Project 20 Report

Automated Facial Expression Recognition using ANN&CNN.

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1. Introduction and Overview

Early in the 1990s, Picard predicted that Affective Computing would be an important direction for future artificial intelligence research [1]. In 1971, the American

psychologist Ekman and Friesen defined seven categories of basic facial expression, which are Happy, Sad, Angry, Fear, Surprise, Disgust and Neutral [2]. In 1991, A. Pentland and K. Mase held the first attempt to use optical flow method to determine the direction of movement of facial muscles. Then, they extracted the feature vectors to achieve four kinds of automatic expression recognition including Happy, Angry, Disgust, Surprise and got nearly 80% accuracy [3].

In 2006, Hinton and Salakhutdinov published an article in "Science" [5], opening the door to a deep learning era. Hinton suggested that the neural network with multiple hidden layers had good ability for learning characteristics. It can improve the accuracy of prediction and classification by obtaining different degrees of abstract representation of the original data. So far, the deep learning algorithm has achieved good performance in speech recognition, collaborative filtering, handwriting recognition, computer vision and many other fields [4].

The concept of Convolutional Neural Network (CNN) was presented by Yann LeCun et al. in [7] in the 1980s, where a neural network architecture was composed of two kinds of basic layers, respectively called convolutional layers (C layers) and subsampling layers (S layers). However, many years after that, there was still not a major breakthrough of CNN. One of the main reasons was that CNN could not get ideal results on large size images. But it was changed when Hinton and his students used a deeper Convolutional Neural Network to reach the optimal results in the world on ImageNet in 2012. Since then, more attention has been paid on CNN based image recognition.

In this paper, we present a method to achieve facial expression recognition based on a deep CNN. Firstly we implement face detection by using Haar-like features and histogram equalization. Then we construct a four-layer CNN architecture, including two convolutional layers and two subsampling layers (C-S-C-S). Finally, a Softmax classifier is used for multi-classification.

The structure of the paper is as follows: Section 2 introduces the whole system based on CNN, including the input module, the image pre-processing module, the recognition algorithm module and the output module. In Section 3, we simulate and evaluate the recognition performance of the proposed system under the influence of different factors such as network structure, learning rate and pre-processing. Finally, a conclusion is drawn.

- A Literature Review of Academic publications relevant to the problem

Abstract

Objectives: This literature review is aiming to explore the use Artificial Neural Network (ANN) techniques in the field of stock market prediction. Design: Content analysis research technique. Data sources: Information

retrieved from ProQuest electronic databases. Review methods: Utilizing key terms and phrases associated with Artificial Neural Network Stock Market Prediction from 2013-2018. Out of the 129 scholarly journal reviewed, there are 4 stock market studies met the inclusion criteria. The analysis and the evaluation includes 6 ANN derivatives techniques used to predict. Results: Findings from the reviewed studies revealed that all studies shows consistency that the accuracy rate of ANN stock market prediction is high. 2 Studies shows accuracy above 90%, 2 studies shows accuracy above 50%. Conclusion: This study reveals that the ability of ANN shows consistency of an accuracy rate of stock market prediction. Four method in predicting stock market had an accuracy above 95%. The highest accuracy achieved by using Signal Processing/Gaussian Zero-Phase Filter (GZ-Filter) with 98.7% prediction accuracy

Facial expression recognition, which many researchers have put much effort in, is an important portion of affective computing and artificial intelligence. However, human facial expressions change so subtly that recognition accuracy of most traditional approaches largely depend on feature extraction. Meanwhile, deep learning is a hot research topic in the field of machine learning recently, which intends to simulate the organizational structure of human brain's nerve and combine low-level features to form a more abstract level. In this paper, we employ a deep convolutional neural network (CNN)OR(ANN) to devise a facial expression recognition system, which is capable to discover deeper feature representation of facial expression to achieve automatic recognition. The proposed system is composed of the Input Module, the Pre-processing Module, the Recognition Module and the Output Module. We introduce both the Facial Expression Database(fer2013) to simulate and evaluate the recognition performance under the influence of different factors (network structure, learning rate and pre-processing).) algorithm compared with CNN to make the results more convincing. The accuracy performance of the proposed system reaches 38%% and 50% OR 60% in the ANN and accuracy 48% and 92% in CNN, respectively, which demonstrates feasibility and effectiveness of our system

Review of Literature

An Artificial Neural Network (ANN) is a massively parallel-distributed-information-processing system that has certain performance characteristics resembling biological neural network of human brain. In application of ANN to

reservoir operation, preparation of train and test data is the first step. Initial storage, inflow forms input data whereas optimal release of reservoir forms output layer of ANN model. Dynamic programming model will be used for optimum operation policy of a reservoir and then simulation model presents the optimum monthly release of the reservoir over a considerable long period. Out of these data some represents train data and some represents test data of ANN model. Finally the structure of an ANN model will be constructed defining 1) the number of hidden layers and neurons in each layer, 2) selection of transformation function‟s type. Lastly supposing the method for acquiring optimum weight of the nodes, the final network will be implemented by trial and error. Performance of a network is usually evaluated by some parameters such as 1) RMSE (root mean square error); 2) R-(correlation coefficient); 3) e-(relative error). All these parameters should be evaluated for both training and testing sets.

