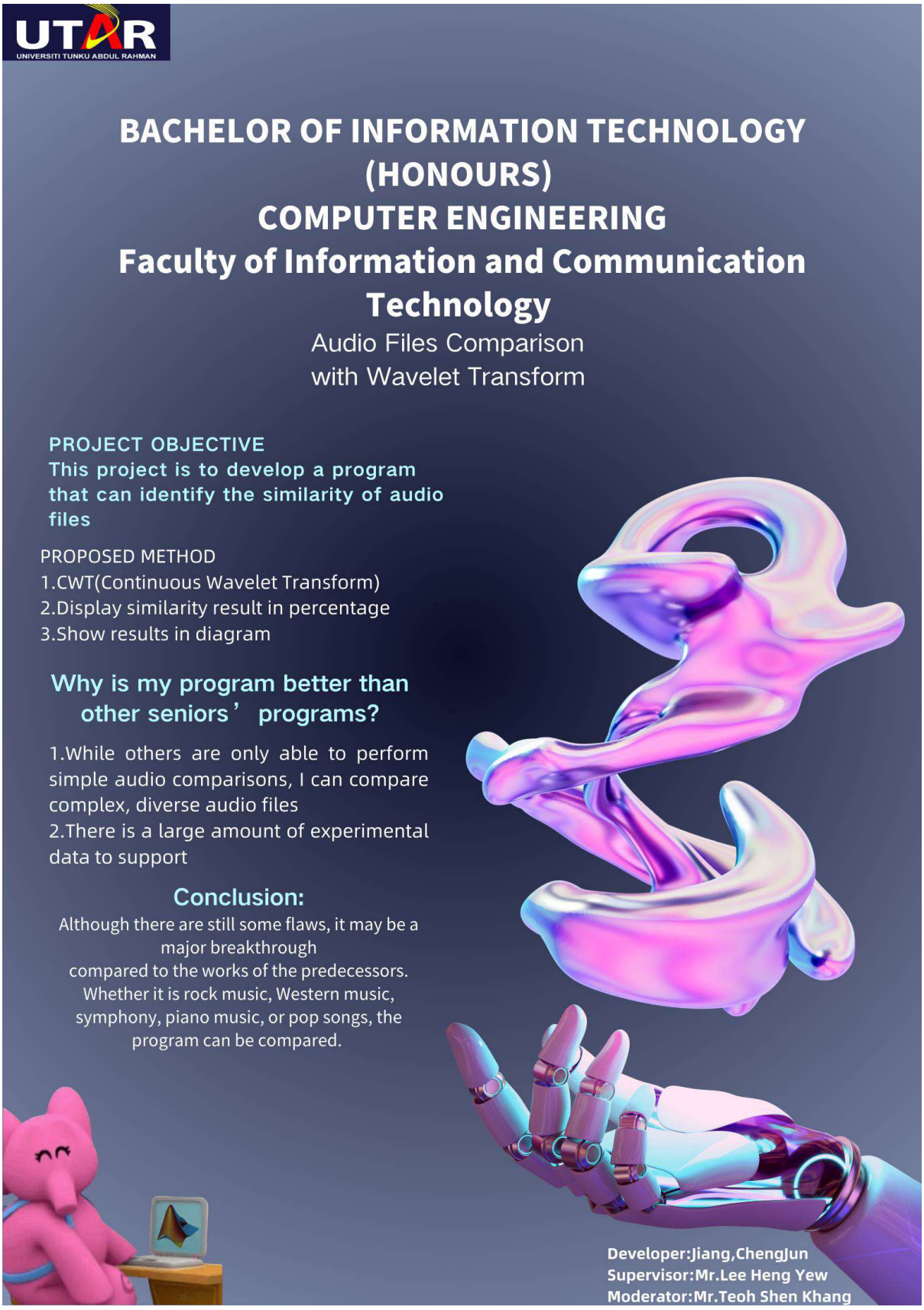
Heng Yew

Supervisor's signature

蒋程骏

Student's signature

POSTER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BACHELOR OF INFORMATION TECHNOLOGY (HONOURS)
COMPUTER ENGINEERING
Faculty of Information and Communication Technology
Audio Files Comparison with Wavelet Transform
PROJECT OBJECTIVE
This project is to develop a program that can identify the similarity of audio files
PROPOSED METHOD
1.CWT(Continuous Wavelet Transform)
2.Display similarity result in percentage
3.Show results in diagram
Why is my program better than other seniors' programs?
1.While others are only able to perform simple audio comparisons, I can compare complex, diverse audio files
2.There is a large amount of experimental data to support
Conclusion:
Although there are still some flaws, it may be a major breakthrough
compared to the works of the predecessors.
Whether it is rock music, Western music, symphony, piano music, or pop songs, the program can be compared.
Developer:Jiang,ChengJun
Supervisor:Mr.Lee Heng Yew
Moderator:Mr.Teoh Shen Khang

