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EDAMAZING: AN AUDIO-FINGERPRINT DETECTING APP FOR OPM SONG TITLE IDENTIFICATION

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ABSTRACT
Music has become a part of life, and through this, people can express their thoughts and emotions. OPM, also known as Original Pilipino Music, is an array of songs created and sung by Filipino artists in the Philippines. Through Ubuntu, Python, and VirtualBox, the proponents made an application called EDAmazing, inspired by Shazam and Dejavu's algorithm and designed to identify song titles through collected audio-fingerprints. They gathered 280 OPM Songs by Filipino bands and solo artists. These songs were randomly selected to ensure the program's efficiency in identifying, since there are more than three genres of song present. The first test run was done on seven collected audio-fingerprints, and it reached an almost 100% accuracy rate with a 6 out of 7 confidence level. The time of recording used to achieve this accuracy rate is 10 seconds. From the tests done, it can be shown that the program works best in controlled places where there is less noise. Also, the analysis of the EDAmazing is fast when there are fewer songs because of fewer fingerprints, and this was proven by the accumulated group test.

Keywords: audio-fingerprints, music, python, song identification, spectrogram.

Manuscript Received 31 March 2025; Revised 21 December 2025; Published 30 November 2025

INTRODUCTION
Filipinos are music-loving beings, and OPM, also known as Original Pilipino Music, is the thing that keeps this kind of passion still burning. The music of the Philippines, composed by Filipinos, is present in different styles and genres, and over time, this has been influenced by other countries. Nowadays, Filipino songs are not just written in Tagalog but also in English. The relevance of OPM in today's generation is great to the point that it has reached close to 10 billion streams on Spotify. Also, according to Spotify's statistics, about 80 percent listening to OPM listeners are from the age group of 18 to 24. OPM is not just listened to in the Philippines but also around the globe, as some of these songs are included in global rankings. Listening diversity in OPM is rising eight percent every year, according to an interview with Sampayan of ANC to Chee Meng Tan of Spotify Southeast Asia [1]. With these statistics and the fact that OPM songs are changing through time, it will be convenient for people to have a handy app that can recognize and analyze OPM Songs directly.

There are apps and other programs that could analyze songs through the use of signals and audio frequencies. They are Shazam, Dejavu, Midomi, or SoundHound, etc these programs make use of audio fingerprints extracted from the songs that people listen to. Apps or programs like these give benefits for people who have very short music memory or the capability of the brain to remember a melodic content, chord progression of tones and pitches, and even the lyrics [2]. They could also serve as a convenient app for people who get easily confused by the rhythms and melodies of the song because of the strong similarities in song features. Even though OPM is wide ranged, some bands and solo artists recycle chords and other tunes over and over to produce an album, and this can get really confusing, especially in title identification [3].

To be able to address the problem, the proponents of the study made an application that can recognize songs and give their titles, which is EDAmazing. With this, the researchers can test the efficiency of the programs aforementioned through EDAmazing. Various tests should be applied to attain results that can give the program's efficiency using the following questions:

a) Can the surrounding noise affect the analysis of the program in OPM songs?

b) Is there a relationship between the time of rendering and the number of songs collected in a program?

c) Is the program accurate or not?

CONCEPTUAL LITERATURE

Spectrograms
Music is a signal, digitally encoded through long lists of numbers. A second of an uncompressed music file has 44100 samples per channel, and this is according to the Nyquist-Shannon Sampling Theorem. This theorem uses a theoretical limit on the maximum frequency of a signal. This large number of samples is compressed by the

VOL. 20, NO. 18, SEPTEMBER 2025 ISSN 1819-6608
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MP3 format to save space on our devices. FFT, also known as Fast Fourier Transform, is a divide-and-conquer algorithm. This can be repeatedly used to create a spectrogram for a song sample by showing the amplitudes of signals at a particular frequency (Hz) [4]. Spectrograms also have peaks, or time-frequency pairs, per song. These peaks are squashed or broken-down spectrograms that can be represented as dots if plotted on a graph. A song will consist of tens of thousands of dots because of the time-frequency pairs or peaks, but a hash function will combine these, making a unique fingerprint for a particular song.