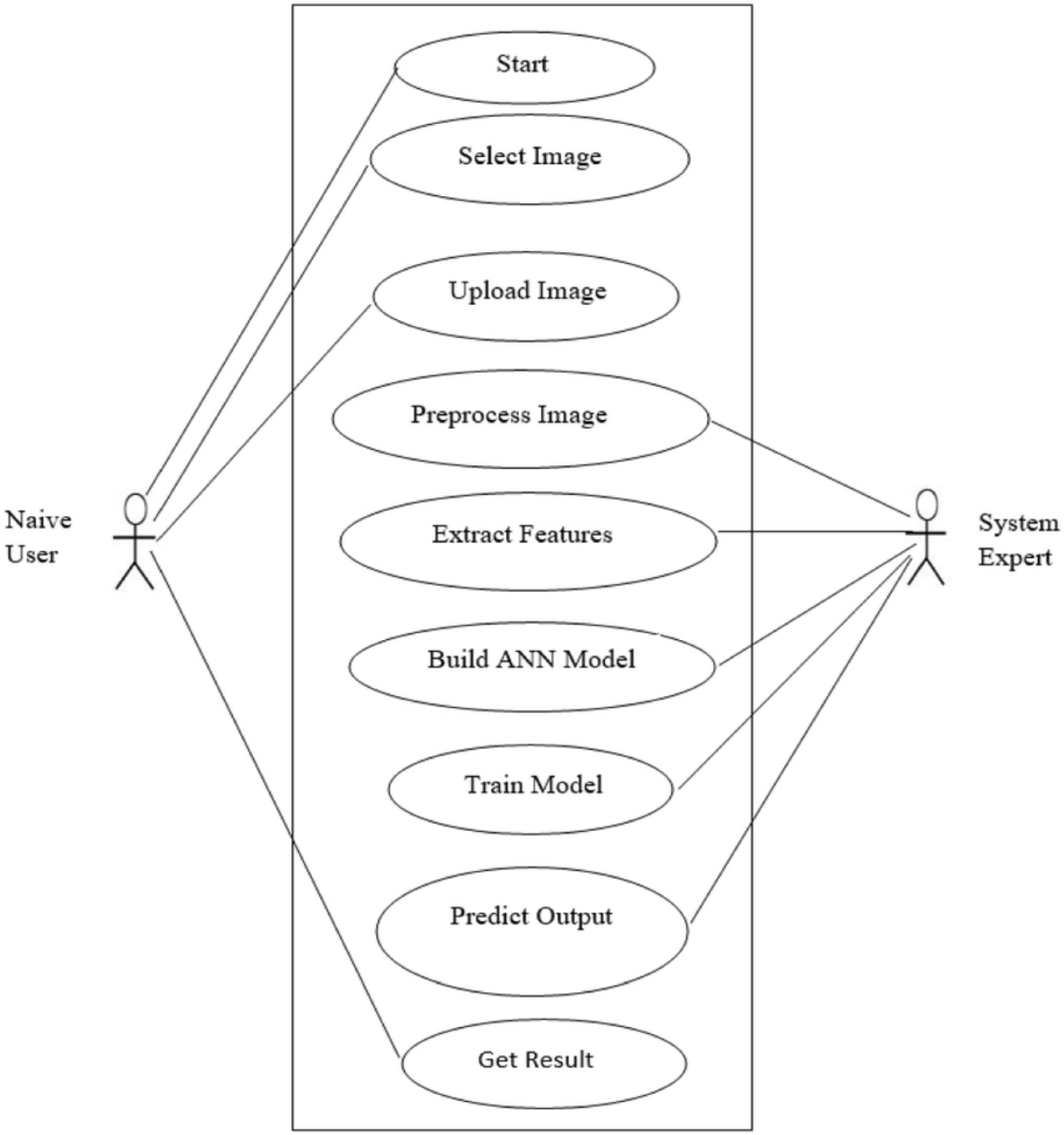
Reference

[1] Essa, I.A.; Pentland, A.P., Facial expression recognition using a dynamic model and motion energy, Fifth International Conference on Computer Vision, 1995. Page(s): 360 –367 [2] Essa, I.A.; Pentland, A.P., Coding, analysis, interpretation, and recognition of facial expressions, IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume:19,Issue:7,July 1997, Page(s): 757 – 763 [3] Yoneyama, M.; Ohtake, A.; Iwano, Y.; Shirai, K., Facial expressions recognition using discrete Hopfield neural networks, Proceedings., International Conference 6 on Image Processing, 1997. Volume: 1, 1997 Page(s): 117 –120 [4] Pantic, M.; Rothkrantz, L.J.M., An expert system for multiple emotional classification of facial expressions, Proceedings, 11th IEEE International Conference on Tools with Artificial Intelligence, 1999, Page(s): 113 – 120 [5] Jyh-Yeong Chang; Jia-Lin Chen, A facial expression recognition system using neural networks, IJCNN '99. International Joint Conference on Neural Networks, 1999, Volume:5, 1999 Page(s): 3511 –3516 [6] Lien, J.J.; Kanade, T.; Cohn, J.F.; Ching-Chung Li, Automated facial expression recognition based on FACS action units, Proceedings, Third IEEE International Conference on Automatic Face and Gesture Recognition, 1998. Page(s): 390 –395 [7] Kobayashi, H.; Hara, F., Recognition of Six basic facial expression and their strength by neural network, Proceedings, IEEE International Workshop on Robot and Human Communication,1992, Page(s): 381 – 386 [8] Ding, J.; Shimaniura, M.; Kobayashi, H.; Nakamura, T. Neural Network Structures For Expression Recognition, IJCNN '93-Nagoya. Proceedings of 1993 International Joint Conference on Neural Networks,1993.,Volume:2 , Page(s): 1430 –1433 [9] Ira Cohen, Nicu Sebe, Larry Chen, Ashutosh Garg, Thomas S. Huang , Facial Expression Recognition from Video Sequences: Temporal and Static