Bangladeshi Online Market Product Classification Using Deep Learning
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This Report Presented in Partial Fulfillment of the Requirements for the

Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project/internship titled **"Bangladeshi Online Market Product Classification Using Deep Learning"**, submitted by Name: **Piyal Barua ID: 172-15-10141** to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on May, 2021.
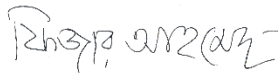
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DECLARATION

I hereby declare that this project has been done by us under the supervision of **Md. Abbas Ali Khan, Department of CSE** Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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Finally, I must acknowledge with due respect the constant support and patients of my parents and brother.

ABSTRACT

Artificial Intelligence, is becoming the most powerful sector current days, especially deep learning or machine learning where program started to learn from our world's data or experience. In future we can have an assistant in our home who can do online shopping for us, can bring the product what we tell it to bring. Online market is a vast network of current world where maximum people want to buy product without going to shopping mall. In Bangladesh approximately 2,000 e-commerce sites and 50,000 Facebook-based outlets delivering almost 30,000 products a day. It will rise day by day. In online market there are different kind of product with different categories. In this paper, I have proposed the convolutional neural network (CNN) based approach for classifying product of five different categories product with thirty tree types of sub-categorical product from Bangladeshi popular online market from 1725 product images. For better research, I have used a model of CNN and identify a product with higher accuracy. Convolutional Neural Network (CNN) calculations, a machine learning system extensively applied to train program and identify product with class and sub-class from given a known type picture. The outcomes model of this project can be applied to future robots or intelligent program or any kind of online ecommerce site's admin panel to detect real product identical with given title. For better outcomes and better accuracy, I used RGB color model of the picture and trained the network with powerful Nvidia GPU. The prepared model accomplished an exactness of 95.14% on test set, showing the achievability of this methodology.

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Introduction

1.1.Introduction:

Online shopping is one of the fastest growing trends in the world. Also, online businesses are growing rapidly in Bangladesh. Although the number of internet users has been growing in the country but the number of online shoppers has not grown to that extent. Online shopping has great economic prospect. Online traders should understand the scope of the industry and for developing this economically potential industry in the country traders should realize that determinants of success not only depend on website presence, low price and product variety but also depend on service quality. In future there can be a service to automate the order process from only picture like user do not the name of a product but have the picture and he/she can have a system to upload the picture and search it on the site. For this site should have an intelligent program to identify the product with its class and sub-class. On the other hand, in future there can be a robot as an assistant who can search product from online and order on behave of us. So, this robot or program both need a way to learn about online product with its class and sub-classes. In future there can be a program which can search product from different ecommerce site and bring all product together in front of the customer. For this program it also needs to have knowledge about online product. For all of this circumstances I proposed an intelligent program which can identify and classify a product from given picture. To achieve this goal and classification, neural organization has been demonstrated to work in a way that is better than conventional classifiers in numerous cases. Combined with this advanced neural form organization, convolutional neural networks (CNN) take a picture of information and use a split layer flexibility. In this paper, we have formalized a RGB shading picture dataset of Bangladeshi famous online market product and used the dataset for detecting the product with its class and sub-class utilizing Convolutional neural network model and its algorithm.

1.2. Types of online products:

i) **Electronic-Devices:** Electronics devices are the most commonly sold product and the largest market in online market of Bangladesh. As we live in age of technology electronics product covers the vast area of online market alone. There are many kinds of electronics product in the online market. So, I put electronics product as a class and variation of this product as sub-class like Laptops, Security-Cameras-System, Desktop-Computers, Smartphones and Tablet.
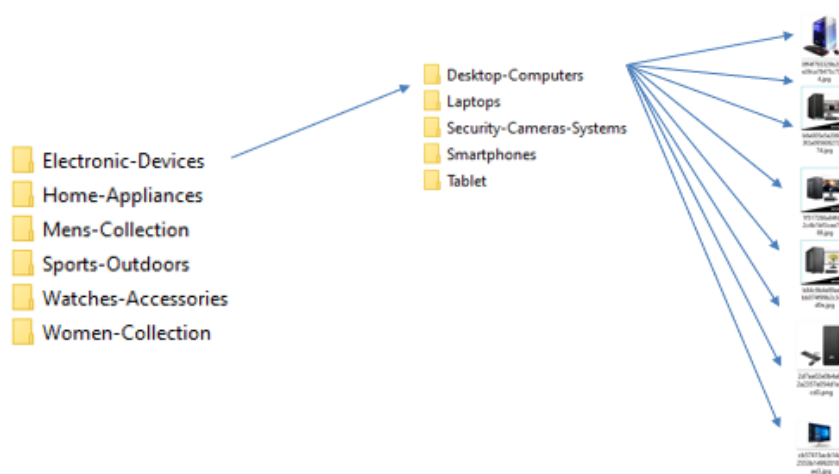
Fig 1. Electronics Devices (Desktop-Computers)
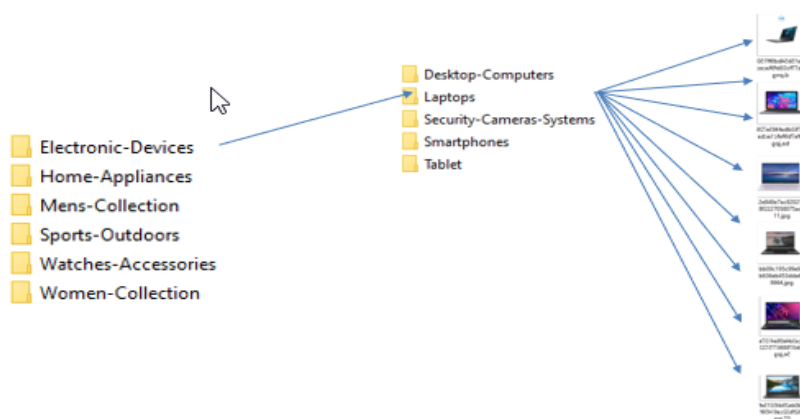
Fig 2. Electronics Devices (Laptops)

ii) **Men's-Collection:** From a search the reality is that some 47.6 million or 30 percent of the total 158.5 million people in Bangladesh are young (10-24 years), and it will be between 10 and 19 percent by 2050. [6] So man's collection is generally seen in maximum ecommerce marketplace. Here I collected data from various sub-category like Jeans, Joggers-Sweats, Man's Bag, Men's shoes, Shirt, Sweater and T-Shirt.

Fig 3. Men's-Collection (Jeans, Jogger-Sweats, Man's Bag)

Fig 4. Men's-Collection (Shoes, Shirt, Sweater, T-Shirt)

iii) Women-Collection: Like man, woman collection is one of the top goods sold in ecommerce market place. Most of the woman are now habituated with online ecommerce market in Bangladesh. In this category of collections, I collected data on some most commonly found sub categories like Bags, Kurti, Salwar-Kamiz, Saree, Shoes, Skirt, Tops and Winter collections.

.

Fig 5. Women's-Collection (Bags, Kurti, Salwar, Sharee)

Fig 6. Women's-Collection (Shoes, Skirt, Tops, Winter)

iv) Sports-Outdoors: Sports goods have large number of sales in online ecommerce market. Since sports is a famous topic from hundreds of years as a result various sports item sold to the market place like Badminton-Rackets, Bikes, Cycling-Machines, Dumbbells, Fitness-Accessories, Team-sports and Treadmills.

Fig7. Sports Outdoors Images.

v) Watches-Accessories: Watches are commonly sold in ecommerce market. In this category I collected different types of watches images from online marketplace like kid's-watches, Man's watches and woman's watches.

Fig8. Watches Accessories.

1.3. **Machine Learning:** AI is the use of Artificial Intelligence (AI) which gives structures the ability to naturally take and improve reality without undoubted change. AI focuses on the development of PC systems that can access information and use it for self-discovery. Machine learning (ML) is an investigation of PC statistics that naturally evolve through experience. It is considered a man-made piece of information. AI statistics create a model based on the knowledge of the model, known as "data preparation", to solve expectations or to choose without having to customize without hesitation to do so. Machine learning statistics are used in a variety of applications, for example, email filtering and PC view, where it is difficult or ineffective to create traditional statistics to play required routes.

1.4. Machine Learning Methods: In machine learning, high performance is expressed in standard categories. Two of the most widely used methods of machine learning are supervised learning algorithm training based on model knowledge and information that has been marked by humans, as well as supervised learning that gives the algorithm anonymous information to allow it to form within its knowledge. We should investigate these methods in more detail.

I. **Supervised Learning:** Supervised learning is an AI instructional learning skill that marks a contribution to a yield based on knowledge that produces a pair-by-two model. It derives strength from marked preparation data that includes a wide range of preparatory models. [7] In supervised learning, PCs are provided with sample data sources marked with their appropriate yields. The motive of this strategy is for a statistic to have a "learning" option by comparing its actual yield with the "taught" fruits of finding errors, and to adjust the model accordingly. [8] The adaptability that is controlled thus uses examples to anticipate word ratings for other non-label information.

