

An Advanced Facial Expression Recognition System Using Novel Machine Learning Approach by Comparing CNN over LeNet

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Abstract

Aim: The primary goal of this study is to compare Convolutional Neural Networks (CNN) and LeNet for classification of facial emotion recognition with improved accuracy.

Materials and Methods: The data of the facial expressions is taken from the FER2013 available on kaggle. The Convolutional neural network (CNN) is the algorithm most popular way of analyzing images with best accuracy and LeNet is also an algorithm used here to compare the accuracy of Novel image classification.

Results: The Convolution neural network (CNN) produces 82.14% accuracy in predicting facial expressions on the dataset, whereas LeNet produces 77.54% accuracy. Convolutional neural network (CNN) is better than LeNet. With ($p < 0.05$), there is a statistically significant difference between the research groups.

Conclusion: Convolutional Neural Network provides better outcomes in accuracy rate when compared to LeNet for predicting facial expressions.

Keywords: Facial Expression Recognition, Convolutional Neural Network, LeNet, Novel Image Classification, Machine Learning, Intelligent processing.

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INTRODUCTION

Human behaviour information is primarily communicated by voice, expression, movement, language, etc., and human emotions are primarily depicted through facial expressions. (Young 2016). Facial expression recognition computer vision classification technology can obtain the person data of emotion through the expression of the person to judge the state and intention of the person. (Elaiwat 2015) Facial emotion recognition is a technology used for analyzing sentiments with the aid of using exceptional sources, together with photos and videos (Miao 2018). It belongs to the circle of relatives of technology frequently mentioned as affective computing, a multidisciplinary area of studies on computer abilities to understand and interpret human feelings and emotions and it frequently builds on artificial intelligent processing technology (Fridlund 2014). The Applications of Facial Expression Recognition (FER) can be broadly utilized to more than a few lookup areas, such as mental diseases diagnosis and human social interaction detection. Facial expressions play an essential function in reputation of feelings and are used within the system of nonverbal communication. (Ravi, Yadhukrishna, and Prithviraj 2020) Just as you listen to your mother's sure tone of voice- yes, that voice you could quickly imply a person's emotion through their facial expressions. This allows us to describe a person's emotional state. Facial expressions help us in ascertaining a person's emotions and body of mind.

There are around 163 related papers in IEEE Xplore 70 and similar publications on Google Scholar. A neural network algorithm is used widely to improve the recognition of facial expressions in various intelligent processing techniques. (AIMarri 2019) A system's performance is measured in terms of accuracy and results reveal that it has the potential for forecasting the expression of face more accurately in CNN.

Our institution is passionate about high quality evidence based research and has excelled in various fields (Parakh et al. 2020; Pham et al. 2021; Perumal, Antony, and Muthuramalingam 2021; Sathiyamoorthi et al. 2021; Devarajan et al. 2021; Dhanraj and Rajeshkumar 2021; Uganya, Radhika, and Vijayaraj 2021; Tesfaye Jule et al.

2021; Nandhini, Ezhilarasan, and Rajeshkumar 2020; Kamath et al. 2020). Several works demonstrate that performance of the LeNet algorithm is poor and provide less accuracy in predicting facial expression (Brownlee 2019). A study compares the accuracy of various neural network algorithms to provide better accuracy. (Wang and Gong 2019) Thus, this paper compares the effectiveness of the Novel Systematic and developed CNN, ResNet, AlexNet, GoogLeNet, and LeNet algorithms in the identification of face expressions. (Khopkar 2021).

MATERIALS AND METHODS

The research work was carried out at the Image Processing Lab, Department of Computer Science and Engineering, Saveetha School of Engineering, SIMATS. A total of 1001 records from the FER2013 dataset were used in this study. The accuracy of face expression recognition was tested using two groups. To improve accuracy, each group was subjected to a total of 10 iterations. The Kaggle website was used to obtain the dataset. There are 1001 rows and 17 columns in the dataset.

