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Sound Waves Entering the Ear Using MP3 Decibel Level Optimizer

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Annotation: The MP3 Decibel Level Optimizer is a project that was developed to optimise the loudness of an audio clip by resetting it to its ideal level. This is accomplished by adjusting the decibel level. According to a number of studies, being subjected to extremely loud noises over an extended period of time can result in hearing loss. It has been established that if sounds are louder than 85 dB, they can cause irreversible harm to the ears. [Citation needed] [Citation needed] When listening to music, audiobooks, or any other recording, the end-user can get assistance from the optimizer in attaining the ideal level of volume for the experience. This project provides the user with the chance to tailor the target volume to a level that is comfortable for them, which is particularly helpful for people who have hearing impairments. This project includes the core and fundamental mechanism of a normalizer, which can be put to use in the creation of perspective graphical user interface applications that are pleasant for end users.

Keywords: MP3 Decibel Level Optimizer, 85 decibels, interface apps, measured in Decibels (dB), audio files.

Introduction:

Imagine going to sleep while listening to your all-time favourite music. When one song ends, the following one immediately begins playing at a very loud volume [1]. In these kinds of circumstances, the logical and speedy solution is to manually press the volume-down button and then adjust it to suit your preferences. It is true that this is a simple way out of the situation; however, what if the following song has a far lower sound level than usual? When faced with conditions such as these, we implement a process known as normalisation. The practise known as "normalisation" of audio files is a process in which the volume of each file is equalised to a given level that has been specified in advance [2-4]. The hushed conversation of a grandchild as they

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reveal a family secret, the piercing wail of a fire truck's siren, and the lulling tune of a song playing on the radio all come to mind. How can we determine the magnitude of the sounds that they produce? The Sound Level is a criterion that can be applied to any sound and is measured in decibels (dB). Let's put it into context (table 1) [5-11].

Table 1: Various noises with increasing sound level

Sound (dB)	Sound noise (with distance)
0 dB	Hearing threshold
10 dB	Distant rustling of leaves
20 dB	Whisper close up
30 dB	Quiet rural area
40 dB	Quiet library
50 dB	Conversation at home
60 dB	Conversation in a bar
70 dB	Vacuum cleaner at 3ft. (1m)
80 dB	Close alarm clock
90 dB	Operating a lawn mower
100 dB	Speaker in a club 3ft. (1m) away
110 dB	Vehicle horn 3ft. (1m) away
120 dB	Chain saw close up (discomfort)
130 dB	Jack hammer (pain threshold)
140 dB	Jet engine (pain threshold)
150+ dB	Eardrum rupture

The graph below shows loudness levels and their decibel levels (figure 1).

Figure 1: Effect of various Loudness levels [12]

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The era of portable music players and other consumer devices is here. Even though earbuds have been around for a while, their popularity is through the roof right now [13-15]. As long as you use them correctly, there is no danger. The widespread prevalence of hearing impairment has led some to question whether or not headphone volume levels are to blame. While this may be over the top, it is important to avoid having your hearing damaged by listening to music at unsafe volumes. You shouldn't blast your tunes to the point of hearing nothing else [16–22]. Therefore, researchers advise keeping the volume of extended hearing between 60 and 85 dB [23-25].

Objectives

Reducing harmful volume levels in audio files while listening to music. You should prioritise your hearing because it is irreparable [26-32]. There are many dangers associated with listening to headphones at extremely high volumes. There is a special danger posed by earbuds because of their location inside the ear canal, right next to the eardrum [33]. Even with the greatest bone conduction and open-back headphones, the volume shouldn't be too loud to bear. The eardrum vibrates when a sound is present, allowing us to hear it. After passing through the small bones in our ears, the vibration reaches the cochlea. Thousands of tiny hair cells in the cochlea act as sensitive receptors for sound [34-39]. Their bodies are shifted by the intense vibrations. They become deafened from the noise over time. As the hairs in your ear bend in response to loud stimuli, you may eventually experience hearing loss (figure 2).