Modelling, Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign [10] Rosenblum, M.; Yacoob, Y.; Davis, L.S., Human expression recognition from motion using a radial basis function network architecture, IEEE Transactions on Neural Networks, Volume: 7 Issue: 5, Sept. 1996, Page(s): 1121 –1138 [11] Iwano, Y.; Yoneyama, M.; Shirai, K. , Recognition of facial expressions using associative memory , Proceedings, IEEE Digital Signal Processing Workshop 1996., Page(s): 243 -246 [12] M.-K. Hu, “Visual pattern Recognition by moment invariants”, IRE Trans. Information Theory, vol IT-8, pp 179-187, Feb 1962. [13] P.Ekman and W.V. Friesen, Facial Action Coding System, Palo Alto, Calif.: Consulting Psychologists Press Inc., 1978. [14] Zhengyou Zhang; Lyons, M.; Schuster, M.; Akamatsu, S., Comparison between geometry-based and Gabor-wavelets-based facial expression recognition using multi-layer perceptron, Proceedings. Third IEEE International Conference on Automatic Face and Gesture Recognition, 1998, Page(s): 454 –459. [15] JAFFE database: http://www.mic.atr.co.jp/~mlyons/jaffe_temp.html, The paper which describes the database: Michael J. Lyons, Shigeru Akamatsu, Miyuki Kamachi & Jiro Gyoba, Coding Facial Expressions with Gabor Wavelets, Proceedings,Third IEEE International Conference on Automatic Face and Gesture Recognition,April 14-16 1998, Nara Japan, IEEE

Computer Society, pp. 200-205. [16] Chenyang Xu and Jerry L. Prince , Snakes, Shapes, and Gradient Vector Flow ,Image Analysis and Communications Laboratory ,Department of Electrical and Computer Engineering ,The Johns Hopkins University ,Baltimore, MD.

2. Proposed Solution & Dataset

- Main functionalities/features *(from the users' perspective).*



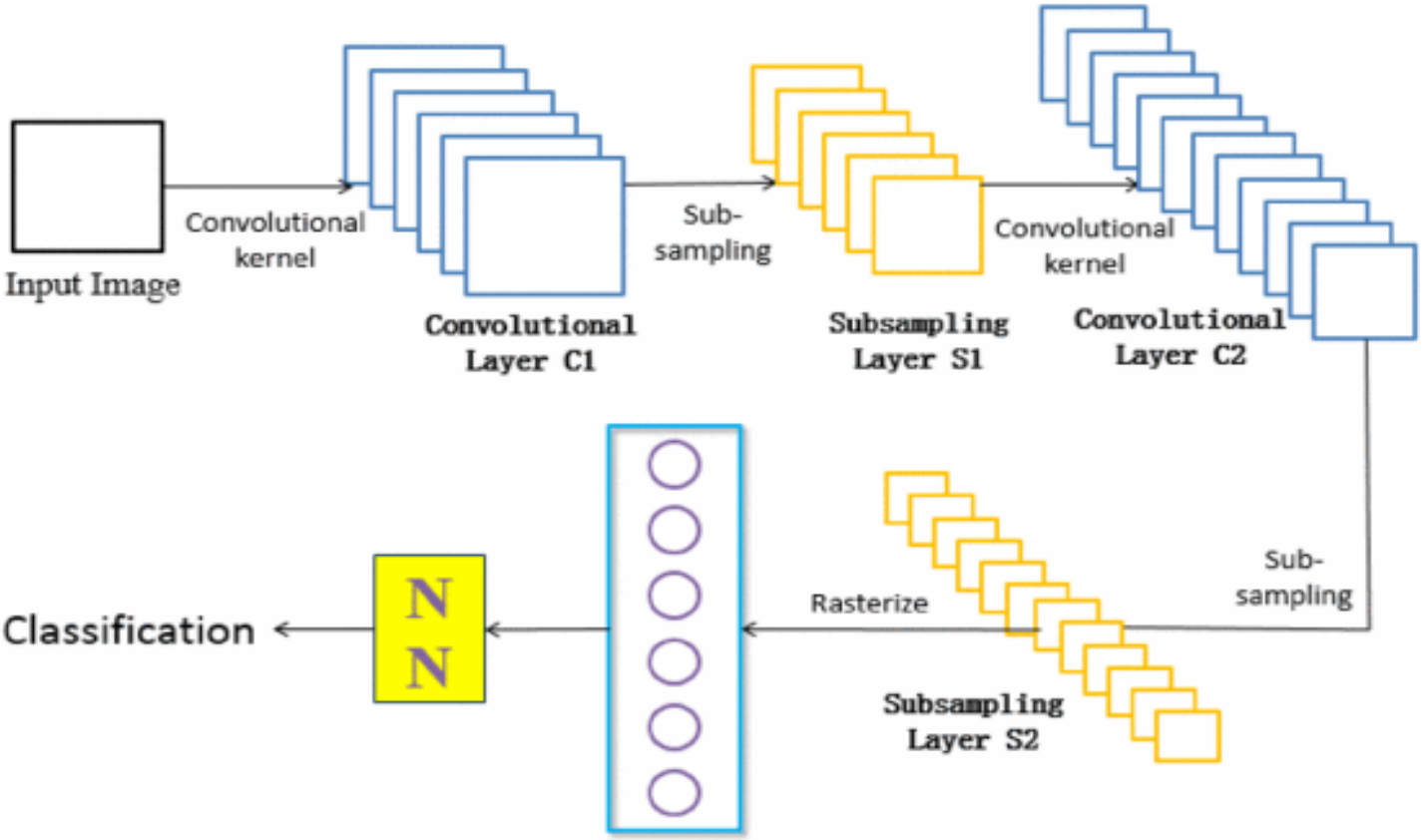
- The Dataset employed is including digital images for 7 expression, containing 28,709 images for training the model and 7,178 images for testing the model.

