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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

"SAFE DISTANCE AND FACE MASK DETECTION USING DEEP LEARNING"

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Agenda

- Introduction
- Literature Survey
- Requirement Engineering
- Project Planning and Scheduling
- System Design
- Applications & Conclusion

Introduction

- The COVID – 19 virus has affected the lives of many people and to curb the spread of this virus we are implementing a safe distance and face mask detector.
- The COVID - 19 face mask detector uses deep learning techniques to successfully test whether a person is wearing a face mask or not.
- Furthermore we implement the Visual Social Distancing (VSD) problem, which automatically detects the interpersonal distance from an image.

Objectives

- To provide a system to detect if people are maintaining a safe distance of at least 6-feet (2-metres) between themselves and the surrounding.
- To include a face mask detector to check if a person is wearing a mask, which could also be capable of displaying if he/she is wearing it properly.
- The aim is to truly detect potentially dangerous situations while avoiding false alarms.

Literature Survey

SL. NO.	TITLE	AUTHOR	YEAR & PUBLICATION	CONTRIBUTION AND DRAWBACK
1.	**Using Computer Vision to enhance Safety of Workforce in Manufacturing in a Post COVID World**	P. Khandelwal, A. Khandelwal, S. Agarwal	2020 (arXiv)	➢ Proposed idea - Uses deep-learning, projectivity geometry techniques, transfer learning approach and fine tuned MobileNetV2 with TensorFlow framework using computer vision on CCTV. ➢ Drawback - the distance between persons can be calculated only if all persons are detected clearly and if face is partially covered by another person in front results are inaccurate.

SL. NO.	TITLE	AUTHOR	YEAR & PUBLICATION	CONTRIBUTION AND DRAWBACK
2.	**Deep Learning based Safe Social Distancing and Face Mask Detection in Public Areas for COVID19 Safety Guidelines Adherence**	Shashi Yadav	2020 (IEEE)	➢ Proposed idea - Used MobileNetV2, Single Shot Detector (SSD) algorithm and raspberry pi4 with camera to automatically track public spaces in real-time and if wearing mask. ➢ Drawback - They are using an average height of 165 cms to detect the depth of person in camera.
3.	**Visual Social Distancing Problem**	Marco Cristani, Alessio Del Bue, Vittorio Murino, Francesco Setti and Alessandro Vinciarelli	2020 (IEEE)	➢ Proposed idea - The paper estimates the ground to be plane where people walk to visualise the scene as a bird's eye view for ease of visualisation and data statistics representation. ➢ Drawback - Estimating depth from single image might be a viable option, but a metric reference is still needed and precise SD measures from images is an issue

SL. NO.	TITLE	AUTHOR	YEAR & PUBLICATION	CONTRIBUTION AND DRAWBACK
4.	**Real-time face mask identification using Facemask Net deep learning network**	Mahura Inamdar and Ninad Mehendale	2020 (SSRN)	➢ Proposed idea - Introduced a face mask detector uses Facemask Net, deep learning techniques to successfully test whether person is wearing a mask or not. ➢ Drawback - It doesn't correctly classify partially hidden faces.
5.	**Validating the correct wearing of protection mask by taking a selfie**	Karim Hammoudi, Adnane Cabani, Halim Benhabiles and Mahmoud Melkemi	2020 (arXiv)	➢ Proposed idea - Designed a mobile application allowing people able to take a picture with a smartphone to verify that their mask is correctly positioned on their faces or not. ➢ Drawback - It always prefered rigid masks because they reduce possibilities of wrong positioning on the face.

SL. NO.	TITLE	AUTHOR	YEAR & PUBLICATION	CONTRIBUTION AND DRAWBACK
6.	**A Vision-based Social Distancing and Critical Density Detection System for COVID-19**	Dongfang Yang, Ekim Yurtsever, Vishnu Renganathan, Keith A. Redmill and Umit Ozguner	2020 (arXiv)	➢ By using a monocular camera and deep learning based real time object detectors, implemented an automated system that can help monitoring & analysing social distancing in a real time without data recording. ➢ Drawback - It is difficult to detect social distance if the place is over crowded.
7.	**A deep learning-based social distance monitoring framework for COVID-19**	Imran Ahmed, Misbah Ahmad, Joel J.P.C.Rodrigues, Gwanggil Jeon, Sadia Din	2020 (Elsevier)	➢ Proposed idea - Developed a deep learning platform for social distance tracking using a overhead perspective, YOLOV3 object recognition paradigm, Transfer learning & tracking algorithm. ➢ Drawback - Having overhead cameras are practically rare, so it can not be implemented in most of the cases.