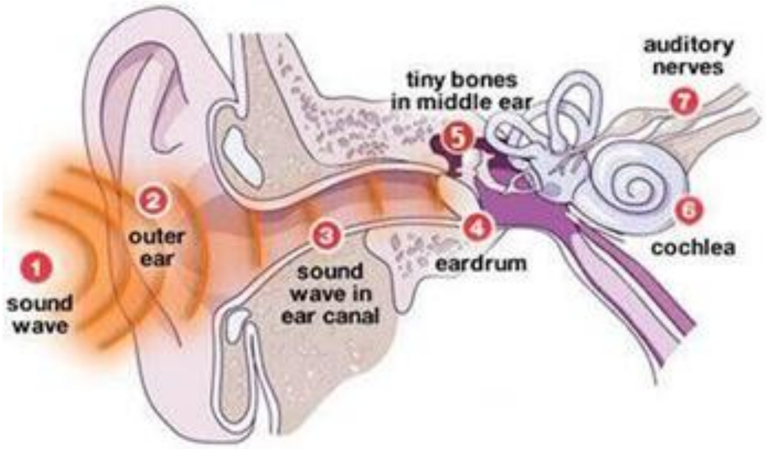

Figure 2: Sound waves entering the ear [41]

As a result, it is critical that audio files be adjusted to a safe volume level (80 dB) for listening.

When listening to a playlist, keep the volume consistent between songs.

One song in a playlist could be significantly quieter than the others, necessitating that the listener increase the level to compensate for the difference [42-46].

Scope of the Project

Within the context of our work, we appreciate the significance of maintaining a safe listening volume as advised by specialists. Continuous exposure to noises louder than 85 dB, for extended periods of time, can cause permanent hearing loss [47–55].

Apart from the practical nature of this research, I've enjoyed the chance to use the Java programming language and its features to create and construct an algorithm to normalise audio files that have been produced by a variety of different sources [56-62].

The goal of this effort is to ensure that the identified solution holds up during testing and validation, and that its existence is widely disseminated [63].

Library Used

The Java Standard Edition Library

Language, utility, I/O, Networking, Mathematics, Swing, and Sound are only some of the packages included. The Java Virtual Machine (JVM) makes use of these packages while they are being executed (Java Virtual Machine) [64-69]

Some of the packages included in this endeavour are as follows:

1.java.io

Offers data streams, serialisation, and the file system as input and output for the system [70].

2.java.util

It includes a string tokenizer, random number generator, and bit array in addition to the collections framework, legacy collection classes, event model, date and time facilities, internationalisation, and other utility classes [71–75].

3.java.lang

Provides core classes used in the development of the Java language [76–79].

4.javax.sound.sampled

Provides APIs and classes for working with sampled audio data, including recording, processing, and playback [80, 82].

Classes Used

1.java.io.File

A symbolic model of file and directory structures.

2.java.io.IOException

Indicates that an unexpected I/O error has occurred.

3.java.util.Scanner

Regular expressions allow a simple text scanner to interpret primitive types and strings.

4.java.lang.Math

Includes routines for doing simple arithmetic.

5.javax.sound.sampled.FloatControl

Allows for fine-tuning of a wide spectrum of floating-point numbers.

6.javax.sound.sampled.AudioInputStream

A data source of a certain length and audio kind.

7.javax.sound.sampled.AudioSystem

Performs the function of a portal to the sampled-audio system's features.

8.javax.sound.sampled.Clip

Represents a data line type in which audio files are not streamed in real time but rather downloaded in advance for playing [83-85].

9.javax.sound.sampled.LineUnavailableException

This means the line is now unavailable and cannot be used.

10.javax.sound.sampled.UnsupportedAudioFileException

This error message is displayed when an operation fails because the specified file does not contain data in a proper, application-compatible format [86-89].

Existing System

During the early days of digital audio's popularity, normalising audio was a frequent practise. There were several audio components whose performance was hindered by a lack of signal-to-noise ratio and dynamic range, but sound normalisation improved things [90].

Still, music industry insiders' views diverge widely. Sound normalisation has been argued for and against [91], with proponents saying it can decrease the quality of audio and detractors saying it can be useful.