II. **Unsupervised Learning:** Unregulated learning (UL) is a form of AI that searches for unpredictable examples in a database that has no previous names and at least has human control. Instead of supervised reading (SL) which often uses personalized data, self-study, otherwise called engagement tends to show the intensity of opportunities beyond input. [10] In unsupervised reading, data is not labeled, so the learning algorithm is left to find shared features within its information. Since non-labeled information is more abundant than tagged information, electronic learning methods that promote self-study are more important.

1.5. CNN: The convolutional neural organization (CNN) is probably the most popular form of in-depth learning, a form of machine learning in which a model shows how to perform an action directly from images, video, text, or audio.[2] CNN is especially useful in finding make-up in photos to see articles, faces, and scenes. They sync directly from image information, use examples to edit images and clear the requirement for manual extraction.[4] A dynamic neural organization can have tens or even layers where each learns how to distinguish the highlights of the image. Channels are used in each photo preparation for various purposes, and the yield of each image displayed is used as a contribution to the next layer. Channels can start out as basic elements, for example, jewelry and fringes, and a rise in a multi-faceted environment is a remarkable highlight.

1.6. Objective:

- In this work, our main goal is to create a model that can identify product categories and sub-categories, these days machine Reading is becoming a popular method of image editing.

- In this work, we used CNN model with some algorithm, we trained our model using the dataset for identifying product perfectly.

1.7. Motivation: Online marketplace has large number of effects in our economy. In the future, there can be a service to automate the order process from only a picture like a user do not the name of a product but have the picture and he/she can have a system to upload the picture and search it on the site. This site should have an intelligent program to identify the product with its class and sub-class. On the other hand, in the future, there can be a robot as an assistant who can search products online and order on behave of us. So, this robot or program both need a way to learn about the online products with its class and sub-classes. In future there can be a program which can search product from a different eCommerce site and bring all product together in front of the customer. For this program, it also needs to have knowledge about online products. For all of these circumstances, I proposed an intelligent program that can identify and classify a product from a given picture. In this paper, we have formalized an RGB shading picture dataset of a Bangladeshi famous online market product and used the dataset for detecting the product with its class and sub-class utilizing the Convolutional neural network model and its algorithm.

1.8. Expected Outcome: Different kinds of products are available in the online market now a days. In this project, I want to make a program that can identify products with its class and sub-class. Like if I give a picture of cloth as input the program should have that ability to tell that the input picture category and sub-category.

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Chapter 2
Background

2.1 Introduction:

Different kinds of products have different kinds of category and subcategory. Identifying the product from by image processing is a process for recognizing the product image. For identifying product, we need a machine learning technic which need a collection of data of images based on product category and sub-category. In order to reset initially, we need a specific image and select this image as the default data for other conditions such as data collection, data redesign, data selection, and accuracy. Various types of work analysis strategies will be discussed. In this chapter are details about current work, related work, research summary, and details about the scope of our work. Here is a brief description of our target and the challenges we faced.

2.2 Related Work:

Now a day's image reorganization researcher has been performed and develop system to recognize the disease of fruit leaves. In various research-Machine Vision based system is performed through K-Means clustering, some experiment has been performed by them to show the utility of the propose expert system. By this system the disease attacked region segment out from the capture image. In this work they have achieved 90% accuracy classification. In another research which was performed to recognize shopping mall products. In this research, researcher proposed model based on Multiclass SVM which gave a fruitful result. Image recognition by image processing techniques is very important to identify product. To recognize the product image processing can be utilized. In our work we use CNN to classify the images He has got 99% accuracy but it was without any extraction. Another machine vision-based fruit classification has been proposed by Sung, Sung, Jae-Kyung, Park, Sang-Min, Sin, Sang-Yun, Kim, Yung-Bok (Received: 2017.05.02 Accepted: 2017.06.09 Published: 2017.06.30) [1]. In this research they have used SVM system. We are going to use CNN because when data is in huge quantity, this CNN algorithm can classify data or image layer by layer.

Chapter 3
Methodology

3.1 Methodology:

In this section, we focus on the proposed model of our experiment to order various online products, their types, and category of online products. A typical cycle of online products using CNN in-depth comes from the image structure in Figure 11. The experimental work is comprised of the basic steps outlined below in the paragraph

3.2 Two type of Research Methods:

Usually, there are a few methods used for the proposal, the two most common methods being the method of quantity and quality research.

    I.   **Quantitative Research Method:** Quantitative Research methods have been developed in conventional science to test virtual reality. The strategy is well-known in the social sciences, which includes experimental research, formal strategies, mathematical strategies, and solar panels. A measurement strategy is used to measure the number of people who feel, think or act with a specific purpose in mind.

    II.   **Qualitative Research Method:** On the other hand, multidisciplinary research methods also emerged socially to facilitate the professional investigation of social and social realities. This approach is based on job research, content analysis testing, and ethnography i.e., the part of the population that provides scientific exposure to individual community orders. Sources of information on these methods include direct and indirect insight, meetings, and polling stations, and expert opinion and feedback. Appropriate research methods used to obtain information on individual behavior, behavior, the framework of respect, concern, motivation, desire, culture, or lifestyle. It is used in the same way to advise business selection, method development, documentation, and testing. In addition, it includes the investigation of any informal matter including customer submissions frameworks, reports, media cuts. This recommendation function crosses the independent testing strategy and the details are based on the visual take on the existing structure and presence report.

3.3. Proposed Methodology:
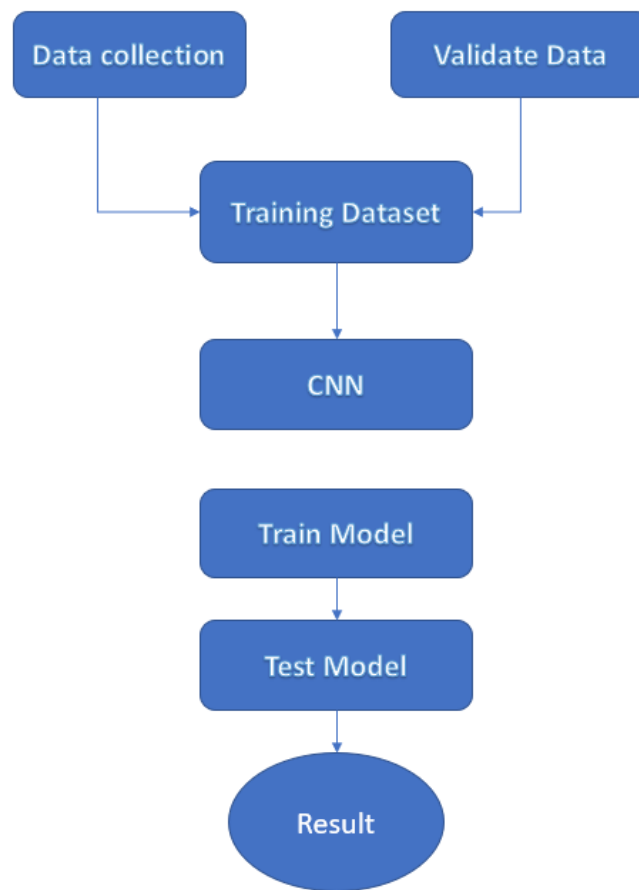
Fig 9. The proposed methodology

3.4 Research Subject and Instrumentation:

This project work can provide a clear idea of the research area in this section that we will use and design, complete data collection, relevant o data, and model training, and then the model app will work. To complete our work, we have used the Windows platform. In the course of our work, we have used the Python editing language and used many library packages - Tqdm, matplotlib, PyPlot, OpenCV, Python CSV, Sklearn, Numpy, and Tensorflow 2.3.0. We used the visual environment and Jupyter notebook. We chose python because this programming language is very reliable in quick testing of any complex algorithm and machine learning applications. If we do not use the physical environment, then we have to deal with many problems with the installation of libraries, packages. To avoid this problem, we have used virtual environment.

