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MEASUREMENT OF THE HIGHEST VOWEL PITCH AND FORMANT USING PRAAT

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Abstract- This study is aimed to analyze the measurements of pitch and formant values in determining the highest vowels which derived from the voices of native and non-native. Linguistically, this research was related to the phonetics and phonology, by applying PRAAT application to calculate the frequency and formant of speech. The subject of the study in this research was vowels contained in several Indonesian words. The focuses were only the element of pitch and formant of the fourth respondents in uttering the vowel-contained words. The research method used in This study used the Forensic audio method. However, in this study, researchers only focus on identifying pitch and formants in the data to be analyzed. In addition, the data wa descriptive analysis with the presentation of data in the form of numerical tables and graphs. This study involved one native researcher and one non-native researcher to get comparable results. Data retrieval method conducted PRAAT with audio files as the main data source. The results of this study indicated that diphthongs with the highest pitch values from both native and non-native respondents was / a/. Based on the sampling of sound data from two respondents, it could be concluded that vowel /a / had the highest frequency compared to other vowels And, / a / had the highest formant number compared to other vowels.

Keywords: Forensic audio. Measurement, PRAAT, Vowel.

I. INTRODUCTION

Forensic linguistics is an interdisciplinary branch of science which main study is the implementation of language within the scope of law or forensics. This study is also being intensively developed throughout the world, especially in Indonesia.

Currently, the usefulness of forensic linguistic studies has been enhanced by the development of technological tools that support the application of this science. Especially, in the aspect of audio-forensic or digital-forensic. Basically, sound is generally produced through two processes, namely generation and filtering. The generation process is the initial process of a speech sound produced through the vibration of the vocal cord and vocal folds located in the larynx in forming and producing periodic sounds.

According to Suyudi, Ichwan., Saptano, and Debyo (2016) In the linguistic system, speech is one of the most basic things to determine the occurrence of communication. Periodic sound which is constant, allows sound filtration which is then streamed through an articulator consisting of teeth, lips, tongue, palate and so on. That is what gives rise to an output sound or output. Moreover, according to Tilman, Rosa da Costa, and Nurhayani (2015) the external sound can be vowels or consonants, and the tendency to communicate in speech is to produce the two types of sounds in a combination. Outcomes like this can be used as a source of data in several studies related to Phonetics & Phonology. Speech sound analysis can produce other outputs, especially in the field of technology.

Thus, with research in the field of Phonetics, several voice recognitions programs have emerged, such as Voice Control introduced by smartphone, or Google Voice used by Google, as well as several VR applications implemented in automotive companies. However, in the speech sound system, there are several things that allow it to be analyzed, such as the existence of different frequencies and pitches in each speaker.

In this case, native and non-native speakers will have different pitches in pronouncing the same word. Nevertheless, in measuring the magnitude of the frequency or decibels issued by the speaker, an accurate method of taking and measuring data samples is needed. The pitch height as well as the intensity in speech is especially easy to measure with words that have vowels and this is what is used in this study to measure the frequency and formant of sound in the utterance of words deviations or errors in pronouncing a word.

According to Durao (Richards &Weber). (2007) the related software used in this study is PRAAT which is a phonetic program to analyze speech sounds even though the speech is manipulative.

The PRAAT application provides a feature to record voice directly using an installed device, but it is still a computer-based program, so it is not yet available for mobile. After getting the sound recording, PRAAT can then dissect the sound into a detailed spectrogram and produce separate, more detailed parts of the sound. Spectrogram consists of low and high frequencies in the form of sound signals. In addition, it is also possible to measure the pitch, intensity and formant of the sound as a whole and display a graph to illustrate the results. Another thing is the intonation of speech, which sometimes varies among speakers, even in pronouncing the same word, there is always a tendency to have different intonations. Some people always end up with a descending intonation when pronouncing a word, but others choose a rising intonation in ending the pronunciation of a word. By using the PRAAT application, the voice will be analyzed proportional and appropriately depend on the menus or program that used to do a measurement.

It has been realized that some applications have been programmed as a part of audio-forensics process. However, according Olsson (2004) it as an application of linguistics in the context of crime, court proceeding, or arguments in law. In addition, Coulthard and Johnson (2010) mention that forensic linguistics ranges from courtroom discourse and legal language to plagiarism.

