TERAKRDITASI INSTITUSI B
SK NO. 229/BAN-PT/AKRED/PT/IV/2015

UNIVERSITAS MUHAMMADIYAH SIDOARJO
DIREKTORAT RISET DAN PENGABDIAN MASYARAKAT
Alamat: Jl. Mojopahit 666 B Sidoarjo 61215, Telp. 031-8945444 psw.130, Faks. 031-8949333 Email: lppm@umsida.ac.id, Website: lppm.umsida.ac.id

Surat Keterangan Tidak Plagiat [Kepangkatan]

Nomor: 776.3/II.3.AU/14.00/C/KET/I/2023

Kepada Yth :
Bpk. Izza Anshory, ST., MT., Dr.
Di
Tempat

Assalamua'alaikum Wr. Wb.
Sehubungan dengan adanya permohonan Surat Keterangan Tidak Plagiat dengan rincian:

Judul Artikel	: Classification of heart signal using wavelet haar and backpropagation neural network
Nama Pemohon	: Izza Anshory / TEKNIK ELEKTRO
URL Sinta Pemohon	: https://sinta.kemdikbud.go.id/authors/profile/5993144
Nama Penulis	: Izza Anshory
Tujuan	: Kepangkatan
Tujuan Kepangkatan	: Lektor

Naskah Yang Dimohonkan pengecekan:
https://dosen.umsida.ac.id/modul/publikasi/filesktp/202239/sktp-10-01-2023%2002:23:46-202239.pdf

Artikel tersebut DAPAT digunakan untuk proses kepangkatan.

Demikian surat keterangan ini kami sampaikan, mohon untuk digunakan sebagaimana mestinya.

Wassalamu'alaikum Wr. Wb.

Mengetahui,
Wakil Rektor 1
Universitas Muhammadiyah Sidoarjo

Hana Catur Wahyuni,ST.,MT

Direktur DRPM
Universitas Muhammadiyah Sidoarjo

Dr.Sigit Hermawan,S.E,.M.Si

sktp-10-01-2023 02_23_46-202239

by Izza Anshory, St., Mt., Dr.

Submission date: 11-Jan-2023 09:00AM (UTC+0700)
Submission ID: 1991009960
File name: sktp-10-01-2023_02_23_46-202239.pdf (378.37K)
Word count: 3058
Character count: 14895

PAPER • **OPEN ACCESS**

Classification of heart signal using wavelet haar and backpropagation neural network

To cite this article: H Hindarto *et al* 2018 *IOP Conf. Ser.: Mater. Sci. Eng.* **403** 012069

Classification of heart signal using wavelet haar and backpropagation neural network

H Hindarto, I Anshory and A Efiyanti

Universitas Muhammadiyah Sidoarjo
Jl. Mojopahit 666B Sidoarjo
Jl. Raya Gelam 250 Candi Sidoarjo
+62-031-8945444

hindarto@umsida.ac.id

Abstract. Researchers used many methods to extract and classify heart signals.In this study wavelet haar is use to extract characteristics of heart signals. Artificial neural networks Backpropagation for the classification of heart signals. The data is taken from Physiobank namely MIT-BIH Arrhythmia Database and MIT-BIH Normal Sinus Rhythm Database. The data is processed using Haar wavelet method for its extraction.The results of feature extraction methods will be use for the classification process. The research found that by using Wavelet Haar feature extraction and classification using Backpropagation obtained classification accuracy rate of 92%.

Keywords: Heart; electrocardiography; Wavelet Haar; backpropagation

1. Introduction

Electrocardiogram (ECG) is the electrical device to detect the activity of the human heart. The ECG is a composite of 5 waves - P, Q, R, S and T. These signals can be measured with electrode, placed on the human body . The signal from this electrode is connect to a simple electrical circuit with amplifier and analog - digital converter. Application of heart rate and heart rate detection by using an electronic circuit with a stethoscope and pulse sensor as input to detect. The pulse sensor is use to determine the heart of a person and a stethoscope is use to detect heart sound. While the series of electronics used ardunio series as an interface to the monitor screen. From Test results on 10 subjects, to measure of heart rate with the pulse sensor obtained the accuracy of the tool sensory pulses by way of 99% [1].