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8.	**Facial mask detection using Semantic Segmentation**	Toshanlal Meenpal, Ashutosh Balakrishnan, Amit Verma	2019 (ResearchGate)	➢ Proposed idea - Aims to design a binary face classifier which can detect any face present in frame irrespective of its alignment using Semantic Segmentation with the help full of Convolution model, with the accuracy of 93.884%. ➢ Drawback - Detects faces from images but does not identify as masked face or unmasked face.
9.	**Application of a Novel and improved VGG-19 Network in the detection of workers wearing masks**	Jian Xiao, Jia Wang, Shaozhong Cao and Bilong Li	2020 (Journal of physics)	➢ This paper uses improved VGG-19 Net (by replacing 1 of 3 FC layer into Flatten layer and original Softmax classifier with 2 labeled Softmax classification layers) to detect whether workers are wearing mask or not, with a precision of 97.62%. ➢ Drawback - Does not detect improper wearing of mask.

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10.	**Identifying Facemask wearing conditions using image Super-Resolution with classification network to prevent Covid-19**	Bosheng Qin and Dongxiao Li	2020 (Research Square)	➢ Proposed idea - Developed a new facial image classification method, by combining SR network with classification network and using deep learning method in automatic identification of facemask wearing conditions as properly worn, improperly worn or without facemask. ➢ Drawback - Designed only for images as dataset, and not the videos.
11.	**Detecting Masked Faces in the Wild with LLE-CNNs**	S. Ge, J. Li, Q. Ye and Z. Luo	2017 (IEEE)	➢ Proposes LLE-CNNs for masked face detecting which can detect masked faces in different orientations accurately & also presents a dataset of masked faces that can be used as an additional training source for developing new face detectors. ➢ Drawback- Considers any type of occlusion in the face as a masked face.

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12.	**Face Mask Detection using Transfer Learning of InceptionV3**	G. Jignesh Chowdary, Narinder Singh Punn, Sanjay Kumar Sonbhadra and Sonali Agarwal	2020 (arXiv)	➢ Proposed idea - Developed a face mask detection model by over-sampling the available limited number of dataset samples using image augmentation and transfer learning. ➢ Drawback - The dataset used is not realistic.
13.	**RetinaFaceMask: A Face Mask Detector**	Mingjie Jiang, Xinqi Fan and Hong Yan	2020 (arXiv)	➢ Proposed idea - Developed a novel face mask detector called RetinaFaceMask (consists of ResNet and MobileNet as backbone, feature pyramid network as neck and context attention modules as head) ➢ Drawback - Does not detect properly if face is covered with miscellaneous objects.

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14.	**Monitoring COVID-19 social distancing with person detection and tracking via fine-tuned YOLOv3 and Deepsort techniques**	Narinder Singh Punn, Sanjay Kumar Sonbhadra and Sonali Agarwal	2020 (arXiv)	➢ Proposed idea - A efficient real-time deep learning based framework to automate the process of monitoring the social distancing via object detection and tracking approaches. ➢ Drawback - The proposed model sometime fails to identify people and draw the bounding box.
15.	**A Deep Learning Based Assistive System to Classify COVID-19 Face Mask for Human Safety with YOLOv3**	M. R. Bhuiyan, S. A. Khushbu and M. S. Islam	2020 (IEEE)	➢ Proposed idea - An approach for detecting a person is wearing a mask or no mask using state of art YOLOv3 architecture. ➢ Drawback - Doesn't detect face if partially visible.

Drawbacks of Existing System

- Most of the models were able to predict any one i.e. either safe distance or face mask detection, in our model we try to implement both.
- A few limitations were observed in some models like, it could not correctly classify partially hidden faces, the model is not able to detect faces if the camera height is greater than 10 feet or camera is far, if a face is covered by another person in front, etc.

Problem Statement

“To implement a system that provides quick and efficient results on whether people are maintaining social distance and to check if people are wearing face masks properly or not.”

Input: Image or video with people wearing mask and no mask.

