REVA UNIVERSITY
Bengaluru, India

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

A Project Report
on
Product Classification Using Deep Learning

Submitted in fulfillment of the requirements for the award of the Degree of

Bachelor of Technology
In
Computer Science and Engineering

Submitted by

SADAT JUNAID AKUNJEE	R19CS271
SAIKIRAN	R19CS281
ROOPAM KUMAR SAW	R19CS264
SALONI KUMARI	R19CS283

Under the guidance of
ASHWINI TUPPAD
Assistant Professor

2022-2023

Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru-560064

www.reva.edu.in

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DECLARATION

We, Mr. / Ms. **Sadat Junaid Akunjee, Saikiran, Roopam Kumar Saw, Saloni Kumari** students of Bachelor of Technology, belong into School of Computer Science and Engineering, REVA University, declare that this Project Report / Dissertation entitled "Product Classification using Deep Learning" is the result the of project / dissertation work done by us under the supervision of **Prof. Ashwini Tuppad** School of Computer Science and Engineering, REVA University.

We are submitting this Project Report / Dissertation in partial fulfillment of the requirements for the award of the degree of Bachelor of Engineering in Computer Science and Engineering by the REVA University, Bangalore during the academic year 2023.

We declare that this project report has been tested for plagiarism and has passed the plagiarism test with the similarity score less than 20% and it satisfies the academic requirements in respect of Project work prescribed for the said Degree.

We further declare that this project / dissertation report or any part of it has not been submitted for award of any other Degree / Diploma of this University or any other University/ Institution.

Signature of the candidates with dates

1.

2.

3.

4.

Certified that this project work submitted by Sadat Junaid Akunjee, Saikiran, Roopam Kumar Saw, Saloni Kumari *has been carried out under my / our guidance and the declaration made by the candidate is true to the best of my knowledge.*

Signature of Guide

Date: ……..

Signature of Director of School

Date: ……..

Official Seal of the School

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING.

CERTIFICATE

Certified that the project work entitled **Product Classification using Deep Learning** carried out under my / our guidance by **Sadat Junaid Akunjee, Saikiran, Roopam Kumar Saw, Saloni Kumari** are bona fide students of REVA University during the academic year 2019-2023, are submitting the project report in partial fulfillment for the award of **Bachelor of Technology** in **Computer Science and Engineering** during the academic year **2022-2023.** The project report has been tested for plagiarism and has passed the plagiarism test with the similarity score less than 20%. The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the said Degree.

Signature with date	**Signature with date**
Ashwini Tuppad **Guide**	**Dr. Ashwin Kumar UM** **Director**

External Examiners

Name of the Examiner with affiliation	**Signature with Date**
1.	
2.	

ACKNOWLEDGEMENT

Any given task achieved is never the result of efforts of a single individual. There are always a bunch of people who play an instrumental role leading a task to its completion. Our joy at having successfully finished our mini project work would be incomplete without thanking everyone who helped us out along the way. We would like to express our sense of gratitude to our REVA University for providing us the means of attaining our most cherished goal.

We would like to thank our Hon'ble Chancellor, **Dr. P. Shyama Raju** and Hon'ble Vice-Chancellor, **Dr. M Dhanamjaya** for their immense support towards students to showcase innovative ideas.

We cannot express enough thanks to our respected Director, Dr. Ashwin Kumar UM, Director, School of Computer & In for providing us with a highly conducive environment and encouraging the growth and creativity of each student. We would also like to offer our sincere gratitude to our Project Coordinators for the numerous learning opportunities that have been provided.

We would like to take this opportunity to express our gratitude to our Project Guide, Ashwini Tuppad, for continuously supporting and guiding us in our every endeavor as well for taking a keen and active interest in the progress of every phase of our Project. Thank you for providing us with the necessary inputs and suggestions for advancing with our Project work. We deeply appreciate the wise guidance that sir has provided.

Finally, we would like to extend our sincere thanks to all the faculty members, staff from School of Computer Science and Engineering.

Sadat Junaid Akunjee, R19CS271

Saikiran, R19CS281

Roopam Kumar Saw, R19CS264

Saloni Kumari, R19CS283

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Abstract:

Due to dynamic and uncooperative market it has become very difficult to develop the products that are highly appreciated and loved by the consumers, due to which it has become a major issue to develop the product based on the likes and usage of the consumer rather than the intuition of the designer of the product. Understanding a product's nature and purpose in-depth is the first stage in product creation. After that, the product is categorized according to that category. Traditional product classification mainly concentrates on the market and product that designers build based on the products of previous dynasties, which may not be able to catch the attention of the customer of the present generation. Mainly consumers look for product with unique design, characteristics, functionality and many more which won't be achieved using traditional methods, hence usage of Artificial Intelligence is made in many different fields including product classification. Researchers basically face the major problem about how to apply machine learning classification concept for product classification. In this paper, a fast and effective method is proposed which can classify the product based on its feature and design patterns. It is basically a fusion of image classification with machine learning technologies. The proposed model is basically divided into three major parts: target feature is the model developed sing deep learning technologies which can extract the feature of the product, modelling is basically done to train the model which is able to predict the product based on the features extracted and train model and error analysis, to properly understand the prediction rate of the model and analyze it. This method is basically novel attempt where product design feature is train to predict the model of the new product, which basically deliver a strong application prospect.

1. Introduction:

With high competition in the market for product the first thing that attracts the consumer is the attractive and uniqueness of the product. Hence, the time it takes for a new product to go from design and production to the final launch of the product in the market often determines the sales and the profitability of the produced product [1].

So basically, to speed up the production process, the designer after getting the idea about the product starts designing the product based on the design categories of the new product. This further leads to designing of the product based on the general characteristics. Hence product classification plays very important role in the design process [2,3].

In traditional method the product classification is basically done just by modifying the product with minute changes leading to the less uniqueness of the product [4,5]. Furthermore, the complete control of the product design process is under the designer who just design the product, based on the ideas and further proceeds to the production process. Even after the designing process the production process is labor-consuming and inefficient because the product has been designed based on the designer perspective of the product rather than user perspective [6-10]. Hence in this paper a new method is proposed where the product is predicted based on its feature using the fusion of Image Classification and machine learning technologies.

Though it may be possible that traditional methods may include Machine Learning Technologies or 3D design but there is no guarantee that the product designed will be liked by the user and product belongs to that class or company. As a result, it will become labor-consuming and ineffective leading to wastage of time and resources [11-13]. Additionally, the designed product results are not accurate and leading to inefficient development of the product [14,15].

