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# IDENIFICATION OF COVID-19 PATIENT

## With HOG-SVM Technique

**Thesis**
**CENTRIA UNIVERSITY OF APPLIED SCIENCES**
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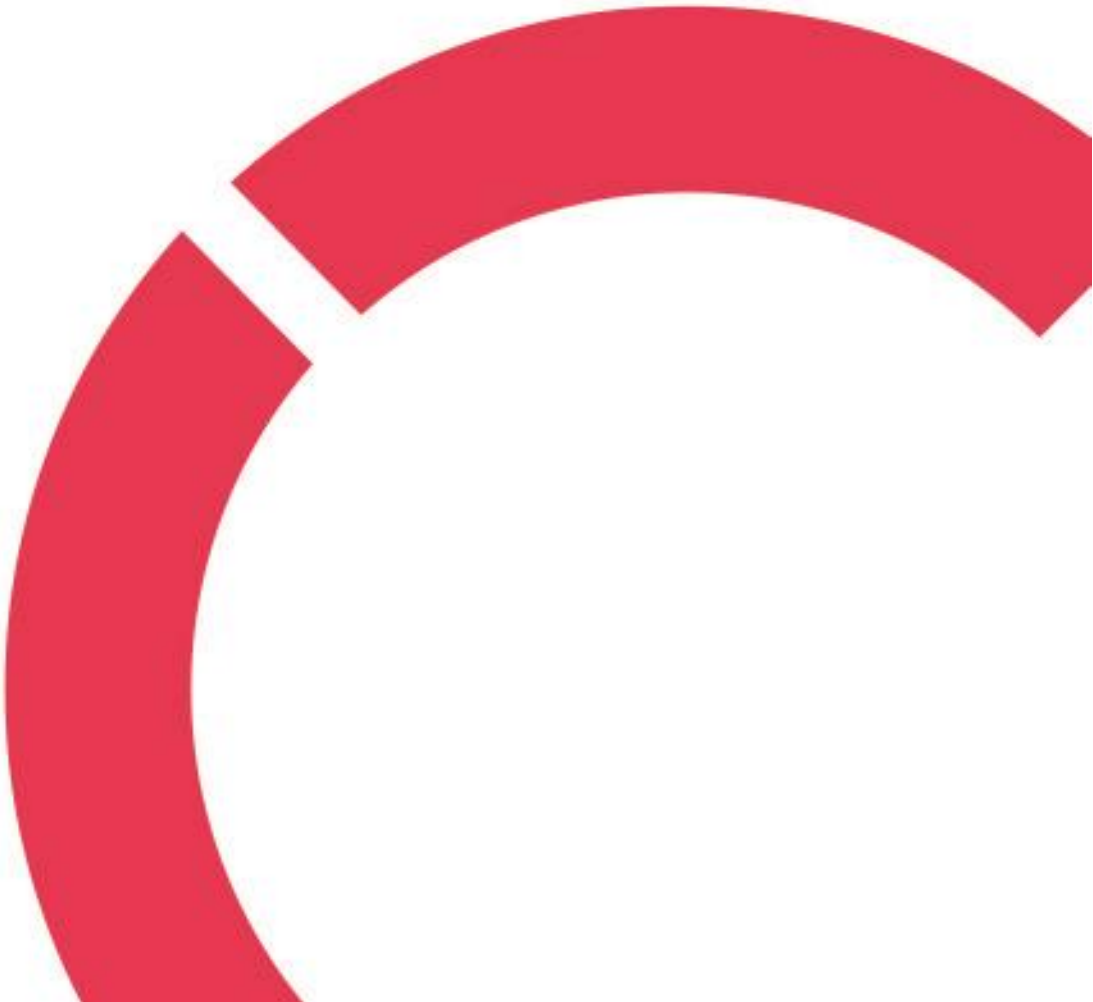

**ABSTRACT**

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The COVID-19 pandemic, globally driven by the rapid spread of different variants of coronavirus, posed a severe threat to public health. Due to different reasons, such as a shortage of radiologists and other manpower in the COVID-19 department, the limited number of test kit availability on hospitals led to an inability to detect COVID-19 early that posed a greater threat to human life. Therefore, this thesis presents an easy and unique method to classify the coronavirus affected patient very easily using the patient's chest x-ray images. This method will propose HOG-SVM algorithm to analyse the x-ray images collect from the online COVID positive patients X-ray images to identify the cases. The experiment was evaluated using python programming languages and the TensorFlow library for the backend procedure while splitting 80% images as training and the rest 20% images as test images where 98.5% accuracy was acquired.

**Key words**
COVID-19, Data processing, Deep learning, Gray, Identify, OpenCV, Patient, X-ray,

**CONCEPT DEFINITIONS**

COVID- Corona Virus Diseases

CNN- Convolutional Neural Network

CV- Computer Vision

HOG- Histogram Oriented Gradients

IDE- Integrated Development Environment

OpenCV- Open Computer Vision. A software suite for real-time image processing, video analytics, and machine learning.