3.5 Data collection procedure:

In this work, we have made a new data set by collecting imaged from the online marketplace and store them in a sequence of their category and subcategory for training the proposed network. We have collected leaf images from a different online eCommerce site. All of the images are in JPG format and obviously, the resolution is not the same. In our data set we have about 1752 images with 5 categories products like "Electronic-Devices", "Men's-Collection", "Sports-Outdoors", "Watches-Accessories" , "Women-Collection" and 33 subcategories like "Desktop-Computers", "Laptops", "Security-Cameras-Systems", "Smartphones", "Tablet" , "jeans", "Joggers-Sweats", "Man's-bags", "men's-shoes", "shirts", "sweater", "t-shirt", "Badminton-Rackets", "Bikes", "Cycling-Machines", "Dumbbells", "Fitness-Accessories", "Team-sports", "Treadmills", "kid's-watches", "Kids-Sunglasses", "Men's-watches", "Men's-sunglasses", "Women-Sunglasses", "women's-watches", "Bags", "Kurti", "salwar-kamiz", "saree", "shoes", "skirt", "tops", "winter". Out of 1752 images, 80% of data for training and 20% for testing.
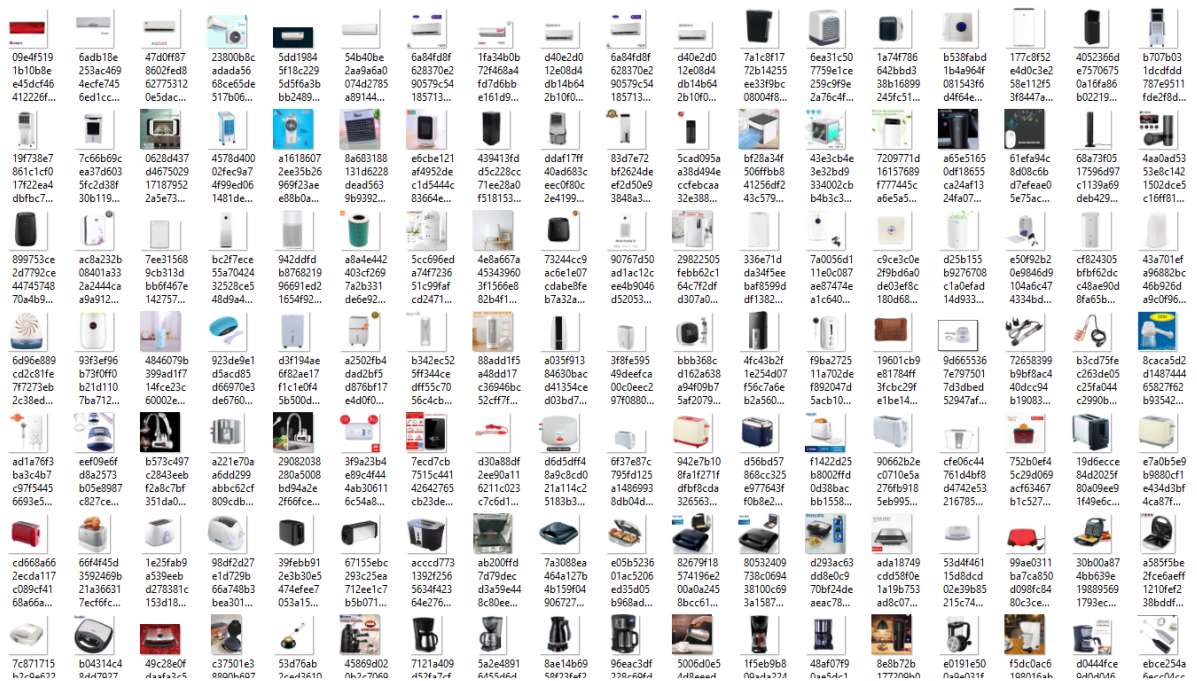
Fig10. Some collected data from online marketplaces
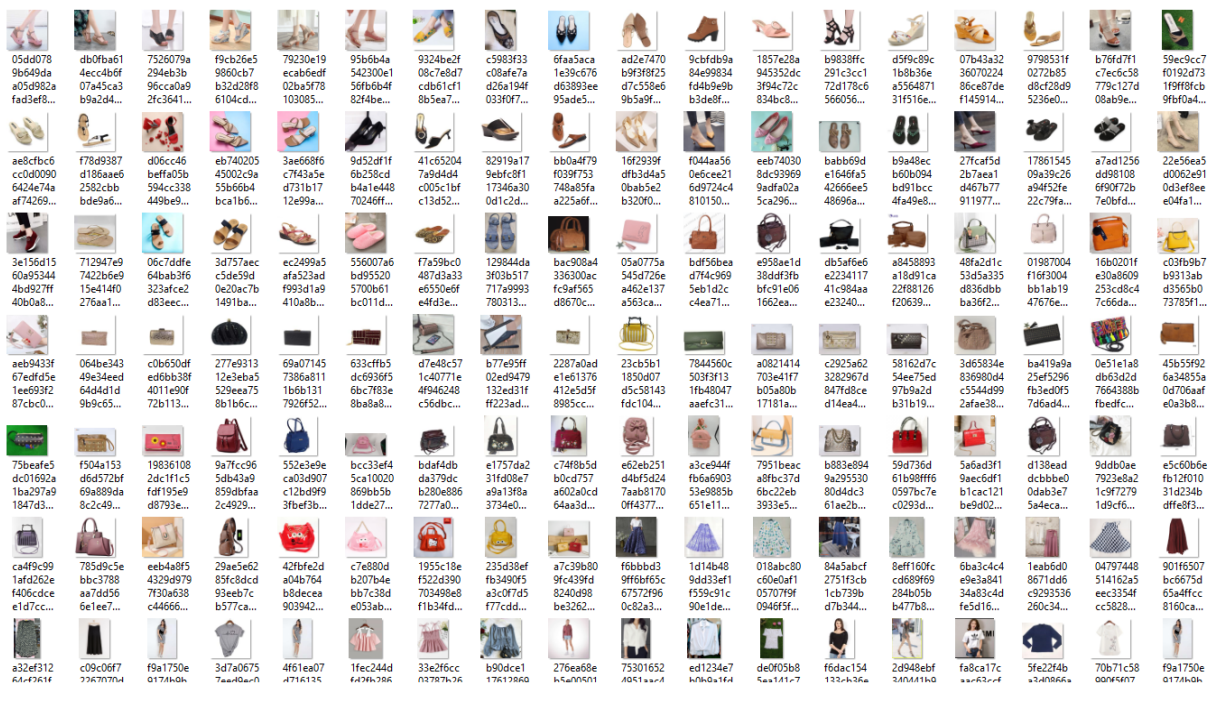
Fig11. Some collected data from online marketplaces

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3.6 Data processing:

When we collected our images, those images were not in a suitable format to use for image processing and this is difficult for us to correct it one by one. So, we have used a program to sort the images and give them a suitable format to use for the processing. This is an important think to rearrange the data for training and to get better accuracy. Before the data processing our data, size and format is in unorganized. Even the name of the data is not ok for making csv file for furthered use. So, we made a way to organize all the images by their classes and subclasses and rearrange them in a suitable manner where csv has the column of proper image name and path of the image that we can use those data for future process. Also, the height and the width data are processed to save in the csv file for future analysis. If we have all the data with a proper format in csv we can rearrange that data with Panda's library of python and anything need to add or modify for the dataset it will be very easier to manipulate those data. After sorting this we have got our data format organized. Hare is a sample of organized and modified data set. Data/Image name also accepted now. And from the csv file any time anyone can tell the information about the

Fig12. Re-arrange of file name for better understanding

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Image information like image category, sub-category, image height and width also. Also from this information we can analysis and sort out data we need, even also we can visualize data pattern with proportional to its height and weight.

	A	B	C	D	E	F
	FileName	Product	Index	width	height	
	Electronic-Devices-Desktop-Computers-1-2.jpg	Desktop-Computers	1	550	600	
	Electronic-Devices-Desktop-Computers-1-3.jpg	Desktop-Computers	1	675	675	
	Electronic-Devices-Desktop-Computers-1-4.jpg	Desktop-Computers	1	680	800	
	Electronic-Devices-Desktop-Computers-1-5.jpg	Desktop-Computers	1	500	500	
	Electronic-Devices-Desktop-Computers-1-6.jpg	Desktop-Computers	1	500	500	
	Electronic-Devices-Desktop-Computers-1-7.jpg	Desktop-Computers	1	626	626	
	Electronic-Devices-Desktop-Computers-1-8.jpg	Desktop-Computers	1	344	466	
	Electronic-Devices-Desktop-Computers-1-9.jpg	Desktop-Computers	1	1200	1200	
	Electronic-Devices-Desktop-Computers-1-10.jpg	Desktop-Computers	1	720	960	
	Electronic-Devices-Desktop-Computers-1-11.jpg	Desktop-Computers	1	588	771	
	Electronic-Devices-Desktop-Computers-1-12.jpg	Desktop-Computers	1	600	600	
	Electronic-Devices-Desktop-Computers-1-13.jpg	Desktop-Computers	1	500	500	
	Electronic-Devices-Desktop-Computers-1-14.jpg	Desktop-Computers	1	1920	1920	
	Electronic-Devices-Desktop-Computers-1-15.jpg	Desktop-Computers	1	626	626	
	Electronic-Devices-Desktop-Computers-1-16.jpg	Desktop-Computers	1	626	626	
	Electronic-Devices-Desktop-Computers-1-17.jpg	Desktop-Computers	1	720	1280	
	Electronic-Devices-Desktop-Computers-1-18.jpg	Desktop-Computers	1	1200	1200	

Fig13. Processed dataset as csv format (1)