When learning about audio normalisation, newcomers often bring up a common misconception. They argue that normalisation can significantly alter the sound quality. About three decades ago, this was an issue because of how computers interpret information. This is no longer a problem today.

Some modern programmes offer a plethora of capabilities and effects, such as movie sound editing and reverberation effects. C#, Xcode, and other modern programming languages are used in the creation of these apps.

Proposed System

In my own application, MP3Normalizer, I have utilised the Java programming language to create the algorithm that accomplishes the normalisation without any extra features, in contrast to the software I have already stated. This program's sole purpose is to immediately adjust the level such that it is optimal for listening.

Users typically have MP3 files of various lengths and quality levels. The audio file cannot be read in its current format because of some restrictions imposed by the Standard Java Library. In addition, Java has a built-in capability for working with WAV files, making it possible to alter audio snippets. This is why MP3Normalizer is compatible with WAV files. This is why an MP3 file is initially converted to a WAV file (table 2).

System Functionality

Table 2: File functions

Read	Opens the given file and plays the audio clip.
Determine original volume	The decibel reading represents the raw volume of the source audio file.
Deduce Track Gain value	Adjustments to the volume of the audio clip are measured in decibels.
Normalization	Track Gain boosts the volume of the source audio file.

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User Functionality

- Clicking "Stop" will halt the presently playing audio. The sound clip will play indefinitely if no action is taken.
- With this function, the user can apply normalisation to the audio file in order to adjust the volume levels (figure 3).

Block Diagram

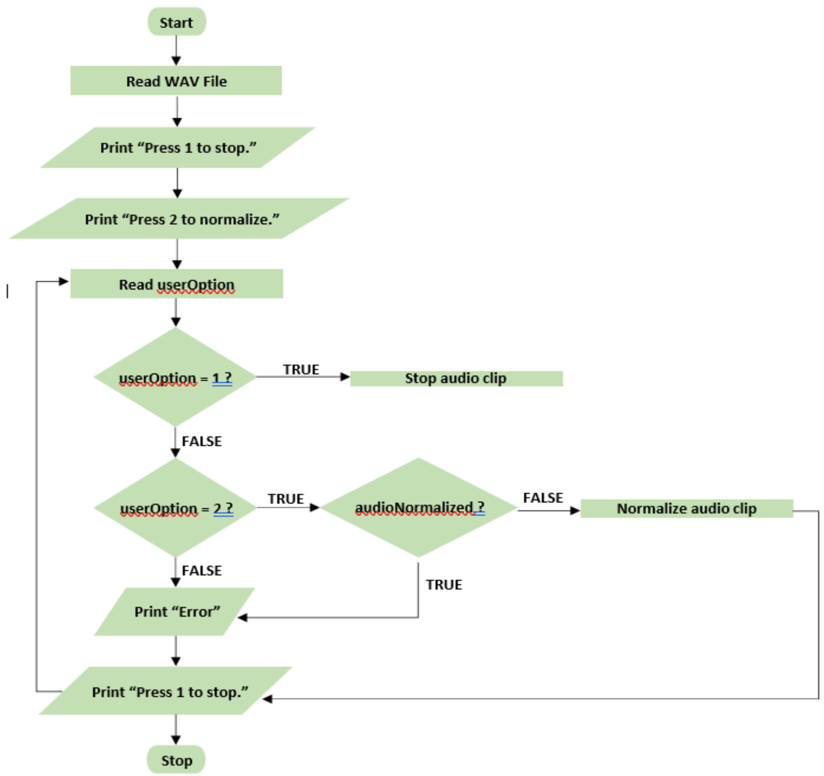

Figure 3: Block Diagram

Hardware and Software Requirements

Table 3: Hardware Requirements

Operating System	Windows 10
RAM	Minimum 4 GB
Sound Output Device	Required: Speaker or Lineout (earphone)

Table 4: Software Requirements

Language	Java SE 7
IDE	Eclipse IDE
Framework	JAVA Media Framework 2.1.1
Running Environment	JAVA Runtime Environment