Technically, according AlAzhar Nuh, (2011) in his book Audio Forensics: Theory and Analysis that sound recordings can be analyzed through the parameters of tone, formant, and spectrogram. This component can be used to identify the characteristics of a person's voice for speech recognition purposes by using the fragments of the analyzed voice recording. Digital forensic science is by definition a combination from the disciplines of law and computer science in collect and analyze data from computer systems, networks, wireless communications, and storage devices digital data for later use as evidence in problem-solving in the realm of law. (Binyamin Widi Prasetya, dkk, 2008)

Therefore, there is one of the digital forensic techniques is Voice Recognition, namely digital forensic techniques for detecting records Voice. People who have conversations can identity is known through audio forensic examination for speech recognition by comparison method, namely, comparing the voices in the recorded evidence (unknown sample) with sound recorded as Comparison (known sample). If the result of voice recognition indicates that the sound of the unknown sample is identical to known sample

voice, then the voice in the conversation in the recording Evidence can be obtained from the owner of the vote Comparison. (Septiyansyah, 2015).

Similarly, Wilson (2018) has conducted the research with by using PRAAT to measure syllable with PRAAT and produce the speech rate. In addition, Aligarh (2016) was conducted research to create environment as natural as possible, conditions Retrieval, and results of the Forensic method that used. In this study, forensic testing of sound evidence is carried out with using pitch, formant, and spectogram values then compare the sound of the evidence (unknown samples) with recorded sound as a comparison (known samples).

Based on the background above, the formulation of the problems in this study are how does the pitch and formant are measured by using PRAAT? And how do the highest vocal pitch and formant can be determined?

Thus, the purposes of this study are to describe the steps of measurement in identifying the value of pitch and formant in PRAAT and to find out the highest value of vocal pitch and formant.

II. METHODS

This study used the Forensic audio method. In Audio forensics: Theory and Analysis, namely Pitch Statistical Analysis, Forman and Bandwidth Statistical Analysis, Graphical Distribution Analysis and Spectrogram Analysis. However, in this study, researchers only focus on identifying pitch and formants in the data to be analyzed.

This research uses software, such as PRAAT application and Microsoft excel. This app is used to search information from the comparison between records of native speaker's voice and recorded comparison voice. Microsoft Excel to use to measure the formant, pitch of each word spoken original and comparison.

Technically, this research was started by recording vocal sounds from various speakers by using the recording application which has available on smartphone. From one speech source will be recorded several words that consisted of consonants and vowels that will be separated with the help of software. Each recorded sound, which is approximately two seconds long, is stored in a single file.

The recording stage is followed by the verification and editing stage. The recording process is carried out to ensure that the recorded sound is the same as the file name. This is intended to avoid data errors for certain phonemes being grouped into other phoneme groups. The verification process is done manually with human assistance. At the editing stage, the recording is cut from one words to others separately. Then, cut each vocals which contained in each words by the boundary. After editing stage, the pitch and formant can be determined depended on the limitation of boundary. In this case, the determination of the number of pitch and formant that will be used as a database of Indonesian vowel sounds in this research is carried out by a) sorting the amplitude values of the frequency components from the largest to the smallest and b) calculating the summation value repeatedly starting from the top, second, third and so on until a certain percentage level is reached (compared to the total value of all frequency components).

III. RESULT

3.1 The Analysis of PRAAT's Program

This process is the essential process of this study. With the Praat application it can be identified the value of pitch, formant and spectrogram of each sound recording. The results of the first stage, namely recording, are in the form of files with MP3 format and each file contains one vowel from a speaker. Figure 1 shows the display of the words list.

Table. 3.1
The word lists and vocals

No.	Word List	Vowel List
1.	Bansos	a & o.
2.	500 milyar	i & a
3.	Sembako	e, a, & o
4.	Mengelola	e-1, e-2, o, & a.
5.	Memperhitungkan	e-1, e-2, i, u, & a.
6.	350 milyar	i & a
7.	Terdeteksi	e-1, e-2, e-3, & i
8.	Pajak	a-1 & a-2
9.	Ambilnya	a-1, i, & a-2
10.	Mengelabui	e-1, e-2, a, & i

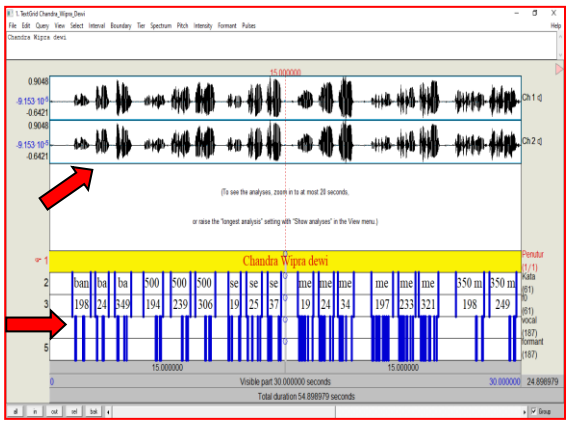
From the table above, there are ten selected words which contained of vocals in each word. Technically, those words have been uttered by ten women (participants) as voice comparison and one original voice (woman) by using the recording application which is available on smartphone. However, from the table above it can be stated that the vowels that have been separately from the selected words can be seen clearly on the table below:

Figure 3.2
The vocal amount

Vowels	a	e	i	o	u
Amount	11	10	6	3	1

Thus, in determining each vowel in several words can be assisted by the boundary on PRAAT and the spectrogram also can be identified easily. Briefly, this process can be seen on the figures below:

Figure. 3.1
The boundary process on PRAAT



From the figure 3.1 above, it can be seen that in determining the word and the vowels on each word precisely and the spectrum can be identified appropriately.

3.2. **Pitch and Formant Analysis**

3.2.1 Pitch and Formant for native speaker

The fundamental parameters for indicating the frequency and the intensity of voice which is analyzed on PRAAT are the values of pitch and formant. Therefore, the results of the research show that the pronunciation of the words below gives rise to various spectrograms and graphs, based on the vowels contained in them. Several studies have measured vowel duration using PRAAT and produced the following spectrogram output:

Figure 3.2
The vowel "a duration in word "Bansos_1"

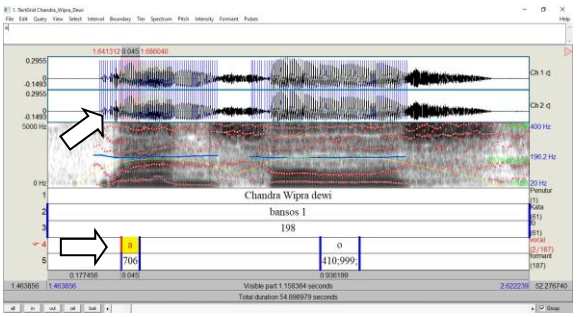
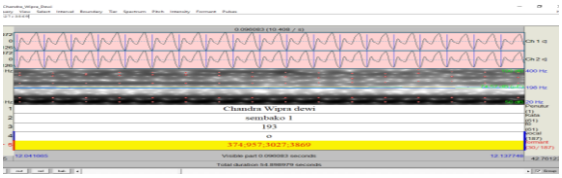


Figure 3.3
The vowel "o" duration in word "Sembako"



Based on the figures above, the spectrogram shows the input data in waveform, the measurements made on the vowels involve the formant and also the duration of the vowel being uttered, in this case, the vowels measurement focuses more on the pitch and formant of the diphthongs uttered by native and non-native speakers. The following are the results of measurements of pitch and intensity on several vowels that have been carried out by presenting data in the form of table:

Sample data
Words: *bansos, sembako, mengelola, and terdeteksi*
Speaker: *native*

Table.3.3
Pitch Value

No.	Words	Pitch
1	Bansos	174 Hz
2	Sembako	171 Hz
3	Mengelola	160 Hz
4	Terdeteksi	172 Hz

Table.3.4
Formant value

No.	Words	Vowels	Formant			
			F1	F2	F3	F4
1.	*Bansos*	a	449	1704	2509	4140
		o	614	1351	3076	4215
2.	*Sembako*	e	256	1263	2355	3579
		a	405	901	2492	3301
		o	336	1074	2341	3650
3.	*Mengelola*	e-1	348	1230	2356	3410
		e-2	487	1530	2764	3757
		o	529	1190	2717	3221
		a	675	1175	2370	3443
4.	*Mengelabui*	e-1	274	1350	2246	3509
		e-2	439	1120	1534	3550
		a	865	1596	3337	5084
		u	327	1106	2363	3114
		i	224	1229	2343	3371

From the tables above, it is obvious that Pitch analysis can be used to perform voice recognition on a person's voice, that is, through statistical analysis of minimum pitch, maximum pitch and average pitch. Meanwhile, formant can be analyzed from first formant until fourth. However, the highest vowels for the native speaker is "a" in word *mengelabui.*

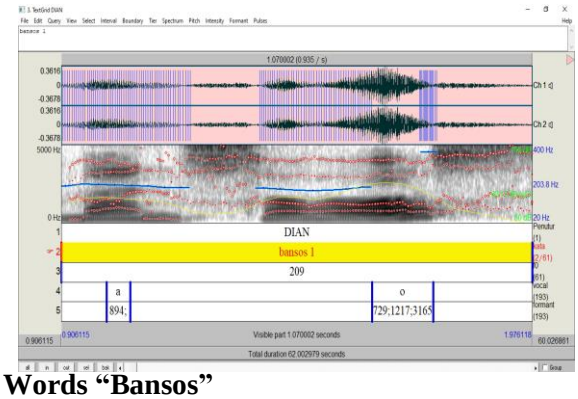
3.2.2. Pitch and Formant for non-native speaker

The results of the research show that the pronunciation of the words below gives rise to various spectrograms and graphs, based on the vowel contained in them.