RGB- Red, Green, Blue

SVM- Support Vector Machine

VR- Virtual Reality

**ABSTRACT**
**CONCEPT DEFINITIONS**
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# 1 INTRODUCTION

Coronaviruses are the viruses that can affect human as well as animals. These viruses are distinguished by their crown-like appearance caused by the ringed proteins that spike on their outer layers. The word "corona," which means crown in Latin, inspired the names of these viruses. Coronaviruses are known to cause a variety of diseases, which include minor illnesses like the common cold and flu to more serious diseases like Severe Acute Respiratory Syndrome (SARS-CoV) and Middle East Respiratory Syndrome (MERS). MERS was initially identified in Saudi Arabia in 2012, while SARS-CoV appeared in China in 2002. In 2019, a new strain of coronavirus, SARS-CoV-2, was discovered in Wuhan, China, and quickly spread throughout the world, resulting in the COVID-19 pandemic (WHO 2022).

The COVID-19 pandemic, caused by SARS-CoV-2, has had a significant influence on world health and the economy. The virus spreads largely by droplets from the breath, causing an extensive spectrum of symptoms, from minor to severe. While many people recover without specialized care, older people and those with previous health problems including, diabetes, cardiovascular disease, and chronic respiratory disorders are at greater risk to suffer severe side effects. According to WHO April 2025 reports, current numbers around 777 million of people have been infected around the world, and the epidemic provided severe hurdles to systems of healthcare. The majority rate, year and the origin where founded for the first time is showed on the below Table 1.

TABLE 1: Overview of major coronaviruses

| Virus | Origin | Mortality Rate | Year |
|---|---|---|---|
| SARS-CoV (SARS) | Guangdong province, China | ~9.6% | 2002 |
| MERS-CoV (MERS) | Saudi Arabia | ~34.4% | 2012 |
| SARS-CoV-2 (COVID-19) | Wuhan, China | ~3.4% | 2019 |

The very early and correct recognition of COVID-19 patients is important for efficient prevention and treatment. Traditional diagnostic procedures, such as real-time reverse transcription-polymerase chain

reaction (RT-PCR), are commonly used, although they are sometimes limited by awareness, availability of resources, and time boundaries. Medical imaging, particularly chest X-rays (CXR), has arisen as a different diagnostic technique. However, manually interpreting these images can be time-consuming and error-prone, particularly in locations with few medical facilities.

This thesis explores the implementation of methods from machine learning, specifically Histogram of Oriented Gradients (HOG) paired with Support Vector Machines (SVM), as well as deep learning approaches, to detect the COVID-19 patient using the chest X-ray images. HOG-SVM is a practically effective technique for feature extraction and classification, whereas deep learning techniques like Convolutional Neural Networks (CNNs) have shown greater efficacy in image-based disease detection due to their ability to learn complex structure from image data. A combination of these technologies aspires to provide a more successful, accurate, effective, and affordable approach for COVID-19 detection. This research helps to create a medical diagnostic system that accurately identified COVID-19 patients by using deep learning and HOG-SVM techniques.

# 2 FUNDAMENTAL CONCEPTS

The aim of this thesis was to detect COVID-19 patients utilizing advanced computer techniques such as the Histogram of Oriented Gradients-Support Vector Machine (HOG-SVM) algorithm and, maybe, Convolutional Neural Networks (CNN). The purpose was to examine and classify COVID-19 instances using medical imaging databases such as chest X-rays and CT scans. The HOG-SVM method was applied for recognizing and categorizing image structures. It is effective at recognizing fundamental features and forms edges, that can assist in differentiating between images of positive and the negative cases.

## 2.1 Prior Research

Domain Extension Transfer Learning (DETL) to a pre-trained deep Convolutional Neural Network (CNN) are applied for assessing a chest X-ray image dataset. The technique was specifically designed to detect COVID-19 instances using chest X-ray pictures. To help with this, author used the Gradient Class Activation Map (Grad-CAM) to detect COVID-19 and highlight the areas that the model prioritized during the classification phase. Despite a restricted dataset, the method displayed an exceptional overall accuracy of 90.13 percent, showing its efficiency in identifying COVID-19 instances (Sanhita, Sushmita &Nilanjan 2022, 2525).

Through image analysis, the authors created a system for early detection and prevention of COVID-19 diseases, using a dataset of chest X-rays. To identify the cases, author trained a deep learning model to investigate the impact of COVID-19 on persons who suffer from lung sickness or pneumonia. To identify patients with coronavirus-induced pneumonia, author suggested utilizing five pre-trained CNN model ResNet50, Res-Net101, ResNet152, InceptionV3, and Inception-ResNetV2. The best classification results were obtained by the ResNet50 model, which had accuracy rates of 96.1 percent for Dataset 1, 99.5% for Dataset 2, and 99.7% for Dataset 3. (Narin, Kaya, & Pamuk 2021,1213.)

Author developed a model which identifies COVID-19 patients based on the individual biological tissue, employing machine learning (ML) and deep learning approaches to determine the treatment kind and concentration level. Before training the deep convolutional neural network (DCNN) model, the algorithm turned numerical data into images. Findings revealed that the DCNN model identified the

case well in identifying treatments, with an accuracy of 98.05%, outperforming established ML model such as support vector machine (SVM) and decision tree (DT). Still, when it came to forecasting treatment concentration levels, the decision tree (DT) model outperformed DCNN somewhat, with 98.5% accuracy versus 98.2%. Furthermore, the study did not include deep transfer learning models like AlexNet. (Khalifa 2020, 11.)

