Classification Heart Diseases Base on Heart Sound Using Backpropagation Algorithm

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Abstract -- Heart sounds have a unique pattern that can indicate a person's heart condition. An abnormal heart will produce a characteristic sound that is often called a murmur. Murmurs are caused by various things that can indicate a person's heart condition. These murmurs can be known as the types of abnormalities experienced by patients. In this study, cardiac abnormalities that can be identified are aortic stenosis (as), mitral regurgitation (mr), mitral valve prolapse (mvp), mitral stenosis (ms), and normal. The data used for training as many as 1000 heart sound files consisting of 200 files each for each heart abnormality.Data in the form of heart rate sound samples with the format. Wav. The program was created using the Artificial Neural Network method to identify the five types of cardiac abnormalities. The training method is created using the traingdx function provided in the Neural Network Toolbox on MATLAB. Based on the results of the training can be obtained a validity value of 97,7%.

Keywords:
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I. INTRODUCTION

The heart is a vital organ that must be present and can function properly in a person. Heart attacks are still in the position of the cause of death in many countries in the world [4]. Most of them do not realize that in their heart, there are characteristics of abnormalities in the heart that can cause attacks or heart failure. The heart functions to pump oxygenated blood to all parts of the body and cleanse the body of the results of metabolism.

Heart sounds have a unique pattern that can indicate a person's heart condition. An abnormal heart will produce a characteristic sound that is often called a murmur [5]. Murmurs often suddenly come so that to avoid death, recognizing a heart disorder that is suffering is a must. By knowing the illness, it will be easier to determine the appropriate treatment and more targeted. Currently, there are still many doctors who use sound cues to find out the heart's work using a stethoscope. A stethoscope is an acoustic medical instrument used to check sounds in the body and is widely used to listen to the sound of the heart, breathing, and blood flow in arteries and veins (hellosehat.com).

Normal heart sounds have a frequency range of 20 Hz to 200 Hz, while abnormal heart sounds have a range of up to 1000 Hz [8]. One type of regurgitation can cause murmurs in the range of 100 to 600 Hz, even for certain types of murmurs can be up to 1000 Hz. To be able to determine the type of abnormality, a database containing 900 heartbeat sound recording files in the .wav format consists of 180 files in five categories, namely aortic stenosis (as), mitral regurgitation (mr), mitral valve prolapse (mvp), mitral stenosis (ms), and normal. Recognition/detection of cardiac abnormalities is done using Artificial Neural Networks and training methods are made using the traingdx function that has been provided in the Neural Network Toolbox on MATLAB by using the backpropagation algorithm.

II. METHOD

The method used in this research is Research and Development that begins by finding the data source used as a sample. After the sample was found as many as 900 heartbeat sound files in five categories, each category containing 180 files with the format .wav. After the data obtained from making changes to a form that is readable sine waveform results and further, each picture is almost the same regrouped into one type of heart defect.

Data source

Data for training were taken from the PhysioNet database of 900 human heartbeat sound files in the .wav format consisting of 180 files in five categories, namely aortic stenosis (as), mitral regurgitation (mr), mitral valve prolapse (mvp), mitral stenosis (ms), and normal.

TABLE I.
Heart sound samples

No	Specification	Amount
1	aortic stenosis (as)	180
2	mitral regurgitasi (mr)	180
3	mitral valve prolapse (mvp)	180
4	mitral stenosis (ms)	180
5	normal	180
	Amount	**900**

Pre Process

Before the sample is grouped according to the type of abnormality, the sample is first processed using FFT (Fast Fourier Transform). This process changes the sample that was in the form of a heartbeat sound recording file into a frequency-based sine wave file and is easier to process.

