International Journal of Advanced Engineering Application
ISSN: 3048-6807, Volume 1 Issue 2 June -2024

The investigation of Image Classification Utilizing Convolutional Neural Network.

Siddhesh Tambe[1], Dr Neelam Labhader[2], Divyani Chavan[3], Hemant Daphal[4] , Tejashri Bhagwat[5]
Department of Computer Engineering, Shree Ramchandra College of Engineering, Pune University, India

***Abstract*— This research paper aims to present a comprehensive evaluation of study done on image classification using convolutional neural networks (CNNs). The targeted result of this paper is to explore the benefits of CNNs in classifying images and to recognize the important factors that affect its functioning. This study aims to present the possible applications that this methodology and evaluation metrics can be used for when performing image classification. This study concludes with a review of all the key aspects found on the topic and suggestions on the future areas the findings can be used for. Overall, this paper contributes to deepen the understating on image classification using machine learning.**

Keyword: **Image Classification, Machine Learning, CNN, Convolutional Neural Network, Computer Vision.**

INTRODUCTION

In the field of computer vision, image classifications is an important factor with multiple applications across various domains like surveillance, healthcare, education and many more. A neural network specialises in analysis of complex data. It extracts information from muddled and noisy data to detect patterns [6]. Convolutional Neural Networks (CNNs) have been an emerging technology that transformed the way that computers undertook to perceive and process audio visual data. With the implementation of hierarchical architecture alongside its capability to perform feature extraction from raw pixels belonging to an image, CNN have showcased success in having superior performance for image classification.

In the existing field of computer vision, information is evaluated in non-textual format, like pixels that together form an image. This results in an increase in volume of database sizes that store and categorise these images for references and use. This formulates a very complex retrieval process. Image classification simplifies that process and help in dealing with the above-mentioned situation.

Process of Convolutional Neural Networks Being Used for Image Classification

The process of image classification consists starts with assignment of labels to the images being used as input. It is a

task to be completed with supervised learning in which a model is the trained based on preexisting image data to then be utilized for prediction of classes of never seen before classes of unlabeled images. Learning facilitated through pre labelled inputs that function as targets is termed as supervised learning [8]. The CNN network comprises of input layer, convolution layer, pooling layer, full connected layer, and output layer from input of image to output generation [1].

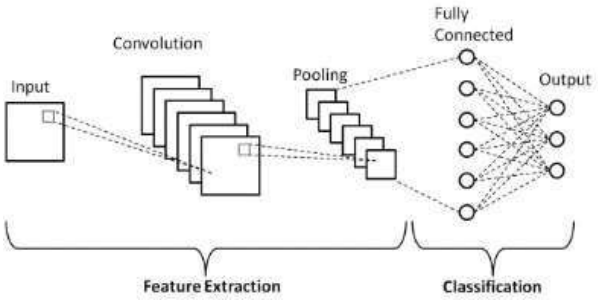

Figure 1. Convolution layer.

The different layer that are engaged in the aforementioned process are explained below.

Input Layer

The input layer is subjected to accept input in the form of a raw image. The representation of image is usually done in matrices as values of pixels. It resizes images and send them to forward layers for processing [2]. It is to be noted that dimensions in co-relation of the input layer are in correspondence to overall size of the input raw image.

B. Convolutional Layers

The task of feature extraction is performed by convolutional layers. They are comprised of filters or kernels. These are then convolved with the images used as input to harness useful are reoccurring patterns. Detection of edge edges and other elements is performed by the convolutional layers.

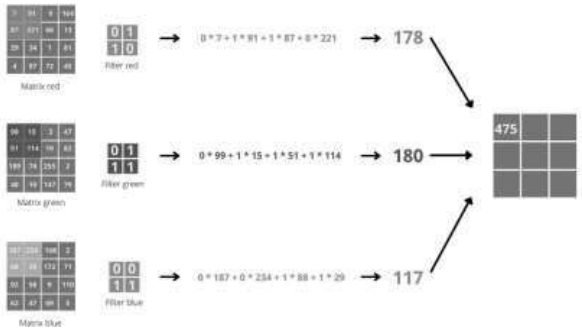

Figure 2. Convolution layer.

C. Pooling Layer

Reduction of spatial dimensions of feature maps developed by the preceding layer is facilitated by the pooling layer. They are also accountable to initiate max pooling operations to keep the most important information while disposing details that aren't important in the classification process. These steps then help in minimising the complexities in computation concerning down sampling operations [3].

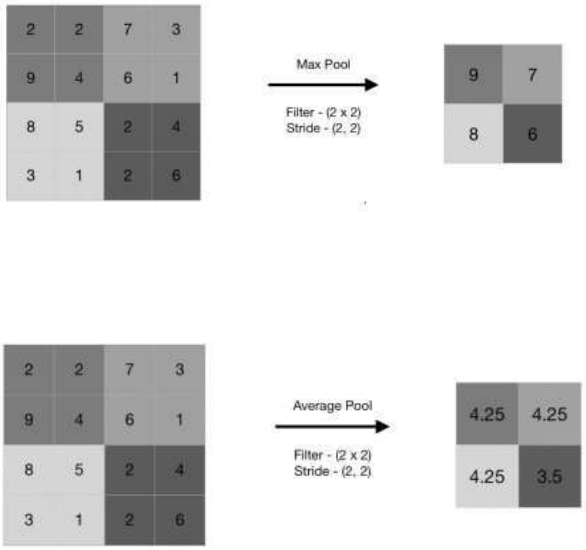

Figure 3. Max and Average Pooling

D. Fully Connected Layers

- The result gained form the pooling layer is then processed and then connected to singular or multiple fully connected layers. The process to categorise the extracted features and therefore function as conventional neural networks layers. The task of learning complex connections and relationships among features and output class possibilities is executed by the fully connected layers. This layer is an amalgamation of Non-Linear function and Affine function.