### 2.2 Theoretical views

For classification of the ray X-ray photography, will be used HOG and CNN technique to extract the feature vector. Using these techniques, the features were obtained by combination of HOG and CNN methods. These feature will be used as input for the final classification model to identify the input x-ray images and provide the final result for that patient whether the patient is affected by the coronavirus or not. The suggested system architecture model will consist of six critical steps which are image pre-processing, object recognition, image segmentation, feature extraction, and COVID-19 illness classification. Image pre-processing processes include scaling, normalization, and minimizing noise. Object detection recognizes chest X-ray pictures. Image segmentation then separates foreground from background. Feature extraction uses CNN and HOG to extract important information from X-ray pictures, with integrated features improving diagnostic accuracy compared to CNN alone. The function known as the sigmoid is used to train, validate, and test CNNs. Finally, SVM applies to identify patient as virus affected or not. (Ayalew 2022, 2.)

#### 2.2.1 Convolutional Neural Network

A Convolutional Neural Network (CNN) is a class of deep neural systems particularly outlined for handling organized framework data, such as images data. CNNs have illustrated remarkable execution in computer vision work, image classification, object classification, and picture specification. Convolutional Neural Networks have become a foundation in computer vision and image handling due to their capacity to consequently learn hierarchical features from the data. They have been widely utilized in different applications, extending from picture and speech acknowledgment to medical data examination and autonomous vehicles. (Hu 2019, 13-17.)

### 2.2.2 Histogram of Oriented Gradients(HOG)

Histogram of Oriented Gradients (HOG) is a feature descriptor that is used in image processing and computer vision. This technique counts occurrences of gradient orientation in localized portions of an image. It works as the following steps. First, this pre-processes data then calculates gradients for every pixel in the image. The second step is to calculate the magnitude and orientation. Then calculate the histogram of gradients and normalize the gradients in the cell. (Ayalew 2022, 3.)

### 2.2.3 MobileNetV2

MobileNetV2 architecture performs better on mobile devices. Its derived from an overturned remaining formation therein the remaining connections among the bottleneck layers. To sort the features as a basis of non-linearity, the intermediary expansion layer uses lightweight depth wise convolutions. MobileNetV2 architecture contains the primary FC layer with 32 filters, followed by 19 residual bottleneck layers. (Mbunge 2021, 242.)

### 2.2.4 Support Vector Machine

Support Vector Machine which is known as SVM. It is used for linear models; also used in binary classification. It can resolve not only linear problems but also non-linear models. The classes are separated by a hyperplane. (Olatomiwa 2015, 665.)

### 2.2.5 Artificial Neural Network

An Artificial Neural Network (ANN) is an algorithmic framework based by genuine neurological structures that uses interrelated neurons to analyse data. ANNs, like the brains of humans, acquire knowledge through history during instruction, allowing them to accumulate information and assume new data. This paradigm, developed by Warren McCulloch and Walter Pits in 1943, includes of multiple pieces that work together to solve certain challenges. ANNs work by imitating the memory and analysing abilities of the brain of humans, creating useful tools for activities like identifying patterns and forecasting. (Tran 2023,9-10.)

# 3 TOOLS AND LIBRARY

Deep learning, a basic component of AI, has quickly developed and drastically affected a wide run of areas such as discourse acknowledgment, picture categorization, and content comprehension. It changes calculation plan by creating a new model with a few covered up layers that specifically out-put results from preparing information from start to end. Deep learning is based on learning valuable features through tremendous covered up some layers and a huge sum of preparing or testing information, which progresses classification and forecast accuracy. This involves changing over test properties from the initial space to a modern feature space, which rearranges classification or forecast. (Hu 2019, 5-6.)

## 3.1 Python Programming Language

Python introduces itself as easy to use, flexible and broadly utilized programming language, particularly in machine learning. Python could be a prevalent programming language among information technology researchers and machine learning professionals due to its ease of utilize, simplicity, readability and extended library function. Strikingly, various libraries such as TensorFlow, PyTorch, and scikit-learn, which give effective instruments for building and preparing machine learning models. The details sentence structure of the dialect empowers for simple prototyping and experimentation, permitting fast advancement forms. Python's quality is improved assist by its huge community support and continues improvement time to time. This total quality places Python as the best choice for implementing and deploying machine learning frameworks, affirming its basic part within the head-way and execution of machine learning arrangements. (Islam 2023,16.)

## 3.2 TensorFlow

The Google Brain group made TensorFlow as an open-source machine learning framework. It offers a total system for creating and actualizing machine learning models, especially for deep learning models. TensorFlow is adaptable and versatile, permitting designers to make a wide run of machine learning applications, from straight forward direct relapse to expansive profound neural systems. TensorFlow includes some key features such as ‘Graph-based Computation’, ‘TensorFlow Serving’, ‘TensorBoard’ and ‘Wide Range of APIs’. (Abadi 2016,265-269.)