Dataset Link: https://www.kaggle.com/msambare/fer2013

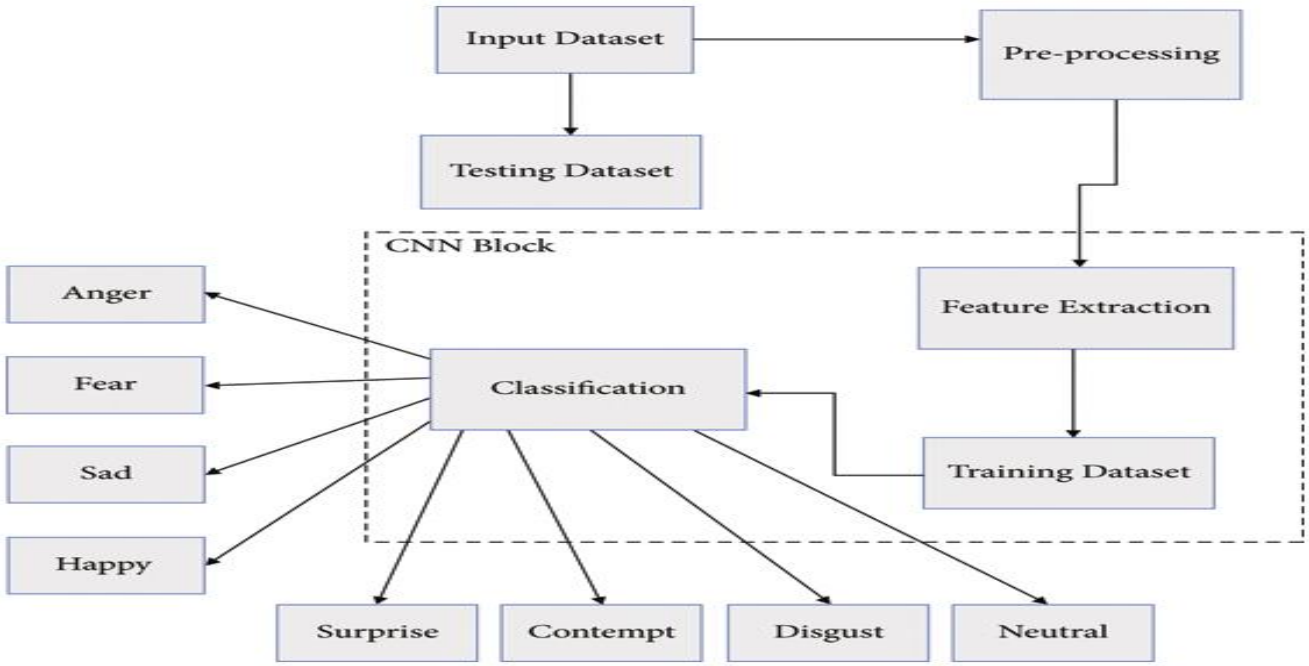
3. Applied Algorithms

- All the details of the AI/Machine-Learning algorithm(s)/Deep-Learning/approach(es) used to develop the project.