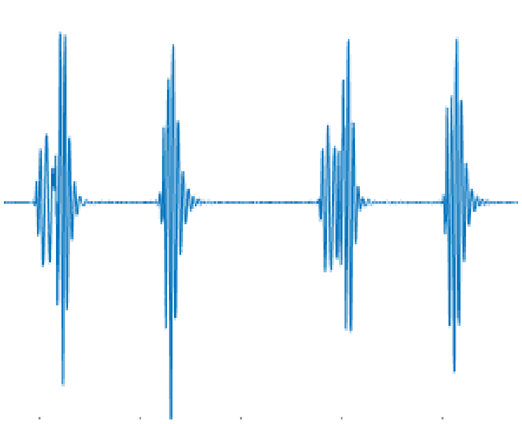

FIGURE 1 a.
Normal sample processing results

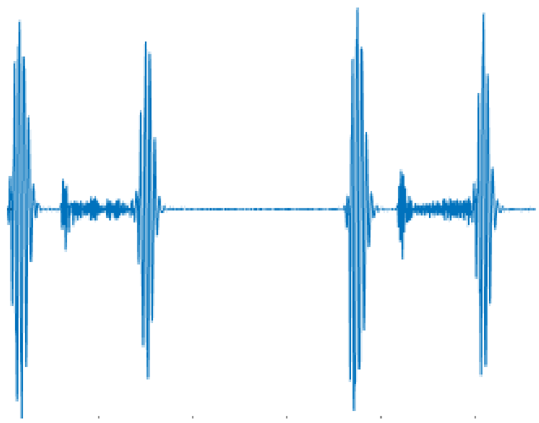

FIGURE 1 b.
Upnormal sample processing results

Labeling

The initial stage in a database is the labeling process. Labeling is used to find out which category the heart sound is detected. The number of samples used was 900 audio files with .wav format consisting of 180 files each for each category. Label 1 is used for types of aortic stenosis (as) abnormalities, label 2 for mitral regurgitation (mr), label 3 for types of mitral valve prolapse (mvp) abnormalities, label 4 for mitral stenosis (ms), and label 5 is used for normal heart conditions. All samples that have been labeled are saved in the label .mat file. The following flowchart is used in the labeling process.

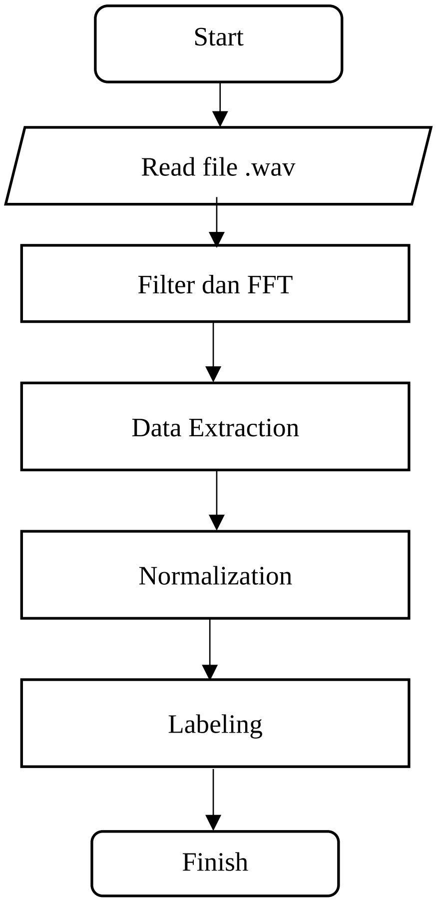

FIGURE 2.
Labeling flowchart

Training Stage

The training was carried out using MATLAB R2015a software by utilizing some of the features that were already provided. The training uses 900 sample files, which are divided into five categories, namely aortic stenosis (as), mitral regurgitation (mr), mitral valve prolapse (mvp), mitral stenosis (ms), and normal with each sample of 180 files. Figure 3 is a process of neural network training that has been carried out as many as 66 iterations. Figure 4 is a clustered regression plot consisting of 5 groups of labels with details of label 1 with numbers 1 - 180, label 2 with numbers 181 - 360, label 3 with numbers 361 - 540, label 4 with numbers 541 - 720 and label 5 with number 721 - 900.

