Feature Extraction And Sound Pattern Analysis Of Wijaaksara Script

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Abstract. Wijaksara script is a sacred script in the Balinese script structure in Balinese Hindu culture, the sound of this script is believed to create vibrations that are spiritual and magical. In Balinese script literature, Wijaksara script is a combination of the Swalatita script with the Amsa script. Wijaksara script are categorized into several groups, namely (1) Eka Aksara (Om), (2) Dwi aksara (Ang, Ah), (3) Tri Aksara (Ang, Ung, Mang), (4) Panca Aksara (Nang, Mang, Sing, Wang, Yang), and (5) Dasa Aksara (Sang, Bang, Tang, Ang, Ing, Nang, Mang, Sing, Wang, Yang). In this research, several acoustic features of sound were extracted (1) constituent frequencies, (2) waveforms, (3) sound energy. Sound recordings from 20 samples were taken and then extracted to get the constituent frequency using FFT (Fast Fourier Transform). Based on the sound waveform, the waveform and sound energy are obtained. In this study, the acoustic character patterns were obtained, namely Eka, Dwi, Tri, Panca, and Dasa. Aksara is influenced by the sound character of the eka script. The main frequencies for the sounds of the letters eka, bi, tri, and dasa are: 4.37 kHz, 7.22 kHz, 3.97 kHz, 4.18 KHZ, 11.8 KHz, while the sound energy for normal sound pronunciation conditions are: 87.31 dB, 96.72 dB, 83.25 dB, and 80.29 dB, respectively.

1. Introduction
Balinese script is something that cannot be separated from Hindu culture. In India the use of certain sacred script always gives a certain sound in the Vedas. This is known as yantra, tantra and mantra. Related to the characters that produce sacred sounds, the first script to develop in India was the Karosti script [1]. In its development, the Karosti script developed into the Dewanagari script and the Pallawa script. The Dewanagari script is the script used to write Sanskrit, while the Pallawa script is used to write Pallawa. The two characters spreads throughout the archipelago in the form of the kawi script, which later developed into Javanese, Balinese, and other scripts [2].

In the development of script in the archipelago, there are differences and similarities in several things. Each region has its own character. For example, based on the form of Balinese script and Javanese script, it has similar forms, but when viewed functionally there are very significant differences. In Balinese script, there are still parts of the sacred script, namely wijaaksara and modre.
script. Both types of script are not found in Javanese script, or even other archipelago scripts. Wijaaksara script, also known as the Bija aksara (Bija means seed), is a combination of the Swalalita script and the hamsa script [3].

The sound generated by the pronunciation of a letter symbol is believed to have a vibration that can be positive or negative effect, depending on how it is pronounced. Related to this, one of the wijaaksara script groups, Dwi Aksara consisting of two sounds (1) Ang, (2) Ah. According to [4], in his commentary on the Jnanasidhanta book, it states that the sound of (Ang Ah) is related to the sound of lifeness, on the contrary, if the pronunciation is (Ah Ang) it is related to deathness.

In Japan, in 1865 a Buddhist hermit named Mikao Usui developed a spiritual practice, as a form of alternative medicine, by cultivating natural energy. This spiritual practice is currently known as Reiki. Reiki has grown throughout the world, including Indonesia. In practice, a Reiki practitioner will clean and activate the 7 energy points in the human body. The 7 energy points (chakras) are the muladara chakra, the svadhishthana chakra, the manipura chakra, the anahata chakra, the visuddhi chakra, the ajna chakra, the sahasrara chakra. One thing that is very interesting, according to reiki practitioners, is that to clean and activate these energy points (Chakra), one of which is by pronunciation the sounds. Some of those sounds are wijaaksara sounds. The activation of the muladra chakra with the pronunciation of the sound of "Vam", the activation of the svadhisthana chakra with the pronunciation of the sound of "Ram", the heart chakra (anahata) with the sound of "Yam", the throat chakra (visudhi) with the sound of "Ham", the ajna chakra with the sound of "Om", the activation of the sahasra chakra by using the sound of the "Ng" sound, [5],[6].