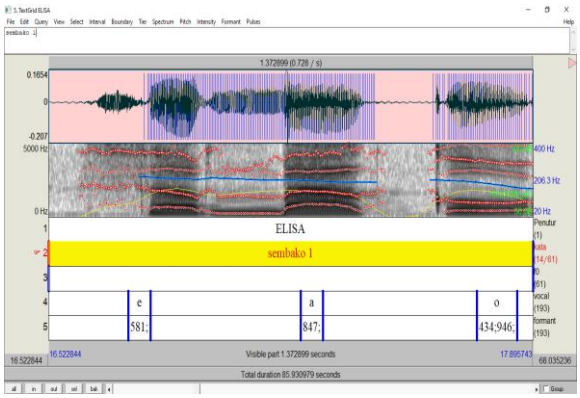
Table 3.5
The value of pitch and formant of non-native speakers

No.	Speaker	words	Pitch
1.	PP1	Bansos	218 Hz
		Sembako	220 Hz
		Mengelola	226 Hz
		Terdeteksi	221 Hz
2.	PP2	Bansos	198 Hz
		Sembako	193 Hz
		Mengelola	198 Hz
		Terdeteksi	212 Hz
3.	PP3	Bansos	183 Hz
		Sembako	182 Hz
		Mengelola	182 Hz
		Terdeteksi	207 Hz

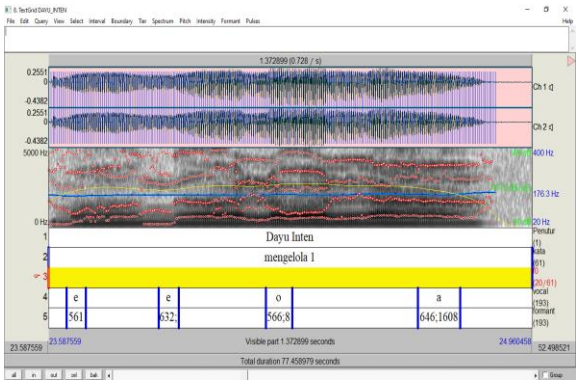
a. The Spectrogram of non-native speakers



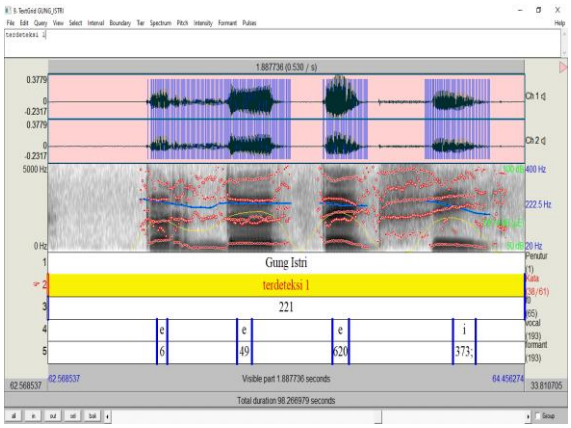
Words "Bansos"



Word "Sembako"



Word "Mengelola"



Word "Terdeteksi"

All graphs and spectrograms displayed in this study were obtained by processing sound data through extraction and processing voice data using the PRAAT program. Each graph shows the frequency and formant of the speaker's voice; while the spectrogram shows all analysis data variables and their supporting elements, complete with pitch and intensity displays for each spectrogram

IV. CONCLUSION

From the analysis obtained, it is shown that there is a relationship between vowels and the high and low pitch and formant in the utterance of these words. It can be concluded that the vowels utterance with the highest pitch value from both native and non-native speakers is when the respondent pronounces the word with vowels /a/, namely the word *mengelabui.* This is influenced by the last vowel experiencing an increase in intonation, so that the pitch becomes high when pronouncing the word. As for intensity, the vowel /a/ in the word here has the highest intensity number, based on the sampling of voice data from the three speakers, it can be concluded that the vowel /a/ has the highest frequency compared to the others. And, vowel /a/ has the highest formant number compared to other vowels.

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