The heart frequency can be detected by many methods and algorithms. Many heart signal detection algorithm is based on the distance between the QRS complexes. Complex QRS algorithms are from the field of artificial neural networks, genetic algorithms, wavelet transforms or bank filters [2]. In addition the next way to detect complex QRS is to use adaptive threshold [3] such as Direct method for detection of heart rate spectral signal spectral ECG [4] and the method of Short-Term Autocorrelation [5]. ECG signals can be used to diagnose heart disease, however, t ECG signals do not fully describe the heart characteristics. It is because the heart is also affected by the opening and closing of the heart valve is a factor in the conscience. In addition, there is a heart damage that is difficult to detect using an ECG, such as natural structural abnormalities or opening and closing imperfect heart valves, as well as heart murmurs or abnormal sounds [6].

There are several studies by taking data from MIT-BIH data base. This research uses Heart Rate Variability (HRV) analysis method to look for feature extraction and classification using artificial neural network classifier. Results obtained with an accuracy of 99.38% [7]. F. Yaghouby et al., In his penisilitan using Generalized Discriminant Analysis (GDA) method for extracting and using Multilayer Perceptron (MLP) method of artificial neural network grouping, the result is 100% [8]. R. Acharya et al., This study took eight classes, feature extractions used by taking from the spectral entropy, the Poincar geometry plot and the largest Lyapunov exponent (LLE). Then classification using artificial neural network method and fuzzy relationship. This research yields value. 80-85 5 [9]. L. Hussain et al., This study to look for feature extraction using HRV analysis includes linear (time and frequency domain) and non-linear techniques and with the result of 92.5% method using LMT (logical tree model) method [10].

This study divides the heart signals into two classes of normal heart and abnormal heart.The first presents a method of Wavelet Haar to as a heart signal feature extraction. The retrieved characteristic is then classified using a backpropagation neural network.

2. Method

Heart signal data is taken from Physiobank database are MIT-BIH Normal Sinus Rhythm Database and MIT-BIH Arrhythmia Database. This database includes for 18 ECG recordings from subjects at the Arithmia Laboratory at Bethlehem Israel Beth (now Beth Israel Deaconess Medical Center). Subjects, included in this database were found to have insignificant arrhythmia; They are 5 men, aged 26-45, and 13 women, aged 20 to 50. The database contains 48 half-hour citations of two-channel ECG recordings of a person treated on the road, obtained from 47 subjects studied by BIH Arrhythmia Laboratory between 1975 and 1979. Twenty-three randomly selected records of a set of 4,000 24-hour ambulatory ECG records are collected from a mixed population of inpatients (about 60%) and outpatients (about 40%) at Home Pain of Israel Beth Boston; 25 remaining records are selected from the same set to include less common but clinically significant arrhythmias that would not be represented in the sample randomly. Digital recording at 360 samples per second per channel with 11-bit resolution at 10 mV range. Two or more cardiologists independently described each record; Disputes were resolved to obtain a readable computer reference explanation for each beat (about 110,000 annotations at all) included with the database [11].

The used data e are 15 files of 1 minute length and 360 Hz sample frequency, normal pulse signal and various types of pulse arrhythmias. All selected files take 6 seconds segmentation to get 150 samples from the experimental data.

Wavelet transformation is an improvement of the Fourier transform. If the Fourier transform only provides information about the frequency of a signal, the wavelet transform provides information about the combination of scale and frequency. Wavelet comes from a scaling function, can be made as a mother wavelet. Other wavelets will come from scaling, dilation and mother wavelet shifts. Wavelet transformation is improvement of the Fourier transform. If the Fourier transform only provides information about the frequency of a signal, the wavelet transform provides information about the combination of scale and frequency. Wavelet comes from a scaling function. From this scaling function can made a mother wavelet. Other wavelets will come from scaling, dilation and mother wavelet shifts.

There are two functions that play a major role in wavelet analysis, which is function of the wavelet scale (wavelet) and wavelet ψ (mother wavelet). The simplest wavelet analysis is base on the Haar function scale [12]. The Haar scale function is define as another using formula (1).

$$\varphi(x) = \begin{cases} 1, & if\ 0 \le x < 1 \\ 0, & OTHER \end{cases} \tag{1}$$

The Haar mother wavelet function is define as formula (2).

Ψ(x) = φ (2x) – φ (2x -1)

$$\Psi(x) = \begin{cases} 1, & 0 \le x < 1/2 \\ -1, & \frac{1}{2} \le x < 1 \\ 0, & OTHER \end{cases} \tag{2}$$

Like all wavelet transforms, the Haar Wavelet transform is a discrete signal that decomposes into two sub-signals of half its length. One sub signal is averages in a row. Haar Level Wavelet Transformation 1, Haar Wavelet transformation is do in several stages, or levels.