Output: A bounding box indicating red if violating social distancing norms and no mask, green otherwise.

Proposed System

- A single efficient system to detect social distancing and face mask.
- We use OpenCV projectivity techniques to detect social distancing and deep learning techniques like SSD, FaceMaskNet, etc along with transfer learning to detect face mask.
- Use of bounding box algorithm to classify the frames and give a confidence score over the box for the predicted output.

Requirement Engineering

Software Requirements

Python 3	Python is an interpreted, high-level and general-purpose programming language. Python's design philosophy emphasizes code readability with its notable use of significant whitespace.
Pip	Pip is a package-management system written in Python used to install and manage software packages.
numpy	NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.
Anaconda	Anaconda is a distribution of the Python and R programming languages for scientific computing, that aims to simplify package management and deployment.
Tensor Flow	TensorFlow is a free and open-source software library for machine learning. It can be used across a range of tasks but has a particular focus on training and inference of deep neural networks.
Google Colab	Colaboratory is a product from Google Research. Colab allows anybody to write and execute arbitrary python code through the browser, and is especially well suited to machine learning, data analysis.

Requirement Engineering Contd...

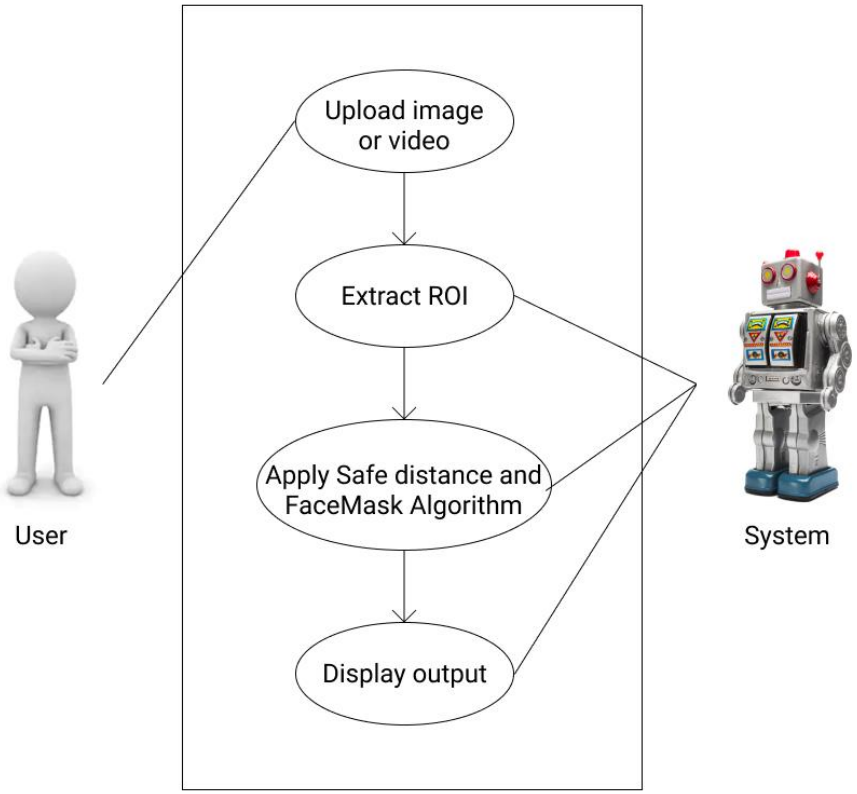
Hardware Requirements

- Processor: Minimum 1 GHz; Recommended 2 GHz or more
- Ethernet connection (LAN) OR a wireless adapter (Wi-Fi)
- NVIDIA GeForce MX 150 - 4GB or above
- Memory (RAM): Minimum 1 GB; Recommended 4 GB or above