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Implementation

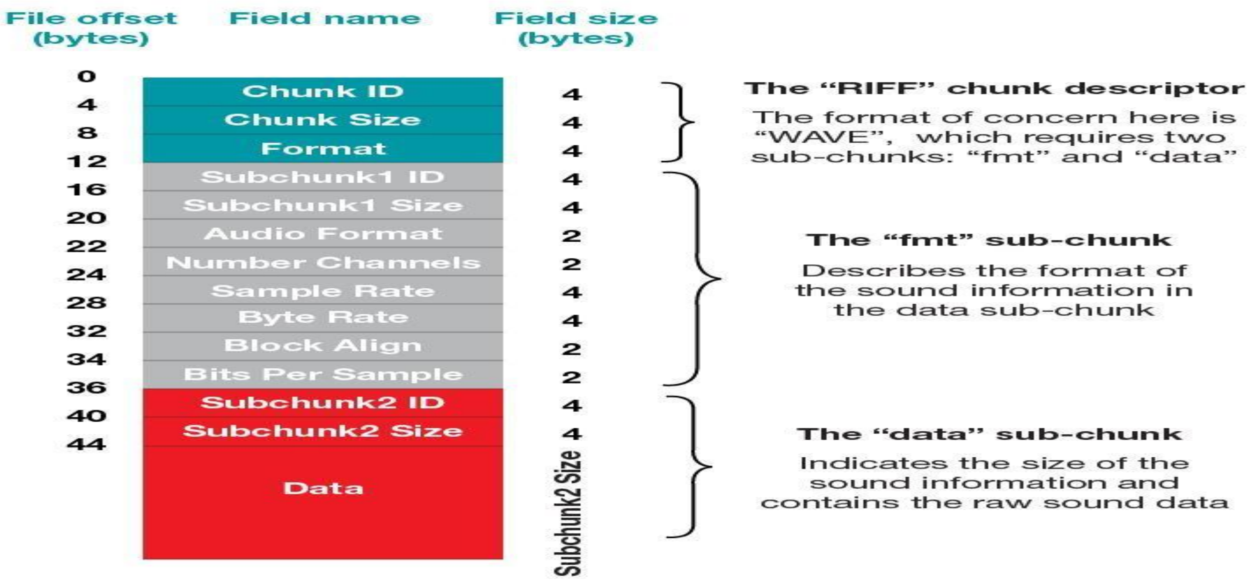
First, the MP3 is changed to WAV. The given directory structures will be used to play the audio files. The volume of the audio clip is adjusted so that it reaches 80 dB once the user gives their approval. It's possible to pause the presently playing audio file in the software as well (tables 4 and 5).

WAV File

In order to store an audio bit stream on personal computers, IBM and Microsoft created the Waveform Audio File Format. It is the default uncompressed audio format for Windows computers. Sounds saved with this format have the.wav or.wave extension. It has become the de facto standard for audio and music applications, while other formats are usually supported. Due to the format's superior resolution, it can be used to safely store high-quality first-generation archived files.

Structure of a WAV File

There is no limit to the number of channels that can be present in a WAV file. A channel describes the passage of sound from its origin to its destination. The information stored in a WAV file is structured in the form of a series of frames. The samples make up a frame. Each channel only gets one sample every frame (figure 4).



Normalization

Normalization of an audio clip is carried out in 4 steps:

- In order to normalise a recording, you must first obtain the highest possible sample value, then calculate the loudest possible volume, and last determine the track gain.

Step 1 – Maximizing the Value of the Sample

- Determine how many channels the WAV file contains of audio.
- To do this, make a 100-frame buffer.
- Import frames into a storage area

- iterate over the frames and locate the highest sample value

Step 2 - Peak Sound Pressure Level Estimation

Amplitude = Maximum Sample Value / 32767 Normalized Delta = 93

- Sample Values of 16 bits are kept as 2's-complement signed integers, ranging from -32768 to 32767, with the amplitude of the waveform being used to determine the volume of the digital sound.

Step 3 - Quantifying the Effectiveness of a Track

Target Volume = 80 dB

- Gain in audio refers to the desired amount of amplification or attenuation of a signal through any means of adjusting the signal's strength. In terms of decibels, that is (dB).

