Conquering fashion MNIST with CNN using computer vision

**Sathvik N S** *Artificial Intelligence and Data Science Rajalakshmi Institute of Technology Chennai ,India* sathvik.n.s.2021.ad@ritchennai.edu.in

**Shivram Narayanan H** *Artificial Intelligence and Data Science Rajalakshmi Institute of Technology Chennai ,India* shivramnarayanan.h.2021.ad@ritchennai.edu.in

**ABSTRACT**

In this project, our goal is to develop a highly efficient Convolutional Neural Network (CNN) model for accurately classifying images from the Fashion MNIST dataset into their respective clothing categories. we aim to develop a CNN model that can accurately classify clothing images from the Fashion MNIST dataset into their respective categories. This report covers the design, implementation and developing an efficient Clothing Classification Model using Convolutional Neural Networks (CNN).

**INTRODUCTION**

In recent years, Convolutional Neural Networks (CNNs) have revolutionized the field of computer vision and pattern recognition. With their remarkable ability to learn complex patterns and features from images, CNNs have been extensively employed in various domains, including fashion recognition and classification. This report aims to provide a comprehensive analysis of the application of CNNs specifically for Fashion MNIST, a popular benchmark dataset in the fashion domain.

Fashion MNIST, introduced as a replacement for the traditional handwritten digit recognition dataset, MNIST, has quickly gained popularity as a challenging benchmark for evaluating machine learning models. Comprising of 60,000 training and 10,000 testing grayscale images, Fashion MNIST includes 10 different classes representing various fashion items, such as dresses, shirts, shoes, and handbags, among others. This dataset serves as an excellent testbed for evaluating the effectiveness of CNN architectures for fashion classification tasks.

This report will delve into the fundamental concepts of CNNs and their relevance to image classification tasks. Additionally, it will explore various CNN architectures and techniques that have been proposed and successfully applied to Fashion MNIST. The performance evaluation and comparison of different models will be presented, highlighting their strengths, limitations, and potential areas for improvement.

Ultimately, this report aims to provide a comprehensive understanding of the application of CNNs for Fashion MNIST, shedding light on the advancements in fashion recognition using deep learning techniques. The findings and insights presented herein will contribute to the growing body of knowledge in the field and serve as a valuable resource for researchers, practitioners, and enthusiasts interested in fashion classification and computer vision applications.

**Literature Survey**

* **Benchmark Dataset: Fashion MNIST**

Fashion MNIST has become a popular benchmark dataset for evaluating fashion classification models. It consists of 60,000 training images and 10,000 testing images, each grayscale and of size 28x28 pixels. The dataset includes ten different fashion categories, such as T-shirts, trousers, pullovers, dresses, coats, sandals, shirts, sneakers, bags, and ankle boots. Researchers have used this dataset to develop and evaluate CNN architectures and techniques for fashion classification.

* **CNN Architectures for Fashion MNIST**

1. **LeNet-5**, proposed by Yann LeCun et al., is one of the pioneering CNN architectures. It consists of several convolutional and pooling layers, followed by fully connected layers. Various studies have explored the effectiveness of LeNet-5 on Fashion MNIST, achieving respectable accuracy rates and serving as a baseline for further improvements.
2. **VGGNet**, introduced by Simonyan and Zisserman, is known for its deep architecture and uniform structure. Researchers have explored different variations of VGGNet on Fashion MNIST, achieving improved accuracy by leveraging its deeper layers and increased model complexity.
3. **ResNet**, proposed by He et al., introduced residual connections to alleviate the degradation problem in deep networks. Studies have shown that ResNet architectures with different depths can effectively classify fashion items in the Fashion MNIST dataset, demonstrating superior performance compared to shallower networks.
4. **DenseNet**, introduced by Huang et al., emphasizes dense connections between layers, facilitating feature reuse and alleviating the vanishing gradient problem. Researchers have explored DenseNet architectures on Fashion MNIST, achieving competitive results by leveraging its dense connectivity.

* **Techniques for Enhancing CNN Performance**

1. **Data Augmentation**

Data augmentation techniques, such as random rotations, translations, and flips, have been widely employed to enhance the generalization and robustness of CNN models. Studies have demonstrated the effectiveness of data augmentation on Fashion MNIST, leading to improved classification accuracy.