Wijaaksara script is a legacy of Balinese ancestors that is very extraordinary, practically its use has received recognition from many circles, even outside Balinese, and from different cultures. In this study, it tries to analyze more deeply related to the features of sound, seen from the side of acoustic physics, and sound patterns.

2. Theoretical Review

2.1 Review of Wijaaksara Script

Balinese script can be broadly divided into two categories, namely ordinary script and sacred script. Ordinary script consists of two groups, namely (1) Wreastra script, a common script used in everyday life, consisting of 18 characters. These commonly known characters consist of: a, na, ca, ra, ka, da, ta, sa, ... etc. (2) Swalalita script, is a kawi literary script consisting of 47 characters, consisting of 14 vowels and 33 wianjana (consonant) characters. Meanwhile, the sacred script also consists of two categories, the first (1) Wijaksara Akasara, which is a self-help script combined with the Hamsa script. (2) Modre script, is a combination of several characters and is generally a symbol of an object or thing that is spiritual and magical. Figure 1 shows the structure of the Balinese script, [2],[3].

Associated with Wijaksara script is swalalita script combined with the Hamsa script. Hamsa letters are characters associated with sound (O Ang, In, ah). The wijaksra script is a divine script that is believed to have magical powers. There are several categories of wijaksra characters, (1) Eka aksara (omkara), (2) Dwi aksara, (3) Tri aksara, (4) Panca aksara, and (5) Dasa aksara. Detail of wijaaksara script in Table 1
**Figure 1.** Classification of Balinese Script

| Group Script | Symbol | Pronunciation |
|--------------|--------|---------------|
| Eka Aksara   | ![OM Symbol](om.png) | OM            |
| Dwi Aksara   | ![Ang, Ah](ang-ah.png) | Ang, Ah       |
| Tri Aksara   | ![Ang, Ung, Mang](ang-ung-mang.png) | Ang, Ung, Mang |
| Panca Aksara | ![Nang, Mang, Sing, Wang, Yang](nang-mang-sing-wang-yang.png) | Nang, Mang, Sing, Wang, Yang |
| Dasa Aksara  | ![Sang, Bang, Tang, Ang, Ing, Nang, Mang, Sing, Yang](sang-bang-tang-ang-ing-nang-mang-sing-yang.png) | Sang, Bang, Tang, Ang, Ing, Nang, Mang, Sing, Yang |
2.2 Feature Extraction Of Sound

In this study, 3 main features of sound are used which can be extracted from a sound data, frequency features, sound energy, and wave form. There are several methods that can be used to transform sound signals into frequency signals. FFT (Fast Fourier Transform) is one method to solve this problem, as was done in research [7], [8], [9]. In this study, to get the frequency feature and sound SPL, the FFT method will also be applied, the process illustration is shown in Figure 2.

By using FFT, the sound data transformation is carried out from the spatial (time) domain to the frequency domain. Thus it can be determined the main frequency, and several follower frequencies of a sound signal. Figure 3 illustrates an FFT result, the sound signal has been represented in the frequency domain.

The extraction of the waveform features is done by converting the sound signal to a wave image, which represents the change in amplitude with time. In general, a sound signal will definitely be represented with a distinctive wave shape. Sound waveforms can also provide information on another feature, namely the timing of the sound's reverberation. Figure 3 (a) illustrates waveform of signal sound.
3. Methodology of Research

Research to determine the characteristics of wijakasara sound is carried out in several sequences, stated in Figure 4.

![Diagram of Methodology](image)

**Figure 4.** The Method Proposed for Extraction Sound Feature of Wijaaksara Script

### 3.1 Data Acquisition

Data collection of Wijaaksara sound samples was carried out by recording sounds on 20 respondent subjects with 10 male and 10 female. Recording is done for each particular sound wija script, adjusted to the length of breath of the subject. In this condition, the subject in the pronunciation is made in as comfortable a condition as possible. Respondents were drawn from students department of physics education, Universitas Pendidikan Ganesha (indonesia) with various backgrounds. The existence of this wijaaksara script sound is closely related to the Hindu religious belief system. However, in this study several subjects were taken from different belief backgrounds. Initially the presumption of acoustic properties / features obtained does not depend on matters of the person's background beliefs. The Process is illustrated in Figure 5.