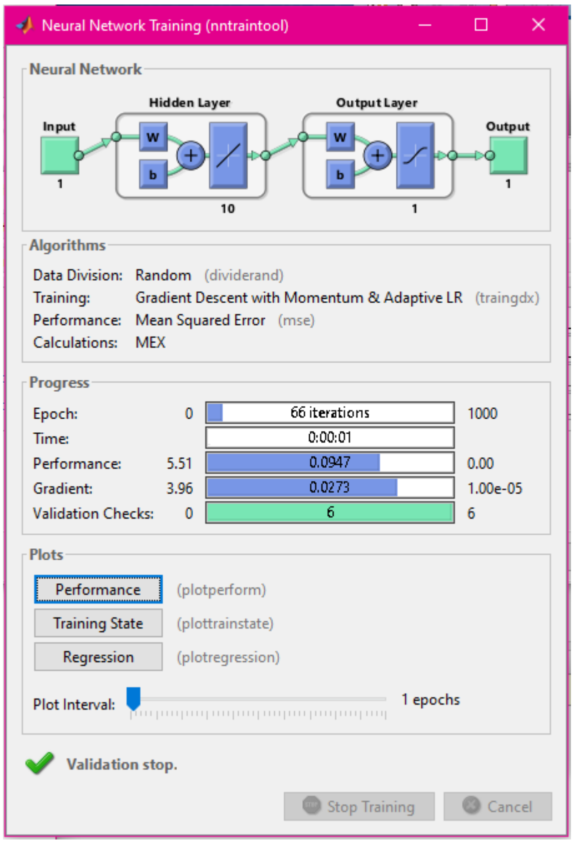

FIGURE 3.
Neural network training

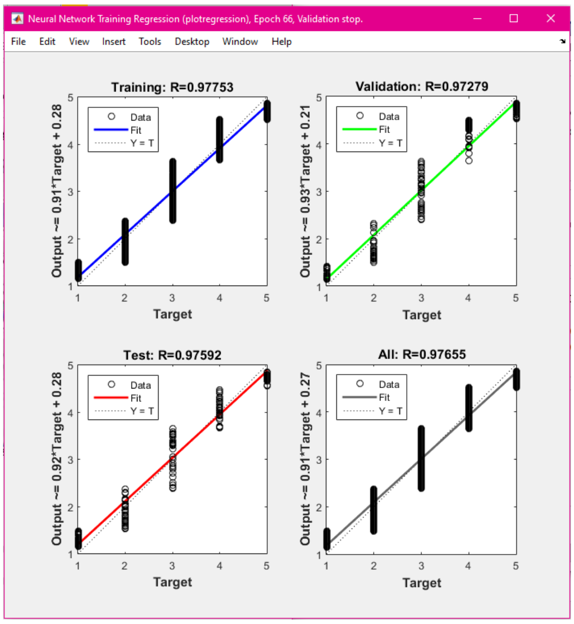

FIGURE 4.
The regression plot

The training graph can be seen in Figure 5, which consists of three kinds of graphs showing the training process in the training state. This graph shows the training process from the first epoch to epoch 66th.

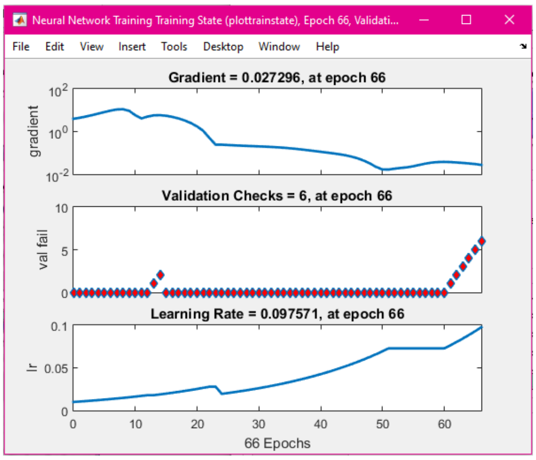

FIGURE 5.
Training State

The best performance validation occurred at epoch 60, with a value of 0.1049. Figure 6 also explained the relationship between the training process, validation, and testing with a dotted line shows the best results.