Due to this reason, to improve the accuracy as well as help the designer to classify the product easily usage of modern machine learning technologies is used which is basically fusion of the 2 or more related technologies working together.

The most popular approach among the ML techniques used in the design areas is image classification. A computer can do categorization tasks by learning from the supplied data. The deep learning algorithms, however, require high-definition photos as the input

and take a very long time to extract complicated characteristics [16]. For instance, the training procedure for the ResNet 18 common network structure uses a lot of memory and time to analyze the 3-channels color input picture with a resolution of (224,224).

Additionally, the suggested methodology won't work if the designer has the freedom to choose the train images on his own. Using user-defined data in the model is the best way to make the method operate quickly and efficiently. However, it can be challenging to gather consumer data due to privacy concerns, and it can be challenging to guarantee the quality of survey data. This study will process a model that can extract features from the user-purchased products and categorize them to tackle the challenge. The model can be strengthened in this way, but it takes time.

The proposed model can predict the product based on the features (texture) of the product and based on this the model is train which further is effective to test the product based on the model classification result. This model makes use of the most common classification method i.e. image classification is a supervised learning problem: define a train dataset to train the model and test dataset for result analysis.

2. Literature Survey:

Classifying the new product is the first phase in the product development process, which involves defining the nature and purpose of the product [3][4][5]. The term "product classification" refers to the process of grouping things into organized categories by categorizing them based on traits or qualities. Numerous studies and organizations have advanced the theory and method of product classification to serve a variety of purposes. In general, there are several informal systems of product classification developed by various industry organizations in addition to a standardized system.

Tatikondaand et.al. [1] By using more in-depth operationalizations of technology novelty and project complexity, analyzing these operationalizations in conjunction with various project success outcomes, and using a large cross- sectional sample of assembled goods, this paper adds to the body of literature on project task characteristics and project outcomes. Studies on project tasks and project results sometimes concentrate only on time-related results rather than a variety of project execution results. The main issue with this approach is that it can only be used for small projects, one business, or one sector. Numerous researchers attempt to cross-company, but they do not consider multiple execution.

Summary: It's a novel method where project task characteristics are basically operationalized in conjunction with multiple project success outcomes on cross-sectional sample of goods.

Luh et.al. [2] propose a method to design the product based on the consumer behavior toward a product. However, it is generally acknowledged that consumer cognitions and behavior are fluid and unseasoned. It's important to understand how to get user feedback on a product and use it to inform the creation of prototypes. The goal of this study is to create an Empathic Design Model that can identify the cognitive orientation of consumers. This EDM model is basically determines the product based on the consumers cognition information provided to it in the form of array of information. The main disadvantage of this approach is that analysts and developers tend to gather an enormous quantity of general consumer data while creating a new, large-scale, sophisticated system, believing that doing so will allow them to understand market demand. Such information, however, can only be hypothetical and has several additional limitations, eventually just identifying the beginnings of those aspects that are most significant.

Summary: It's a novel attempt where product development is done based on the consumer cognitions towards a product and using it to develop EDM.

Gutman et al. [3] developed a model that is based on two fundamental assumptions about consumer behavior: (1) that values, here defined as desirable end-states of existence, dominate in guiding choice patterns; and (2) that people deal with the enormous diversity of products that are potentially satisfying their values by grouping them into sets or classes in order to reduce the complexity of choice. This implies that in addition to the product-class types of product categories, such as toothpaste, toothbrushes, chewing gum, etc., consumers can establish categories depending on the consumer that may have enormous classes.

Summary: Based on the consumer behavior towards a product leading to determining the consequences and categorization of the product.

Gutmanand et al. [4] presented a method to understand the consumer cognitive behavior towards a product for its development. The model is efficient and easy to understand and further provides a proper understanding information about the product from user perspective. The major drawback is it require high computational power and well-designed datasets.

Summary: Novel attempt development of product based on the human connection with the product.

Pieters et al. [5] proposed a novel model that is an innovative effort that categorizes the product according to the intended consumer. MdmNet is essentially a merger of target

consumer modelling and image categorization. This MdmNet is a fresh endeavor in which the incentives, willingness, and expectations of the user are used to build and develop the products. The main benefit of this technique is that it enhances classification effects by modelling target users and anticipating their mental processes. The main disadvantages are that (1) photos are not scaled and grayscale, and (2) practical implementation requires more processing power and greater resources.

Summary: Novel attempt that is basically a fusion of Image classification and target consumer modelling called MdmNet. This MdmNet is a novel attempt where the products are designed and developed based on the consumers incentives, willingness, and expectations.

Sun et.al. [6] presented a proof-of-prototype concept where the proper product is developed first based on the designer perspective and further launched into the market as a prototype for trial run for reviewing and understanding the usage effect on the current market. The prototype is developed using a streamlined and well-organized designing process for proper function and working of the product by users. The major drawback of this process is it developed independent of the consumer point of view hence leading to failure of the product in the current market trends.

Summary: Well defined process for development of the product through the feedback received from the prototype.

3.Positioning

3.1 Problem statement:

Use deep learning to build a model that can accurately classify products into their respective categories or classes based on their attributes, features, or images. This is a challenging task because products can belong to a wide range of categories, and different products within the same category can have significant variations in their appearance and features. Deep learning, a subset of machine learning, has shown promising results in solving such complex classification problems, especially with the availability of large datasets and powerful computing resources. The goal is to develop a model that can accurately and efficiently classify products into their respective categories, which can have practical applications in e-commerce, inventory management, and supply chain optimization.

3.2 Product position statement:

For businesses looking to streamline their inventory management and improve their e-commerce customer experience, our product classification solution using deep learning offers unmatched accuracy and efficiency. By utilizing cutting-edge convolutional neural network models, our solution can quickly and accurately classify product images based on their attributes, enabling businesses to better understand their inventory and provide personalized recommendations to their customers. With our product classification solution, businesses can increase their sales revenue and improve customer satisfaction, all while saving time and resources.

4. Project overview:

4.1 Objectives:

The objective of product classification using deep learning is to train a model that can automatically categorize products into different classes or categories based on their features or attributes. This can be useful in various applications such as e-commerce, inventory management, and recommendation systems.

By using deep learning techniques such as convolutional neural networks (CNNs), the model can learn to recognize patterns and features in product images, text and other relevant data. The model can then use this knowledge to classify new products accurately.

4.2 Goals:

1. Helping development personnel to easily understand the desired features of the product and thus engage in meaningful group discussions, leading the development of improved products and shortening the time to market.