### 3.3 OpenCV

The term “OpenCV” refers to an “Open Source Computer Vision” library which was designed for immediate analysis for machine learning including images and video processing. OpenCV now supports real-time GPU amplification. OpenCV library was explained in 1999 by Gary Bradski and first version was released in 2000 under BSD (Berkeley Software distribution) license free for academic and commercial use. It supports Windows, Linux, Mac OS, iOS, and Android, with interfaces in C++, C, Python, and Java. OpenCV is developed for fast processing, with a strong emphasis on applications that work in real time. OpenCV has the distinct benefit of providing over 2,500 classic and innovative algorithms, all of which are designed for machine learning and computer vision. Furthermore, as it is written in efficient C/C++, the library supports multi-core operations. OpenCV's primary goal is to enable applications that operate in real time (Tran 2023,24-25).

### 3.4 Numpy

Numpy is known as math library on Python Programming language. Numpy is the most useful library for the multi directional arrays and matrices. It offers a wide range of high level mathematical operations for the efficient computer calculations. Python is used for mathematical computation in machine learning and AI. Likewise, compared to other Python lists, it provides a broad N-dimensional. The array structure and linear algebra algorithms have factors of magnitude where the Numpy processes data faster and more memory efficient. (Bohara 2020,20)

### 3.5 Pandas

Pandas is a highly beneficial Python package for working with dataset. Pandas is usually ideal for organizing, analysing, and cleansing data. This library works with labelled data, making it easy to import, study, and show data in an understandable manner. Since it is open-source, it is widely used for real-world data analysis. Pandas also provides numerous tools for managing and organizing vast volumes of data. It includes methods for integrating, classification, and filtering data, making it ideal for working with time-sensitive data. (Bohara 2020,20)

## 4 PROJECT IMPLIMENTATION

The goal of this research was to create a computerized procedure that can identify corona virus infected patients from chest X-ray pictures using methods based on machine learning. The primary goal is to build a system for classification that can accurately identify between normal and the COVID positive cases using the visual features retrieved from the X-ray images. The suggested approach uses the Histogram of Oriented Gradients (HOG) feature descriptor and the Support Vector Machine (SVM) algorithm for identification. Below the FIGURE 1 the step by step working process showed with an arrow direction. Before all the input data set was prepared to process in the same format and same resolution also, then it transferred RGB to Gray images to do noise filtering. The next task is extracting; it is quite a complex procedure where the x-ray film images are being prepared for next processing with the SVM model. After the last step, the final decision is made on whether the patients images are COVID-positive or negative.

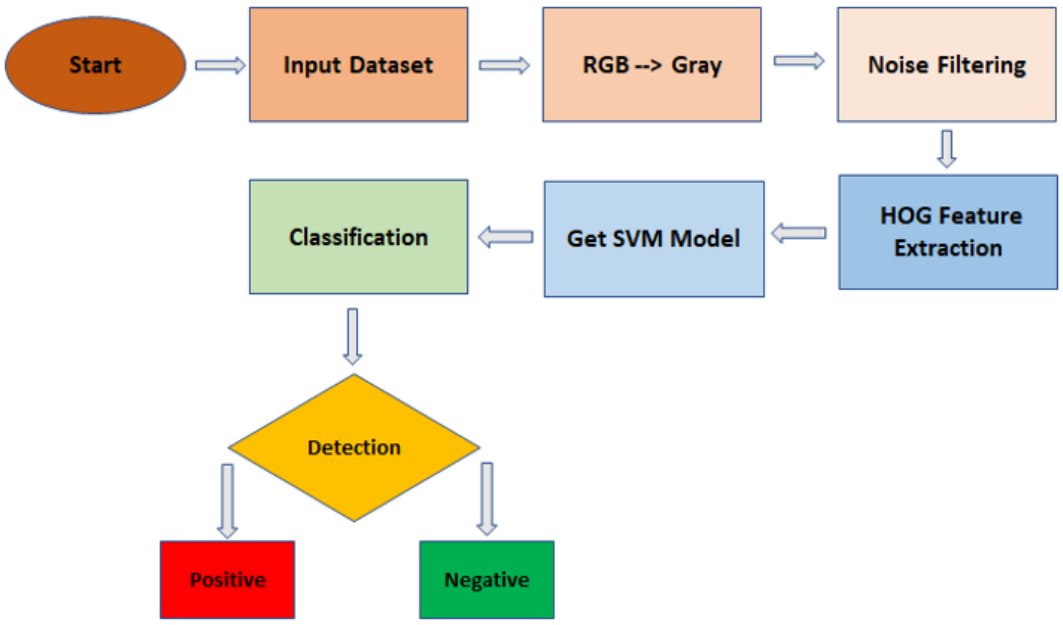


FIGURE 1. Flowchart of proposed model working process (HOG-SVM)

### 4.1 System architecture

This specified model utilizes chest X-ray pictures as primary data input to identify coronavirus. Initially, the algorithm used uncompressed photos in "RGB" format, subsequently converting them to grey to remove distortion from the images that were provided as data input. A filtering system was used to remove noise, and also to adjust the image size from the image dataset. This also helps to detect changes in image quality. The median filter is operated for this experimental research because it removes noises from pictures. In this system, HOG (Histogram-Oriented Gradient) will be used to classify the negative and the positive COVID data to produce the expected results. Higher accuracy of output may be found in testing and training will be carried out with mere selected better quality images, so for this reason the dataset would be a mixture of both poor and good quality images.