Using G power, a sample size of 188 was calculated for each Group. In facial expression recognition there should be some null values and missing values remove the null and missing values. Clinical analysis was used to determine sample size, with alpha and beta values of 0.05 and 0.2, pretest power of 80%, and enrollment ratio 1.

The two algorithms of convolutional neural network have both definitions. Convolutional neural networks are mostly utilised for novel picture categorization, intelligent processing segmentation, as well as other autocorrelated data. In essence, a convolution is a filter being slid over the input. The LeNet architecture comprises of two sets of convolutional and average pooling layers, a flattening convolutional layer, two full-connected layers, and a softmax classifier.

Convolutional neural network (CNN)-Group 1

Inputs: FER2013 Dataset

Output: Selected features and Accuracy.

1. Load the dataset.
2. Remove the null values in a dataset
3. Divide a dataset into a training dataset (80%) and a testing dataset (20%) at random.
4. Decide on a target variable.
5. Train the model in a dataset.
6. Make a prediction about the testing set using the training dataset.
7. Analyze the model.
8. Accuracy of Return

A controlled machine learning algorithm that can be used to image processing problems is the convolutional neural network. In this study, a Convolutional neural network of Tarfile library was used. Import an FER2013 data.csv dataset and load the dataset. The dataset is randomly divided into training (80%) and testing (20%). It chooses a target variable.

Then the

Convolutional neural network based on an Intelligent processing training dataset is generated. Based on a training set, a testing set is projected. Accuracy is measured and evaluated for the Convolutional neural network.

Convolutional neural networks, one of the best types of neural networks with one or more convolutional layers, are frequently employed in real-world applications for intelligent processing and are mostly used for new image processing. (Brownlee 2019).

LeNet-Group 2

Inputs : FER2013 Dataset

Output : Accuracy

1. Import the data and read it.
2. Features from the dataset are chosen at random.
3. Remove the null values
4. Set the target variable
5. Train the model in a dataset
6. Based on a training dataset, predict the testing set.

7. Analyze the model.
8. Accuracy of Return.

In this study (Soyel and Demirel 2008) LeNet of a Tarfile library was used. A dataset is randomly divided into training (80%) and testing (20%). It chooses samples at random, collecting the LeNet for each sample to forecast the outcome.

A planned project was tested in the Google Collaboratory. A Intel i7 processor, 512GB SSD, 8 GB RAM, Windows OS, Python: colab are the hardware and software prerequisites for experimenting with the task.

A data set was first split into two sections: the training set and the test set. The algorithm is then put to the test using the training and test sets. Depending on the size of the test set, the training and test sets are switched 10 times. Table 1 compares the precision of CNN and LeNet over a period of 10 iterations. The following formulas can be used to determine various analytical parameters:

Accuracy :- The number of cases that were correctly categorized is indicated by the following equation 1.

$$\text{Accuracy} = \frac{\text{True positive} + \text{True Negative}}{\text{True Positive} + \text{True Negative} + \text{False Positive} + \text{False Negative}} \quad (1)$$

Statistical Analysis

The work was statistically examined in addition to an experimental analysis utilizing the statistical package for social sciences (SPSS). The mean, standard deviation, and mean standard error were calculated during the analysis. To compare parameters between two groups, an independent variable T test was used. Facial, face shape, and gender are independent factors in the analysis. The precision of a dependent variable has an impact on the result.

RESULTS

Table 1 depicts the various parameters of both groups. For CNN and LeNet, table 2 contains the accuracy, mean, standard deviation, and standard error mean. CNN is more accurate than LeNet, according to a comparison of the two groups. With various test datasets, Table 3 displays statistical analysis of CNN and LeNet. In comparison to the LeNet model, a CNN model appears to have a greater mean accuracy. The performance of a CNN algorithm is superior to a LeNet algorithm. The two groups don't significantly differ from one another. Hence CNN is better than LeNet. In Fig. 1, a statistical comparison of two separate groups reveals that CNN is more accurate than LeNet. LeNet's mean is slightly lower than CNN's.