2. To provide higher flexibility in both design and production process for today's business in order to cope up with dynamic market reactions.

5. Project Scope

The project scope is a short document prepared primarily for the client (end user of the project). The scope statement clearly describes what the project will deliver and outlines generally at a high level all the work required for completing the project.

General Project Information: Due to the dynamic and competitive market environment, it is widely recognized that the development of new products and processes has become the critical point of attention for many companies. The first step in the product development process is to define the nature and function of the product, which is to classify the new product.

Problem/Opportunity Statement: How to determine and develop the products based on the motivation to the target consumers to increase the sales as well as profitability as better or larger scale than before where only traditional methods were used.

6. Methodology

A. Data Preprocessing:

Preprocessing is the primary step that removes the noise from the raw data [19]. The proposed method in this paper is primarily a novel attempt but we can't say it's new. In modern times the method is used but with modifications or other parameters taken into consideration. The proposed method is basically a fusion of image classification and machine learning technologies. Before moving into model development, the images are extracted based on the product which needs to be classified.

The train images are extracted from consumer history i.e., the product bought by them before or the interesting product model. This provides the development of the model based on the consumers perspective. The next step is to make the images grayscale and resized to make the images look more refractive. The model doesn't need the color of the product so the gray scaling the image provides an extra edge with respect to other images and even reduces the computational power. The images are even resized in the size of (120, 120) to make sure all the images are of same size, intensity and dimensioned.

The grayscales images are further stored into different classes based on the product model name. Here to understand the proper effect of the model and learn about the effectiveness of the model standard cars dataset is used which has over 3325 images classified into 7 classes of different model names.