For SVM procedures, the input test data is processed by first resizing its height and width first. Then it transforms images from RGB to gray images to classify the data with median filter processing. The extraction of features is performed using cv2(OpenCV) and the classification method. HOG SVM processes first generate lists for training, testing, and validation; images are resized to (90,90) for both COVID and negative cases. Arrays or lists are produced containing both gradient pictures and HOG characteristics, with 8 pixels per cell and 4 cells each block. Tags are generated with 0 for positive and 1 for negative cases. SVM is trained using a linear kernel for binary categorization. Model convergence is optimized by pre-processing and normalizing attributes. The computational model and its test variables have been processed and standardized. Then, a confusion table is developed, and the performance indicators are assessed.

Following that step, if it is possible to get more time, another classifier is developed to perform crossover validation checks and generate the result by going 10 to 15 test of the training set which includes a cross-check. After completing the process, the CNN classifier will be employed binary classification to confirm positive or negative COVID-19 outcomes, while the HOG-SVM technique utilized SVM as a classifier. For the HOG-SVM model feature extraction, model simulation structure showed below on the FIGURE 2.

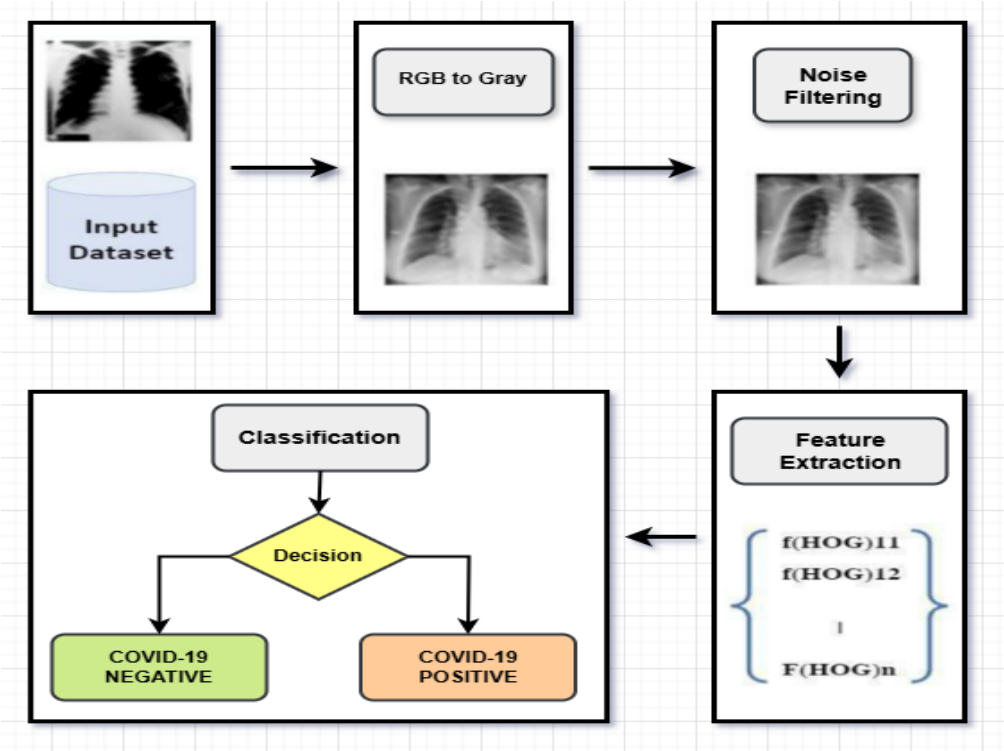


FIGURE 2. Overview of the pre-planned simulation structure.

### 4.2 Experimental Setup

In this experiment, having to insufficient high-performance computational equipment, it wasn't possible to handle a large number of the data set because processing a large number of data sets needs more powerful configured devices. Implementing this experiment with thus low performance devices may lead to a higher possibility of decreased accuracy percentages.

TABLE 2: Experimental setup for project implementation

| | |
|---|---|
| Operating System | Microsoft Windows 10 |
| Processor | Intel(R) Core(TM) i7-7500U CPU @ 2.70GHz 2.90 GHz |
| Memory | 8.00 GB (7.89 GB usable) |
| Programming Language | Python |

### 4.3 Working Procedure

Before all the input data set was prepared to process in the same format and same resolution also, then it transferred RGB to Gray images to do noise filtering. The next task is extracting; it is quite a complex procedure where the x-ray film images are being prepared for next processing with the SVM Model. After the last step is given the final decision that the images are COVID positive or negative. Previously on FIGURE 1 described all the procedure using arrow diagram.

#### 4.3.1 Dataset

We utilized a random COVID positive and the negative dataset of 77 chest X-ray images from kaggle for classification of COVID affected case and normal case. Where 43 case are positive and 34 cases are normal. The distribution of images across validation, testing, and training sets is presented in the following table.

