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Convolutional Neural Network on Brain Concentration and Art of Reading the Qur'an

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Abstract

In Islam there is a belief that reading the Qur'an can increase one's concentration power in doing something. Concentration can be influenced by several factors, to be able to identify or characterize individuals, it is necessary to measure brain wave activity. Brain waves are one of the biometric properties that can be used to identify individuals based on their physical. An electroencephalogram (EEG) can be used to measure and capture brain wave activity. To be able to naturally record brain wave activity requires constant and emergent brain activity. The activities needed are in the form of giving assignments to get the thinking process and concentration needed for the Basic Cognitive Test. The object of this research is the students of the University in Yogyakarta. EEG data recording was carried out in two stages, the first stage the respondents were given 10 minutes to work on the test questions without reading the Qur'an before working on the questions, the second stage the respondents were given 10 minutes to work on the test questions by reading the Qur'an before doing the work. about. When the respondent was working on the test, the researcher recorded the EEG signal using Neurosky Mindwave Mobile 2, so that the data in the form of brain signals was obtained. The data acquisition will undergo a preprocessing process in the form of a domain transformation signal using Fast Fourier Transform (FFT). Then enter the labeling process and after that the next process will be carried out the classification process using the CNN algorithm. The results of this study showed that 10 of 30 students' concentration levels experienced an increase, with an accuracy rate of 85% and a significant F test is 0.002

Keywords: Brain, Al-Quran, EEG, FFT, CNN, Concentration

INTRODUCTION

The human brain can perform various activities, both normal and abnormal [1]. Normal conditions consist of physical conditions such as sleep, wakefulness, activity and mental conditions such as comfortable, sad, angry [2]. Abnormal conditions can occur in neurological disorders and imbalances due to the influence of drugs [3]. Brain activity affects concentration which is an important part of human life [4]. Concentration is related to the individual's effort to focus his attention on an object so that the individual can understand and understand the object he is paying attention to [5]. Good concentration is one of the factors that can bring success in the learning process which is the key when storing information or when issuing information [6]. Individuals who experience disturbances in their concentration have difficulty focusing their concentration so that they need a relaxed condition [7]. Relaxation itself is the

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return of a muscle to a resting state after experiencing a contraction or stretching or a state of low tension without strong emotions [8].

According to Dr. Al Qadhi [9] listening to the reading of the verses of the Qur'an can feel enormous psychological changes, decrease depression, sadness, peace of mind and ward off various diseases. This is in accordance with the word of Allah which means "and when the Qur'an is recited then listen carefully, and pay attention quietly so that you receive mercy" (Surah Al-A'raf 204) and "And We send down from Al-A'raf 204). The Qur'an is something that is an antidote and a mercy for those who believe" (Surah Al-Isra' 82).

A relaxed state of the brain is expected to increase concentration [10]. Based on the background, the researcher is interested in conducting research on how much influence reading the Qur'an has on increasing concentration, in this case the researcher will try to implement the Convolutional Neural Network algorithm. This study will focus on proving the case of the effect of reading the Qur'an to increase human concentration, using the NeuroSky Mindwave tool to record brain waves and combined with the CNN method for classification.

Currently, a more practical tool for measuring EEG signals has been developed, one of which is NeuroSky Mindwave. NeuroSky has developed a dry sensor system for consumer applications of EEG technology. The NeuroSky system consists of dry electrodes and an electronic circuit specially designed for dry electrodes. NeuroSky has performed a dry EEG benchmark test by comparing the EEG signal measured by the dry sensor system with the signal from the Biopac system, a well-known wet electrode EEG system widely used in medical and research applications. The EEG was simultaneously recorded by the NeuroSky system and the Biopac system. EEGs were recorded for various conditions such as when the subject was relaxed and in a meditative state, alert and in a state of mindfulness, and during blinking artifacts. The NeuroSky Mindwave tool only produces data in the form of raw data (numeric), where this data will be extracted and then classified, there are various methods in the classification process, but what this researcher will use is the Convolutional Neural Network (CNN) method.