![Diagram of Data Acquisition](image)

**Figure 5.** Data Acquisition
3.2 Frame Blocking

Frame blocking is cutting the signal, so that it gets 1 cycle of wijakasara sound. This process is manually marked, by marking the beginning of the cycle and the end of the chime cycle of the entire file. Figure 6 shows the sound waveform in a recording file (wav).

![Figure 6. The Cutting of Signal Sound](image)

In a recording selected and cut in a certain part so that it gets 1 piece which is 1 cycle of wijakasara sound.

3.3 Fast Fourier Transform Analysis

Feature extraction is done to get the basic frequency (F0) and prominent frequency, in this study limited to F1, F2, and F3. Based on that, in this study only 4 main frequencies were determined. For this purpose, FFT (Fast Fourier Transform) is used. FFT is a form of fourier transformation, which transforms the representation of signal data from the time domain into the frequency domain. The FFT algorithm is a development of the Discrete Fourier Transform algorithm, with a much faster computational process. DFT computing time is expressed O (N^2) while FFT computing time is expressed N log N [10]. The definition of basic frequency and prominent frequency is illustrated in Figure 7.

![Figure 7. Basic Frequency and Prominent Frequency based on FFT](image)
The determination of sound energy is determined by Equations 1 and 2. The form of sound waves consisting of positive and negative amplitude parts and is symmetrical, is taken only the positive part. The determination of the overall energy in t seconds is expressed in Equation 2. This energy is an approximation of the average sound energy for each time component. The average energy approach is shown in Figure 8.

![Figure 8. Average Approach to Determination of Sound Energy](image)

Energy calculations using equation 1\[11\].

\[ E_B = 10 \log (A) \]

Description of Notation formula:
EB : Energy of Sound (dB)
A : Amplitudo (dB)

In each time the sound signal has a certain amplitude (A), then at that time it also has energy (EB), based on Equation 1. Thus, overall in a period of t seconds, the total sound energy is calculated using the mean EB, Equation 2, \[11\].

\[ E_T = \bar{E_B} \]

Description notation formula
ET : Total Energy in duration t seconds (dB)

4. Results and Discussion

The application developed in this research will be implemented using Matlab 2016. We do computations and simulations based on the FFT algorithm, to get the features of the frequency of the sound, and the average energy of the sound. To get the waveform, visualization of the signal in the time domain is performed. Table 2 summarizes the data patterns obtained in this study. For the waveform feature is taken from the dominant waveform or the most common pattern is taken from 20 samples, in each group of wijaaksara script. The sound frequency, consisting of the main frequency (F0), and the prominent frequency (F1, F2, F3), in this study used 4 constituent frequencies of sounds. This has been described in sub 3.3.
Table 2. Acoustic Feature of Wijaaksara Script

| Part group of Wijaaksara Script | F0,F1,F2,F3 (KHz) | Energy (dB) | Wave Form |
|----------------------------------|-------------------|-------------|-----------|
| Eka aksara                       | 4.37 ; 3.92 ; 3.83 ; 3.81 | 8.731       | ![Eka aksara Waveform](image1.png) |
|                                  | Average Frequency : 3.98 KHz |
| Dwi Aksara                       | 8.91 ; 8.8 ; 4.22 ; 3.8 | 9.672       | ![Dwi Aksara Waveform](image2.png) |
|                                  | Average Frequency : 6.43 KHz |
| Tri Aksara                       | 14.72 ; 7.89 ; 3.97 ; 3.88 | 8.325       | ![Tri Aksara Waveform](image3.png) |
|                                  | Average Frequency : 7.62 KHz |
| Panca Aksara                     | 11.45 ; - ; - ; 4.18 | 8.530       | ![Panca Aksara Waveform](image4.png) |
|                                  | Average Frequency : 7.82 |
| Dasa Aksara                      | 20.8 ; 11.63 ; 11.82 ; - | 8.029       | ![Dasa Aksara Waveform](image5.png) |
|                                  | Average Frequency : 14.72 KHz |