PLAGIARISM CHECK RESULT

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FYP2 By JIANG CHENGJUN

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ABSTRACT This is a development-based project, signal processing project, the purpose of which is to design a program that can identify the similarity of audio, mainly used to identify the similarity between audio in different file name or different audio formats. Nowadays, a piece of music in the world may have many musical instruments, some are played by the piano, some are played by the saxophone, and some are even synthesized by software... Now, people often download many songs to listen to, but sometimes they repeatedly download the same song in different folders, sometimes give them different names, and sometimes download the same song but in different formats. So the goal of this project is to find the same or similar songs, that is, songs with the same name but in different formats, or songs with different names and formats but actually in the same format. The project will compare their similarities in MATLAB. Chapter 1 Introduction 1.1 Problem Statement Nowadays, especially in China, some music software has the function of recognizing music, which is more useful. They can sing or recognize the music played outside and match to the most similar song at last. But they also have many drawbacks. Most of the audio contrast software on the market is integrated in some music software, which can only be used after downloading and registering. There are few audio file comparison programs on the market, Even some software on the marketnone of them can recognize files. They can only recognize music based on the sound collected by the microphone of their mobile phone, which is easily influenced by the environment and other factors. And in these music recognition functions, if the identified music is very similar or is suspected of plagiarism, it will lead to confusion of music recognition, resulting in the normal recognition of music. All in all, the functions of these software can only identify and find similar songs, and must register an account before use, or even open VIP membership. Comparing music similarity is also a function that these software do not have, making these software Limited. 1.2 Motivation There are few audio file comparison programs on the market, Only some music software has built-in similar "music recognition function" Now there are some mobile music software on the market that can recognize music, but they all have great limitations. So this project is to develop a way to compare music in different audio files name or in different audio formats, and show their similarity by percentage, so as to visually judge the similarity between the audio to achieve user's purpose. 1.3 Objectives This project purpose is to develop a music file similarity comparison program that can identify different names, or different formats, or different names and different formats, but all are the same music, and display the results in the most intuitive way. 1.4 Project Scope Usually there are many music files in a personal computer. The scope of this project is to find out those audio files with different names, different formats, or different names and different formats but actually the same music, and finally display the results with similarity. 1.5 Contributions The contribution of this project is to supplement the music comparison function of existing software and to verify that it is possible to compare audio files using CWT method. This project can achieve functions that are not available by the mainstream music software on the market at present, such as uploading files for identification, showing the similarity between audio, etc. 1.6 Report Organization Specifics about this report are described in the sections that follow. The first is to introduce the project, including problem statements, project motivation and contributions. The second chapter reviews some relevant backgrounds such as related software. Then, Chapter 3 describes the system design, including the use case, system component and activity diagram. Then, the Chapter 4 describes the system implementation and evaluation. Finally, Chapter 5 summarizes the project and recommended. Chapter 2 Literature Review This part involves the methods of comparing audio files studied by predecessors, the introduction of CWT and DWT, and some software/functions that have been applied to relevant audio recognition technologies. 