CNN is one of the Deep Learning methods that can be used to detect and recognize an object in a digital image [11]. Deep Learning is one of the sub-fields of Machine Learning [12]. CNN's ability is recognized as the best model for solving object detection and object recognition problems [13]. In several studies Deep Learning has shown remarkable performance. This is largely influenced by its ability to learn large datasets and techniques to train deeper networks, besides that with the support of more powerful computing devices, Deep Learning has now become widely used [14]. This study deals with the human brain where EEG as a method for recording brain waves and CNN as a method for data classification.

METHODS

Based on Figure 1, the first stage is a study was conducted on supporting theories for conducting research. These supporting theories come from previous papers/journals on EEG, concentration and related books. In this second stage, data was collected using an EEG tool to the object of research with the stimulus given in the form of a trial test.

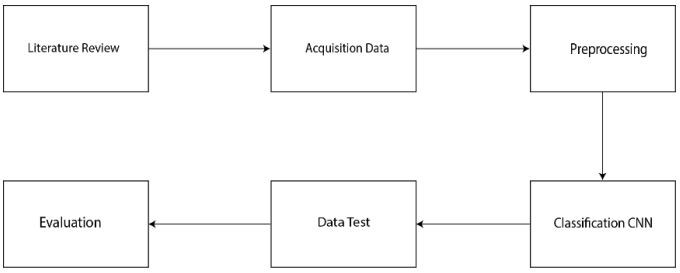

Figure 1. Research Diagram [4]

In this study, the number of respondents was 30 people with the number of taking two trials. The first trial and the second trial had a free time of 4 days, each respondent was also given 10 minutes to take the test stimulus, the first and second trials had different test stimuli. In this third stage, a preprocessing process is carried out on the data that has been taken. There is a lot of wave data recorded on the device but in this study, it only requires high beta data to be processed, after that a feature extraction process is carried out by only taking beta waves in the data and then converting the waves into FFT. In this fourth stage, a data grouping process is carried out with a classification method using the CNN algorithm. In the CNN algorithm there is a testing process, in this process there are Training data and Testing data where the comparison between the two is 70:30, In this fifth stage, a data testing process is carried out in this study, researchers use training data and test data, confusion matrix to test accuracy, and F test is used to test the relationship between one independent data and dependent data. This is an outline of the pseudocode of this research was described on Table 1.

Table 1. Pseudocode of Mind Wave Classification

Algorithm mind wave classification
Description raw_file; fft_file
Begin
1: read(raw_file)
2: DO preprocessing_beta
3: DO FFT
4: DO Labeling
5: DO CNN
6: DO Classify

In this paper, researchers carried out several stages of research, the first stage was entering brain wave data in .csv format, then connecting the system to google collab, the next process was the preprocessing stage, at this preprocessing stage the first was to select data so that only beta data would be used, beta data is data that represents the strength of concentration in a person, then beta data will be converted into an FFT signal so as to produce data with an FFT signal graph, FFT is a process of changing the time domain of the signal into a frequency domain, then the graph data is labeled with data, namely no concentration, concentration and very concentration, next is the data processing stage using CNN then data classification, CNN is one of the good classification algorithms for a study and after the classification stage is complete the data will be tested using the Confusion Matrix to test the level of accuracy and n F test to test the significance level of the system and at the end of all stages the evaluation results are obtained.

Data Acquisition

Data retrieval using the EEG method with the NeuroSky MindWave tool then given a stimulus in the form of questions in the process to the respondents. In this study, data collection was carried out 2 times with a time span of 10 days for 30 respondents who were willing to have their brain wave data taken for use in this study. Concentration can be influenced by several factors; therefore, each respondent has been prepared to undergo a pilot test by telling several factors that must be done before data collection is taken, these factors are hours of sleep, bedtime, bathing, breakfast, and stress, which can affect the concentration of respondents at when the test was carried out. The recording time took 10 minutes which resulted in 153,600 brain wave signal points. The following is the respondent's bio. The following is the respondent's bio.