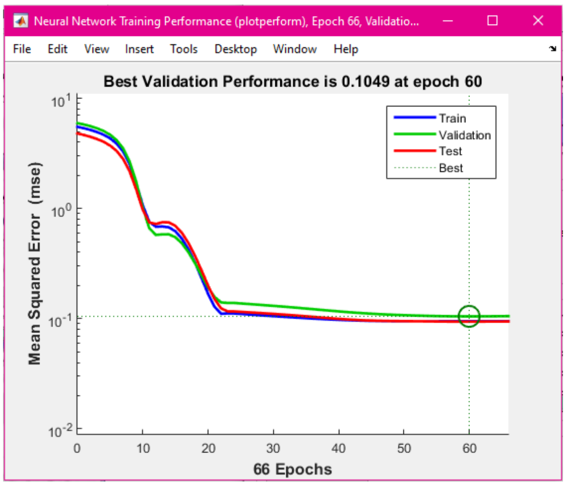

FIGURE 6.
Best performance validation

III. TESTING PHASE

The last stage after the system made is testing. Testing is done by running the GUI made earlier, then selecting randomly tested files from sample numbers 191 to 200 for each sample. The test results are carried out 50 times with the results, as in Table II. All the tests carried out show that the results are the same between the types of files tested with the results of the classification of the neural network.

TABLE II.
Test result

No	Testing	File Clasification	Result Clasification	Information
1	New_AS_191.wav	Aortic Stenosis	Aortic Stenosis	true
2	New_AS_192.wav	Aortic Stenosis	Aortic Stenosis	true
3	New_AS_193.wav	Aortic Stenosis	Aortic Stenosis	true
4	New_AS_194.wav	Aortic Stenosis	Aortic Stenosis	true
5	New_AS_195.wav	Aortic Stenosis	Aortic Stenosis	true

6	New_AS_196.wav	Aortic Stenosis	Aortic Stenosis	true
7	New_AS_197.wav	Aortic Stenosis	Aortic Stenosis	true
8	New_AS_198.wav	Aortic Stenosis	Aortic Stenosis	true
9	New_AS_199.wav	Aortic Stenosis	Aortic Stenosis	true
10	New_AS_200.wav	Aortic Stenosis	Aortic Stenosis	true
11	New_MR_191.wav	Mitral Regurgitasi	Mitral Regurgitasi	true
12	New_MR_192.wav	Mitral Regurgitasi	Mitral Regurgitasi	true
13	New_MR_193.wav	Mitral Regurgitasi	Mitral Regurgitasi	true
14	New_MR_194.wav	Mitral Regurgitasi	Mitral Regurgitasi	true
15	New_MR_195.wav	Mitral Regurgitasi	Mitral Regurgitasi	true
16	New_MR_196.wav	Mitral Regurgitasi	Mitral Regurgitasi	true
17	New_MR_197.wav	Mitral Regurgitasi	Mitral Regurgitasi	true
18	New_MR_198.wav	Mitral Regurgitasi	Mitral Regurgitasi	true
19	New_MR_199.wav	Mitral Regurgitasi	Mitral Regurgitasi	true
20	New_MR_200.wav	Mitral Regurgitasi	Mitral Regurgitasi	true
21	New_MVP_191.wav	Mitral Valve Prolapse	Mitral Valve Prolapse	true
22	New_MVP_192.wav	Mitral Valve Prolapse	Mitral Valve Prolapse	true
23	New_MVP_193.wav	Mitral Valve Prolapse	Mitral Valve Prolapse	true
24	New_MVP_194.wav	Mitral Valve Prolapse	Mitral Valve Prolapse	true
25	New_MVP_195.wav	Mitral Valve Prolapse	Mitral Valve Prolapse	true
26	New_MVP_196.wav	Mitral Valve Prolapse	Mitral Valve Prolapse	true
27	New_MVP_197.wav	Mitral Valve Prolapse	Mitral Valve Prolapse	true
28	New_MVP_198.wav	Mitral Valve Prolapse	Mitral Valve Prolapse	true
29	New_MVP_199.wav	Mitral Valve Prolapse	Mitral Valve Prolapse	true
30	New_MVP_200.wav	Mitral Valve Prolapse	Mitral Valve Prolapse	true
31	New_MS_191.wav	Mitral Stenosis	Mitral Stenosis	true
32	New_MS_192.wav	Mitral Stenosis	Mitral Stenosis	true
33	New_MS_193.wav	Mitral Stenosis	Mitral Stenosis	true
34	New_MS_194.wav	Mitral Stenosis	Mitral Stenosis	true
35	New_MS_195.wav	Mitral Stenosis	Mitral Stenosis	true
36	New_MS_196.wav	Mitral Stenosis	Mitral Stenosis	true
37	New_MS_197.wav	Mitral Stenosis	Mitral Stenosis	true
38	New_MS_198.wav	Mitral Stenosis	Mitral Stenosis	true
39	New_MS_199.wav	Mitral Stenosis	Mitral Stenosis	true
40	New_MS_200.wav	Mitral Stenosis	Mitral Stenosis	true
41	New_N_191.wav	Normal	Normal	true
42	New_N_192.wav	Normal	Normal	true
43	New_N_193.wav	Normal	Normal	true
44	New_N_194.wav	Normal	Normal	true
45	New_N_195.wav	Normal	Normal	true
46	New_N_196.wav	Normal	Normal	true
47	New_N_197.wav	Normal	Normal	true
48	New_N_198.wav	Normal	Normal	true
49	New_N_199.wav	Normal	Normal	true
50	New_N_200.wav	Normal	Normal	true