TABLE 3: Experimental dataset

| Dataset for experiment | Total Images | Positive Case | Negative Case |
|---|---|---|---|
| Complete dataset | 77 | 43 | 34 |
| Training sample | 56 | 34 | 22 |
| Testing sample | 15 | 9 | 6 |

This research engaged a whole number of 77 unstrained and 43 COVID-19 affected and 34 images are non-affected images are used for training. For testing, 15 unstrained and 9 COVID-19 affected and 6 non-affected images were used. For analysis, 80% of the mentioned data applied as train data and the remaining 20% utilized as test data. Below on FIGURE 3 and FIGURE 4 some random positive and negative images displayed as sample dataset used for these experiment.

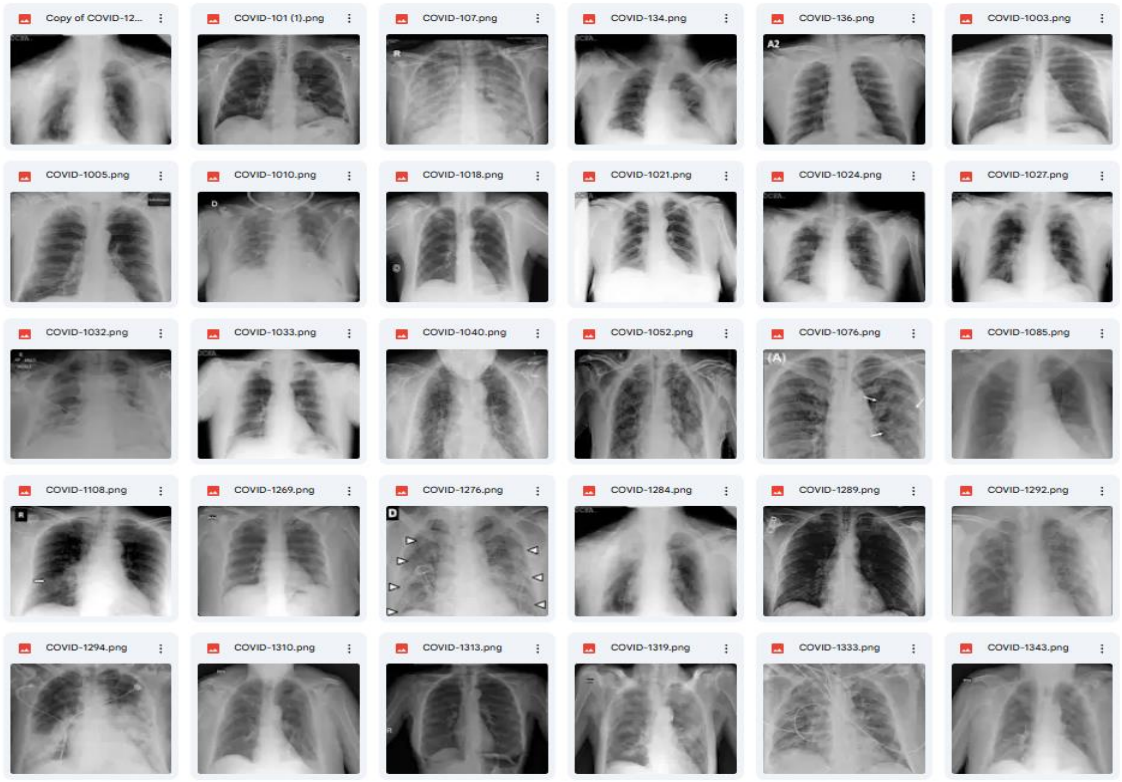


FIGURE 3: Random COVID positive data

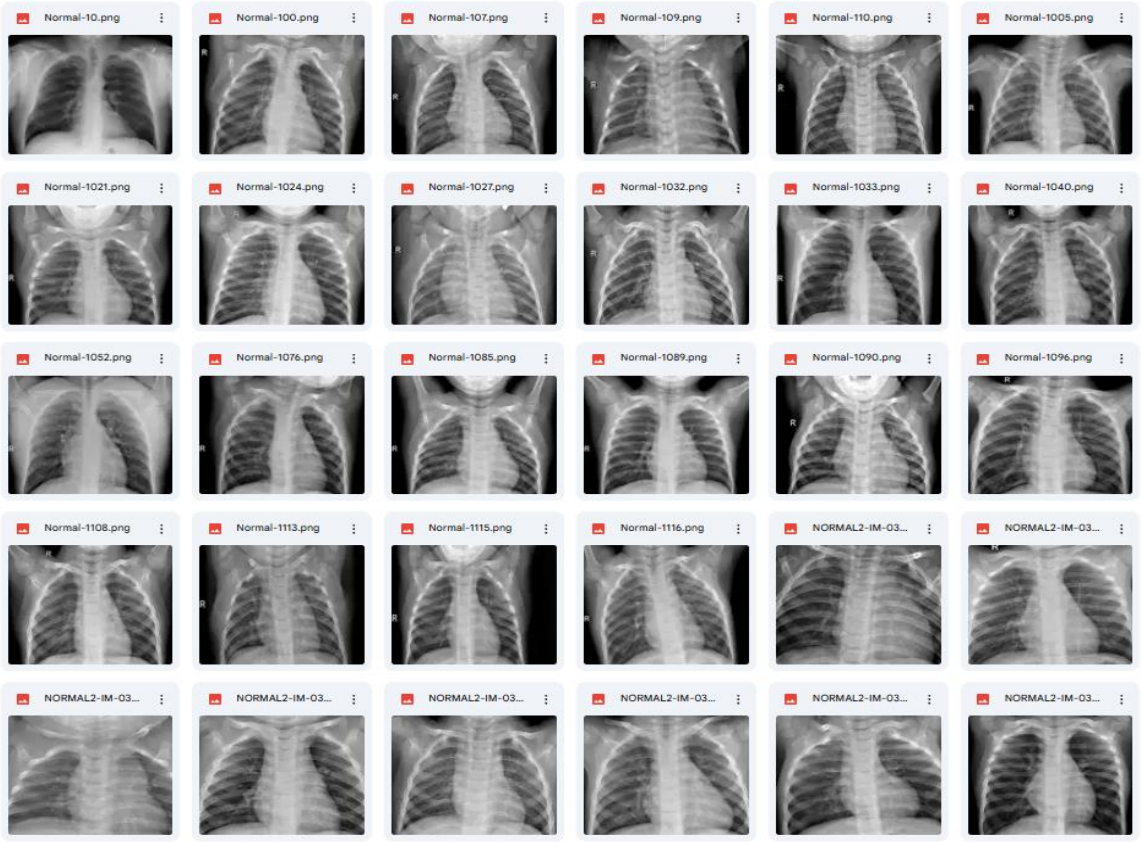


FIGURE 4: Random COVID negative data

### 4.3.2 Project Data Path

This experiment was implemented using google colab notebook. A dedicated folder was created for these experiment ‘COVID_Dataset’ to organize the project data images. At the first step of the project on Google Colab, an environment was set up containing the main file named ‘Covid_Identification.ipynb’. Additionally, two subfolders named ‘COVID’ and ‘Non-COVID’ created to store the experimental X-ray images. Some additional images are also stored in project main folder for using them for getting the final output from these experiment. During the project a path was created to get access all the stored data for using the data during the project runtime. For these project the data path is dataset_path = "/content/drive/MyDrive/COVID_Dataset".