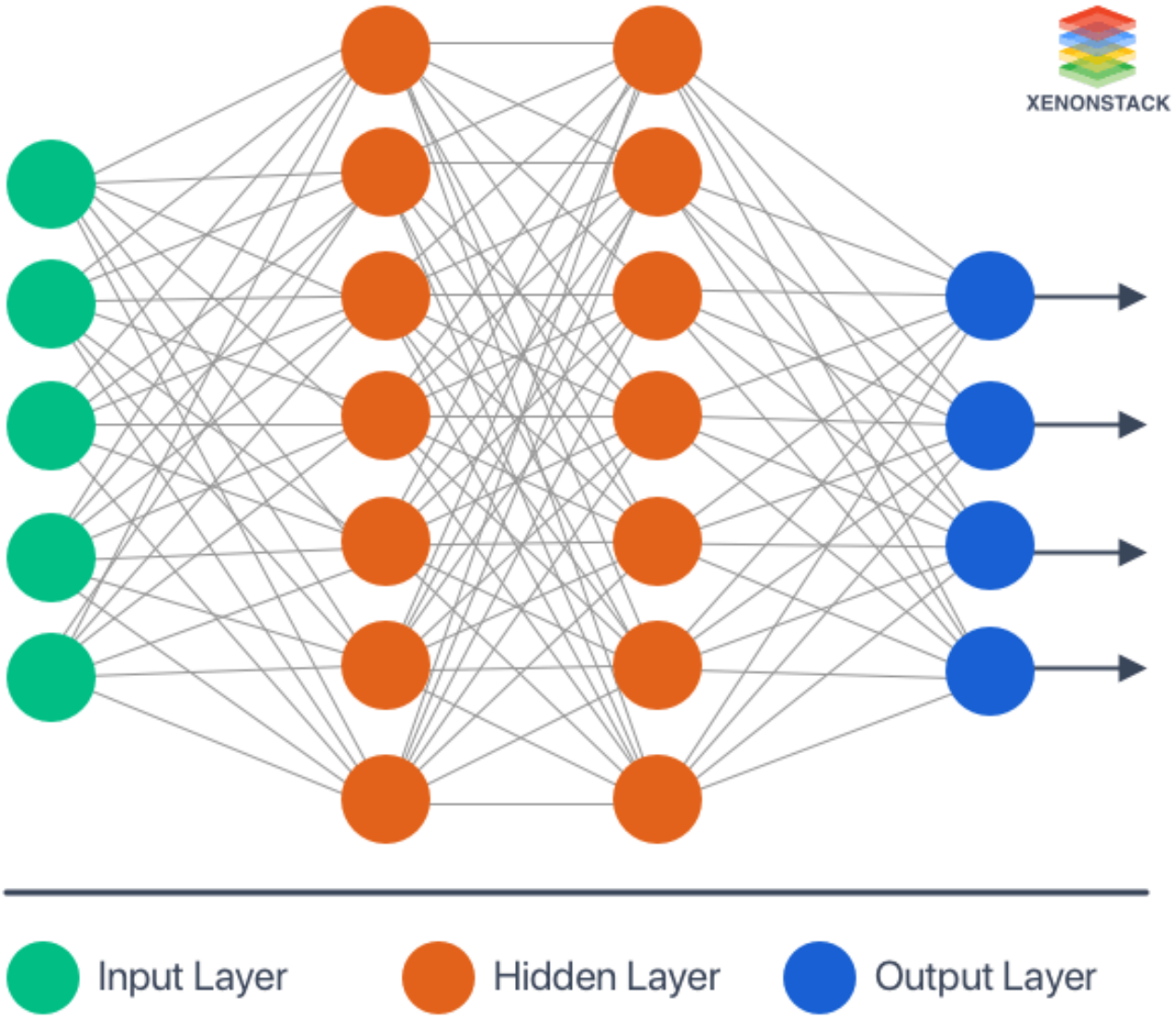
(CNN)