Assume 1 dimension of signal f with signal length equal to N. Haar level transformation 1 for f = (x_1, x_2, ……, x_N).

$$f \xrightarrow{H_1} (a^1|d^1) \tag{3}$$

Where :

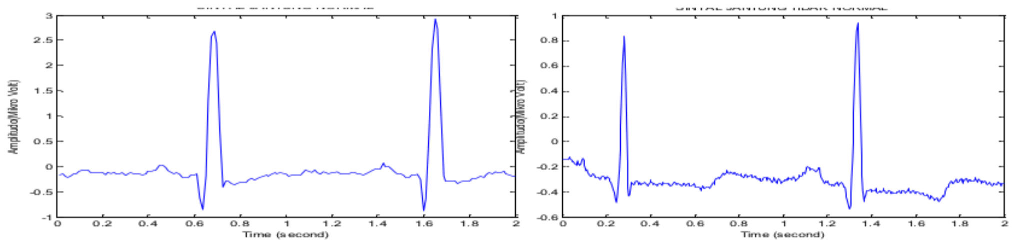
$$a^1 = \left(\frac{x_1 + x_2}{\sqrt{2}}, \quad \frac{x_3 + x_4}{\sqrt{2}}, \dots\dots\dots, \quad \frac{x_{N-1} + x_N}{\sqrt{2}}\right)$$
$$d^1 = \left(\frac{x_1 - x_2}{\sqrt{2}}, \quad \frac{x_3 - x_4}{\sqrt{2}}, \dots\dots\dots, \quad \frac{x_{N-1} - x_N}{\sqrt{2}}\right)$$

Heart signals that have been selected based on normal and abnormal heart, then each signal is process using Wavelet Haar level 4. Totals of 300 heart signals are extrac to get two special features. 300 cardiac data signals consisting of 150 normal and 150 abnormal heart signals. Extraction of heart signal features is take from the Haar Wavelet process with level 4.

IOP Conf. Series: Materials Science and Engineering **403** (2018) 012069 doi:10.1088/1757-899X/403/1/012069

3. Results and Discussion

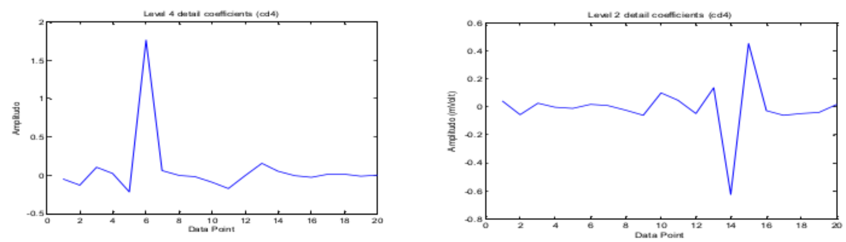
In this study, Haar Wavelet transformation was use for characteristic extraction of normal and abnormal heart signals. Normal and abnormal heart signals can be seen in Figure 1.



(a) (b)

Figure 1. (a) a normal heart signal (b) an abnormal heart signal

Results Haar Wavelet process in the form of a vector consisting of several data point elements. In this study using Wavelet Haar level 4, the results of the wavelet haar process can seen in Figure 2.



(a) (b)

Figure 2. Wavelet Haar level 4 results (a) normal heart signal (b) abnormal heart signal

The data taken in this study is 300 data files of heart signals. A normal heart signal file has 350 data points and an abnormal heart signal file has 80 data points. The result of the wavelet haar value is show in Table 1 by taking five samples of haar wavelet results on each signal.

Table 1. Result Of Wavelet Haar Of Heart Signal

Signal	Signal 1	Signal 2	Signal 3	Signal 4	Signal 5
	20 Point data	20 Point data	20 Point data	20 Point data	20 Point data
Normal heart signal	0.03	-0.013	-0.06	-0.02	0.001
	-0.05	-0.05	0.03	0.045	-0.015
	0.02	0.03	0.02	-0.075	0.013
	-0.02	0.01	0.01	-0.02	0.014
	-0.02	0.02	0.03	0.03	0.002
	0.01	-0.01	0.02	-0.02	-0.032
	0.02	0.02	0.01	0.02	-0.08
	-0.02	-0.04	0.03	0.11	0.08
	-0.05	0.01	0.02	0.03	0.04
	0.15	0.04	0.02	0.01	-0.01
	0.06	0.02	0.01	0.62	0.05
	-0.04	0.45	-1.61	-1.58	-0.05