### 4.3.3 Data Processing

X-ray image pre-processing is a critical step before training the model. This technique involves resizing all images from the dataset to a uniform dimension. In the beginning of the procedure, it read date from the dataset folder using OpenCV from the drive and process them for the experiment. Grayscale conversion is utilized to minimize issues related to low-quality images and enhance the learning capability of the model. Initially, both training and testing images are adjusted to identical height, width, and batch size. An image data generator is applied to introduce variations within the image dataset. Moreover, images are converted from RGB to grayscale to further improve image quality and consistency. Some random gray images can be seen on the FIGURE 5 below.

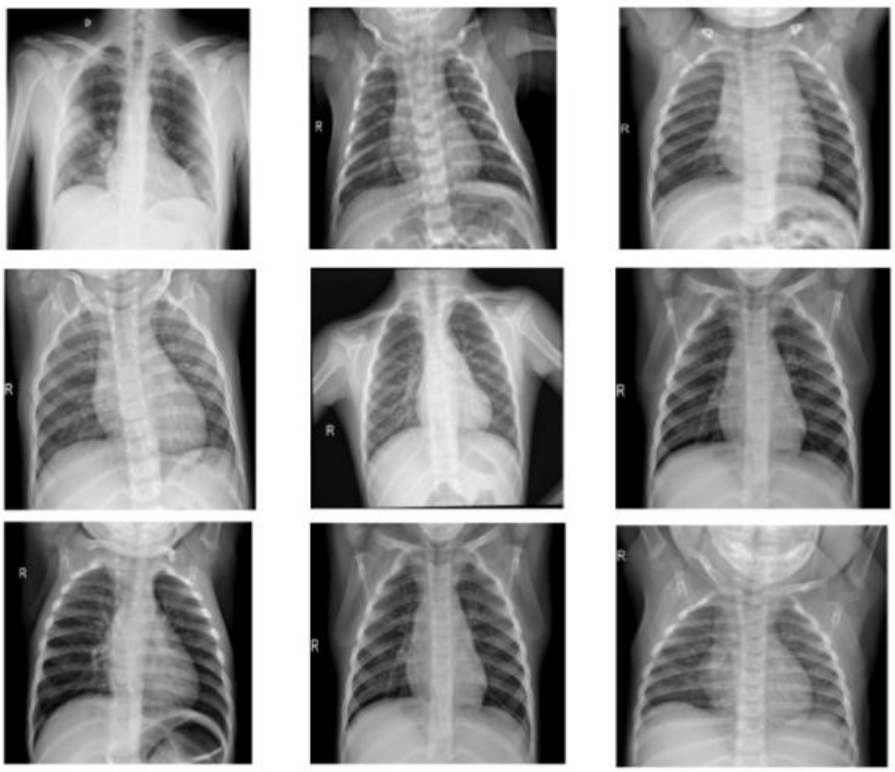

FIGURE 5: Random gray images

### 4.3.4 Import Libraries

To identify negative and positive results from the random dataset, machine learning and deep learning methods were applied in conjunction with the Python programming language. The required libraries were installed using the command prompt within the project's directory. Important libraries like TensorFlow, NumPy, Keras, OpenCV, SciPy, and Matplotlib were imported after installation. Each of these libraries carries out particular tasks that the program requires. Below on the FIGURE 6 showed all the imported libraries which used during theses COVID identification experiment.

```
0s
import os
import cv2
import numpy as np
import matplotlib.pyplot as plt
from skimage.feature import hog
from sklearn.svm import SVC
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.metrics import accuracy_score, classification_report
```