DISCUSSION

The works prove that Convolutional neural network (CNN) is better than LeNet in recognition of face expression in terms of accuracy. Recognition of face expressions is a major issue in the real Novel image classification sector. Experimental work was done on two groups CNN and LeNet by varying a test size (Song 2021). From an experimental analysis done in colab, the accuracy of CNN is 82.14% whereas LeNet provides an accuracy of 77.54%. This shows that CNN is better than LeNet. From a SPSS graph, a proposed (Jeon et al. 2021) Convolutional neural network offers better performance in terms of accuracy (82.14%) and accuracy (78.01%) compared to a LeNet algorithm.

Accuracy is the most crucial factor in facial expression recognition prediction. In a study a machine learning based algorithm (Mahrishi et al. 2020) for facial expression recognition by using the FER2013 dataset was proposed. (Mohseni et al. 2015) A study used popular machine learning algorithms, a dataset FER2013 used libraries are Tarfile, os, numpy as np, pandas as pd, tensorflow as tf, from matplotlib import pyplot and sklearn. Based on the subject's facial expression in the FER2013 dataset, the photos are classified as showing expressions of anger, disgust, fear, happiness, sadness, surprise, and neutrality.

In a study the author used different databases of caltech faces, the CMU database and NIST database to compare with each other to find the accuracy and the NIST database got the highest accuracy with (96%) and other databases got the least accuracy. (Yang and Yin 2017) In our study we used the FER2013 database. It includes

more images and it is the latest dataset and it has labeled images with their person's expressions and it gives more accuracy when compared with other databases.

The quantity of the training and test data sets affects how accurate the CNN algorithm is. In our study, the accuracy seems to be superior to the LeNet algorithm. (Arabian et al. 2021) Our proposed work appears to have a higher mean error, which needs to be reduced. (Miao 2018) There are certain limitations to the work even though experimental and statistical analysis produce superior study outcomes. (Kumar et al. 2021) On larger data sets, accuracy assessment is unable to produce a more favorable outcome. (Wu et al. 2021). In addition, in CNN, the average error seems to be greater than LeNet. A large reduction in the average error would be preferable. However, work can be improved by applying neural network algorithm techniques, to achieve better accuracy and lower mean error. (Miao 2018) Feature selection algorithms can be used prior to classification to improve the accuracy of a classification of classifiers. Thus, with the feature selection algorithms, (Kumar et al. 2021) It can reduce the computation time and improve the recognition accuracy.

CONCLUSION

Convolutional neural network is an algorithm that is used to improve the accuracy. The work shows that Accuracy of facial expression recognition using Convolutional neural network (CNN) is better than LeNet algorithm. It is found that CNN performs significantly better than LeNet in recognizing facial expression accurately, but the mean error is found to be little higher than LeNet. Hence, it is concluded that CNN algorithm results in acceptable accuracy than LeNet.

DECLARATIONS

Conflict of interest

No conflict of interest in this manuscript

Author Contributions

Author TEP was involved in data collection, data analysis, algorithm framing, implementation and manuscript writing. Author RPL was involved in designing a workflow, guidance and review of manuscript.

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TABLES AND FIGURES

Table 1. Accuracy achieved during evaluation of Facial expression recognition using a test dataset with Convolutional neural network (CNN) and LeNet for different iterations.

Iterations	Accuracy	
	CNN	LeNet
S.no		
1	82.14	77.54
2	82.07	77.52

3	81.98	77.51
4	81.88	77.49
5	81.76	77.47
6	81.53	77.44
7	81.34	77.43
8	81.12	77.41
9	81.02	77.39
10	81.00	77.38

Table 2. The accuracy, mean, standard deviation, and standard error mean for CNN as determined by experimental analysis in Colab are higher (82.14%) than those for LeNet.