2.1 Previous work on Audio Files Comparison 2.1.1 Audio Compression by Using Discrete Wavelet Transform Speech is a weapon used to convey information from one person to another, with a bandwidth of 4 kHz. The increased usage of multimedia communication necessitates the optimal use of transmission bandwidth, storage space, and electricity. To avoid the repercussions, we must compress data, and this work takes a beginner's approach to evaluating and compressing the speech signal. PCM was the primary audio encoding technique used in the past, however it lacks a mechanism for redundancy reduction. The majority of signals in the world are non-stationary, and for best results, they should be examined without any assumptions that signals are linear and stationary for Fourier analysis. The introduction of wavelets has revolutionised signal analysis, which is used to evaluate both linear and non-stationary signals. Due to the time changing nature and sudden shift in frequencies of the human voice production system, speech is a non- stationary random process. Non-stationary signals are distinguished by transient fluctuations in frequency. Wavelets' key localization property, combined with their time-frequency resolution properties, makes them well suited for coding voice signals. Speech compression is critical in today's environment since bandwidth is restricted due to advances in multimedia technologies. [1] 2.2 Common methods in Wavelet Transform 2.2.1 WT The wavelet transform is a mathematical method for analysing data whose features change with scale. The properties of signals can be frequency, transitory, or steadily varying patterns over time. Edges and textures are examples of image features. The To solve the inadequacies of the Fourier transform, the wavelet transform was created. Fourier analysis requires dividing the data into sinusoidal waves of a specific frequency, whereas wavelet analysis divides the signal into scaled and shifted versions of the wavelet. Wavelet, as opposed to sinusoidal waves, is a fast-decaying wave oscillation. As a result, the wavelet may represent data at different scales. Depending on the application, different wavelets can be utilised. Transients typically disturb the piecewise smoothing behaviour of signal of audios, financial data of time series, and biological signals. Similarly, photos frequently feature smoothing sections that are uniform and segmented, separated by transients that appear as edges. Smooth regions and transients in signals and images can be represented sparsely using a wavelet transform. [2] A Wavelet is a time-localized wave-like oscillation. Wavelets have two basic properties: scale and position. The scale of a wavelet determines how "stretched" or "squished" it is. A location is a point in time. [3] 2.2.2 CWT Time-frequency transform includes continuous wavelet transform, which is suitable for non-stationary data. When the frequency domain representation of the signal changes with time, signal instability will occur. The CWT is similar to another transform -- the short-time Fourier transform (STFT). STFT generates local frequency analysis by using a fixed window. whereas CWT tiles time-frequency planes using variable-size windows. With time, the window becomes broader, making it ideal for low frequency phenomena, and smaller, making it suited for high frequency phenomena. Transient behaviour, fast changing frequency, and slow changing behaviour can all be analysed using the continuous wavelet transform..[4] Figure 2.2.2 Formula of CWT 2.2.3 DWT The discrete wavelet transform (DWT) is a transform that decomposes a given signal into many sets, each is a time series coefficient that describes the signal's time evolution in the related frequency band.[5] 2.3 Some Software 2.3.1 Netease Cloud Music NetEase Cloud Music, a NetEase music product, is the output of NetEase Hangzhou Research Institute. Online music services focus on song lists, social networking, large brand recommendation, and music fingerprints, relying on professional artists, DJs, friends' recommendations, social functions. It focuses on discovery and sharing through music lists, DJ shows, social networks and geolocation. [6] NeteaseCloud can use the function of "listening to songs and recognizing songs", which can identify the released songs, humming, and speaking lyrics, improving the accuracy of music

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Full Name(s) of Candidate(s)	Jiang,ChengJun
ID Number(s)	20ACB00714
Programme / Course	Bachelor of Information Technology (Honours) Computer Engineering
Title of Final Year Project	Audio Files Comparison with Wavelet Transform

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Heng Yew

Signature of Supervisor

Name: **Lee Heng Yew**

Date: **07/09/2023**

Signature of Co-Supervisor

Name: _____

Date: _____

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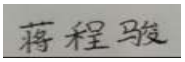

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