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Electromyogram Signal Analysis in Frequency Domain of Uterine Muscle Contraction During Childbirth

Niko Fahadi*, Suryono Suryono[1], Djatmiko Endro Suseno[2]
*Magister of Physics, Faculty of Science and Mathematics, Diponegoro University,Indonesia**
Department of Physics, Faculty of Science and Mathematics, Diponegoro University,Indonesia [1,2]
nikofahadi@st.fisika.undip.ac.id;

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Abstract *- A research on signal processing in the uterine muscle contraction of normal birth mother was committed. The processed signals are the result of signal recording by electromyogram (EMG). EMG is used to detect the electrical potential generated by muscle cells when the muscle contraction and relaxation. Muscle electrical signals can be obtained through the installation of EMG electrodes placed on the skin surface of the normal birth maternal uterine muscle that its data signal would be taken. After this EMG data acquisition, then the signal processing was performed using MATLAB R2015b. Several steps were taken in this research are inputting signal, pre-processing signal by providing a band-pass filter (BPF) which then performed the domain signal change from the time domain into the frequency domain using Fast Fourier Transform (FFT). In the frequency domain, feature extraction was carried out to see information on the signals. Some characteristic parameters were observed in this research, those are the value of Mean Power (MNP), Mean Frequency (MNF), and Total Power (TTP). Results obtained from this research are; The first patient have an average of mean power of 0.019535, average of mean frequency of 133.6642, and average of total power of 5.861746. For the second patient, it has an average of mean power of 0.018487, average of mean frequency of 135.1483, and average of total power of 5.541304.*

Keywords: *Electromyogram(EMG), Fast Fourier Transform (FFT), band-pass filter (BPF), Feature Extraction*

I. INTRODUCTION

Developments in the technology and health brought great changes in improving the quality of human life. This is influenced by the increasing number of electronics technology development that leads to the field of biomedicine. The development of these technologies allows the body's signals can be measured and analyzed, so as to determine the quality of a person's health. One frequently used the right biomedical signals are electrical signals in the muscles. To learn the electrical signals in the muscles, supporting tools are necessary, one of those is using an electromyogram. Electromyogram (EMG) basically is used to record and evaluate the electrical activity of the contraction and relaxation of the muscle tissue. The electrical signals generated by muscle contractions are known as myoelectric signals. This signal is generated by a weak electric current, which is generated from the ion exchange across the muscle membrane and detected with the aid of electrodes. Installation of EMG electrodes placed on the surface of the skin on the muscle that its data signal will be taken [1]. In addition to recording the activity of the muscle tissue contraction and relaxation of the arms and legs, EMG also can be used to record muscle contraction in the uterus.

The contractions of uterine muscle are very organized. It happens because of the electrical activity originating from depolarization-repolarization of billions of smooth muscle's myometrium cells [2]. Uterine recordedly using EMG has proven to be able to represent uterine contractility [3]. Monitoring of uterine contractions using EMG is very helpful in the monitoring process during childbirth. One woman died every hour during childbirth or reasons relating to pregnancy [4]. Prevention of complications during delivery to reduce maternity morbidity and mortality. This is very important in the effort to reduce maternal death rate. By using EMG, we expect the measurement and monitoring of uterine contractions during childbirth can be optimized with the result more objective and valid. Based on these descriptions, so in this study measured the electrical activity of uterine contractions using EMG.

II. MATERIALS AND METHODS

2.1 Data Acquisition

Research was conducted in 2 patients tested normal birthmothers. Techniques of data retrieval was done by using an electromyogram with electrodes mounted on the surface of the maternity abdomen. The amount of data taken in this study respectively are 10 times, each performed 10 minutes for each retrieval signal. Example output signal is recorded that can be seen in Fig 1.