The stimulus test is made to stimulate the brain to emit waves, then the resulting waves will be recorded to become data used in this study, at the stage of working on the stimulus the respondent also produces a factor that can reduce the level of concentration.

Preprocessing Data

In this study only the frequency of the beta wave is 18-30 Hz. This pre-processing stage is carried out in two steps to obtain these frequencies:

Selection Beta

Filters are carried out to separate waves with a beta frequency of 18-30 Hz. In this signal separation using a Bandpass filter with the aim of only getting beta frequencies and rejecting data on other frequencies. pseudocode can be seen in Table 2.

Table 2. Pseudocode of Selection Beta Wave

Algorithm function preprocess_beta	
Description beta_file: beta wave	
	Begin
1:	beta_file <- raw_file[‘High Beta’]
2:	end

Labeling

Based on Table 3, this process labeling serves to label each data that has been acquired, there are 3 labels "0 = not concentrated", "1 = concentration", "2 = very concentrated". On Figure 2 and 3, the graph was described about number of respondents per label.

Table 3. Pseudocode of Labeling Process

Algorithm function Labeling	
Description label_test_1: array of integer; label_test_2: array of integer	
	Begin
1:	label_test_1 <- [1,1,1,1,1,1,1,1,1,1,2,1,1,2,1,1,1,1,1,0,1,1,1,0,1,1,1,1,0]
2:	label_test_2 <- [1,2,2,2,2,1,1,2,2,1,2,2,2,1,2,1,2,1,1,2,1,1,1,1,1,1,1,2,1,1]
3:	list_label <- label_test_1
4:	list_label <- list_label + label_test_2
5:	x_train, x_test, y_train, y_test = train_test_split(list_metrics, list_label, test_size=0.33, random_state=42)
6:	return x_train, x_test, y_train, y_test
7:	end

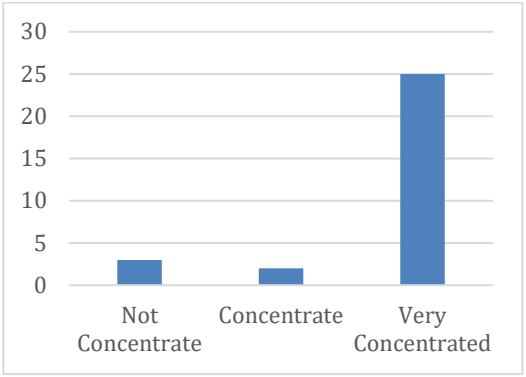

Figure 2. Labeling Test 1

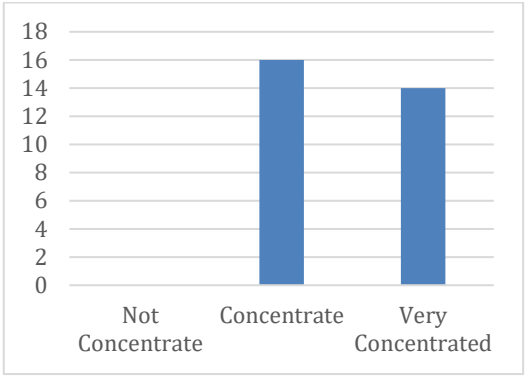

Figure 3. Labeling Test 2

Fast Fourier Transform

FFT Fast Fourier Transform (FFT) which was discovered in 1965 is the development of the Fourier Transform (FT). The inventor of FT is [15]. FT divides a signal into different frequencies in a complex exponential function. Definition Fast Fourier Transform (FFT) is a very efficient method for calculating coefficients from discrete Fourier to a finite sequence from complex data [4]. Due to the fact that more time is stored than conventional methods, the fast Fourier transform is an important application of the findings in a number of different fields such as spectrum analysis, speech and optical signal processing, digital filter design [16]. Table 4 describes the pseudocode of the FFT method.