Women-Collection-salwar-kamiz-28-147.jpg	salwar-kamiz	28	700	600	
Women-Collection-salwar-kamiz-28-148.jpg	salwar-kamiz	28	720	720	
Women-Collection-salwar-kamiz-28-149.jpg	salwar-kamiz	28	680	680	
Women-Collection-salwar-kamiz-28-150.jpg	salwar-kamiz	28	680	680	
Women-Collection-salwar-kamiz-28-151.jpg	salwar-kamiz	28	800	600	
Women-Collection-salwar-kamiz-28-152.jpg	salwar-kamiz	28	720	720	
Women-Collection-salwar-kamiz-28-153.jpg	salwar-kamiz	28	1000	725	
Women-Collection-salwar-kamiz-28-154.jpg	salwar-kamiz	28	950	577	
Women-Collection-salwar-kamiz-28-155.jpg	salwar-kamiz	28	1060	799	
Women-Collection-salwar-kamiz-28-156.jpg	salwar-kamiz	28	2048	1446	
Women-Collection-salwar-kamiz-28-157.jpg	salwar-kamiz	28	1577	1200	
Women-Collection-salwar-kamiz-28-158.jpg	salwar-kamiz	28	1280	1044	
Women-Collection-salwar-kamiz-28-159.jpg	salwar-kamiz	28	1440	1080	
Women-Collection-salwar-kamiz-28-160.jpg	salwar-kamiz	28	800	600	
Women-Collection-salwar-kamiz-28-161.jpg	salwar-kamiz	28	756	593	
Women-Collection-salwar-kamiz-28-162.jpg	salwar-kamiz	28	1500	1125	
Women-Collection-salwar-kamiz-28-163.jpg	salwar-kamiz	28	960	720	
Women-Collection-saree-29-164.jpg	saree	29	960	1280	
Women-Collection-saree-29-165.jpg	saree	29	1200	1200	
Women-Collection-saree-29-166.jpg	saree	29	800	800	
Women-Collection-saree-29-167.jpg	saree	29	600	600	
Women-Collection-saree-29-168.jpg	saree	29	748	640	
Women-Collection-saree-29-169.jpg	saree	29	450	330	
Women-Collection-saree-29-170.jpg	saree	29	800	800	
Women-Collection-saree-29-171.jpg	saree	29	734	719	
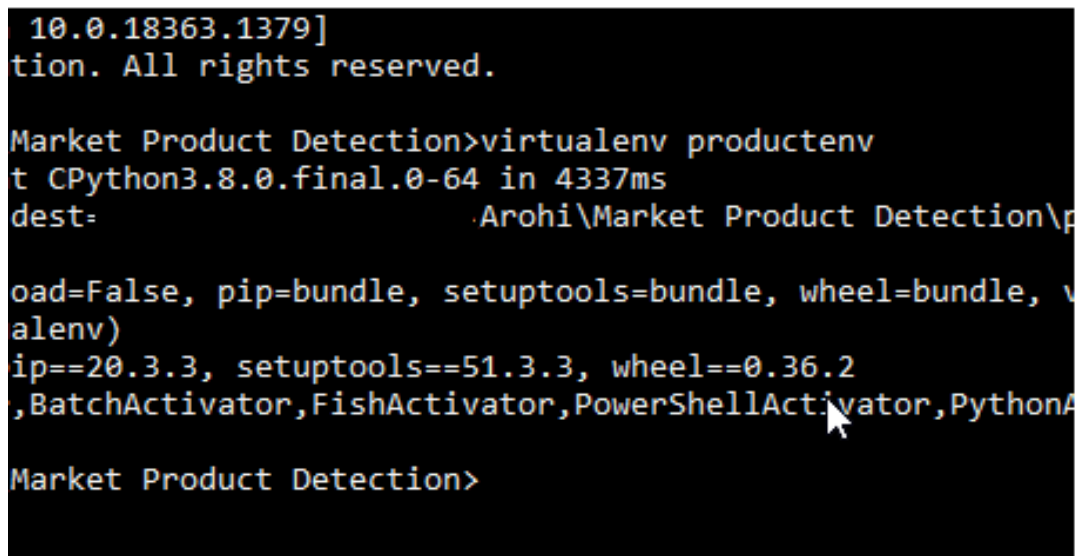
Fig14. Processed dataset as csv format (2)

Chapter: 4
Working procedure

4.1 Introduction:

Here we have discussed the working process from the first step. Brief description of environment setting, activation, Installing Jupyter Notebook. First of all, A virtual environment is a tool that helps to keep dependencies required by different projects separate by creating isolated python virtual environments for them. So, we will create virtual environment and activate that for our work.
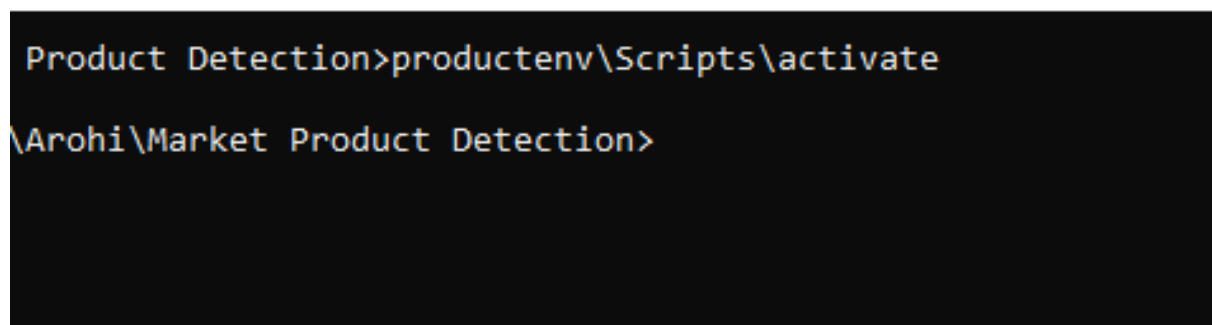
Fig15: Virtual Environment Creation

Fig16: Virtual Environment Activating

After creating and activating the virtual environment, we installed the **Jupyter Notebook**. Project Jupyter is a project and community whose goal is to "develop open-source software, open-standards, and services for interactive computing across dozens of programming languages". It was spun off from IPython in 2014 by Fernando Pérez. All steps included here

Fig17: Jupyter Notebook Installation

Fig18: Opening Notebook

So, if we browse at http://127.0.0.1:8888/?token=<generated_token> we will see the notebook interface and there we can work for our project.

After opening the notebook panel, we will see a interface where we can create ipynub format file with python 3 environment

Fig19: Jupyter Notebook Interface

This a sample of Jupyter notebook interface. Here we have created our python file and started to work implementation.

4.2 Required Library Installation: library_install.ipynb is the file name from where we installed all our required library and setup the project library needed.
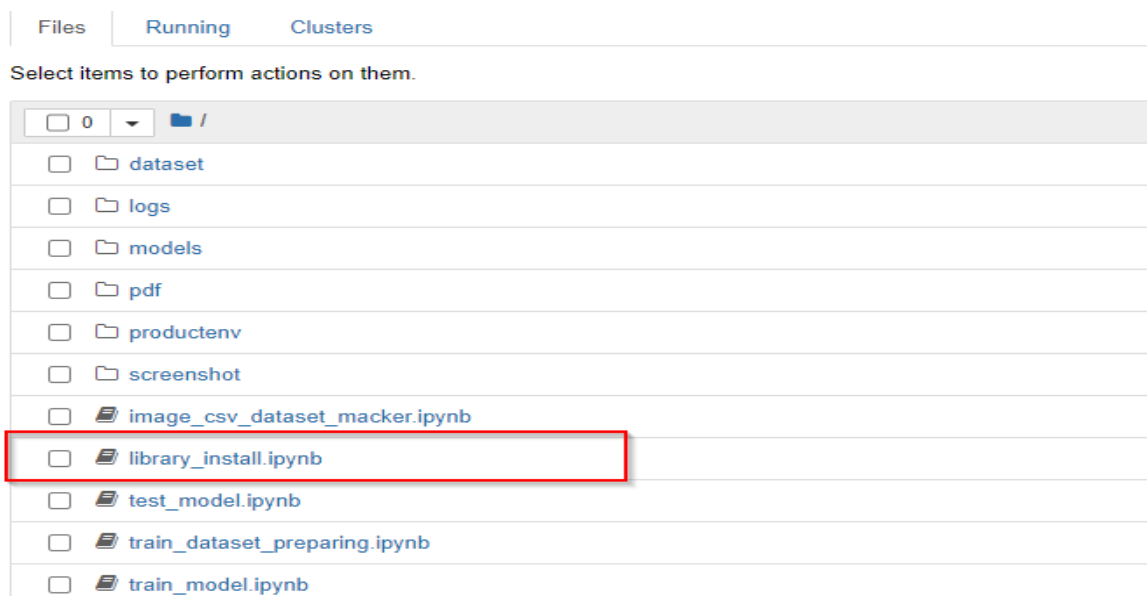
Fig20: Library Installation File

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4.2.1 OpenCV – Computer Vision is a process by which we can understand any images and videos and this is understandable and how this image will be used. This is widely used in Artificial Intelligence. OpenCV is a library of computer vision, machine learning, and image processing. This is used for any type of recognition such as image recognition, facial recognition, hand vision, self-care driving, traffic counting, medical image analysis, object recognition, etc. When incorporating various libraries, for example, NumPy, python is equipped to prepare an OpenCV collection structure for investigation.

```
In [1]:  !pip install opencv-python

Collecting opencv-python
  Using cached opencv_python-4.5.1.48-cp38-cp38-win_amd64.whl (34.9 MB)
Collecting numpy>=1.17.3
  Downloading numpy-1.20.1-cp38-cp38-win_amd64.whl (13.7 MB)
Installing collected packages: numpy, opencv-python
Successfully installed numpy-1.20.1 opencv-python-4.5.1.48

WARNING: You are using pip version 20.3.3; however, version 21.0.1 is available.
You should consider upgrading via the 'D:\Professional\DIU\Arohi\Market Product Detection\productenv\Scripts\python.exe -m pip
install --upgrade pip' command.
```