- Non-Linear Function **Sigmoid, TanH and ReLu**
- Affine Function **y = Wx + b**

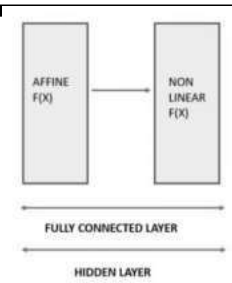

Figure 4. Fully Connected Layers

Output Layer

The final output layer give every class's classification possibilities or predictions [5]. Additionally, it also showcases the probability of a specific image which as used as an input to be related to unique class.

Benefits Of Image Classification Using CNN

Applying CNN for image classification can provide numerous benefits for a wide range of applications due to its precise approach in solving visual recognition problems. These are listed below.

- CNNs can perform highly accurate image classifications due to being proficient in hierarchical feature learning with low- and high-level features like edges and object shapes.
- CNNs utilise minimal training parameters and high flexibility makes its optimal for pattern recognition and image processing [7].
- CNNs eliminated the requirement of manual feature engineering as it automatically learns desired features from given input data.
- CNNs can be scaled as per requirement to work with large datasets that contain complex classification tasks with the help of employing distributed computing resources and parallel processing.
- CNNs can used for applications that have low latency classification requirements as it can provide real-time results.
- CNNs are capable leveraging knowledge extracted from pre trained models to facilitate quicker convergence on new and unique tasks being executed on datasets of varying sizes.

Applications Of Image Classification Using CNN

- Performing medical image diagnosis:

CNNs can be used to classify images generated through medical exanimations like MRIs and X rays for medical diagnosis of numerous health conditions [4]. They can assist in premature detection and precise identification of diseases when trained on medical image datasets, thus helping in optimising healthcare treatment.

- Product recognition in retail and e commerce:

CNNs are used for product recommendation and recognition systems to improve accuracy when segmenting items for stocking shelves and storing surplus supplies. They can also be utilised for conducting visual searches using a product logo or form factor, hence shortening the time required for shopping, leading to be better consumer experience.

- Enforcing quality control policies in manufacturing:

CNNs are used for classification of defects by identifying images of products with manufacturing anomalies that do not meet required quality control standards. They hence perform a crucial role in implementing industrial automation and thus help in enforcing product quality standards.

Conclusion

In conclusion, this paper has conducted a brief exploration about study of image classification using Convolutional Neural Networks. CNNs when utilized for image classification resulted into precise recognition of objects identified in an image. We concluded that each layer in CNN performs a substantial role in carrying out feature extraction and classification procedures on an image. The paper also discussed a multitude of benefits of using CNNs for image classification. The study also concludes that CNNs can be applied in varied applications due to its automated learning capabilities and accuracy in feature extraction. We aim to utilize the knowledge gained for this study in various real world scenarios.

REFERENCES

[1] Xin, M., Wang, Y. Research on image classification model based on deep convolution neural network. J Image Video Proc. 2019, 40 (2019). https://doi.org/10.1186/s13640-019-0417-8.

[2] Neha Sharma, Vibhor Jain, Anju Mishra, An Analysis Of Convolutional Neural Networks For Image Classification, Procedia Computer Science, Volume 132, 2018, Pages 377-384, ISSN 1877-0509, https://doi.org/10.1016/j.procs.2018.05.198.

[3] Ramprasath, Muthukrishnan & Hariharan, Shanmugasundaram & Prasath, Ram. (2022). Image Classification using Convolutional Neural Networks.

[4] Yadav, S.S., Jadhav, S.M. Deep convolutional neural network based medical image classification for disease diagnosis. J Big Data 6, 113 (2019). https://doi.org/10.1186/s40537-019-0276-2.

[5] Alzubaidi, L., Zhang, J., Humaidi, A.J. et al. Review of deep learning: concepts, CNN architectures, challenges, applications, future directions. J Big Data 8, 53 (2021). https://doi.org/10.1186/s40537-021-00444-8

[6] Neelam Labhade-Kumar, Dr.Yogesh Kumar Sharma, Dr. Parul Arora," STUDY OF NEURAL NETWORKS IN VIDEO PROCESSING", 2019 Journal of Emerging Technologies and Innovative Research(JETIR) March 2019, Volume 6, Issue 3PP-330-335

[7] Neelam Labhade-Kumar, Dr.Yogesh Kumar Sharma, Dr. Parul Arora "Key Feature Extraction for Video Shot Boundary Detection using CNN", International Journal of Recent Technology and Engineering (IJRTE) blue Eye (Scopus),ISSN: 2277-3878, Volume-8 Issue-5, January 2020 Retrieval Number: E6789018520/2020©BEIESPDOI:10.35940/ijrte.E6789.018520, PP 4763-4769.

[8] O'Shea, Keiron & Nash, Ryan. (2015). An Introduction to Convolutional Neural Networks. ArXiv e-prints.