Table 4. Pseudocode of FFT Algorithm

Algorithm function FFT (tradeoff_factor)	
Description	Description
begin	14: if(ss_cnt>1)
1: if(tradeoff_factor == 0)	15: begin
2: begin	16: for(s=0;s<ss_cnt)
3: fft(input, output, N, w[1]);	17: fft_radix2p2_stage(input+k*step+s*ss,ss,w[j++]);
4: return;	18: else
5: end	19: fft_no_last_stage(input+k*step, step, w[j:log4(step_]);
6: ss <- N/(2^(tradeoff_factor-1));	20: step <- 16;
7: step <- N;	21: end
8: j_s <- 1;	22: end
9: while(step > 4) loop	23: step <- step/4;
10: ss_cnt=step/ss;	24: j_s <- j;
11: for(k=0;k<N/step)	25: end loop
12: begin	26: last_fft_stage(input, output, step);
13: j <- js;	27: end

The FFT algorithm is based on the main principle of decomposition of discrete Fourier transform calculations from a sequence along N into a smaller successively smaller discrete Fourier transform [17]. The way this principle is applied leads to a variety of different algorithms, all of which account for an increase in computational speed. FFT is a method for transforming signals/waves in the time domain into signals in the frequency domain, meaning that the wave recording process is stored in digital form in the form of frequency-based sound spectrum waves, making it easier to analyze the recorded frequency spectrum [18].

Splitting Data

In this stage, a data collection process which consists of 30 data is carried out. Of the 30 data will be divided into two parts to serve as training data and test data. Comparison of training data and test data is 70:30. The results of the comparison are 42 Training data and 18 Testing data. Table 5 explains how to process data split.

Table 5. Pseudocode of Splitting Data

Algorithm function preprocess split data
Description x_train = int; x_test = int; y_train = int; x_test = int
begin
1: train_test_split(c, y, test_size=0.33)
2: end

Convolutional Neural Network

On this study uses the Convolutional Neural Network method (Figure 4), CNN is included in the type of deep learning because of the depth of the network. Deep learning is a branch of machine learning that can teach computers to do work like humans, just as computers can learn from the training process [19].