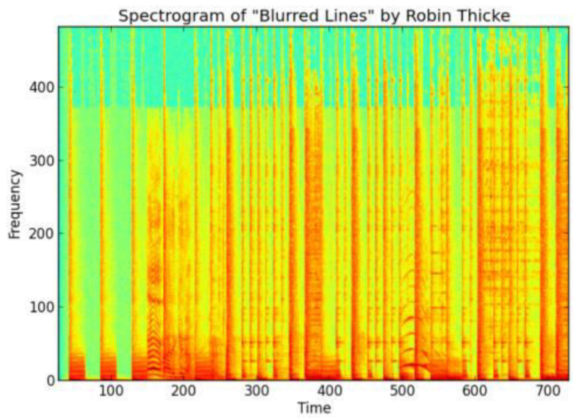

Figure-1. Spectrogram of blurred lines by robin thicke.

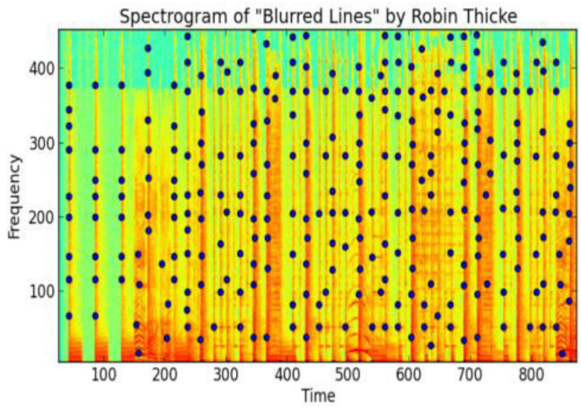

Figure-2. Spectrogram of blurred lines using dots by robin thicke.

Audio Fingerprinting

Audio fingerprint, also called acoustic fingerprint, is a condensed digital summary of the most significant part or feature of a song [5]. The term was first used around the year 2000 and is still being used up to the present to identify song titles, tracks, and even the artists who produced them. Audio fingerprinting has unique characteristics that make it a top choice for audio identification. Below are the following characteristics of audio fingerprinting according to [6]:

- High accuracy
- High reliability
- Efficient even when it encounters noise (Robustness)
- Able to identify whole titles within a few seconds of recording (Granularity)
- Secure and not vulnerable to tampering
- Efficient in identifying audio regardless of audio format (Versatility)
- Can perform with very large databases (Scalability)

An audio fingerprinting system has two tasks: first is to learn a song by fingerprinting it, and second, to recognize an unknown song by scanning the database of learned songs. For this system to work, a song should undergo audio fingerprinting processes like extraction and conversion. Below is the following figure that will describe the audio fingerprinting process according to [6].

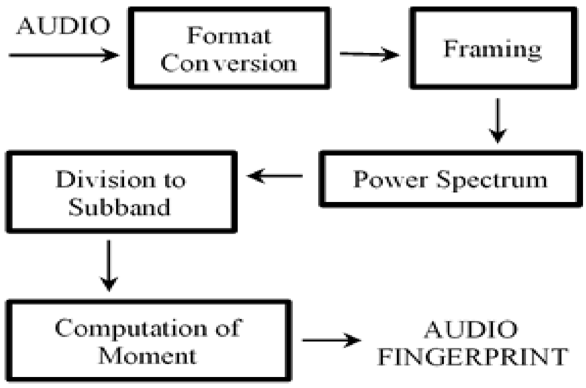

Figure-3. Audio fingerprinting process.

Shazam and Dejavu

Shazam is an audio-recognition app that uses audio fingerprints based on spectrograms or time-frequency graphs [7]. It was invented by Avery Li-Chung Wang in 2003 by analyzing the properties of sound, using theorems like the Nyquist-Shannon Theorem, using frequency domains, and algorithms like the Fast Fourier Transform [3]. The Shazam algorithm converts MP3 files to fingerprints and matches these to known songs, considering timing, relative to each other within a song. To summarize, basically, what the app does is to listen to or record an audio by microphone, analyze it by comparing it to other audio fingerprints, and suggest a song title. This app's algorithm is related to the researchers' program but was made using different software, like Python, through Audio-fingerprinting in Ubuntu.

Other Applications

The sound extracted from the audio waves, which were generated by the skull bone conduction, was implemented using a laryngophone. This audio response is processed by the computer using a sound-to-feature algorithm. An artificial neural network (ANN) is then used for the training and classification of the unique frequency response of different users. The said data is then

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ARPN Journal of Engineering and Applied Sciences
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used in identifying or authenticating a certain user who will access a secured computer [8].

Meanwhile, three classes of coconuts were determined using the sound made due to the knocking of their shells. The sound acquired from this shell knocking was processed using the FFT algorithm in Octave [9].