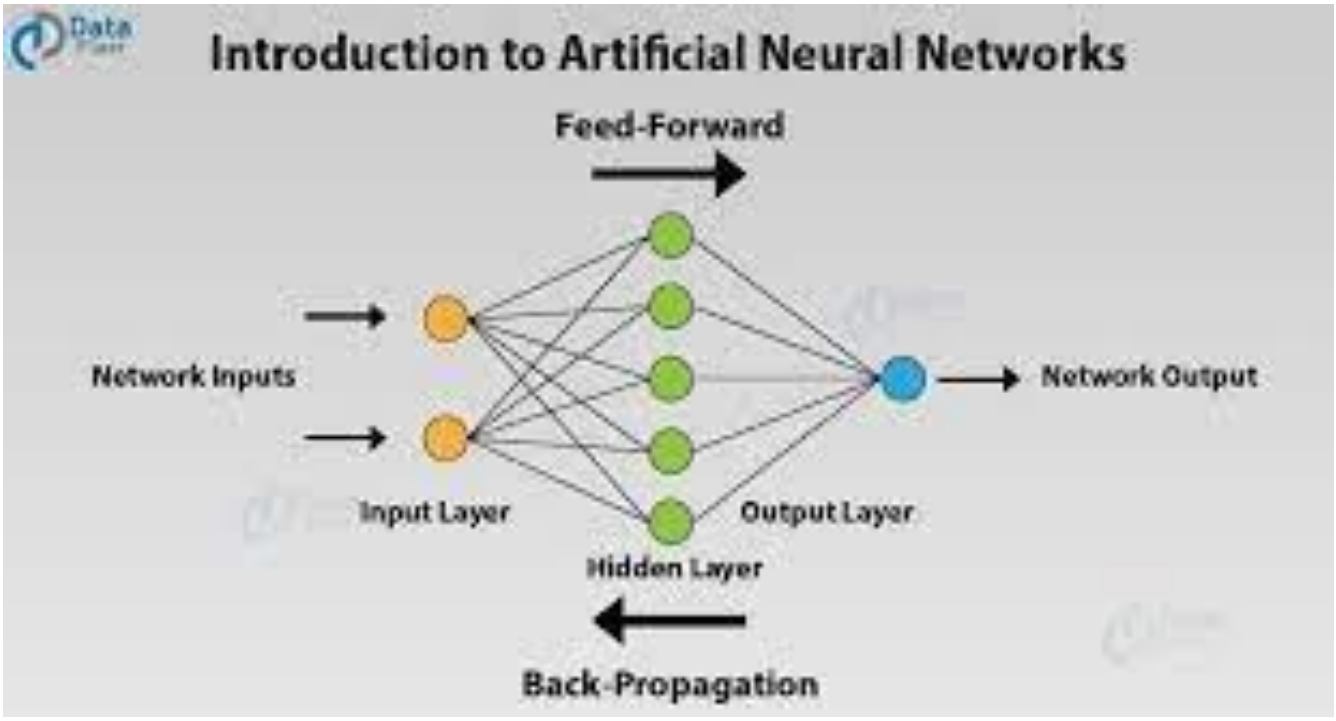


Block Diagram

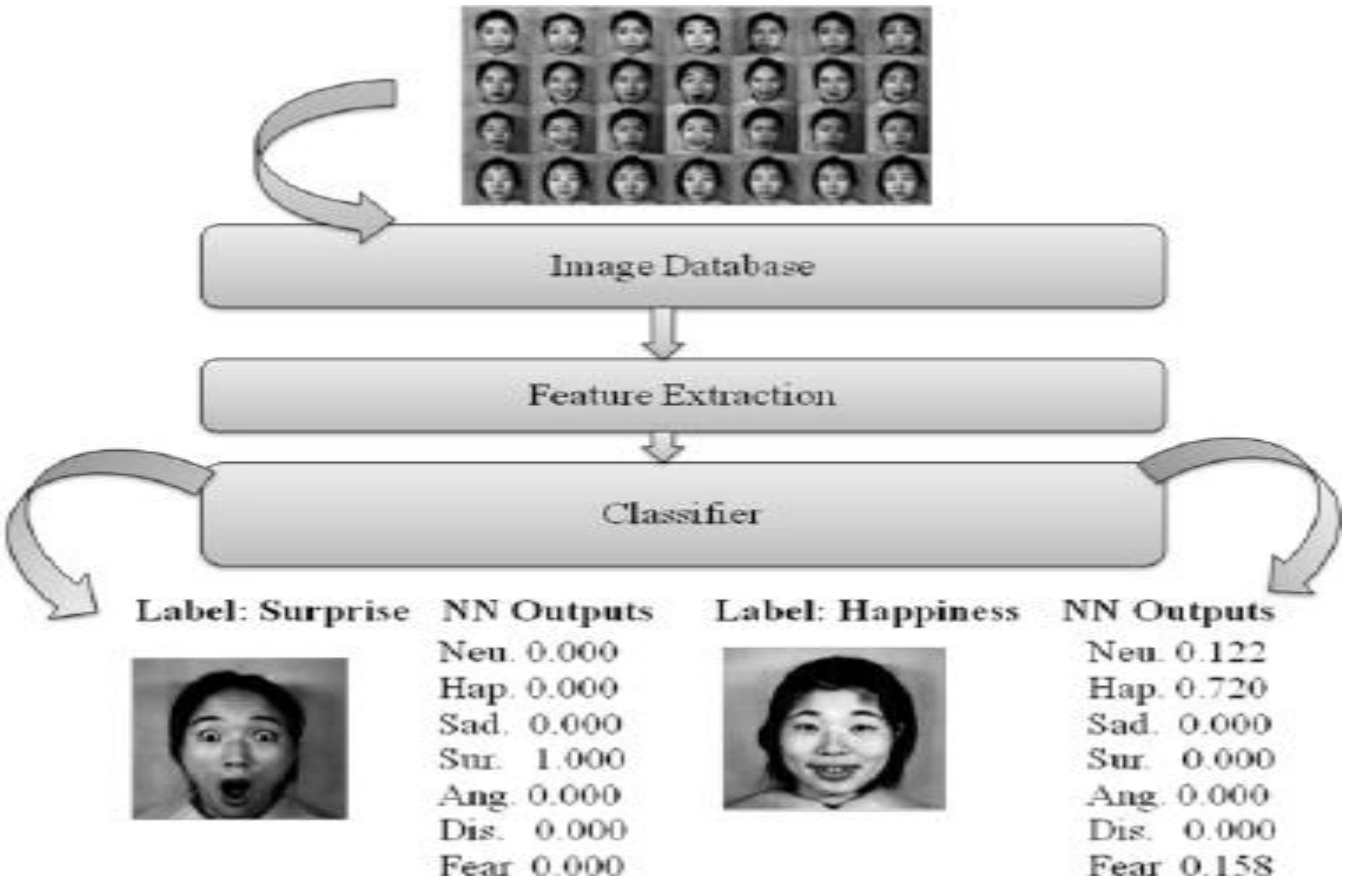


(ANN)