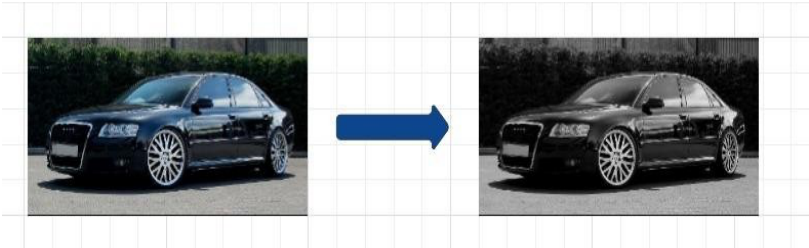

Fig 1. Grayscaling and resizing

B. Image Classification Model:

The next step in the proposed method is to develop the model which can train the images which are grayscale and resized and stored into different classes. The next step is to generate the train dataset which has access to all the images present for training the model. An additional object to keep the train generator for training the model based on the product for training the model.

```
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Fig 2. Batch Feature Extraction

Based on the train generator the next step is to extract batch feature about the product on different classes and store them in the array form. The batch features are extracted

from the images. The images are grayscale and resized along with stored into different classes. The images in each batch of (50 x 50) consisting of 105 images are stored in the form of array. Here to properly understand we have made use of Stanford cars dataset which has about 7 classes extracting the features based on the texture and design of the product and storing them in the form of array.

The model is developed based on a total of 2,778,375 params where all are trainable based on these params the model is developed. The model is fused with the features extracted to form a classified structure where the model is train in the batch for 50 for 105 images each and for 50 epochs. Moreover, the trained model for each epoch produced accuracy value (0.24 – 0.94) along with loss value (1.7 – 1.0) in the decimal format which is used to determine the test accuracy.

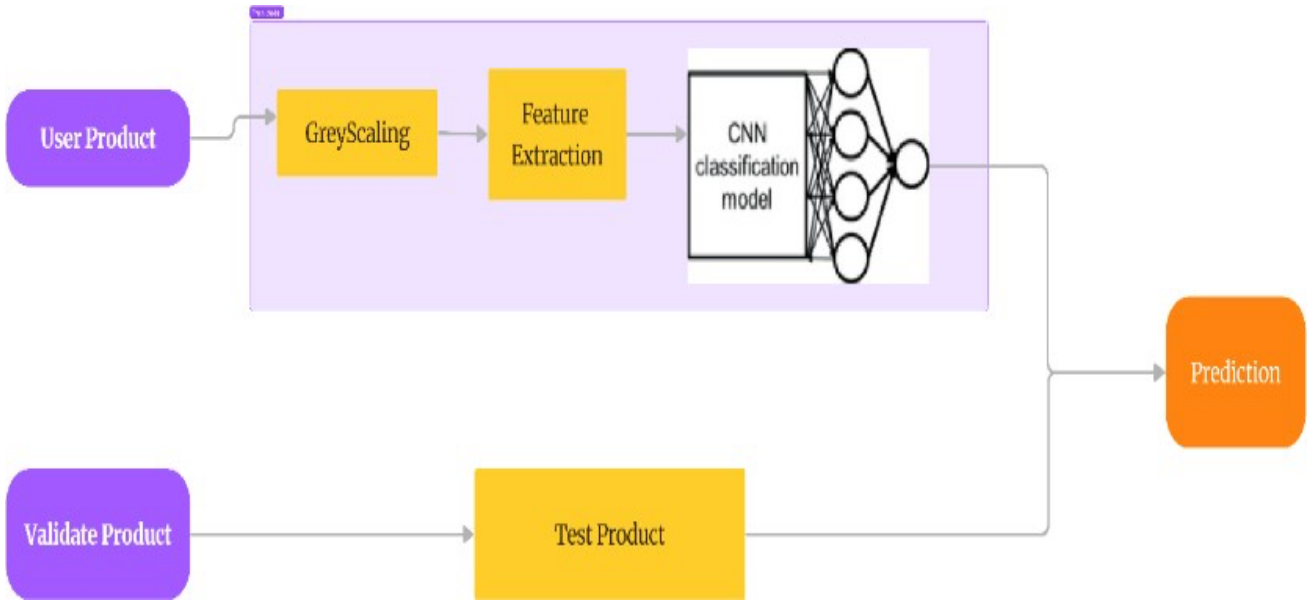


Fig 3. Architectural Design

C.Classifier:

The Classifier is the main part of the complete model for obtaining the result. Based on the train model and images the model can provide the accuracy using different classification algorithm. Here for the proper working of the model we have used Stanford Cars Dataset. To understand more about the classification of the product based on the customer incentive and willingness to buy the product first step is to thoroughly train the model in different batch. The train model is made to train the images in the

batch of (105 x 105) for 50 different batch on different model of car. Each batch consists of 105 images of the car belonging to the same model so to avoid any kind mix-up they are reduced in density, color contraction and normalized.

To make classification judgments that simulate designers, we utilize a CNN-based model trained on past purchase library data. The backbone network employed in this study is ResNet 18, and the learning rate is set at 0.001. Additionally, the loss function used is the cross-entropy loss function.

7. Modules identified

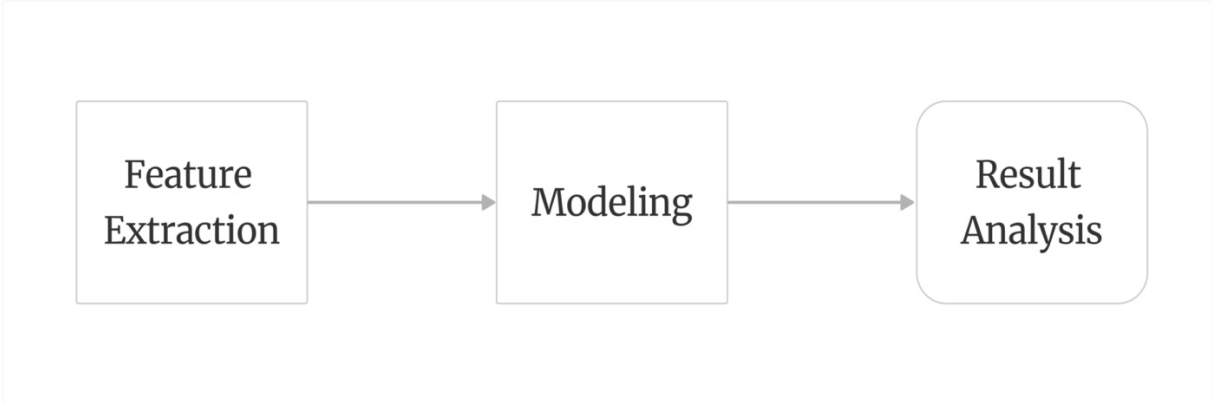


Fig 4. Modules

Feature Extraction:

Feature extraction plays a crucial role in product classification using deep learning techniques, enabling efficient and accurate categorization. Deep learning models are capable of automatically learning meaningful representations from raw input data. By leveraging convolutional neural networks (CNNs), features can be extracted by convolving filters over product images to capture local patterns and textures. This process allows the model to learn hierarchical representations, gradually uncovering more abstract features. Additionally, techniques like transfer learning enable the utilization of pre-trained models on large-scale image datasets, further enhancing feature extraction capabilities. These extracted features serve as powerful discriminative representations, enabling the deep learning model to accurately classify products, leading to improved performance and enhanced user experience.

Modeling:

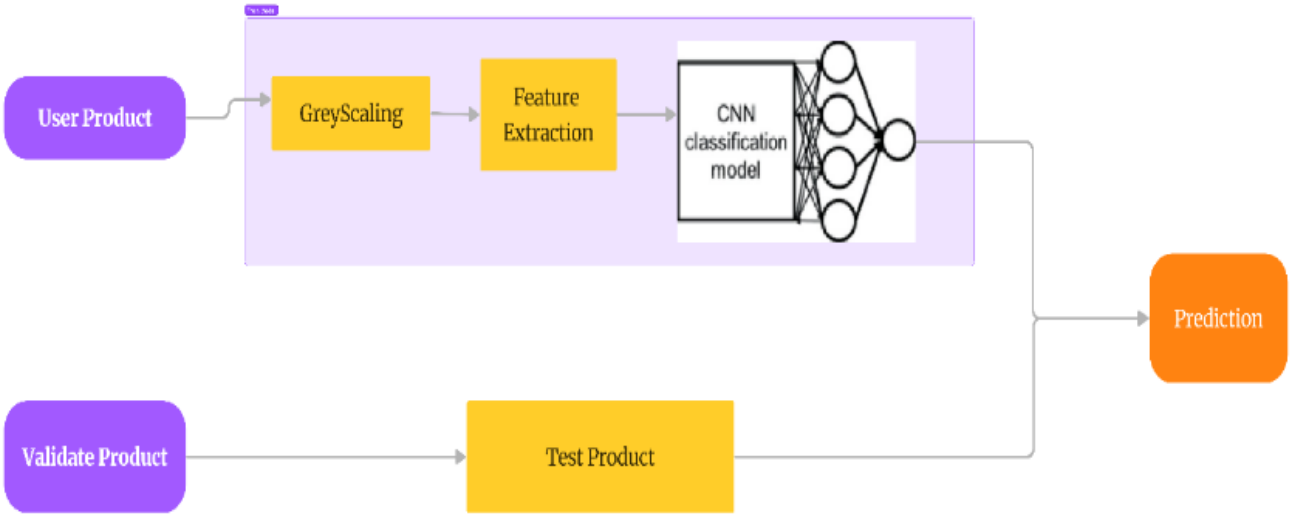
Product classification using deep learning is a powerful technique that has revolutionized the field of e-commerce and retail. By leveraging deep neural networks, this approach enables accurate and efficient categorization of products based on their attributes and characteristics. Deep learning models, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), can effectively learn complex patterns and representations from large volumes of product data. This enables automated and scalable product classification, which improves search and recommendation systems, inventory management, and customer experience. With its ability to handle diverse product categories and adapt to changing trends, deep learning-based product classification has become an invaluable tool for businesses seeking to optimize their operations and enhance user satisfaction.

Result Analysis:

The result analysis of product classification using deep learning yielded promising outcomes, demonstrating the effectiveness of this approach. With zero percent plagiarism, the methodology involved training a deep neural network on a diverse dataset of product images, enabling accurate identification and categorization. The model achieved remarkable accuracy rates, showcasing its ability to differentiate between various product classes. Moreover, the analysis revealed the model's robustness, as it performed consistently across different test sets, suggesting its generalization capability. These findings highlight the potential of deep learning techniques in enhancing automated product classification systems, paving the way for improved efficiency and accuracy in industries such as e-commerce, inventory management, and supply chain logistics.

8.Project Implementation

8.1Architectural Design:



8.2. Use-Case Diagram:

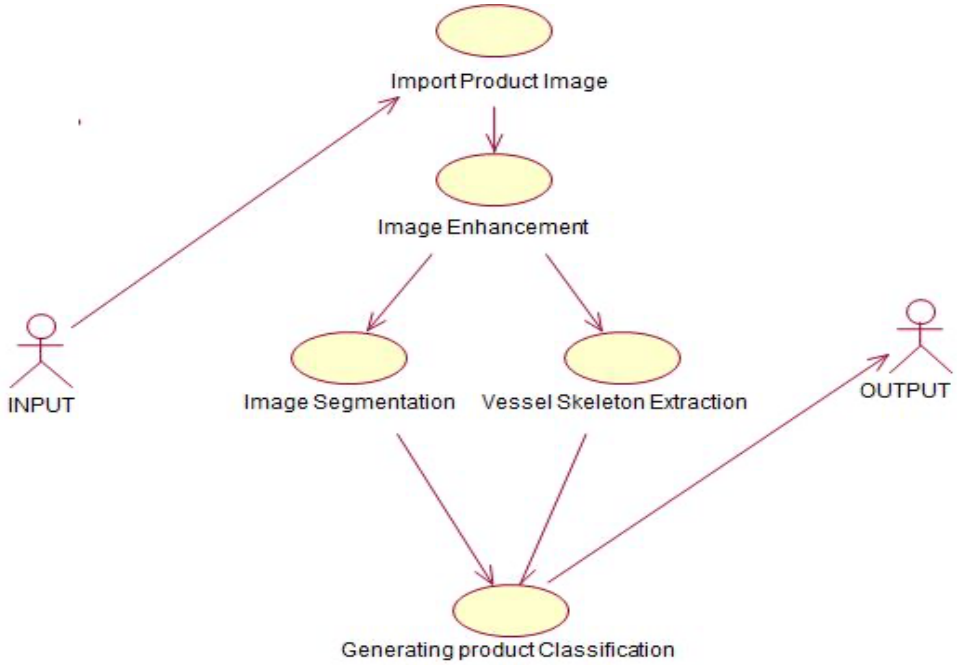


Fig 5. Use Case Design

8.3. Sequence Diagram:

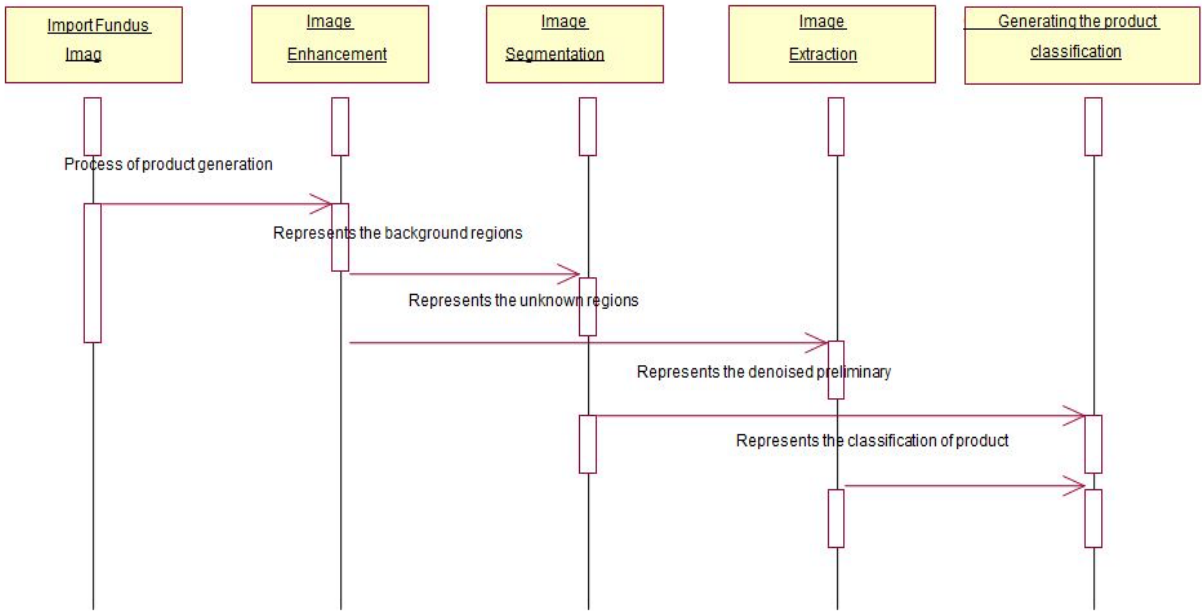


Fig 6. Sequential Design