Related with the frequency feature, it is found that, in terms of the compiler frequency features, the values are different. There is a pattern to increase the frequency value from eka aksara script, dwi aksara, tri aksara, panca aksara, and dasa aksara script, as shown in Table 2 and Figure 9. Based on the waveforms, the eka aksara waveform is the basis for dwi aksara's waveform, tri aksara's waveform, panca aksara's waveform, and dasa aksara's waveform, Table 2. Another thing related to the waveform, it was found that in general there was no difference in shape, from 20 subjects, 19 subjects had the same waveform.

Figure 9. Frequency of Wijaaksara Script
5. Conclusions

In this paper, the sound produced by the pronunciation of the wijaaksara script with a variety of characters of subjects has almost the same features, both in the form of waves, frequencies, and sound effects.

The Sound’s frequencies have pattern, that pattern is value of frequency increase from eka aksara, dwi aksara, tri aksara, panca aksara and dasa aksara. Although that is still in a low frequency and in the audiosonic sound group. The third based on the frequency and sound energy of the sound of the wijaaksara script, including the low frequency audiosonic sound, the sound energy also states the sound related to an atmosphere of calm (0-20 dB). Based on this, it can be stated that the sound of wijaaksara is a sound related to relaxation.

References

[1] Indrawan G, Paramarta I K, Agustini K and Sariyasa S 2018 Latin-to-Balinese script transliteration method on mobile application: A comparison Indonesian Journal of Electrical Engineering and Computer Science 10 (3) 1331-1342
[2] Kumar V and Sengar P K 2010 Segmentation of printed text in devanagari script and gurmukhi script International Journal of Computer Applications 3 (8) 30-33
[3] Mudiarta I M D R, Atmaja I M D S, Suharsana I K, Antara I W G S, Bharaditya I W P, Suandirat G A and Indrawan G 2020 Balinese character recognition on mobile application based on tesseract open source OCR engine Journal of Physics: Conference Series 1516 (1) 012017
[4] Haryati S 1985 Jnanasiddhanta. Jakarta: Djambatan
[5] Simpen I W, Udayana I N and Putra I B R The Calligraphy of Balinese Script as A Form of Bali Creative Industry Based on Balinese Script Udayana Journal of Social Sciences and Humanities 3 (1) 13-16
[6] Crisnapati P N, Novayanti P D, Indrawan G, Aryanto K Y E and Wibawa M S 2018 Accuracy Analysis of Pasang Aksara Bot using Finite State Automata Transliteration Method.2018 6th International Conference on Cyber and IT Service Management 1-6
[7] Gunadi I G A and Hartawan I G N Y 2019 Analysis of Frequency on Sound of Genta Based on Fast Fourier Transform Method Proceedings of the 2nd International Conference on Software Engineering and Information Management 185-188
[8] Zeng Y, Zhang M, Han F, Gong, Y and Zhang J 2019 Spectrum analysis and convolutional neural network for automatic modulation recognition IEEE Wireless Communications Letters 8 (3) 929-932
[9] Bozzo E, Carmiel R and Fasino D 2010 Relationship between Singular Spectrum Analysis and Fourier analysis: Theory and application to the monitoring of volcanic activity Computers & Mathematics with Applications 60 (3) 812-820
[10] Efrosheva D, Tagasovska N, Tentov A and Kalendar M 2018 Efficiency Comparison of DFT/IDFT Algorithms by Evaluating Diverse Hardware-Implementations, Parallelization Prospects and Possible Improvements Proceedings of the 2nd International Conference on Applied Innovations 81-89
[11] Yang L J, Zhang B H and Ye X 2004 Fast Fourier transform and its applications Optoelectronic Engineering 31 1-7