Hearing levels between 60 and 85 dB are considered safe. All of the audio tracks included in this endeavour are compressed to a maximum volume of 80 dB.

Final Step – Normalization

- Normalization in this Java program is achieved by using the method setValue() of the javax.sound.sampled.FloatControl class.
- It applies loudness correction to the audio clip.

Example:

If you have a wave that peaks at 14731, then:

Maximum Sample Value = 14731

Amplitude = 14731 / 32767

= 0.44

Maximum Loudness = 20 * log10 (0.44) + 93

= 85.87 dB

Track Gain = 80 – 85.87

= -5.87 dB

gainControl.setValue (-5.87);

This adds -5.87 dB to the Maximum Loudness, and subsequently, the audio clip plays at a lesser volume, i.e., at:

85.87 + (-5.87) = 80 dB

The volume of the audio playback is reduced to 80 dB.

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Sample Output

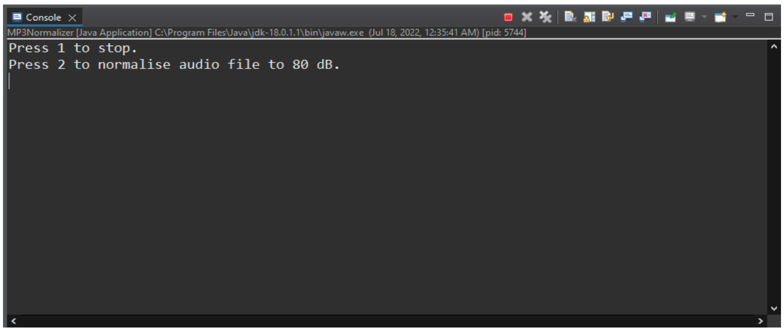

Figure 5: User has to input their choice

The clip begins playing at the volume it was recorded at. The user can choose to either pause the playing or normalise the audio. (figures 5 and 6).

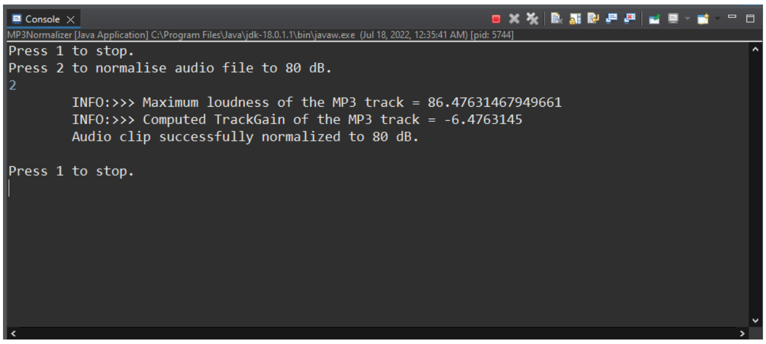

Figure 6: User chooses (2) Playback audio volume reduced to 80 dB

An option to normalise the audio was selected by the user. After that, the audio clip keeps playing, but it's loudness is lowered to 80 dB. The audio clip's metadata is provided in the written text (figures 7 and 8).

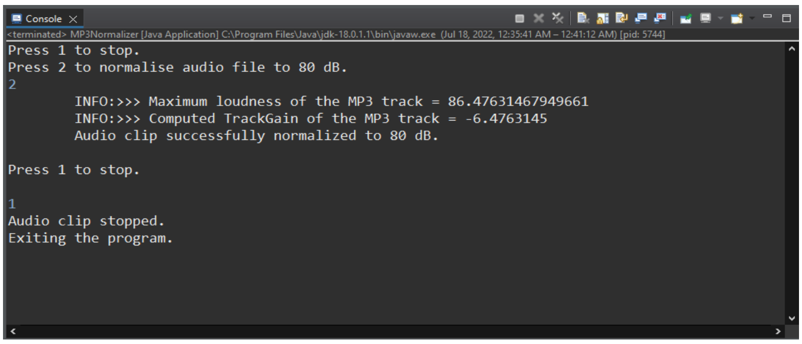

Figure 7: User chooses (1) Playback audio stopped

To end the music, the user selected that option. The audio clip then abruptly ceases.