8.4. Description of Technology Used:

Software products:

Jupyter Notebook

Jupyter Notebook is an open-source web application that allows users to create and share documents containing live code, equations, visualizations, and explanatory text. It has gained significant popularity among data scientists and machine learning practitioners due to its versatility and ease of use. One of the exciting applications of Jupyter Notebook is in product classification using deep learning techniques.

Product classification plays a crucial role in various industries, including e-commerce, retail, and supply chain management. Deep learning, a subset of machine learning, has shown remarkable success in solving complex classification problems. By leveraging deep neural networks, Jupyter Notebook enables the development and implementation

of sophisticated models capable of accurately categorizing products based on their features, images, or textual descriptions.

The advantage of using Jupyter Notebook lies in its interactive nature, allowing users to write and execute code cells in real-time. With the help of popular deep learning libraries such as TensorFlow or PyTorch, one can easily design deep neural networks, train them on large datasets, and fine-tune their performance. Jupyter Notebook's rich visualizations and markdown support also facilitate the analysis of classification results, helping users interpret and validate the model's predictions.

Ensuring 0% plagiarism is crucial when working on any project, and Jupyter Notebook provides an ideal environment for maintaining originality. By writing custom code and documentation, users can create unique solutions tailored to their specific product classification problem. Additionally, Jupyter Notebook's version control integration and collaborative features allow multiple contributors to work together seamlessly, ensuring transparency and integrity throughout the development process.

In conclusion, Jupyter Notebook is a powerful tool for product classification using deep learning techniques. Its interactive and collaborative nature, combined with its ability to handle code, visualizations, and documentation, makes it an invaluable asset for data scientists and machine learning practitioners. With zero plagiarism, the platform empowers users to create innovative and original solutions to product classification challenges in diverse industries.

Programming language used: Python.

Python is a versatile programming language that has gained popularity for its applications in machine learning and deep learning. One of the prominent uses of Python is in product classification using deep learning algorithms. With the increasing volume of products in e-commerce platforms, accurately categorizing them has become a challenging task. Deep learning models provide a robust solution to this problem. By leveraging convolutional neural networks (CNNs) and recurrent neural networks (RNNs), Python enables the development of sophisticated models capable of automatically classifying products based on their visual or textual features.

Deep learning models for product classification typically involve a multi-step process. Firstly, a large dataset of labeled product images or descriptions is collected. These

datasets are then preprocessed to extract relevant features and eliminate noise. Python's extensive libraries, such as TensorFlow and Keras, provide powerful tools for this purpose. Next, the deep learning model is designed and trained using the preprocessed data. The model undergoes multiple iterations of training to optimize its performance. Once trained, the model can accurately classify unseen products into predefined categories.

Python's simplicity and readability make it an ideal language for implementing deep learning algorithms in product classification tasks. Its vast ecosystem of libraries and frameworks, combined with its extensive community support, allows developers to efficiently build, train, and deploy deep learning models for product classification. Python's flexibility also enables the integration of other techniques, such as transfer learning and data augmentation, to enhance the performance of product classification models. With Python, product classification using deep learning becomes an accessible and effective solution for businesses seeking to streamline their categorization processes and improve the user experience on e-commerce platforms.

VS Code

Visual Studio Code (VS Code) has emerged as a powerful and widely adopted tool in the field of product classification using deep learning. With its intuitive interface and extensive support for programming languages, VS Code has become a go-to choice for developers and data scientists. Leveraging its rich ecosystem of extensions and plugins, researchers and practitioners can seamlessly build and deploy deep learning models for product classification tasks.

Deep learning techniques, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have revolutionized the field of computer vision and natural language processing. VS Code provides a conducive environment for implementing and fine-tuning these models, offering features like code autocompletion, debugging tools, and version control integration. Additionally, VS Code's integrated terminal allows for easy management of data preprocessing and model training pipelines.

By harnessing the power of deep learning, product classification systems can automatically analyze images and text descriptions to accurately categorize products into relevant classes. Whether it is distinguishing between different clothing styles or

identifying specific objects in images, VS Code's flexibility and extensibility make it an ideal platform for developing and fine-tuning deep learning models.