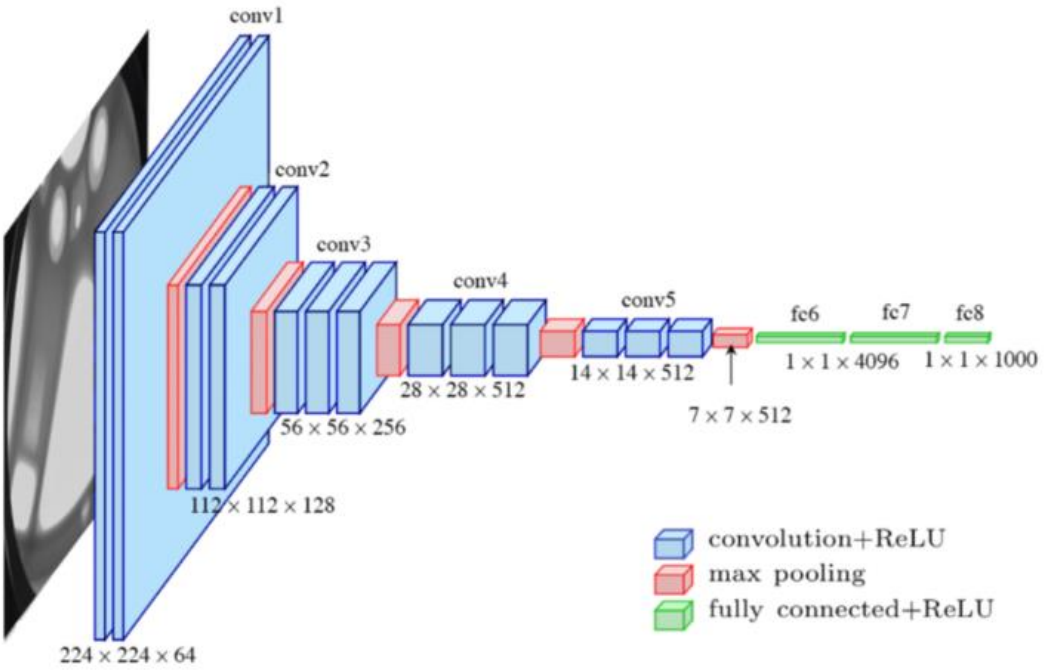

Figure 4. CNN Architecture

CNN is a convolution operation that combines several processing layers, uses several elements that operate in parallel and is inspired by a biological nervous system [20]. On CNN each neuron is presented in 2-dimensional form, so this method is suitable for processing with image input [21]. The CNN structure consists of input, feature extraction process, classification process and output. The extraction process in CNN consists of several hidden layers, namely the convolution layer, activation function (ReLU), and pooling. CNN works hierarchically, so the output in the first convolution layer is used as input in the next convolution layer. The classification process consists

of fully-connected and an activation function (softmax) which produces an output in the form of classification results [22]. Table 6 describes the CNN method pseudocode.

Table 6. Pseudocode of CNN Algorithm

Algorithm function CNN

Description model: Sequential Model

```
    begin
1:  model <- Conv2D(filters=32, kernel_size=(3,3),
2:  input_shape=list_metrics.shape[1:], activation='relu')
3:  model <- MaxPooling2D(pool_size = (2, 2))
4:  model <- Conv2D(32, (3, 3), activation = 'relu')
5:  model <- MaxPooling2D(pool_size = (2, 2))
6:  model <- Flatten()
7:  model <- Dense(units = 128, activation = 'relu')
8:  model <- Dense(units = 3, activation = 'softmax')
9:  model.compile(optimizer=Adam(learning_rate=0.000001)

10: loss=SparseCategoricalCrossentropy(from_logits=True),
11: metrics=[SparseCategoricalAccuracy()])

12: model <- fit(x_train, y_train, batch_size=32, epochs=500, verbose=1,
13: validation_data=(x_test, y_test))
14: end
```

Evaluation

Test

Simultaneous test is used to determine whether all independent variables included in the regression model have a simultaneous (simultaneous) effect on the dependent variable. The F test can be done by comparing the calculated F with table F: F Table in Excel, if F count > from F table, (Ho is rejected, Ha is accepted) then the model is significant or can be seen in the significance column on ANOVA (Processed with SPSS, Use Test Regression with Enter/Full Model Method). The model is significant as long as the significance column (%) < Alpha (readiness to err type 1, which determines the researcher himself, social science is usually at most alpha 10%, or 5% or 1%). And conversely if F count < F table, then the model is not significant, it is also indicated that the value of the significance column (%) will be greater than alpha.

Confusion Matrix

Pay attention to Table 7, calculation of the level of accuracy is the last stage in this research process. The testing phase in this study uses the Confusion Matrix. Confusion Matrix is a method that is usually used to calculate the accuracy of the methods used in the classification process [4].

Table 7. Confusion Matrix [4]

		True Values	
		True	False
Prediction	True	TP	FP
	False	FN	TN

a. TP is True Positive, is the number of positive data correctly classified by the system.
b. TN is True Negative, is the number of negative data correctly classified by the system.
c. FN is False Negative, is the number of negative data but classified incorrectly by the system.
d. FP is False Positive, is the number of positive data but classified incorrectly by the system.

Based on the values, it can produce accuracy, precision and recall values. The formulas for calculating the value can be explained as follows:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (1)$$

RESULT AND DISCUSSIONS

On this study, data collection was carried out 2 times with a time span of 10 days for 30 respondents who were willing to have their brain wave data taken for use in this study. Concentration can be influenced by several factors, therefore each respondent has been prepared to undergo a pilot test by telling several factors that must be done before data collection is taken, these factors are hours of sleep, bedtime, bathing, breakfast, and stress, which can affect the concentration of respondents at when the test was carried out. The recording time took 10 minutes which resulted in 153,600 brain wave signal points. The following is the respondent's bio. Here is the respondent's bio.

Preprocessing

FFT (Fast Fourier Transform) is a method for transforming signals/waves in the time domain into signals in the frequency domain, meaning that the sound/wave recording process is stored in digital form in the form of frequency-based sound spectrum waves so that it is easier to analyze the recorded sound frequency spectrum. FFT visualization can be seen in Figure 5.