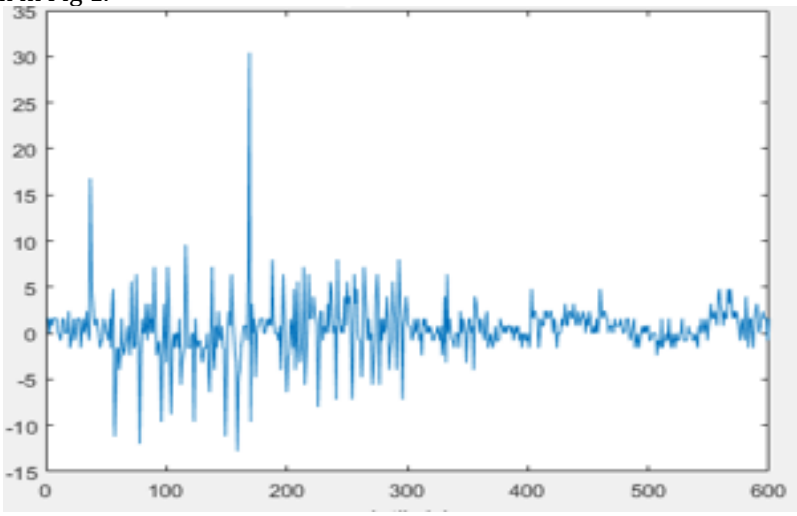

Fig 1. Raw signal from uterus contraction

Fig 1. is the rawrecording signal of uterus contractions using EMG. The x-axis shows the duration or length of time data retrieval, ie for 600 seconds or 10 minutes and the y-axis shows the magnitude of the signal magnitude in millivolts (mV). The preliminary results of the EMG signal recording is there are noise that can interfere in data processing.

2.2 EMG Data Processing

After data acquisition had been done, it was followed by signal processing and improving. Signal processing was performed by using MATLAB R2015b software.

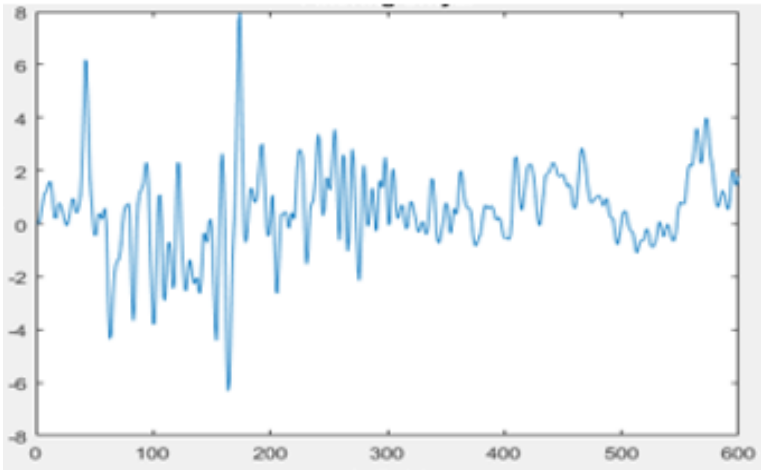

Fig 2. Signal filtering using band-pass filter

Recording signals that have been obtained was given the filtering function to improve signal quality and reduce noise that may be recorded while performing the data acquisition. The used filter is a band-pass filter, with a cutoff of 5-50 Hz. Results filtring can be seen in Fig 2.

Fig2. shows a signal spectrum after used band-pass filter. It can be seen improved signal occurring after the process filtering was given. This shows the signal quality improvement after it was given filter on it. After the signal is processed and repaired by using a band-pass filter, the transformation from the time domain signal into a frequency was committed by using FFT function. This transformation is performed to view the information contained in the signal in the frequency domain. Fig3. shows a spectrum of the signal in the frequency domain. The signal spectrum obtained from the FFT signal from Fig3, the result of the transformation from the time domain signal into a frequency.

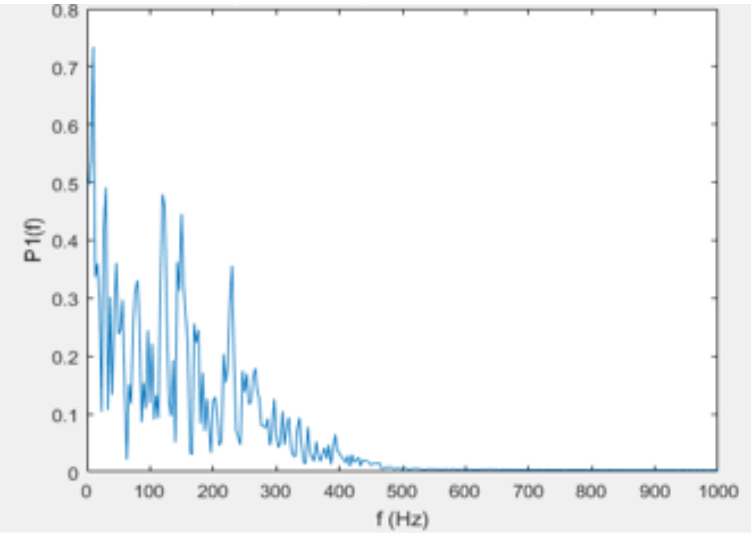

Fig 3. Signal convertion to frequency domain

III. RESULT & DISCUSS

This section will explain the research. After the time domain signal was transformed into the frequency domain, then it was retrieved some characteristics extraction values of the signals. Some of these traits areMean Power (MNP), Mean Frequency(MNF) and Median Frequency (MNF).