FIGURE 6: Imported libraries

### 4.3.5 Feature Extraction

the Histogram of Oriented Gradients (HOG) method was used to feature extraction for this project. The skimage.feature.hog function from the skimage.feature library is used to compute the HOG features for each image. At first, all the images loaded from the both folder. Program read all the images and turn into grayscale images. The HOG parameters was set to extract the orientations, all the images turned into 128*128 pixel sizes. It trained 80% images from the tota; loaded images and the rest 20% images used as test sample results. Below on FIGURE 6 is showing the difference between the HOG and the normal X-ray image.

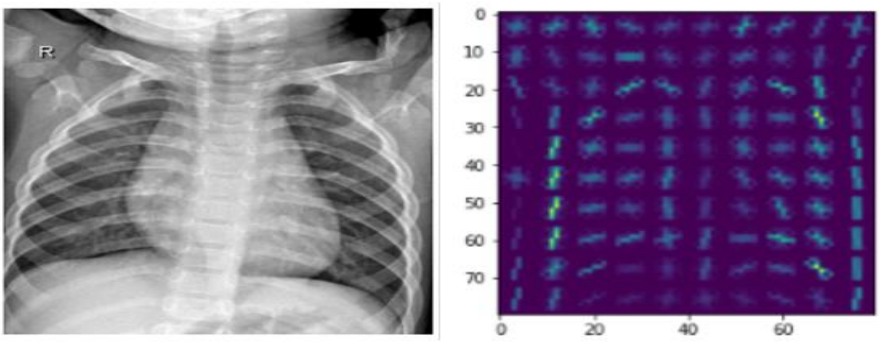


FIGURE 7: Difference between normal images and HOG features images

### 4.4 Result Analysis

The accuracy of these experiment was 100% when the project was working with small dataset. Then then project was consuming small memory from the machine and providing perfect accuracy. But when the dataset become larger then result accuracy decreases to 93.33% as its handling a bigger number of dataset where some images may contain lots of noises, poor quality images or sometimes overlapping also. A larger dataset also consumes more memory from the devices. Below on the figure 7 displayed the model accuracy after using a large number of dataset where the final accuracy decreases from 100% to 93.33%.

```
Model Accuracy: 93.33%
Classification Report:
              precision    recall  f1-score   support

       COVID       0.91      1.00      0.95        10
   Non-COVID       1.00      0.80      0.89         5

    accuracy                           0.93        15
   macro avg       0.95      0.90      0.92        15
weighted avg       0.94      0.93      0.93        15
```

FIGURE 8: Model accuracy captured from the project

At the end of the project, when the projects receive single experimental images for analysing whether the patients have COVID positive or not, it can identify successfully. Below on the table it showing couple of the test result for both COVID negative and the positive cases for the single images.

TABLE 4. Single images test result

| Sample Images | Actual Result | Predicted Result |
|---|---|---|
|  | Normal Case | Non-COVID |
|  | COVID Positive | COVID |

## 5 CONCLUSION

This research about coronavirus based on data from ‘WHO’, machine learning, artificial intelligence. dataset collected from ‘Kaggle’, information collected from various related papers and ‘Wikipedia’ articles. The classification of COVID-19 patients using machine learning technique is critical for early detection and diagnosis, minimizing the load on healthcare systems. In this thesis, the histogram of oriented gradients (HOG) with support vector machine (SVM) and deep learning approaches was imposed in classifying chest X-ray images for COVID-19 classification. The pre-processing methods, which included grayscale conversion, scaling, and feature extraction with HOG, enabled efficient data representation. The SVM model was developed on a well-structured dataset and showed promising results in discriminating COVID-19 cases from normal and COVID infected cases.

The final results showed that HOG-SVM is a lightweight but effective model for COVID-19 identification, making it ready for real-time and resource-constrained situations. Deep learning methods, such as CNN, could also increase classification more accuracy by learning more complicated patterns from the data. Despite its success, it has some limitations. Sometimes the result can come positive though the patient is not affected by coronavirus but other diseases as like pneumonia-infected cases. The model's performance could be improved by using a larger dataset, more advanced feature extraction techniques, and using hybrid machine learning models.

Finally, this study advances the field of medical image analysis by presenting a dependable, cost-effective, and automated strategy for COVID-19 identification. Future research could concentrate on combining sophisticated deep learning architectures, transfer learning approaches, and real-world clinical validation to improve model robustness and accuracy. The findings of this study have the potential to aid in the early diagnosis of COVID-19, allowing medical practitioners to make more timely and accurate judgments.

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