Fig21: Installing OpenCV

4.2.2 NumPy: This is a python library used to work by the same members. Here we use version 20.0.3 of NumPy. NumPy is 50x faster to remove any of the same members. NumPy array is called ndarray. This provides many support functions that are very easy to work with ndarray. Our collected images have a value, height range. This was a list and this was modified by NumPy.

```
!pip install numpy

Requirement already satisfied: numpy in d:\professional\diu\arohi\market product detection\productenv\lib\site-packages (1.20.
1)

WARNING: You are using pip version 20.3.3; however, version 21.0.1 is available.
You should consider upgrading via the 'D:\Professional\DIU\Arohi\Market Product Detection\productenv\Scripts\python.exe -m pip
install --upgrade pip' command.
```

Fig22: Installing NumPy

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4.2.3 Tqdm: Tqdm is a Python library that allows you to output a smart progress bar by wrapping around any iterable. A tqdm progress bar not only shows you how much time has elapsed, but also shows the estimated time remaining for the iterable.

```
!pip install tqdm

Collecting tqdm
  Downloading tqdm-4.59.0-py2.py3-none-any.whl (74 kB)
Installing collected packages: tqdm
Successfully installed tqdm-4.59.0

WARNING: You are using pip version 20.3.3; however, version 21.0.1 is available.
You should consider upgrading via the 'D:\Professional\DIU\Arohi\Market Product Detection\productenv\Scripts\python.exe -m pip
install --upgrade pip' command.
```

Fig23: Progress showing

4.2.4 CSV: A CSV file (Comma Separated Values file) is a type of plain text file that uses specific structuring to arrange tabular data. Because it's a plain text file, it can contain only actual text data—in other words, printable ASCII or Unicode characters. The structure of a CSV file is given away by its name. Python csv is used for arrange the tabular data.

n-Collection-tops-1-269.jpg	tops	32	2222
n-Collection-tops-32-270.jpg	tops	32	1119
n-Collection-winter-33-271.jpg	winter	33	600
n-Collection-winter-33-272.jpg	winter	33	681
n-Collection-winter-33-273.jpg	winter	33	1200
n-Collection-winter-33-274.jpg	winter	33	2000
n-Collection-winter-33-275.jpg	winter	33	1004
n-Collection-winter-33-276.jpg	winter	33	1200
n-Collection-winter-33-277.jpg	winter	33	1502

Fig24: CSV Dataset

4.2.5 TensorFlow 2.3.0: TensorFlow is a python library developed by Google. Here we use it to build our core model. This is an open library and this will work very quickly. This library is an all-encompassing database that we can use for image processing, data processing, image classification, model recognition, natural language processing. This is a very powerful framework that performance uses a series of nodes and each node will display mathematical performance. Throughout a series of nodes, a graph can be generated. With tensor flow installation small libraries installed. In our project, we used version 2.3.0 version of TensorFlow because it happened to be different from the graphics card. Therefore, we are using version 2.3.0.

```
Collecting werkzeug>=0.11.15
  Using cached Werkzeug-1.0.1-py2.py3-none-any.whl (298 kB)
Collecting wrapt>=1.11.1
  Using cached wrapt-1.12.1-cp38-cp38-win_amd64.whl
Installing collected packages: pyasn1, rsa, pyasn1-modules, oauthlib, cachetools, requests-oauthlib, google-auth, werkzeug, ten
sorboard-plugin-wit, protobuf, numpy, markdown, grpcio, google-auth-oauthlib, absl-py, wrapt, termcolor, tensorflow-estimator,
tensorboard, scipy, opt-einsum, keras-preprocessing, h5py, google-pasta, gast, astunparse, tensorflow
  Attempting uninstall: numpy
    Found existing installation: numpy 1.20.1
    Uninstalling numpy-1.20.1:
      Successfully uninstalled numpy-1.20.1
  Attempting uninstall: scipy
    Found existing installation: scipy 1.6.1
    Uninstalling scipy-1.6.1:
      Successfully uninstalled scipy-1.6.1
Successfully installed absl-py-0.12.0 astunparse-1.6.3 cachetools-4.2.1 gast-0.3.3 google-auth-1.27.1 google-auth-oauthlib-0.4.
3 google-pasta-0.2.0 grpcio-1.36.1 h5py-2.10.0 keras-preprocessing-1.1.2 markdown-3.3.4 numpy-1.18.5 oauthlib-3.1.0 opt-einsum-
3.3.0 protobuf-3.15.6 pyasn1-0.4.8 pyasn1-modules-0.2.8 requests-oauthlib-1.3.0 rsa-4.7.2 scipy-1.4.1 tensorboard-2.4.1 tensorb
oard-plugin-wit-1.8.0 tensorflow-2.3.0 tensorflow-estimator-2.3.0 termcolor-1.1.0 werkzeug-1.0.1 wrapt-1.12.1
```

Fig25: Installing TensorFlow

4.2.6 Sklearn (Scikit-learn): This library provides a range of supervised and unsupervised learning algorithms via a consistent interface in Python. The library is built upon the SciPy (Scientific Python) that must be installed before you can use scikit-learn. Extensions or modules for SciPy care conventionally named SciKits. As such, the module provides learning algorithms and is named scikit-learn. Although the interface is Python, c-libraries are leverage for performance such as numpy for arrays and matrix operations, LAPACK, LibSVM and the careful use of cython. The library is focused on modeling data. It is not focused on loading, manipulating and summarizing data. For these features, refer to NumPy and Pandas.

4.3 Image CSV Dataset Making: Initially we need make a csv dataset from our collecting collection of images and label them with a suitable name that can be understandable easily and can find class and subclasses from that name also find the sequence number of that image from that name. First, we need to import all the necessary libraries for that particular work. Then we store all our category and sub category in variable that can be useful for data labeling.

```
In [1]: import os
        import cv2
        import numpy as np
        from tqdm import tqdm

In [2]: CATGORIES= ["Electronic-Devices","Mens-Collection","Sports-Outdoors","Watches-Accessories","Women-Collection"]
        AllSubCat = [["Desktop-Computers","Laptops","Security-Cameras-Systems","Smartphones","Tablet"],
                     ["jeans","Joggers-Sweats","man_s-bags","men_s-shoes","shirts","sweater","t-shirts"],
                     ["Badminton-Rackets","Bikes","Cycling-Machines","Dumbbells","Fitness-Accessories","Team-sports","Treadmills"],
                     ["kid_S-watches","Kids-Sunglasses","Men_S-watches","Mens-sunglasses","Women-Sunglasses","women_S-watches"],
                     ["Bags","kurti","salwar-kamiz","saree","shoes","skirt","tops","winter"]]
        dsDirectory = "dataset/main-images/"
        trainDsDirectory = "dataset/train-data/"
```

Fig26: Import Libraries and Categories

Then we combined all the subcategories and as we know the category and subcategory, we know the specific location of the images that we store in their categorical and sub-categorical folder. From that then we sperate all images as their category and sub-category and store them in another folder name image-dataset. This folder contains all the images of all kind of category and sub-categorical product image and as well as the information was saved in csv file.

```
100%|████████████████████████████████████| 56/56 [00:02<00:00, 22.76it/s]
  0%|                                     | 0/11 [00:00<?, ?it/s]

All Train Image Transfered for Women-Collection-shoes
100%|████████████████████████████████████| 11/11 [00:00<00:00, 15.65it/s]
 20%|███████                              | 4/20 [00:00<00:00, 31.01it/s]

All Train Image Transfered for Women-Collection-skirt
100%|████████████████████████████████████| 20/20 [00:01<00:00, 16.50it/s]
  7%|██                                   | 3/42 [00:00<00:01, 26.09it/s]

All Train Image Transfered for Women-Collection-tops
100%|████████████████████████████████████| 42/42 [00:02<00:00, 20.13it/s]

All Train Image Transfered for Women-Collection-winter
Transfered and Rename Successfull!
```

Fig27: Processing of Images to proper label and csv output

4.4 Dataset preparing:

The main work of any machine learning project is to make train and test set which we called our target dataset preparing. For that first of all we need to import all necessary libraries and our previously generated csv file mentioned in 4.3.

```
In [1]: import numpy as np
        import pandas as pd
        import  matplotlib.pyplot as plt
        from tqdm import tqdm
        from sklearn.model_selection import train_test_split
        from tensorflow.keras.preprocessing import image
```

```
In [2]: data = pd.read_csv('dataset/excels/train_set_mod.csv')
        data.shape
```

Fig28: Import Required Things

Here, required library packages have been installed. Panda is used for visualizing the data. Matplotlib is used to plot the data by visualizing on graph. Sklearn used for train test data set splitting. Keras module from TensorFlow used for image processing. Then the system will read the csv file and give the out with 1211 number of images and 5 columns csv file. 1st row was the column name and after that index, width and height come in front.