1. **Transfer Learning**

Transfer learning, where pre-trained CNN models on large-scale datasets like ImageNet are fine-tuned on Fashion MNIST, has gained popularity. By leveraging the learned representations, transfer learning has shown promising results in fashion classification tasks, reducing training time and achieving competitive accuracy rates.

1. **Regularization Techniques**

Regularization techniques, such as dropout and weight decay, have been extensively employed to prevent overfitting in CNN models. Researchers have explored the impact of different regularization techniques on Fashion MNIST, finding that they can improve model generalization and prevent overfitting.

* **Performance Evaluation and Comparative Analysis**

Numerous studies have evaluated and compared different CNN architectures, techniques, and variations on the Fashion MNIST dataset. These evaluations include accuracy metrics, precision, recall, and F1 scores, among others. Comparative analysis provides insights into the strengths and weaknesses of various approaches, enabling researchers to identify the most effective techniques for fashion classification tasks.

* **Future Directions**

The literature on CNNs for Fashion MNIST demonstrates the progress made in fashion recognition using deep learning techniques. However, there are still several avenues for future research. These include exploring novel architectures, investigating attention mechanisms, leveraging ensembles, and integrating other modalities (e.g.,textual descriptions) to improve fashion classification performance. Additionally, the interpretability and explainability of CNN models on Fashion MNIST can be further explored to gain insights into the decision-making process.

* **Conclusion**

In conclusion, this literature survey provides an overview of the application of Convolutional Neural Networks (CNNs) for fashion classification on the Fashion MNIST dataset. It covers various CNN architectures, techniques for enhancing performance, performance evaluation, and comparative analysis. The findings from these studies contribute to the understanding of CNNs in fashion recognition and serve as a foundation for further advancements in the field. The survey highlights the potential for future research directions to continue pushing the boundaries of accuracy and interpretability in fashion classification tasks.

**OBJECTIVE**

Develop an efficient CNN model: We aim to design and train a CNN model that can achieve high accuracy in classifying clothing images from the Fashion MNIST dataset. CNNs are widely used in computer vision tasks and have proven to be highly effective in image classification tasks. By leveraging the power of CNNs, we can capture relevant features and patterns in the images, enabling accurate classification.

Look into the Fashion MNIST dataset as a comparison tool for dress classification model evaluation.Discuss the features of the dataset, preprocessing methods, and model augmentation techniques used to improve performance.

Apply optimization for enhanced performance: By providing various optimization tools and libraries that can boost the performance of deep learning models By utilizing optimization resources, we can achieve faster predictions and improved efficiency, making the model suitable for real-time applications.

**OUTCOMES**

An efficient CNN model for clothing classification: By the end of this project, we aim to develop a CNN model that can accurately classify clothing images from the Fashion MNIST dataset into their respective categories.

Performance analysis: We will analyze the performance of our model using metrics like accuracy and precision. This analysis will provide insights into the model's strengths and weaknesses, enabling us to further optimize its performance.

The development and evaluation of four different Convolutional Neural Network(CNN) models for classifying garments from the Fashion - MNIST dataset.

**CHALLANGES**

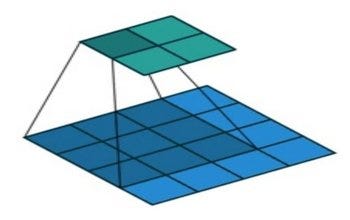
Overfitting: The Convolutional Neural Network (CNN) models used in this paper were found to be prone to overfitting, which means that they were too specialized to the training data and performed poorly on test data. This is a common challenge in deep learning models. When this happens the network fails to generalize the features/pattern found in the training data.

To address this challenge of overfitting , One of the best strategies to avoid overfitting is to increase the size of the training dataset. When the size of the training data is small the network tends to have greater control over the training data. But in real-world scenarios gathering of large amounts of data is a tedious & time-consuming task, hence the collection of new data is not a viable option.

Several techniques such as increasing the number or size of layers in the CNN models or using dropout. Dropout is a technique where random neurons are temporarily removed from the model during training, which has been shown to improve the accuracy and performance of neural networks in various applications.

**SOFTWARE MODEL**

Deep Learning is becoming a very popular subset of machine learning due to its high level of performance across many types of data. A great way to use deep learning to classify images is to build a convolutional neural network (CNN). The Keras library in Python makes it pretty simple to build a CNN. Computers see images using pixels. Pixels in images are usually related. For example, a certain group of pixels may signify an edge in an image or some other pattern. Convolutions use this to help identify images. A convolution multiplies a matrix of pixels with a filter matrix or ‘kernel’ and sums up the multiplication values. Then the convolution slides over to the next pixel and repeats the same process until all the image pixels have been covered.