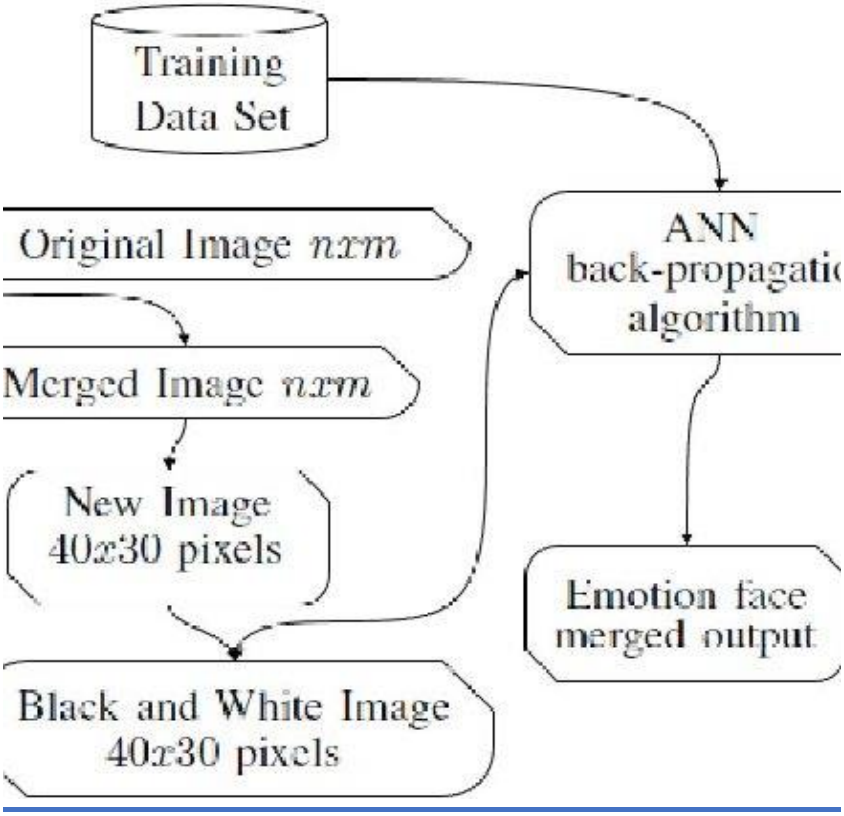




Block Diagram



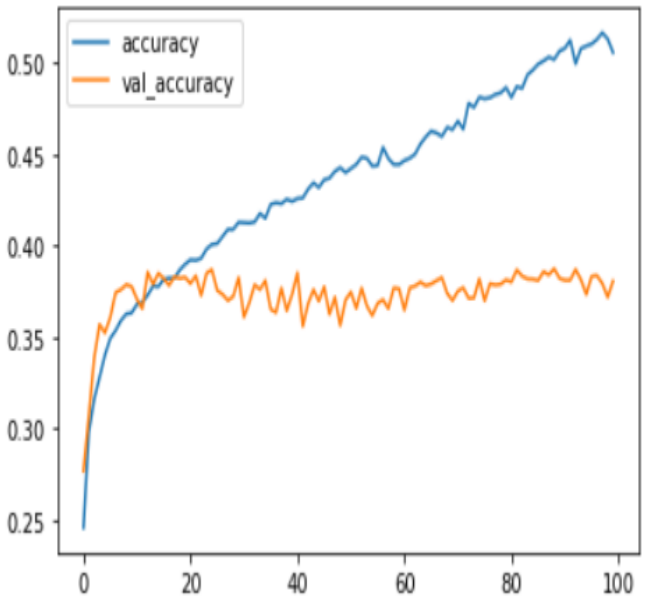
Flow chart

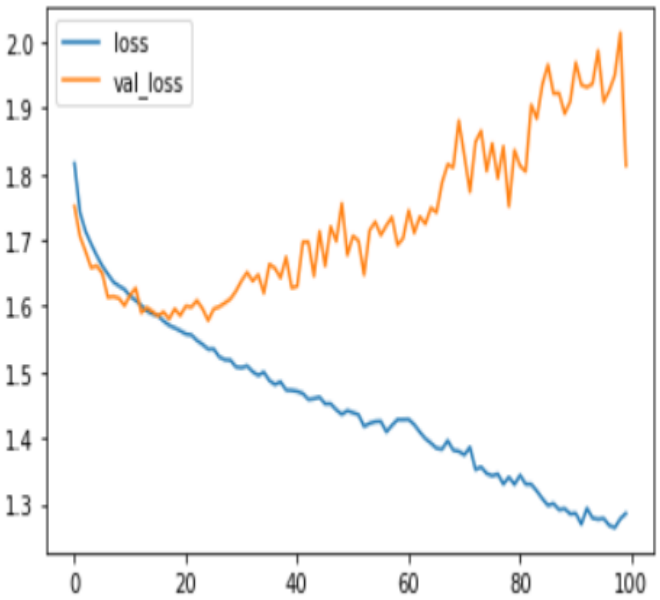


4. Experiments & Results

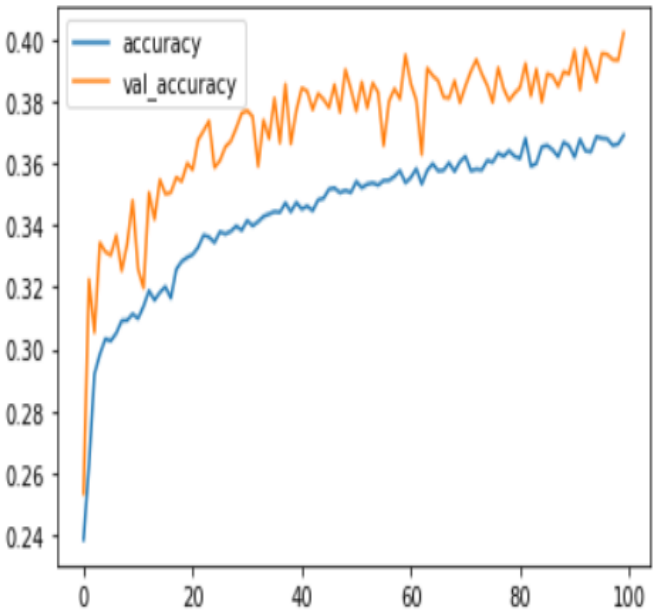
- ANN

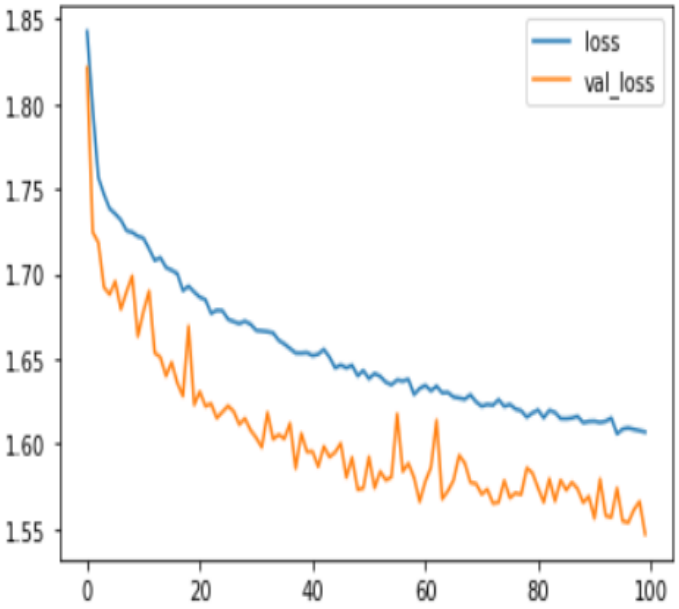
- The First Algorithm applied is ANN, we got 25% test accuracy of the model , and after many experiments on tuning, epochs = 100 &, gave the best result and optimized the test accuracy to 39%and training accuracy 50% .





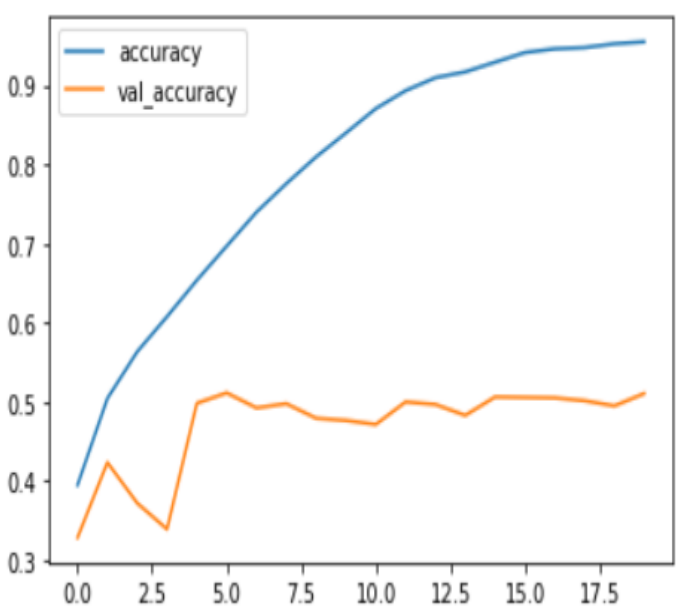
-ANN(Different preprocessing)

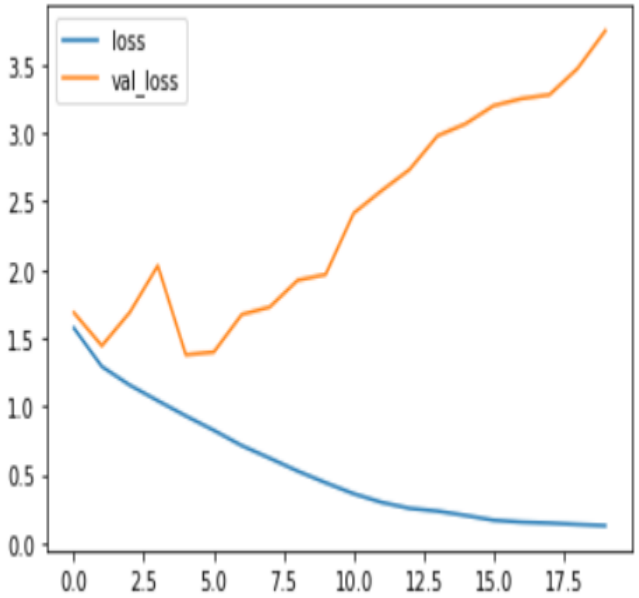




- CNN

- The Second Algorithm applied is CNN , we got 40% accuracy of the model , and after many experiments on tuning, epochs=20 , , gave the best result and optimized the test accuracy to 50% and training accuracy 98%.





- Solution tested on the testing images by uploading it and detecting the face on the image then extracting the features of the face and preprocessing it then applying the preprocessed features of the face to the model to classify it, finally we got insights by plotting the confusion matrix of the model to see the performance of the model after applying all the testing images.

5. Analysis, Discussion, and Future Work

- By analyzing the results of both algorithms , we got insights about the efficiency of both algorithms then we found that performance of results of CNN algorithm is better than ANN.

- The advantage of CNN algorithm in this solution is the testing accuracy percentage which is very good while the disadvantage is the training accuracy

percentage which may be overfitting and may not predicting accurately the results of the data which was not trained .

- The future modification for solving the problem can be by applying another machine learning algorithm which can has better efficiency and performance for the classification of faces to recognize it and choosing a better approach for extracting face expression from image .

Similar applications in the market

Automated Facial Expression Recognition App Development on Smart Phones using Cloud Computing

6. Development platform

Tools: Anaconda , Jupyter Notebook .

Programming Languages : Python .

Python Libraries :, matplotlib , os , PIL , NumPy , cv2 , tesnserflow, sklearn , keras, PIL, pathlib.

Automated Facial Expression Recognition App Development on Smart Phones using Cloud Computing