3.1 MEAN POWER

Mean Power (MNP) is the power average of the EMG signal spectrum of essentially[5] (Phinyomark et al., 2012a).Mean power observed in this study is the mean power of the muscle contractions of the uterus during the birth. Mean power equation can be written as

$$MNP = \frac{\sum_{j=1}^{M} Pj}{M} \quad (1)$$

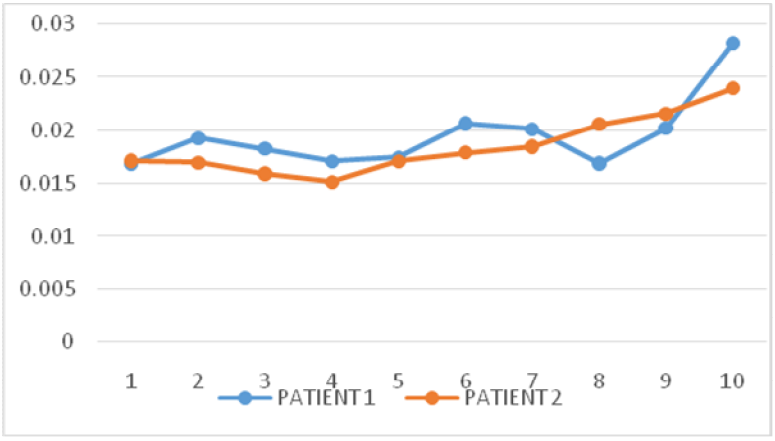

Fig 4. Mean power graphic of 2 maternity patients

The calculation results for the mean power of this study can be seen in Fig 4. By the 2 patients maternity observed, it can be seen that the mean power had increased from first up to 10 recording. Fig 4. is the value of themean power of this undertaken research. In Fig 4, there are two birth mothers's recording data signal charts. The x-axis shows the number of recording data. In this research, 10 times data recording was performed for each maternitypatient, and the y-axis shows the amount of mean power on the performed recording. For the first patient, the first recording data havemean power of 0.0169, then rose to 0.0192, and then back down to 0.0183. Themeanpower increase and decrease for any performed data recording. This is a fairness because the uterine muscle contraction and relaxation as time passes. Mean power in the first patients had increased to 0.0202 on the 9th data recording, and reached the highest and the peak value of the last data recording that is equal to 0.028. The second patient had mean power which is not much different from the first patient. The first recording data for the second patient in the amount of 0.0171, which had suffered a slight decline in the mean power becomes 0.0169. Themean power of the second maternity patients had the greatest and peak mean power on the last data recording, that is equal to 0.02393. From the data that has been processed and analyzed, it can be seen that the MNP increases for each increment of time. This shows the increasing amount of the average strength of uterine contractions every increment of time when going into childbirth.

3.2 Mean Frequency

Mean Frequency (MNF)is also known as the average frequency that is calculated from a signal. Mathematically, mean frequency can be regarded as the quotient of the frequencies number to the total amount of spectrum intensity [6].Mean frequency equation is written as the following equation.