**CONCLUSION**

In conclusion, the clothing classification model using convolutional neural network(cnn) can categorise fashion mnist data more accurately than other traditional machine learning models.

It was shown that the dropout strategy works well for lowering the models bias when combined with more convolution layers. Keras sequential model was used to achieve higher training times and accuracies by utilising Tensorflow and Gpu.

**REFERENCE**

[1] “Classification of Garments from Fashion MNIST dataset using CNN LeNet-5 Architecture” by Mohammed Kayeed and Ahmed M.Anter(Link: <https://www.researchgate.net/publication/340237897_Classification_of_Garments_from_Fashion_MNIST_Dataset_Using_CNN_LeNet-5_Architecture> )

[2] “Fashion-MNIST:a Novel Image Dataset for Benchmarking Machine Learning Algorithm” by Han Xioa and Kashik Rasul (Link: <https://www.researchgate.net/publication/319312259_Fashion-MNIST_a_Novel_Image_Dataset_for_Benchmarking_Machine_Learning_Algorithms> )

[3] “Classifying Garments from Fashion MNIST dataset Through CNNs” by Alison Steffens, Anita Maria And Rodrigo Lyra (Link: <https://www.researchgate.net/publication/349553873_Classifying_Garments_from_Fashion-MNIST_Dataset_Through_CNNs> )

[4] “Fashion-MNIST:Classification based on HOG feature descriptor using SVM” by Greeshma K.V and Sreekumar.K (Link: <https://www.researchgate.net/publication/332035279_Fashion-MNIST_classification_based_on_HOG_feature_descriptor_using_SVM> )

[5] “CNN Model for Image Classification on MNIST and Fashion-MNIST Dataset” by Sivam Sanjay Kadam (Link: <https://www.academia.edu/55555220/CNN_Model_for_Image_Classification_on_MNIST_and_Fashion_MNIST_Dataset> )

[6] “Pre-convoluted neural networks for fashion classification” by Mustafa Amir Obaid and Wesam M Jasim (Link: <https://www.researchgate.net/publication/350560501_Preconvoluted_neural_networks_for_fashion_classification>)

[7] Xavier Snelgrove. "Fashion MNIST with Keras and Deep Learning." Practical Business Python (2018). Link [8] Zalando SE. "Fashion-MNIST: A Drop-in Replacement for the Original MNIST Dataset." GitHub Repository (2017).

[9] Anh Nguyen, Jason Yosinski, and Jeff Clune. "Deep Neural Networks are Easily Fooled: High Confidence Predictions for Unrecognizable Images." Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (2015).

[10] Nitin Kumar, Avantika Singh, and Ashutosh Kumar Dubey. "Comparison of Different Activation Functions on Deep Neural Networks for Fashion-MNIST Classification." International Journal of Advanced Research in Computer Science (2018).

[11] Muhammad Fajar, Andino Maseleno, and Ayu Purwarianti. "Performance Comparison of Deep Neural Networks for FashionMNIST Classification." 2019 International Conference on Electrical Engineering and Informatics (ICEEI) (2019).

[12] Narenda Yadav, Anil Kumar Bharti, and Praveen Kumar. "A Comprehensive Study of Convolutional Neural Networks for FashionMNIST Classification." 2020 International Conference on Computer Science and Information Technology (CSIT) (2020).

[13] Prachi Singhal and Ram Bhagwan Yadav. "A Comparative Study of Various Activation Functions in Convolutional Neural Network for Fashion-MNIST Classification." 2020 IEEE International Conference on Electrical, Computer and Communication Technologies (ICECCT) (2020).

[14] Nandhini Subramanian, Ramesh Gopalakrishnan, and Venkataramanan Balakrishnan. "Comparative Analysis of FashionMNIST Classification using CNN and Transfer Learning." 2019 10th IEEE Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON) (2019).

[15] Priyanka Khulbe, Avinash Kori, and Sudhir Kumar Sharma. "Performance Analysis of Convolutional Neural Networks for Fashion-MNIST Classification." 2020 3rd International Conference on Advanced Computational and Communication Paradigms (ICACCP) (2020).