IOP Conf. Series: Materials Science and Engineering **403** (2018) 012069 doi:10.1088/1757-899X/403/1/012069

	0.13	-2.61	1.43	1.08	0.30
	-0.62	2.23	0.02	0.02	0.02
	0.44	0.02	0.01	-0.07	-0.04
	-0.02	-0.02	0.05	-0.03	-0.04
	-0.05	-0.03	0.01	-0.03	-0.13
	-0.04	-0.05	0.01	0.02	0.03
	-0.03	0.01	0.03	0.04	-0.03
	0.01	0.02	0.02	-0.02	-0.02
abnormal heart signal	-0.04	-0.015	-0.07	0.00	-0.02
	-0.12	-0.22	-0.15	-0.06	-0.01
	0.12	0.11	0.12	0.09	-0.07
	0.02	0.03	0.021	0.09	-0.03
	-0.21	-0.61	-0.751	0.05	0.16
	1.75	1.46	1.632	0.26	0.01
	0.05	0.04	0.042	0.22	-2.20
	-0.02	-0.01	0.013	0.00	0.42
	-0.02	-0.02	-0.013	-0.01	0.00
	-0.08	-0.05	-0.074	-0.01	-0.02
	-0.16	-0.13	-0.142	-0.10	-0.02
	-0.02	-0.02	-0.022	-0.15	-0.07
	0.15	0.12	0.174	0.04	-0.16
	0.04	0.02	0.075	0.13	-0.07
	-0.02	-0.01	0.012	0.00	0.17
	-0.02	0.01	0.002	0.02	0.05
	0.012	0.01	0.022	-0.02	-0.04
	0.014	0.02	0.012	0.00	-0.01
	-0.015	0.012	0.013	0.03	-0.03
	0.001	-0.013	0.034	-0.01	0.00

Classification of heart signals processed using neural network Back Propagation as show in Figure 3. Final processing is do after the initial process is feature search.

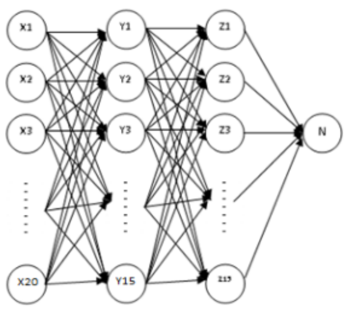


Figure 3. Neural Network Architecture Backpropagation with 2 Hidden layers

Extraction feature of wavelet haar is use for input to Backpropagation, this study using Backpropagation (20-15-15-1) number 20 the input of the wavelet haar value, the number 15 layer is hidden one to the number of nodes 15, the number 15 represents the number of nodes in the layer Hidden second, and the number 1 is the target (normal heart and abnormal heart).

There are two stages for the classification process that is the learning process and Mapping process. The learning process using learning rate parameter 0.1 and error be achieved 0,00001. The value for weights is random in the range of -1 to 1. In search of optimal parameter performance to produce the best value of the neural network is to assess the size of Mean squared error (MSE) and the number of hidden layer units at trainning. Examples of performance results can found in Figure 4.

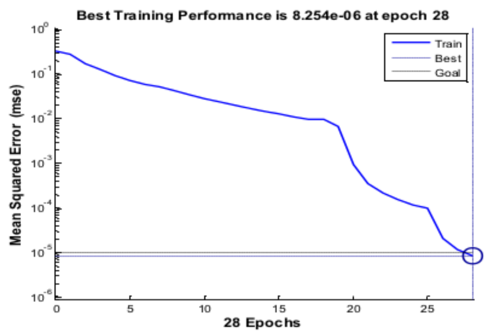


Figure 4. Performance performance results of the identification of Backpropagion (20-15-15-1)

The backpropagation performance of 20-15-15-1 show that the desired target error of 0.00001 has been achieved. In this network come about error 8.25. 10-6 so that the training process for the classification on this heart signal can already reach 100% accuracy. The result of the trainning process for classification of heart signals by using the 20-10-15-1 network has obtained the value of bias and weight. After the trainning process, the next process is the testing process. The data used in this trial process is to retrieve data as much as 100 heart signal data, consisting of 50 data of normal heart signals and 50 data of heart signals upnormal. In this research, data trainning and data testing with total data amount 300 data yield accuracy level 276/300 * 100% = 92%. From Figure 4 shows that by using 2 hidden layers have reached the desired target.