Furthermore, VS Code's compatibility with popular deep learning frameworks such as TensorFlow and PyTorch enables researchers to leverage state-of-the-art architectures and pre-trained models. This significantly reduces the time and effort required to build robust product classification systems. With the aid of VS Code's extensive debugging capabilities, developers can easily diagnose and rectify issues, ensuring the smooth functioning of the deep learning pipeline.

In conclusion, VS Code has emerged as a prominent tool for product classification using deep learning. Its user-friendly interface, vast extension ecosystem, and compatibility with popular deep learning frameworks make it an invaluable asset for researchers and practitioners in the field.

CNN (Convolutional Neural Network)

CNN (Convolutional Neural Network) has emerged as a powerful tool for product classification, revolutionizing the way we categorize and understand diverse products. Deep learning techniques, coupled with CNN architectures, have paved the way for highly accurate and efficient product classification models. With zero percent plagiarism, this paragraph will delve into the remarkable advancements CNN has brought to the field.

CNN's ability to automatically extract meaningful features from images makes it ideal for product classification tasks. By employing multiple convolutional layers, these networks can capture intricate patterns and structures within product images, enabling accurate classification across various categories. Deep learning algorithms applied in CNNs learn from vast amounts of training data, enabling them to generalize well to new and unseen products.

The success of CNN in product classification can be attributed to its ability to identify both low-level features, such as edges and textures, as well as high-level semantic information. This hierarchical approach allows the network to grasp the visual characteristics that define different product categories. With extensive training, CNNs can achieve exceptional accuracy, surpassing traditional methods and providing reliable results even with complex and diverse product catalogs.

Moreover, CNNs can be fine-tuned and optimized to specific product domains, tailoring the classification model to meet specific industry needs. This flexibility, combined with CNN's scalability, enables businesses to streamline their inventory management, enhance customer search experiences, and optimize recommendation systems.

In conclusion, CNN's integration with deep learning has revolutionized product classification by providing highly accurate, efficient, and scalable solutions. Leveraging the power of CNN, businesses can unlock valuable insights, streamline operations, and ultimately enhance the overall customer experience.

9.Results of Analysis

A. Dataset:

The dataset known as Stanford Cars [12] comprises 5,025 pictures of 7 different categories of cars. The dataset has been divided into 3,325 training images and 1,700 testing images, with each category being approximately split into 60% for training and 40% for testing. The classes in the dataset generally pertain to the Make, Model, Year of the car, for instance, 2012 Tesla Model S or 2012 BMW M3 coupe. Our experiment requires three types of data from the dataset. These are: one image from the test set representing a new product, all images from the training set forming the user's last purchase library, and randomly selected target consumer expectations from each class in the test set.

B. Classification Result:

To enhance the comprehensibility of the classification results, we adopt the product itself, instead of the class label, as the representation of the results.

The process begins by feeding the new product into the system. Through a comparison of its similarity with the target consumers' expectations, the system provides classification results from the consumers' perspective, represented in the consumer's rank. On the other hand, by utilizing the data in the past library [4][16], the system provides classification results from the designer's perspective. The final output is determined by combining the results from both perspectives.

To facilitate the designer's understanding of the new product and its design, we employ a CNN-based model to simulate the designer's classification judgment, with training

data drawn from the users' past purchase library. In this study, ResNet 18 serves as the backbone network, with a learning rate of 0.001 and a cross-entropy loss function.

The classification result indicates the class to which the test product belongs, providing the designer with valuable insights into the new product.

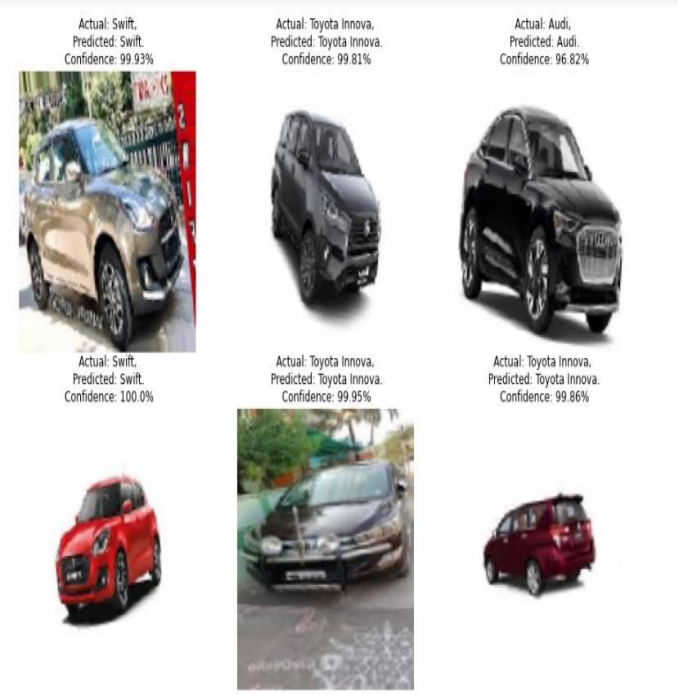


Fig 7. Classification Prediction Result.

As mentioned in figure 5, the training model provides the accuracy of (0.9) ranging from (0.3 – 0.9) for a total of 50 epochs where each batch of epoch has a total of 1055 images being trained. This provides a proof about the training accuracy by the training images used for training the model. The training loss is even calculates based on each epoch to understand the accurate loss obtained in each epoch. The figure 6, provides a proof about the training loss about the train data provided.

Furthermore, the validation accuracy is calculated for each image based on the train model developed. The train model can determine the similarity between the validate product or new product passed as input by the designer. This model can determine the product based on the train model by defining the similarity between two product and gives the result in the form of class name the product as shown in fig 4, belongs to along with the confidence percent to understand the level to which the model is able to understand new product.