	Groups	N	Mean	Std.Deviation	Std.Error mean
Accuracy	CNN	10	81.5840	.44192	.13975
Accuracy	LeNet	10	77.4580	.05633	.01781

Table 3. Statistical analysis of mean, standard deviation and standard error of precision and accuracy of CNN and LeNet algorithms. There is a statistically significant difference in accuracy values between algorithms. CNN had the highest accuracy (82.14%) and LeNet had the lowest accuracy (77.54%). There is a statistically significant difference between the study groups with ($p < 0.05$).

		Levene's test for Equality of Variances		T-test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence interval of the difference	
									Lower	Upper
Accuracy	Equal variances assumed	33.035	.001	29.288	18	.001	4.12600	.14088	3.83003	4.42197
	Equal variances not assumed			29.288	9.292	.001	4.12600	.14088	3.80883	4.44317

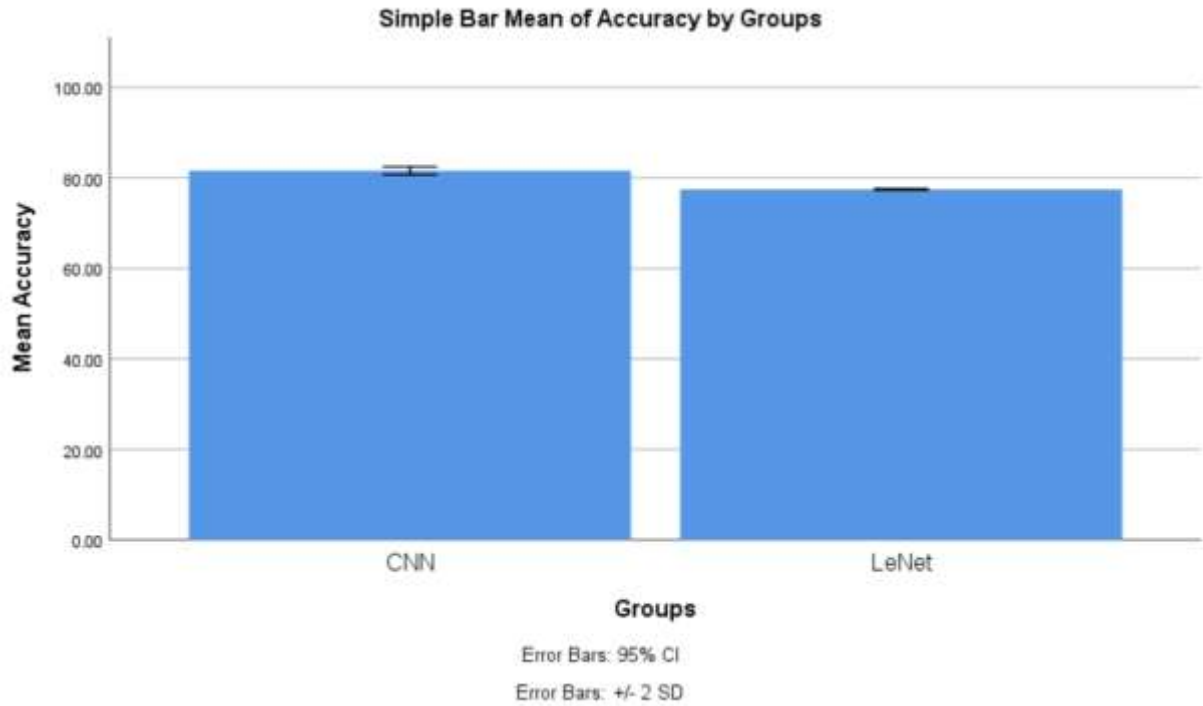


Fig. 1. Bar Chart representing the comparison of Mean Accuracy of CNN and LeNet algorithms. Mean accuracy of CNN is 82.14% appears to be better than LeNet which is 77.54%. The X-axis represents CNN and LeNet algorithms and the Y-axis represents the mean accuracy ± 2 SD.