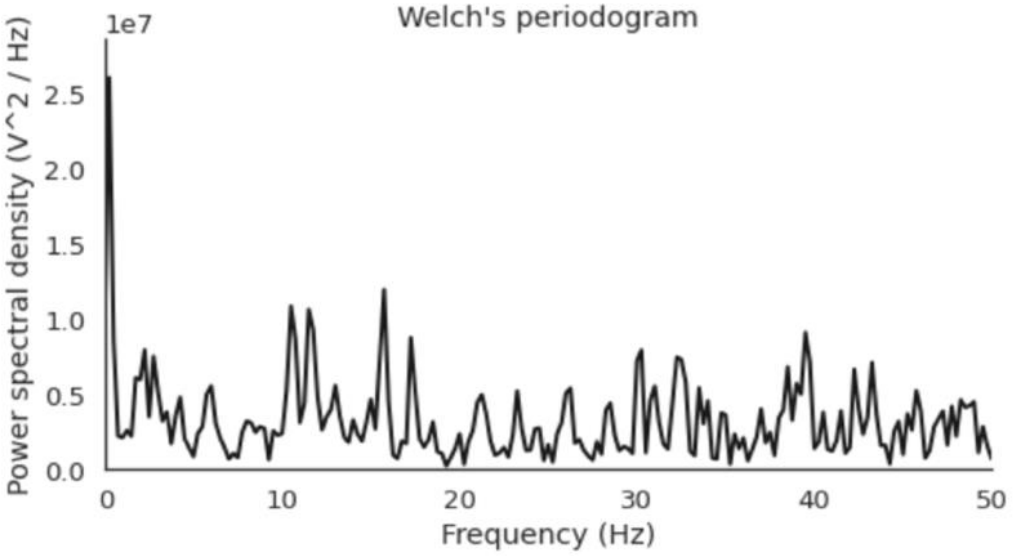

Fig 5. Spectrum Waves

Classification CNN

The template is designed so that author affiliations are not repeated each time for multiple authors of the same affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization). This template was designed for two affiliations. Table 8 describes the detailed summary of the CNN architecture used in this study.

Table 8. Detail of Summary CNN Architecture

Layer	Type	Filters	Kernel	Output Shape	Parameter
0	Input	1	3x3	(254,254,1)	0
1	Convolutional (Conv2D)	32	3x3	(254,254,32)	320
2	Convolutional (Conv2D)	32	3x3	(127,127,32)	0
3	Convolutional (Conv2D)	32	3x3	(125,125,32)	9248
4	Convolutional (Conv2D)	32	3x3	(62,62,32)	0
5	Flatten			123008	0
6	Dense			128	15745152
7	Dense_1			3	387
	Total				15,755,107

The results of the convolution carried out, along with the explanation, on the display looks like a table where at the top is the table name, there are three tables with the names Layer (type), Output Shape, Parameters.

a. In the conv2d layer, the first input is (254, 254, 32) where 254*254 is the first input pixel size and 32 is the convolution filter, in this process it produces 320 parameters.
b. Max_pooling2d, this process produces an output shape with values (127, 127, 32)
c. Conv_1, this is the second process of convolution so that the output shape (125, 125, 32) is obtained with the number of parameters 9248.
d. Max_pooling2d_1 is the pooling process of the second convolution so that it gets the output shape value (62, 62, 32).
e. Flatten, in this process is the change from 2-dimensional matrix to 1-dimensional the result of the output shape 123008 is obtained from the last maxpooling product, which is 62*62*32 = 123008.
f. Dense, is a process in which the hidden layer 128 neurons produce parameters 15745152.
g. Dense_1, is the final process, namely the output of 3 neurons which is used as a category in this study, in this process it produces 387 parameters.
h. The total parameter is 15.755.107 and the trainable parameter is 15.755.107, the number is obtained from the sum of the parameters for each CNN process.

Splitting Data

Training Data and Test Data.