The speech signal's quality and intelligibility were determined in [10] by implementing an algorithm by added different noise signals, e.g., white, brown, and pink. Lastly, in [11], the audio sources' direction of arrival was determined using generalized cross correlation phase transform, and the said system was implemented using Raspberry Pi. Through this system, the location and direction of the audio source were determined easily.

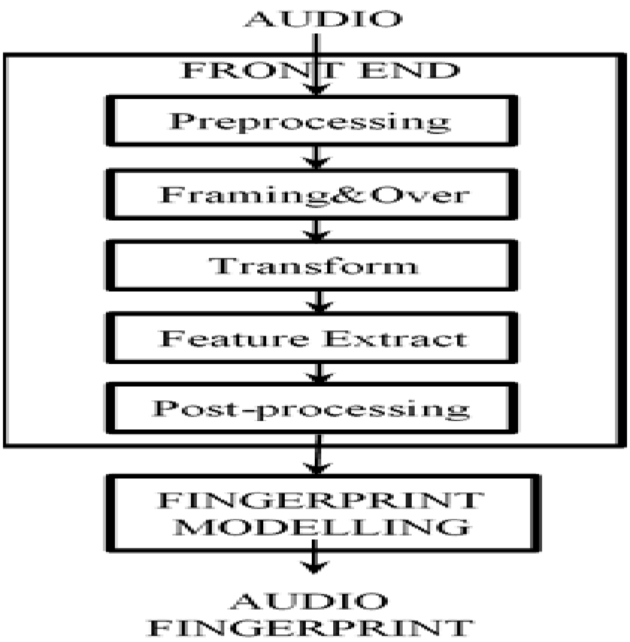

Figure-4. Fingerprint extraction framework: Front-end (top) and fingerprint modelling (bottom).

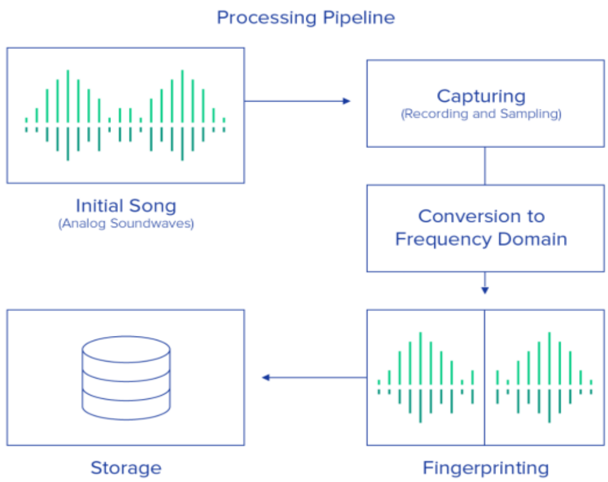

Figure-5. Framework of Shazam and Dejavu's storing process.

There are several programs that are somehow related to Shazam. They are Dejavu, Soundhound/Midomi, Chromaprint, and Echoprint. Dejavu is also an audio fingerprinting and recognition algorithm that is a work-in-progress application. Dejavu can memorize a song by listening to it once and fingerprinting it, then, by using of microphone to record a part of the song, the program will try to match it to other hashes or fingerprints. Midomi and the other programs aforementioned also do the same algorithm and function.

METHODOLOGY

Dataset

The dataset was produced by the proponents of the study because there was no available dataset for OPM Songs on the internet yet. The accumulated dataset was composed of 280 OPM Songs of different artists and genres. The songs were gathered from online music streaming platforms like YouTube and Spotify and were converted to compressed or MP3 files.

Data Preparation

The dataset contains sets of OPM Songs in MP3 format. The songs were downloaded randomly and were not equally grouped to ensure program efficiency in terms of audio-fingerprint recognition.

Sample Selection

Below are the following bands, groups, and solo artists that were used for sample selection:

- December Avenue- 16 songs
- Bamboo- 3 songs
- Ben and Ben- 7 songs
- Eraserheads- 7 songs
- Freestyle- 3 songs
- Gloc9- 14 songs
- Hale- 28 songs
- Jireh Lim- 5 songs
- Kamikazee- 21 songs
- Mayonnaise- 1 song
- Moonstar88- 4 songs
- Noel Cabangon- 4 songs
- Parokya ni Edgar- 45 songs
- Regine Velasquez- 5 songs

VOL. 20, NO. 18, SEPTEMBER 2025 ISSN 1819-6608
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- Rivermaya- 48 songs
- Sarah Geronimo- 5 songs
- Silent Sanctuary- 3 songs
- Spongecola- 1 song
- Sugarfree- 8 songs
- This band- 1 song
- Up Dharma Down- 3 songs
- Yeng Constantino- 5 songs
- Random- 48 songs