$$MNF = \sum_{j=1}^{M} \frac{f_j P_j}{P_j} \quad (2)$$

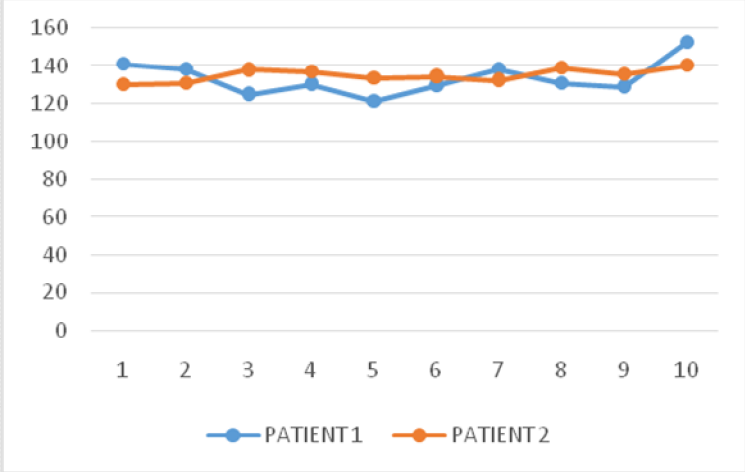

Fig 5. Mean Frequency graphic of 2 maternity patients

The results of calculation of mean frequency of this research can be seen in the picture below. From 2 patients maternity observed, it can be seen that the mean frequency had increased the value of the first recording of up to 10. Fig 5. shows a graph of meanfrequency value from 2 maternity patients. In the first patient the mean frequency value of 141.153 Hz, which then decreased to 138.17 Hz. The first birth mothermean frequency had decreased and increased in every recorded data, but got increase at the end of the data recording. The peak of mean frequency is 152.367 Hz on the 10th recordings of the first maternitypatients. In the second maternitypatient, the first mean frequencydata recording was obtained in the value of 130.387 Hz which always increase to the subsequent calculations, then go down and have the smallest mean frequency is equal to 132.501 Hz on 7th recording. However after it increased the mean frequency back up to 140.189 Hz in the final performed signal recording.

3.3 Total Power (TTP)

Total Power is defined as the union of the whole spectrum signals that have been recorded[5]. Total power equation is written as the following equation.

$$\mathrm{TTP} = \sum_{j=1}^{M} P_j \quad (3)$$

In the research,total power can be seen in Fig 6.

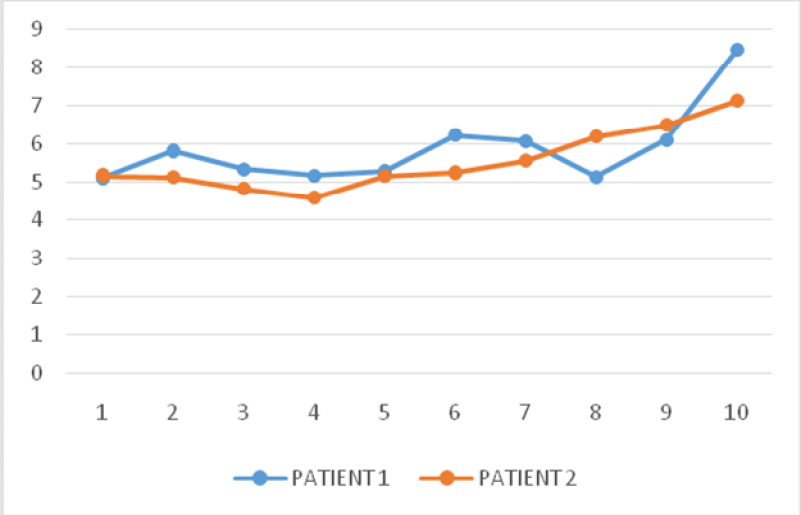

Fig 6. Total power graphic of 2 maternity patients

Fig 6 shows graphics of 2 maternity patients. there are two birth mothers's signal recording data charts. The x-axis shows the number data recording, which in this study was conducted 10 times for each maternity patient and y-axis shows the amount of total powerwhen the recording is done. For the first patient, for the first data recording hastotal power of 5.094, then increased to 5.806, and then back down to 5.3263. Thetotal power increase and decrease for any recording data. The greatest value of the recording is on the last signal that is equal to 8.469. The second patient had total power that was not much different with the first patient. The first recording data for the second patient was in the amount of 5,160, which had suffered a slight decline in the total powerthat becomes 5.1111. Thetotal power of the second maternity patient hasthe greatest and peak total power on the last data recording that is equal to 7.1310. From the data that has been processed and analyzed, it can be seen that total power increases for each increment of time. This shows that the increasingly large number of uterine contractions force for each increment of time when going into childbirth.This is a fairness because the uterine muscle contractions and relaxations as time passes.

IV. CONCLUSION

A Research on signal processing of maternaluterine muscle contractionduring the childbirth had been done. There are some parameters that were tested in this study, such as Mean Power (MNP), Mean Frequency (MNF) and Total Power (TTP). Results of this research shows that the value of the frequency and power will increase along theincreasing time. This happens due to contractions are getting stronger when the mother get into the childbirth phase. By this research, it can be seen some parameters such as Mean Frequency (MNF), Mean Power (MNP), and Total Power (TTP) can be used to make observations on uterine muscle contraction during the childbirth.

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