Note: If the user does not select option (1), which is to pause the audio, the clip will play indefinitely. (figures 9 and 10).

Invalid Input - Error Messages

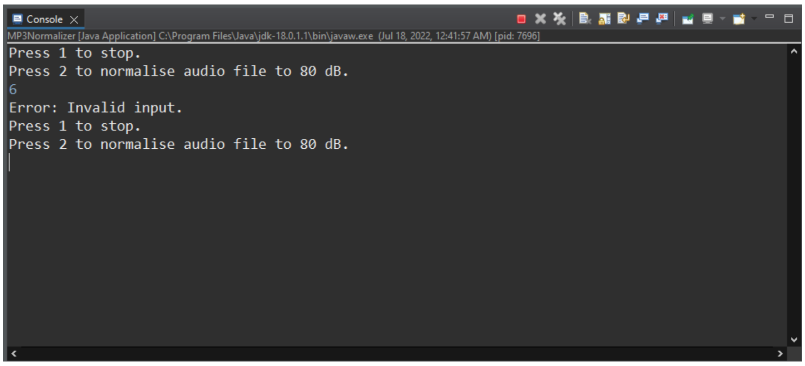

Figure 8: User enters invalid input

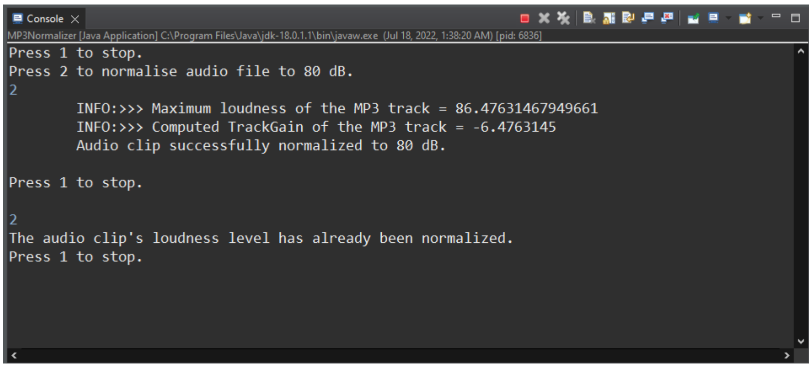

Figure 9: User enters invalid input after normalization to stop audio playback

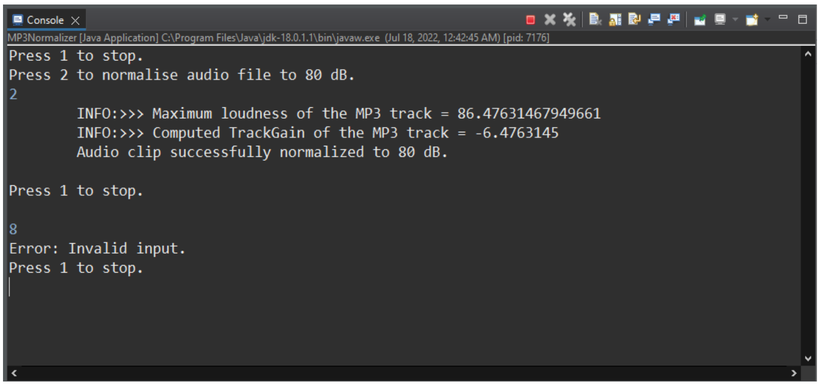

Figure 10: User attempts to reapply normalization to the normalized audio clip

5. Conclusion

The mini-project was successful in reaching the objectives it had outlined for itself in the areas of this report devoted to its scope and objectives. Because the Java software that was produced for this mini-project was able to provide a straightforward and intuitive user interface, we now have the luxury of listening to music at the ideal volume, which is beneficial to the health of our ears and can help prevent hearing loss. This project provides the user with the chance to tailor the target volume to a level that is comfortable for them, which is particularly helpful for people who have hearing impairments. This project includes the core and fundamental mechanism of a normalizer, which can be put to use in the creation of perspective graphical user interface applications that are pleasant for end users.

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