The comparison between training data and testing data is 70: 30, where 70% of the data will be training data that can build weights on the optimal artificial neural network. The results of the training data obtained an accuracy of 89% and the results of the test data obtained an accuracy of 75%. Figure 6 describes the accuracy of the CNN method on the data used. The best epoch at Epoch = 200 with an accuracy value of almost 99%.

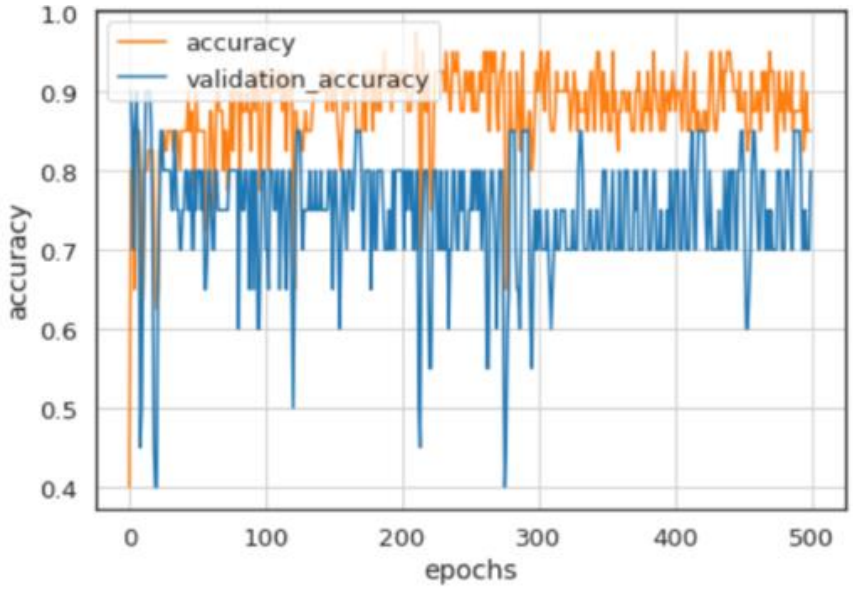

Fig 6. Accuracy Value

Confusion Matrix

The result of the process obtained in the evaluation process (confusion matrix) is 85%, where this number is a good score in the level of accuracy. Table 9 explains the details regarding the results of the Confusion Matrix on the labeling results generated by CNN on the Test Data

Table 9. Confusion Matrix

	Not Concentrate	Concentrate	Very Concentrate
Not Concentrate	3	2	1
Concentrate	0	32	4
Very Concentrate	0	8	10

It can be seen from the picture that there is an array with three 2*2 matrices, the first matrix is a matrix that describes the very concentrated category, the second matrix describes the concentration category, and the third matrix describes the non-concentration category, in the confusion matrix accuracy test there is a formula, so that the results can be concluded that the accuracy test used in this program produces a percentage rate of 85%.

Test F

The F test is a test to see how the influence of all independent variables together on the dependent variable [23]. In this study, the average of the beta waves for each respondent at the time of the first test, namely without reading the Qur'an, then is the average of the beta waves for each respondent at the time of the second test, namely by reading the Qur'an. The results of the F-Test using SPSS can be seen in Table 10.

Table 10. Result F-Test with SPSS

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.870	2	3.435	8.210	.002[b]
	Residual	11.297	27	.418		
	Total	18.167	29			

a. Dependent Variable: Y
b. Predictors: (Constant), X2, X1

The results of the linear regression analysis of the F test in the significant table are 0.002 where this number is a good score in the F test results, which means that the relationship or influence between the independent variable and the dependent variable is significant.

CONCLUSIONS

The conclusion obtained based on the results of this study is that CNN is a method that can produce good performance for classification, the amount of data obtained from this study has met the minimum dataset requirements of 30 data, but there is a drawback that the sample population is too wide. using the Confusion Matrix in this study was 85%. The level of significance carried out using the F test is 0.2%. There was an increase in concentration during the trial by reading the Qur'an compared to not reading the Qur'an, namely 10 out of 30 people proved to have increased.

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