Table 2. The Performar Of The Neural Network To The Different Number Of Hidden Layer

	1 Hidden Layer	**2 Hidden Layer**	**3 Hidden Layer**
Time	30	53	62
Iteration	1000	503	407
MSE	$9.9x10^{-4}$	$8.25x10^{-6}$	$3.55x10^{-6}$
Accuracy	89 %	92 %	92 %

5. Conclusion

In this study, researchers introduced Wavelet Transformation by taking a 4th level haar wavelet to extract features. Backpropagation neural network is used to train 200 heart signal data files.. The testing process used 300 data file data signal heart. The precise classification of two hidden layers of backpropagation is 92%. The future research will be focused on exploration of better feature extraction methods.

References

[1] Hindarto, dkk. Aplikasi Pengukur Deteksi Detak dan Suara Jantung. Jurnal Saintek, Volume 13, nomer 2, Desember.
[2] Kohler, B.-U.; Hennig, C.; Orglmeister, R. The principles of software QRS detection. Engineering in Medicine and Biology Magazine IEEE, vol. 21, pp. 42 – 57, January -February 2002.
[3] I. I. Christov. Real time electrocardiogram QRS detection using combined adaptive threshold. BioMedical Engineering OnLine, 2004. [cit: 2011-10-16]. [Online]. Available on internet: http://www.biomedical-engineering-online.com/content/3/1/28.
[4] Surda, J.; Lovas, S.; Pucik, J.; Jus, M. Spectral Properties of ECG Signal. Radioelektronika, 2007. 17th International Conference, Brno, Czech Republic, 24th – 25th April 2007, pp. 1 – 5.
[5] Piotrowskia Z.; Rózanowski K. Robust Algorithm for Heart Rate (HR) Detection and Heart Rate Variability (HRV) Estimation. ACTA PHYSICA POLONICA, vol. 118, pp. 131 – 135, No. 1/2010.
[6] Glass L, Mackey MC. *From Clocks to Chaos: The Rhythms of Life.* Princeton, NJ: Princeton University Press; 1988.

[7] Babak Mohammadzadeh-Asl, Seyed Kamaledin Setarehdan, Neural Network Based Arrhythmia Classification Using Heart Rate Variability Signal. 14th European Signal Processing Conference (EUSIPCO 2006), Florence, Italy, September 4-8, 2006, copyright by EURASIP

[8] F. Yaghouby, et al. Classification of Cardiac Abnormalities Using Reduced Features of Heart Rate Variability Signal, orld Applied Sciences Journal 6 (11): 1547-1554, 2009.

[9] R. Acharya U, et al. Classification of cardiac abnormalities using heart rate signals. Medical & Biological Engineering & Computing 2004, Vol. 42.

[10] L. Hussain, et al. Classification Of Normal And Pathological Heart Signal Variability Using Machine Learning Techniques. International Journal Of Darshan Institute On Engineering Research & Emerging Technologies Vol. 3, No. 2, 2014.

[11] PhysioBank, at http://www.physionet.org

[12] Chun-Lin, Liu. A Tutorial of the Wavelet Transform. February 23, 2010.

sktp-10-01-2023 02_23_46-202239

ORIGINALITY REPORT

9%	8%	7%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	tel.archives-ouvertes.fr Internet Source	1%
2	www.nrso.ntua.gr Internet Source	1%
3	content.iospress.com Internet Source	1%
4	www.alliedacademies.org Internet Source	1%
5	Nemati, S, O Abdala, V Monasterio, S Yim-Yeh, A Malhotra, and G D Clifford. "A Nonparametric Surrogate-Based Test of Significance for T-Wave Alternans Detection", IEEE Transactions on Biomedical Engineering, 2011. Publication	1%
6	www.ijsr.net Internet Source	1%
7	citeseerx.ist.psu.edu Internet Source	1%

8	acikerisim.deu.edu.tr Internet Source	1 %
9	Peiming Zhang. "Detection and Protection of Short Circuit Fault Based on Morphology-wavelet", 2005 IEEE/PES Transmission & Distribution Conference & Exposition Asia and Pacific, 2005 Publication	1 %
10	G.B. Moody, R.G. Mark, A.L. Goldberger. "PhysioNet: a Web-based resource for the study of physiologic signals", IEEE Engineering in Medicine and Biology Magazine, 2001 Publication	1 %

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		