	FileName	Product	Index	width	height
0	Electronic-Devices-Desktop-Computers-1-2.jpg	Desktop-Computers	1	550	600
1	Electronic-Devices-Desktop-Computers-1-3.jpg	Desktop-Computers	1	675	675
2	Electronic-Devices-Desktop-Computers-1-4.jpg	Desktop-Computers	1	680	800
3	Electronic-Devices-Desktop-Computers-1-5.jpg	Desktop-Computers	1	500	500
4	Electronic-Devices-Desktop-Computers-1-6.jpg	Desktop-Computers	1	500	500

Fig29: csv dataset

Then we have taken all the height and width and we have gotten rows of 1211 height and width from the images. We need both height and width because input layer of TensorFlow depends on it and all images has not the same height and width. So wee need to analyze that for correct input layer.

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Input Layer is consisting of neurons. Every input is called neuron.

i)   Input layer transfers data directly to the hidden main layer where the information is amplified by loads of the main covered layer.

ii)   The installation layer conveys information about the startup function before transferring it. The details are then enhanced by hidden principal responsibilities.

iii)   The data layer has its own responsibilities that duplicate the information that comes up. The background information then conveys the details of the consolidation function before transferring it. Details are then enhanced by the basic burdens of basic encryption.
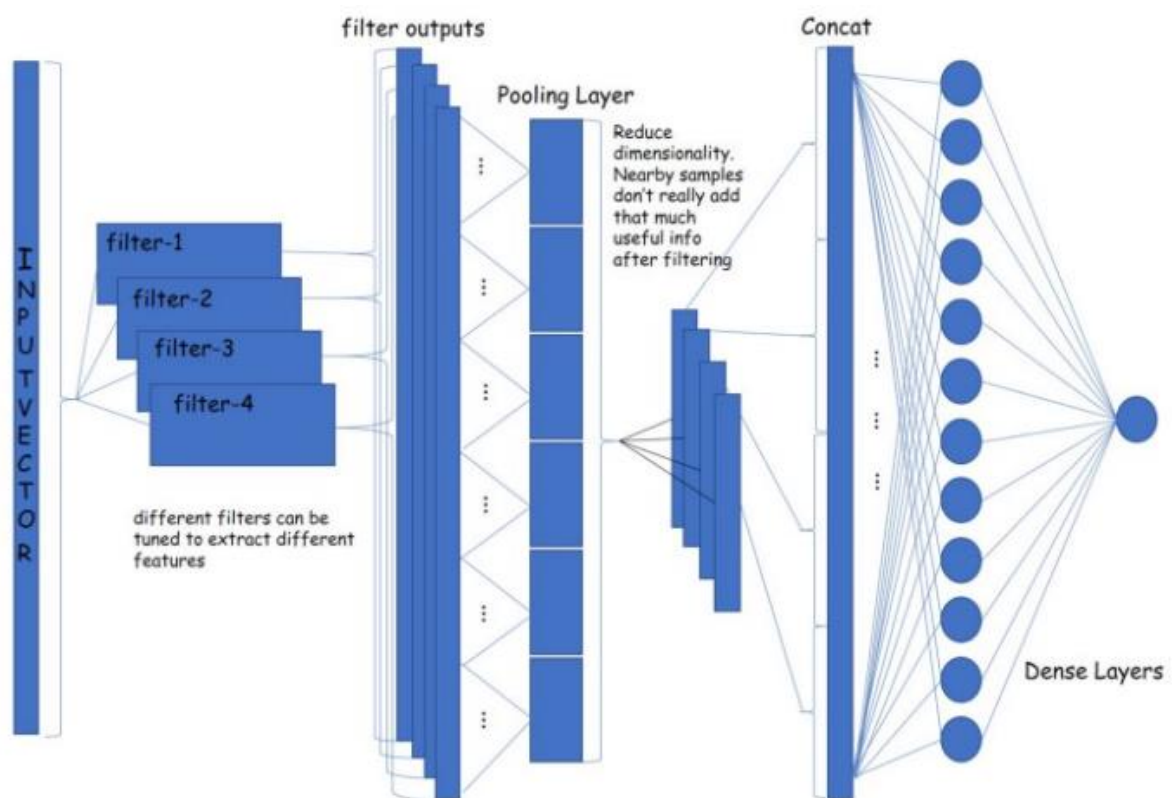
Fig29: An illustration of CNN input layer and others layer

Now we plot the data with proportional to all image's height and width so that we can understand and select a perfect combination of image height and width for input layer. Here we made scatter plotting for better analysis.


```
In [7]: plt.scatter(heights, widths)
        plt.show()
```
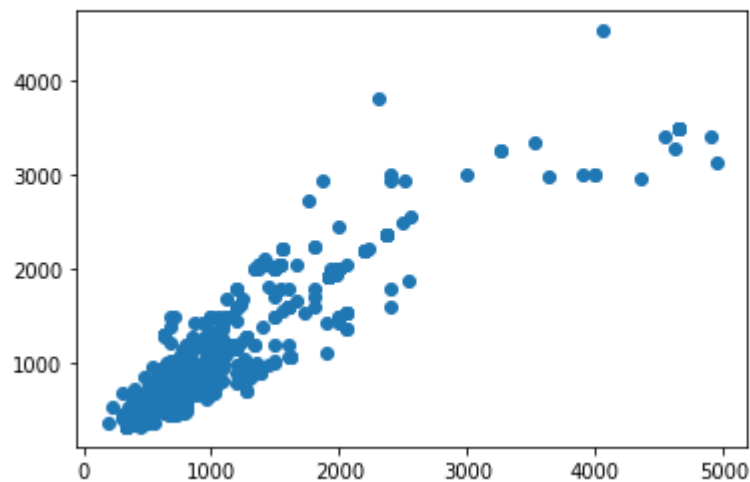
Fig30: Image's plot of height and width

From the above figure we can see that our dataset image has no regular or similar size from each other. So, we need to make a choice for selection. Maximum images are between height and width of 3000 pixel so if we can plot a figure of image which height and width is between 3000 pixel that will be more visible for seeing that image plotting of most of the images. After plotting height and width of those images we get a good plot view.


```
filtered_data = pd.read_csv('dataset/excels/train_set_mod.csv')[lambda x: x['width'] < 3000][lambda x: x['height'] < 3000]

plt.scatter(filtered_data['height'], filtered_data['width'])
plt.show()
```
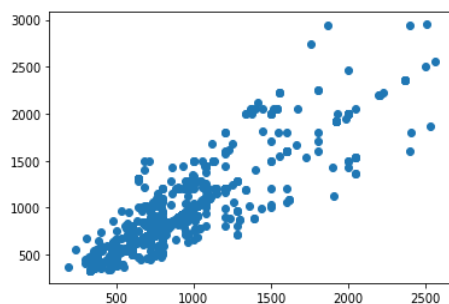
Fig31: csv data read from csv dataset

Now, we need to calculate mean and median value from that images to select the perfect image height and width for input layer and also, we need to take care about the layer size because of the limitation of GPU processing for image classification in TensorFlow. We know that the "mean" is the "average" you're used to, where you add up all the numbers and then divide by the number of numbers. The "median" is the "middle" value in the list of numbers. To find the median, your numbers have to be listed in numerical order from smallest to largest, so you may have to rewrite your list before you can find the median.

$$\text{Mean } \bar{x} = \frac{\sum xi}{N} \qquad \text{Variance} = \frac{\sum (xi - \bar{x})^2}{N}$$

$$\text{Median} = \begin{cases} \dfrac{(N+1)^{th}}{2} \text{ term;when N is even} \\[2ex] \dfrac{\dfrac{N^{th}}{2} \text{ term} + \left(\dfrac{N}{2} + 1\right) \text{term}}{2} \text{;when N is even} \end{cases}$$

Fig31: mean median formula

After did the calculation we got mean and median value where we got the image mean height of 639 and width 666. So, all of our image's array should be converted to that height and width for TensorFlow input layer. Now we can resize all images and store them in variable.

```
print(Train_Height,Train_Width)

639 666
```

```
In [22]: X=[]
         for i in tqdm(range(data.shape[0])):
             path = 'dataset/train-data/'+data['FileName'][i]
             img = image.load_img(path,target_size=(Train_Height,Train_Width,3))
             img = image.img_to_array(img)
             img = img/255.0
             X.append(img)
         X= np.array(X)

         100%|████████████████████████████████████████| 1211/1211 [00:22<00:00, 55.00i
         t/s]
```

```
In [23]: X.shape
Out[23]: (1211, 639, 666, 3)
```

Fig32: resized images for input layer

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Now we did label and made a new csv file for training set. The label represents the justify of outcomes of the dataset images. As we have 33 types of outcomes, we need to make label for 33 types of outcomes. After preparing all the requirement we can save the training dataset for future use.