Sample selection

The proponents' program algorithm was similar to Dejavu. They used audio fingerprinting for song identification and data storage. Below is the framework for the working algorithm of the program:

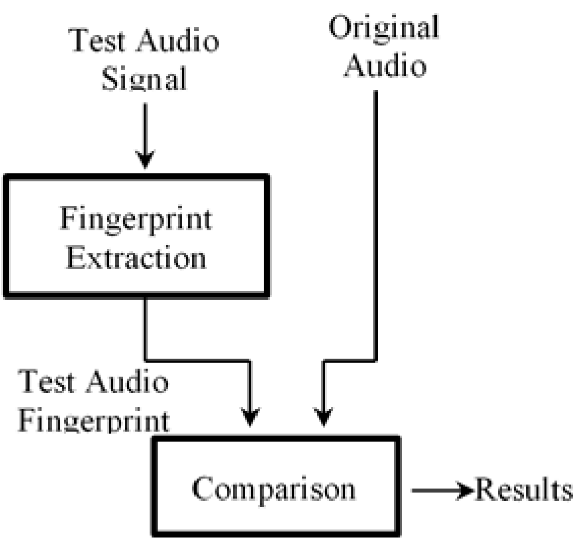

Figure-6. Framework for EDAmazing's algorithm.

First, the application will start working after a few commands.

<python /recognize-from-microphone.pv -s 10>

Second, the device will record the audio signal being played as a song. In the application's case, it will record for 10 seconds. Third, the device will extract an audio fingerprint from the test audio signal. Fourth, this test audio fingerprint will be compared or analyzed against the stored database of audio fingerprints. Lastly, it will give the analyzed result. The proponents expect song titles as results from the process.

RESULTS AND DISCUSSIONS

In order to attest to the algorithms in the app, the researchers tested the program in various conditions.

Noise Test

The researchers tested the application under room conditions versus under noise conditions in order to look for discrepancies in the accuracy. The proponents tested the 3 different songs per environmental condition.
The researchers tested the application under room observation with less noise and disruption.

Table-1. Time rendered by a song observed inside the room.

Song Number	Time Rendered (min)
1. Dive	17.03
2. Breathe Again	18.00
3. Gitara	17.00
Average	17.343

The researchers found out that the optimal place is just around the court, which has significant noise, and the same three songs were tested.

Table-2. Time rendered by a song observed in the school grounds.

Song Number	Time Rendered (min)
Dive	16.23
Breathe Again	17.10
Gitara	19.47
Average	17.6

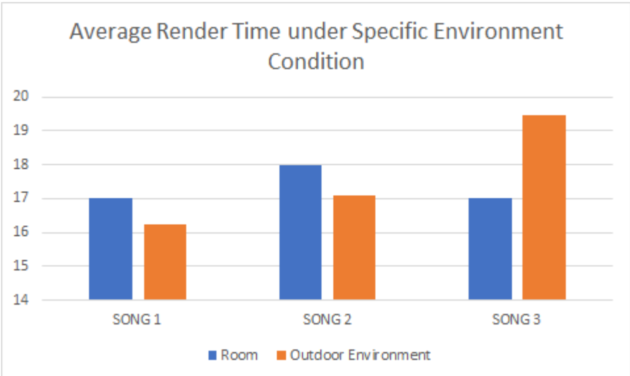

Figure-7. Average rendering time under specific environment condition.

Based on the graph above, the researchers concluded that the rendering time of the program can be affected by the surrounding sounds. The more noise in the background, the longer it can analyze the audio provided.

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Accumulated Group Testing

In order to maximize the algorithm's potential, the researchers tested the relation of time rendering with respect to the number of songs collected in the program. It also tests if the song is correctly recognized at a certain time.

Table-3. 50 Songs.

Song Title	Recognized (Y/N)	Time Rendered	Song Matched (If not recognized)
Swabe Maria	Yes	25s	-
Buloy	No	12s	Bent Down
Kahit Di Mo Na Alam	Yes	12s	-
Chinito	Yes	26s	-
Sa Ngalan ng Pag-ibig	Yes	25s	-
Maybe the Night	Yes	26s	-
Back to Love	Yes	26s	-
Closer	Yes	24s	-
Blue Sky	Yes	26s	-
Brown Sunset	Yes	25s	-
Total Recognition	9 out of 10	Average:	25.5s

Table-4. 100 Songs.