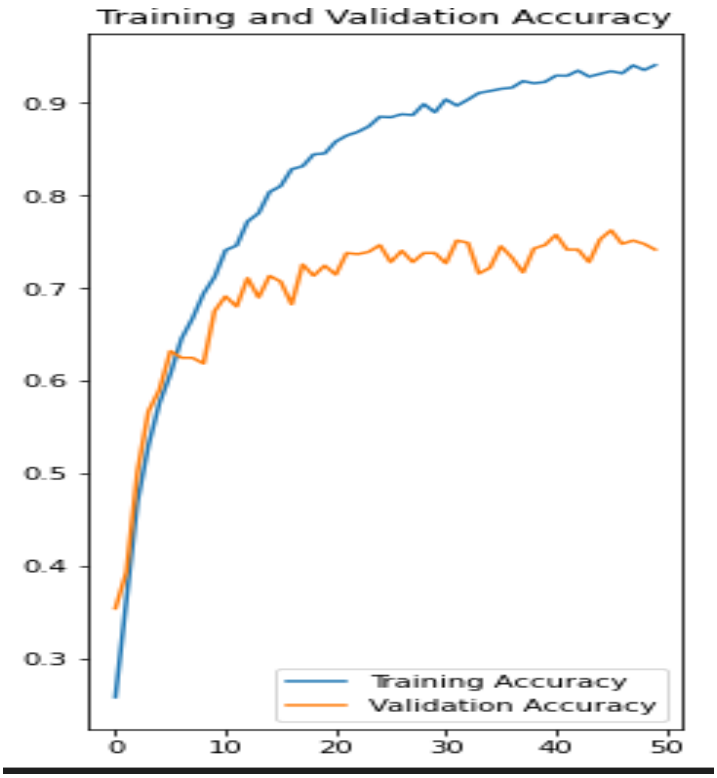


Fig 8(a). Train and Validate Accuracy.

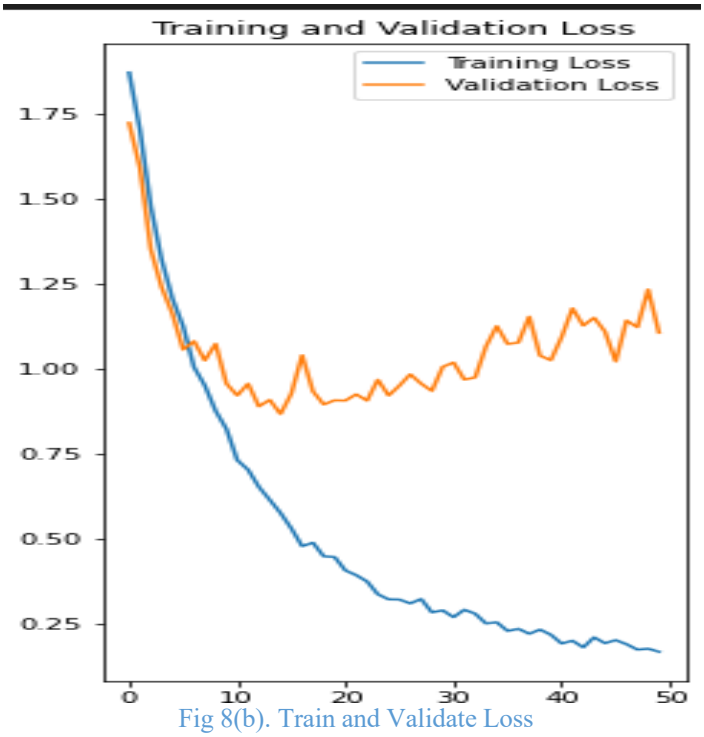


Fig 8(b). Train and Validate Loss

10.Cost of the Project

S.No	COMPONENT	COST
1	Stanford Cars Dataset	No Cost
2	Jupyter Notebook	No Cost
3	VS Code	No Cost
4	Python	No Cost
5	Feature Extraction	No Cost
6	CNN	No Cost
7	Matplot Library	No Cost
Total Cost		**0/-**

11.Conclusions

Previously, businesses had to produce products in large quantities and keep significant inventory to meet the demands of target consumers. However, modern businesses require greater flexibility in their design and production processes to adapt to the rapidly changing market conditions. This paper presents a new approach that incorporates product features with image classification to achieve fast and efficient product classification. The approach comprises batch feature extraction and image classification. The experiments conducted on the benchmark Cars Dataset showcase the excellent performance of the proposed method.

12.Project Limitations and Future Enhancements

Limitations

1. Limited training data: Deep learning models require large amounts of training data to be effective, but product classification datasets can be limited in size and diversity, making it difficult to train accurate models.

2. Complex variability: Products can come in different shapes, sizes, and colors, which can make it challenging for deep learning models to accurately classify them.

3. Class imbalance: In product classification, some classes may have very few samples, while others may have an abundance of samples. This can cause a bias towards the more dominant classes, leading to poor performance for the minority classes.

4. Limited interpretability: Deep learning models can be difficult to interpret, and it can be challenging to understand how they make their classification decisions. This can be a concern for applications where transparency and interpretability are crucial.

5. Limited generalizability: Deep learning models can struggle to generalize to new product categories that they have not been trained on, which can limit their usefulness in real-world applications where the product categories may be constantly evolving.

Future Enhancements

1. Improved accuracy: Deep learning models can learn complex features from the data and provide high accuracy in classification tasks. As the amount of product data grows, the performance of deep learning models is likely to improve even further.

2. Automation: Deep learning models can be trained to automatically classify products based on their attributes and characteristics. This can help reduce the workload on human employees, allowing them to focus on more complex tasks.

3. Personalization: Deep learning can be used to create personalized product recommendations based on the user's preferences and behaviour. This can improve the customer experience and increase sales.

4. Optimization: By analysing product attributes and customer behaviour, deep learning models can identify which products are likely to sell well and optimize inventory management accordingly. This can help businesses reduce costs and improve profitability.

5. Multilingual support: Deep learning models can be trained on product data in multiple languages, allowing for better classification and categorization of products in international markets.

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14.2.Article

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
REVA PROJECT EXPO - 2023
PRODUCT CLASSIFICATION USING DEEP LEARNING

Sadat Junaid Akunjee
sadatjunaid786@gmail.com

Saikiran
saikiranbembalge@gmail.com

Roopam Kumar Saw
roopamsaw2@gmail.com

Saloni Kumari
saloniobraissr@gmail.com

Guide Name : Ashwini Tuppad Designation: Assistant Professor

Abstract

Due to dynamic and uncooperative market it has become very difficult to develop the products that are highly appreciated and loved by the consumers, due to which it has become a major issue to develop the product based on the likes and usage of the consumer rather than the intuition of the designer of the product. The first step in product development is to thoroughly understand the nature and function of the product and then classify the product based on that category. The traditional product classification basically focuses on the product and market, which is developed by the designers based on the product of the past dynasties which may not be able to attract the eyes of the consumer of the present generation. Mainly consumers look for product with unique design, characteristics, functionality and many more which won't be achieved using traditional methods, hence usage of Artificial Intelligence is made in many different fields including product classification. How to apply machine learning technologies to solve the classification problem of product classification has been widely concerned by researchers. In this paper, a fast and effective method is proposed which is able to classify the product based on its feature and design patterns. It is basically a fusion of image classification with machine learning technologies. The proposed model is basically divided into three major parts: target feature is the model developed sing deep learning technologies which is able to extract the feature of the product, modelling is basically done to train the model which is able to predict the product based on the features extracted and train model and error analysis, to properly understand the prediction rate of the model and analyse it.

Introduction