	Filename	Product	Desktop-Computers	Laptops	Security-Cameras-Systems	Smartphones	Tablet	jeans	Joggers-Sweats	man_s-bags	...	Women-Sunglasses	women_S-watches	Bags	kurti	salwar-kamiz	sa
0	Electronic-Devices-Desktop-Computers-1-2.jpg	Desktop-Computers	1	0	0	0	0	0	0	0	...	0	0	0	0	0	
1	Electronic-Devices-Desktop-Computers-1-3.jpg	Desktop-Computers	1	0	0	0	0	0	0	0	...	0	0	0	0	0	
2	Electronic-Devices-Desktop-Computers-1-4.jpg	Desktop-Computers	1	0	0	0	0	0	0	0	...	0	0	0	0	0	
3	Electronic-Devices-Desktop-Computers-1-5.jpg	Desktop-Computers	1	0	0	0	0	0	0	0	...	0	0	0	0	0	
4	Electronic-Devices-Desktop-Computers-1-6.jpg	Desktop-Computers	1	0	0	0	0	0	0	0	...	0	0	0	0	0	

5 rows × 35 columns

Fig33: Final csv file for train-test dataset

Now we dropped out the extra two layer named "Filename" and "Product" from csv file as they are not important for training and both test set.

```
In [42]: Y = new_data.drop(['Filename','Product'],axis=1)
         Y = Y.to_numpy()
         Y.shape

Out[42]: (1211, 33)

In [43]: x_train, x_test,y_train,y_test = train_test_split(X,Y,random_state=0,test_size=0.20)

In [44]: np.savez_compressed('dataset/train_test_set/product_classification_compressed_processed_train_test_set_02',
                 x_train=x_train, x_test=x_test,y_train=y_train,y_test=y_test)

In [ ]:
```

Fig34: Sorting out the Final csv file

4.5 Details of Proposed Methodology

4.5.1 Convolutional neural Network (CNN) is a type of neural network. This is specialized in in-depth learning using the perceptron, AI unit calculation, managed learning, breaking down various types of information. CNN operates a large part of the work depends on the contributions to diversify project acceptance and works wonderfully with local-related information.[13] We can apply to photos, split prediction issues, face recognition, object recognition, etc. There are a few layers of image collection, for example, the first layer of CNN's layer of information. This layer will read pixel images to pixel. The various types of layering will put the images in a reliable system.
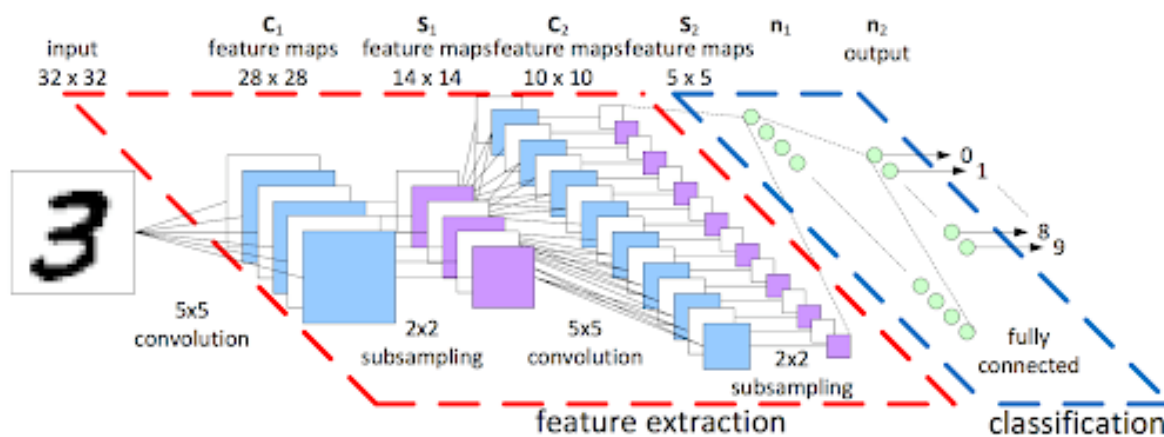

Fig35: CNN based image classification

4.5.2 Pooling layer: **Pooling layer** is an indirect layer that separates part of the information and reduces the number of parameters, controls overload and the most important data is stored. We can show the size of the PoolingLayer which can eliminate unnecessary highlights and maintain basic highlights. Here are three types of integration layer MaxPooling, AveragePooling, and MinPooling.

- MaxPooling: Selects the most important value contained in the merge window. In CNN engineering MaxPooing is often used to earn outstanding points on the grounds that MaxPooling offers the best because of the AveragePooling and MinPooling layer.
- AveragePoing: Selects only the average amount contained in the merge window.
- MinPooling: Selects only a small amount contained in the merge window

4.5.3 Flatten layer: **Flatten layer** in the middle of the convolutional layer and a perfectly aligned frame, there is a 'Smooth' layer. Switching over all 2-dimensional clusters into a 1D element vector, this function is called smooth. This smooth structure creates a coherent vertical vector to be applied to the thick layer of the final layer.

4.5.4 Fully connected layer: **Fully connected layer** s the last phase of the CNN organization, talking about the vector of the information component. The FC layer includes loads, priorities, and neurons. It connects neurons one layer to neurons in another layer. The FC layers also assemble the entire neuron to order accurately and precisely each detail. It is used to organize images between different categories by arrangement. FC layers can be derived from Multilayer Perceptron (MLP) where every neuron has a complete connection with the entire beginning of the previous layer.

4.6 :Train Methodology

In this context, we will discuss how to train. With training, the machine will understand the data I have to enter the learning. So how to train, how to train data, and how to process it is described here. First we loaded our pre-saved dataset model and then tmake a tensorflow model for training.

```
In [2]: import tensorflow as tf
        from tensorflow.keras import Sequential
        from tensorflow.keras.layers import Flatten, Dense, Dropout,BatchNormalization,Conv2D,MaxPool2D,MaxPooling2D
        from tensorflow.keras.optimizers import Adam
        from tensorflow.keras.preprocessing import image
        import numpy as np
        import pandas as pd
        import matplotlib.pyplot as plt
        from tqdm import tqdm
        from tensorflow.keras import layers
```

```
In [3]: #product_classification_compressed_processed_train_test_set_01

        data = np.load('Dataset/train_test_set/product_classification_compressed_processed_train_test_set_02.npz')
        x_train = data['x_train']
        x_test = data['x_test']
        y_train = data['y_train']
        y_test = data['y_test']
```

Fig37: Load dataset for training

Then we made a train model for tensorflow with four different hidden conv layer for the training. So the total model has 8,788,785 of Total params, 8,788,177 of Trainable params and 608 of Non-trainable params.

```
_____
batch_normalization_4 (Batch (None, 64)                256

_____
dropout_4 (Dropout)          (None, 64)                0

_____
dense_1 (Dense)              (None, 33)                2145
=================================================================
Total params: 8,788,785
Trainable params: 8,788,177
Non-trainable params: 608
_____
```

Fig38: Model summery

```
Model: "sequential"

Layer (type)                    Output Shape              Param #
=================================================================
block1_conv1 (Conv2D)           (None, 937, 964, 16)      448
_____
conv2d (Conv2D)                 (None, 935, 962, 16)      2320
_____
batch_normalization (BatchNo    (None, 935, 962, 16)      64
_____
block1_pool (MaxPooling2D)      (None, 467, 481, 16)      0
_____
dropout (Dropout)               (None, 467, 481, 16)      0
_____
block2_conv1 (Conv2D)           (None, 467, 481, 32)      4640
_____
block2_conv2 (Conv2D)           (None, 467, 481, 32)      9248
_____
batch_normalization_1 (Batch    (None, 467, 481, 32)      128
_____
block2_pool (MaxPooling2D)      (None, 233, 240, 32)      0
_____
dropout_1 (Dropout)             (None, 233, 240, 32)      0
_____
block3_conv1 (Conv2D)           (None, 233, 240, 64)      18496
_____
block3_conv2 (Conv2D)           (None, 233, 240, 64)      36928
_____
block3_conv3 (Conv2D)           (None, 233, 240, 64)      36928
_____
batch_normalization_2 (Batch    (None, 233, 240, 64)      256
_____
block3_pool (MaxPooling2D)      (None, 116, 120, 64)      0
_____
dropout_2 (Dropout)             (None, 116, 120, 64)      0
_____
block4_conv1 (Conv2D)           (None, 116, 120, 128)     73856
_____
block4_conv2 (Conv2D)           (None, 116, 120, 128)     147584
_____
block4_conv3 (Conv2D)           (None, 116, 120, 128)     147584
_____
batch_normalization_3 (Batch    (None, 116, 120, 128)     512
_____
block4_pool (MaxPooling2D)      (None, 58, 60, 128)       0
_____
dropout_3 (Dropout)             (None, 58, 60, 128)       0
_____
block5_conv1 (Conv2D)           (None, 58, 60, 256)       295168
_____
block5_conv2 (Conv2D)           (None, 58, 60, 256)       590080
_____
block5_conv3 (Conv2D)           (None, 58, 60, 128)       295040
_____
block5_pool (MaxPooling2D)      (None, 29, 30, 128)       0
_____
flatten (Flatten)               (None, 111360)            0
_____
dense (Dense)                   (None, 64)                7127104
_____
batch_normalization_4 (Batch    (None, 64)                256
_____
dropout_4 (Dropout)             (None, 64)                0
_____
dense_1 (Dense)                 (None, 33)                2145
=================================================================
```