Song Title	Recognized (Y/N)	Time Rendered	Song Matched (If not recognized)
Time to Go-	Yes	324s	-
You'll be safe Here	Yes	22s	-
City Lights	Yes	20s	-
Faithless	No	49s	Maybe the Night
Much Has Been Said	Yes	40s	-
Kathang Isip	Yes	41s	-
Balita	No	45s	Back to Move
Pangarap Ko Ang Ibigin Ka	Yes	46s	-
Bagsakan	No	46s	Ilog
Hinahanap-hanap kita	Yes	47s	-
Total Recognition	7 out of 10	Average:	68s

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Table-5. 150 Songs.

Song Title	Recognized (Y/N)	Time Rendered	Song Matched (If not recognized
Karayom	Yes	199.2s	-
Tungkol Sayo	Yes	78s	-
Bakit	Yes	66s	-
Indak	Yes	96s	-
Basketbol	Yes	114s	-
I'll Never Go	Yes	32s	-
Grow Old With You	Yes	68.4s	-
My Beating Heart	Yes	67.2s	-
One Step	Yes	67.8s	-
Saint or Sinner	No	68.4s	In Your Eyes
Total Recognition	9 out of 10	Average	85.7s

Table-6. 200 Songs.

Song Title	Recognized (Y/N)	Time Rendered	Song Matched (If not recognized)
Maniwala ka sana	Yes	384s	-
Dahan	No	84s	I'll Be Watching You
Sana kahit minsan	Yes	83.4s	-
Kung wala ka	Yes	81.6s	-
Panahon na naman	Yes	82.2s	-
214	Yes	78s	-
With a smile	Yes	84s	-
You or nothing	Yes	135.6s	-
Shooting star	Yes	48s	-
Forever	Yes	134.4s	-
Total Recognition	9 out of 10	Average	119.52s

Table-7. 250 Songs.

Song Title	Recognized	Time Rendered	Song Matched (If not recognized)
Di na muli	Yes	294s	-
Ilog	Yes	120s	-
Ligaya	Yes	92.4s	-
Paano ba ang magmahal	No	60s	Kathang isip
Tagpuan	Yes	63s	-
Agent Orange	Yes	121.2s	-
Romantic Kill	No	120.6s	Olats
I'll be waiting for you	Yes	94.2	-
See you	Yes	120s	-
Your Song	No	120s	Sandali na lang
Total Recognition	7 out of 10	Average	120.54s

 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences
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Table-8. 280 Songs.

Song Title	Recognized	Time Rendered	Song Matched (If not recognized)
Walang iba	No	514.18s	Kundiman
Torete	Yes	138s	-
Huling Sayaw	Yes	243.6s	-
Simpleng Tao	Yes	135.6s	-
Sirena	Yes	139.8s	-
Bring me down	Yes	138s	-
Waltz	Yes	70.8s	-
Boys Do Fall In Love	Yes	143.4s	-
Sunday Driving	Yes	139.2s	-
The Ordertaker	Yes	136.2s	-
Total Recognition	9 out of 10	Average	179.82s

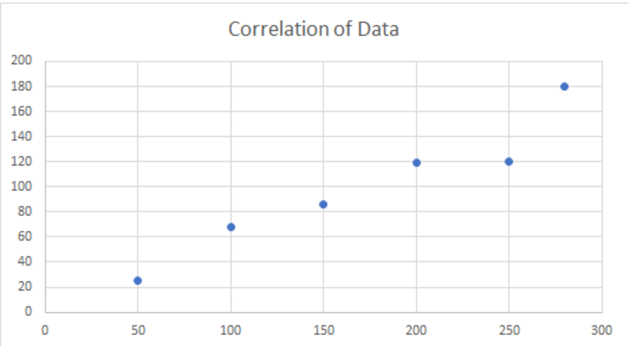

Figure-8. Correlation of the given data.

The graph above shows that the more the number of collected audio-fingerprints, the higher the probability of getting a wrong recognition/analysis. The number of audio fingerprints also affects the processing of the program or time rendering. There is a positive linear correlation between the variables.

CONCLUSIONS

The project went to an almost perfect accuracy rate in identifying OPM Song titles using audio fingerprinting. Under the processes, it was found that a higher number of songs collected in the program will lead to a longer period of analysis. It was also found that noisy environments could also affect the time of rendering, but it would not affect the accuracy, as it would also arrive in the same OPM song title. From here, the proponents can conclude that the program is efficient.

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