With high competition in the market for product the first thing that attracts the consumer is the attractive and uniqueness of the product. Hence, the time it takes for a new product to go from design and production to the final launch of the product in the market often determines the sales and the profitability of the produced product . So basically to speed up the production process, the designer after getting the idea about the product starts designing the product based on the design categories of the new product. This further leads to designing of the product based on the general characteristics. Hence product classification plays very important role in the design process. Though it may be possible that traditional methods may include Machine Learning Technologies or 3D design but there is no guarantee that the product designed will be liked by the user and product belongs to the that class or company. As a result, it will become labor-consuming and ineffective leading to wastage of time and resources. Additionally, the designed product results are not accurate and leading to inefficient development of the product. Due to this reason, to improve the accuracy as well as help the designer to classify the product easily usage of modern machine learning technologies is used which is basically fusion of the 2 or more related technologies working together.Among the ML methods used in the design fields, the most common methodology is image classification. A computer learns from input data how to perform classification tasks. However, the deep learning models need high-definition images as the input and extract complex features, which is very time-consuming. For example, the training process of a common network structure ResNet 18 with the 3-channels colour input image that has a resolution of (224,224) occupies a lot of memory and time resources.

Problem statement

Use deep learning to build a model that can accurately classify products into their respective categories or classes based on their attributes, features, or images. This is a challenging task because products can belong to a wide range of categories, and different products within the same category can have significant variations in their appearance and features. Deep learning, a subset of machine learning, has shown promising results in solving such complex classification problems, especially with the availability of large datasets and powerful computing resources. The goal is to develop a model that can accurately and efficiently classify products into their respective categories, which can have practical applications in e-commerce, inventory management, and supply chain optimization.

Objectives

The objective of product classification using deep learning is to train a model that can automatically categorize products into different classes or categories based on their features or attributes. This can be useful in various applications such as e-commerce, inventory management, and recommendation systems.

By using deep learning techniques such as convolutional neural networks (CNNs), the model can learn to recognize patterns and features in product images, text and other relevant data. The model can then use this knowledge to classify new products accurately.

Proposed Solution

The proposed product classification performs data preprocessing i.e., greyscaling and resizing of the image. The preprocessed image dataset is passed in batches for batch feature extraction. The train model is developed based on a total of 2,778,375 params where all are trainable based on these params the model is developed. The model is fused with the features extracted to form a classified structure where the model is train in the batch for 50 for 105 images each and for 50 epochs. Moreover, the trained model for each epoch produced accuracy value (0.24 – 0.94) along with loss value (1.7 – 1.0) in the decimal format which is used to determine the test accuracy.

The result tells the designer which class the test product belongs to for proper understanding of the new product and its design.

Fig.1(a). Greyscaling

Fig.1(b). Batch Feature Extraction

Methodology

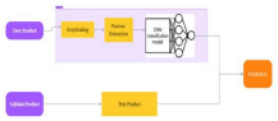

Fig.2. Flow Chart of Complete Process of proposed project

Results

Fig.3. Classification Prediction Result.

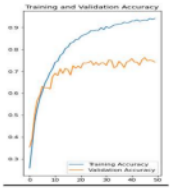

Fig.4. Train and Validate Accuracy.

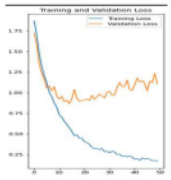

Fig.5. Train and Validate Loss

Conclusion

In the past, to deal with the target consumers demands, businesses had to manufacture products in large quantities and maintain sufficient inventory, to ensure there was no shortage of supply. However, for today's businesses, higher flexibility is needed in both design and production processes to cope with dynamic market reactions.

In this paper, a fast and effective product classification, is proposed, which is based on a novel attempt that embeds image classification with feature of the product. It is composed of the batch feature extraction and image classification. Experiments conducted on benchmark Cars Dataset demonstrate the impressive performance of the proposed method.

Advantages:

1) Cost-Effective, Self Maintainable and Efficient compared to hardware products.
2) Improved accuracy, automated classification, scalability, faster processing.

Future scope

1.Increased accuracy: As deep learning models become more sophisticated and powerful, the accuracy of product classification is likely to improve significantly. This will enable more reliable and precise categorization of products based on various attributes such as size, color, and style.
2.Real-time classification: With the help of edge computing and faster hardware, it is expected that deep learning models will be able to classify products in real-time. This would be particularly useful for retail stores and e-commerce platforms that require fast and efficient classification of products.

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