IV. TESTING PHASE

This section explains the workings of the system used. The first step prepared is looking for samples. Samples were obtained as many as 1000 heartbeat recording files in .wav format divided into five categories from https://archive.physionet.org/ with each sample consisting of 200 files. From 1000 divided into 900 for training data and 50 files for test.

The initial stage in classification using a neural network is the labeling of each data. Labeling begins by converting the .wav file into a sine file, which is then filtered and processed using Fast Fourier Transform until an output in the form of numerical data in the file.mat table is obtained. The file contains 900 data that is divided into five categories with data division 1 - 180 for label 1, 181 - 360 for label 2, 361 - 540 for label 3, 541 - 720 for label 4 and 721 - 900 for label 5.

Fast Fourier Transform (FFT) is an algorithm used to calculate discrete Fourier Transform (Discrete Fourier Transform, DFT) quickly and efficiently. So by using this FFT algorithm, files that were difficult to process can be simplified.

After labeling, the training process continues. In the training process, the resulting correlation coefficient (R) is 0.97655 and epochs 66. The backpropagation ANN architecture used consists of the input layer, hidden layer, output layer, and output, as shown in Figure 7.

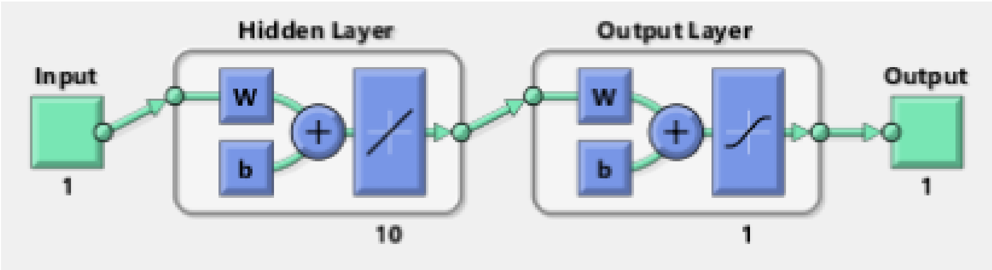

FIGURE 7.
Backpropagation ANN architecture

After the training, file.mat is used to classify the program that has been made. Figure 8 is a display of a cardiac abnormality classification program based on heart sounds. The program is created using the Matlab R2015a program which to operate the first step is to enter the .wav file to be classified by clicking on the browse button then select the file with the .wav format to be tested. The file name will appear at the bottom of the browse button with the file location. After that, press the process button then the .wav sound file will be converted into a sine signal file, which will then be classified based on the waveform. The classification results in five types categories: aortic stenosis (as), mitral regurgitation (mr), mitral valve prolapse (mvp), mitral stenosis (ms), and normal. Next, the last step is to press the analyze button, and the classification results will appear in the classification box.

FIGURE 8a.
GUI classification of aortic stenosis cardiac abnormalities

FIGURE 8b.
GUI classification of mitral heart disease regurgitation

FIGURE 8c.
GUI classification of mitral stenosis

FIGURE 8d.
GUI classification of mitral valve prolapse cardiac abnormalities

FIGURE 8e.
GUI classification of normal heart

V. CONCLUSION

The application of the classification of heart disorders based on heart sounds can be applied with outstanding results with a validity of 97.7%. Epochs change in the training process does not affect the results of the training conducted. Furthermore, the more samples entered into the database, the better the system in recognizing and classifying heart disease suffered by patients.

VI. REFERENCES

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