Fig39: Model detailed summery

In training session we got different accuraccy level in different time. We used a batch size of 10 and we trained the model about 95 epoch of times and got the final accuracy 90.18% which is really acceptable and standard for image classification.

```
0.4239
Epoch 90/95
97/97 [==============================] - 31s 315ms/step - loss: 0.0374 - accuracy: 0.8977 - val_loss: 0.1206 - val_accuracy:
0.4444
Epoch 91/95
97/97 [==============================] - 29s 303ms/step - loss: 0.0365 - accuracy: 0.8998 - val_loss: 0.3097 - val_accuracy:
0.4362
Epoch 92/95
97/97 [==============================] - 30s 307ms/step - loss: 0.0347 - accuracy: 0.9163 - val_loss: 0.1219 - val_accuracy:
0.4403
Epoch 93/95
97/97 [==============================] - 30s 304ms/step - loss: 0.0369 - accuracy: 0.9008 - val_loss: 0.1222 - val_accuracy:
0.4609
Epoch 94/95
97/97 [==============================] - 30s 310ms/step - loss: 0.0357 - accuracy: 0.9236 - val_loss: 0.1230 - val_accuracy:
0.4444
Epoch 95/95
97/97 [==============================] - 30s 305ms/step - loss: 0.0360 - accuracy: 0.9019 - val_loss: 0.1226 - val_accuracy:
0.4527
```

Fig40: Model accuracy

Then we plot an accuracy vs validation accuracy matrix graph to ensure the model stability. Also, we plot a loss vs validation-loss graph for better understand our model loss.
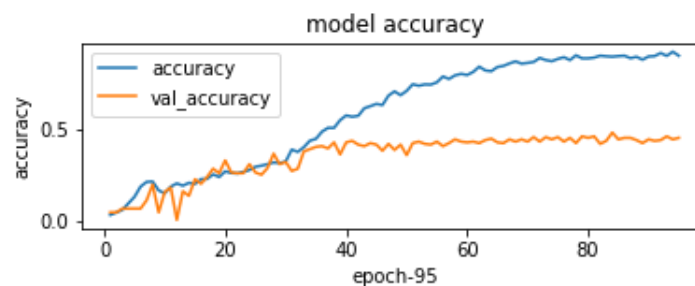

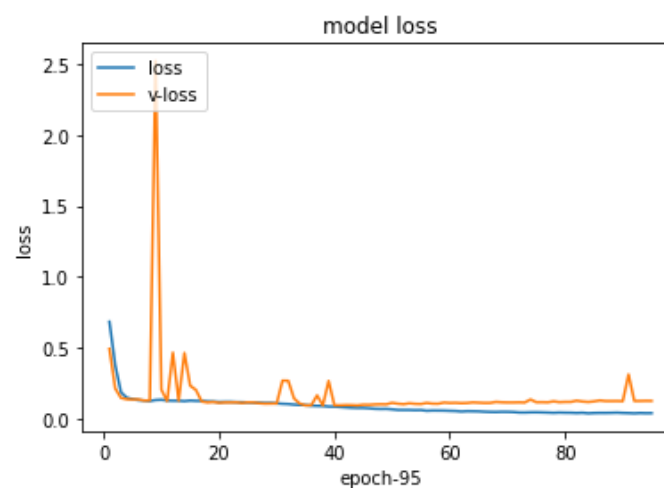**Fig41:** accuracy vs validation-accuracy

Fig42: loss vs validation-loss

36

Also, we know that confusion matrix is a tabular way of visualizing the performance of your prediction model. Each entry in a confusion matrix denotes the number of predictions made by the model where it classified the classes correctly or incorrectly. So, in our product classification we also populate a confusion matrix.
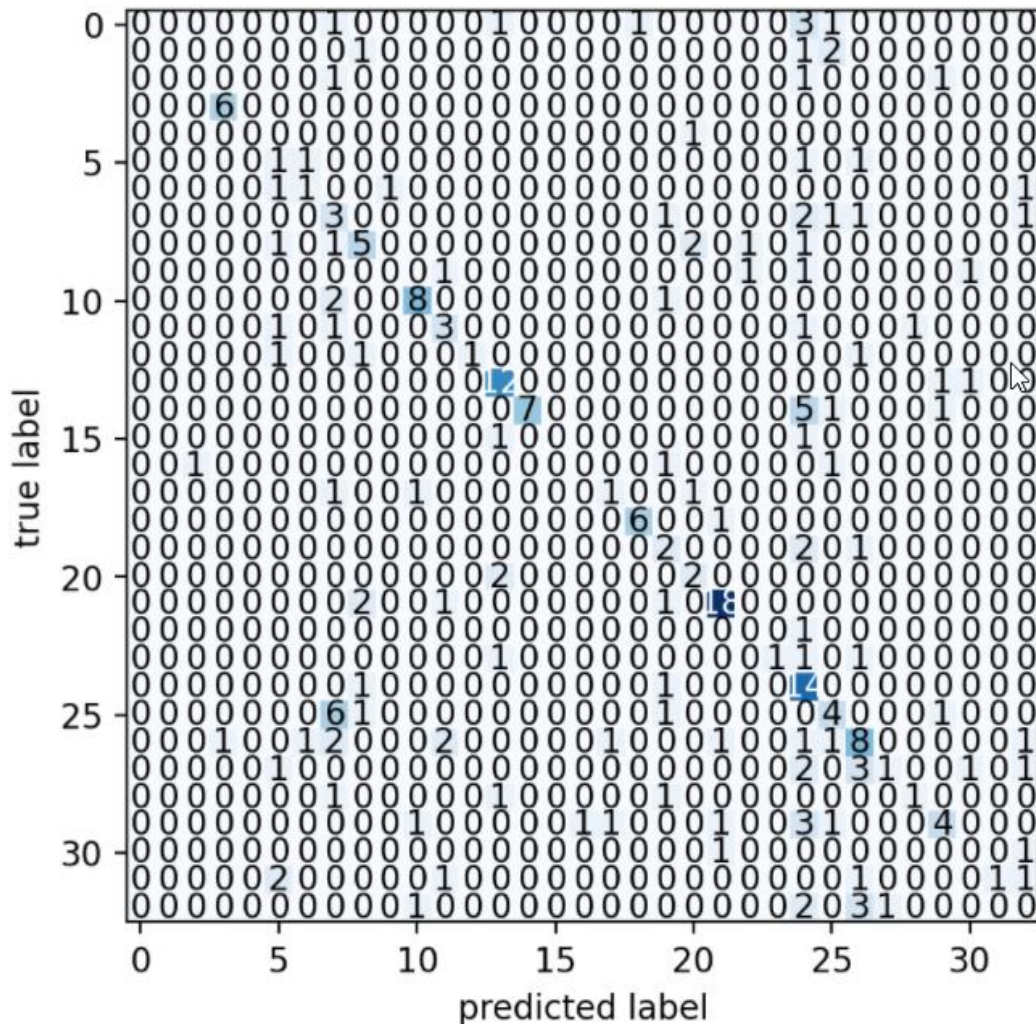

Fig43: confusion matrix

Chapter 5
Results and Discussion

Now we have got the result for the recognition of 3 product. Here is the result for 1st product which we know as Men's Watches and it should be in Watches-Accessories category. So, our model predicts the image correctly with 27.37% accuracy. This image is a random men's watches collected from google search and this image not was in any of our collected data.

Fig44: 27.37% accuracy for Men's Watches

Here is the result for 2nd product which we know as Bags and it should be in Women-Collection category. So, our model predicts the image correctly with 21.09% accuracy. This image is a random woman's bag collected from google search.

Fig45: 21.09% accuracy for Woman's Bag

Here is the result for 3rd product which we know as Bags and it should be in Women-Collection category. So, our model predicts the image correctly with 67.62% accuracy. This image is a random woman's bag collected from google search this image not was in any of our collected data.

Fig47: 67.62% accuracy for Woman's Bag

Chapter 6

CONCLUSION

7.1 Conclusion: In this project we tried to make identifier of online market product classification with category and sub-category. Our CNN layer was complex and that's why we got better result with low accuracy and the standard training accuracy for the model. If we have more data for every sub-category the result accuracy will be higher and the project will work better that now in future.

7.2 Future work: In future anyone can learn and make some project from this complex project and it can be applied with many programs which are for online market and this will be useful for product identification without human hands.

7.2 Requirement Accessories:

After the description of our CNN methodology and completely trained our model, that model was trained in a machine which configuration is given below:

- Operating System (Windows 10)
- Hard Disk (1TB)
- Ram (16 GB)
- GPU (NVidia 6GB GTX-1660)

References:

[1] Deep learning-based product image classification system and its usability evaluation for the O2O shopping mall platform by Sung, Jae-Kyung, Park, Sang-Min, Sin, Sang-Yun, Kim, Yung-Bok Received: 2017.05.02 Accepted: 2017.06.09 Published: 2017.06.30 https://doi.org/10.7236/JIIBC.2017.17.3.227

[2] Ayesha Islam, M.S., Foysal, F.A., Neehal, N., Karim, E. and Hossain, S.A., 2018. InceptB: a CNN Based classification approach for recognizing traditional Bengali games. Procedia computer science, 143, pp.595-602.

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