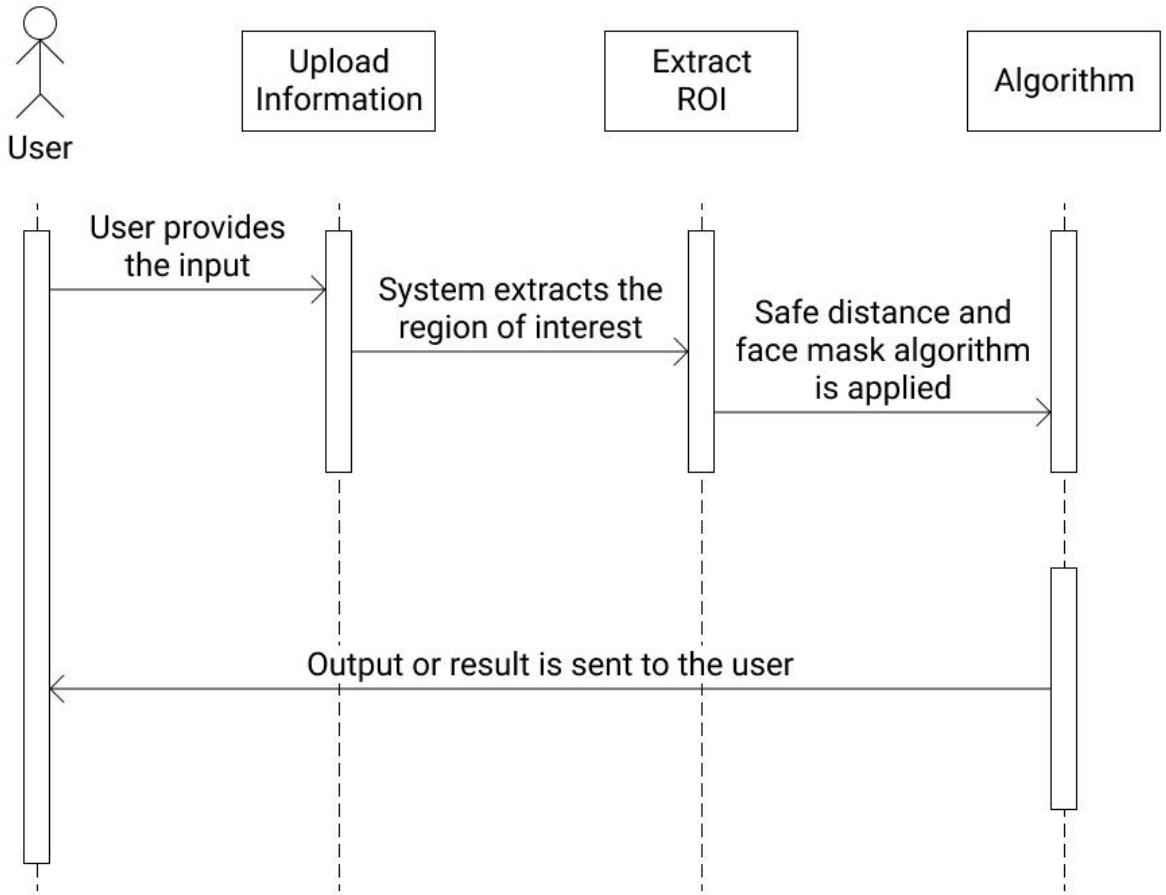
Conceptual/Analysis Modelling

- Use Case Diagram
- Sequence Diagram
- Activity Diagram
- State Diagram

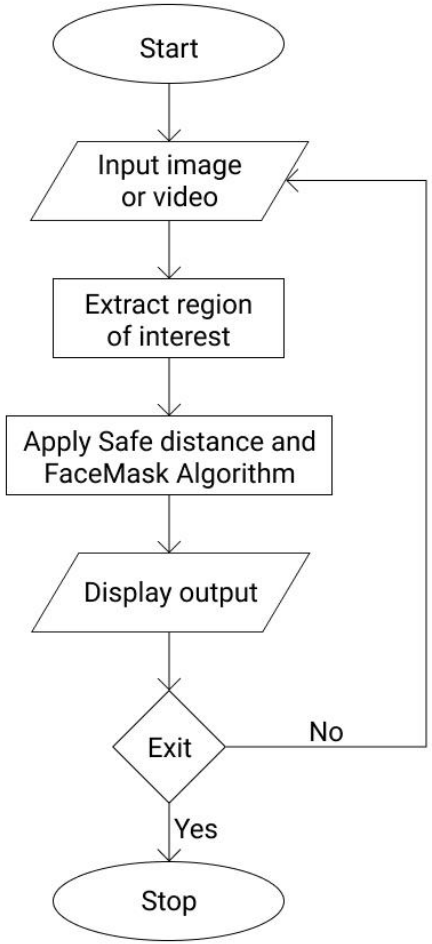
Use Case Diagram



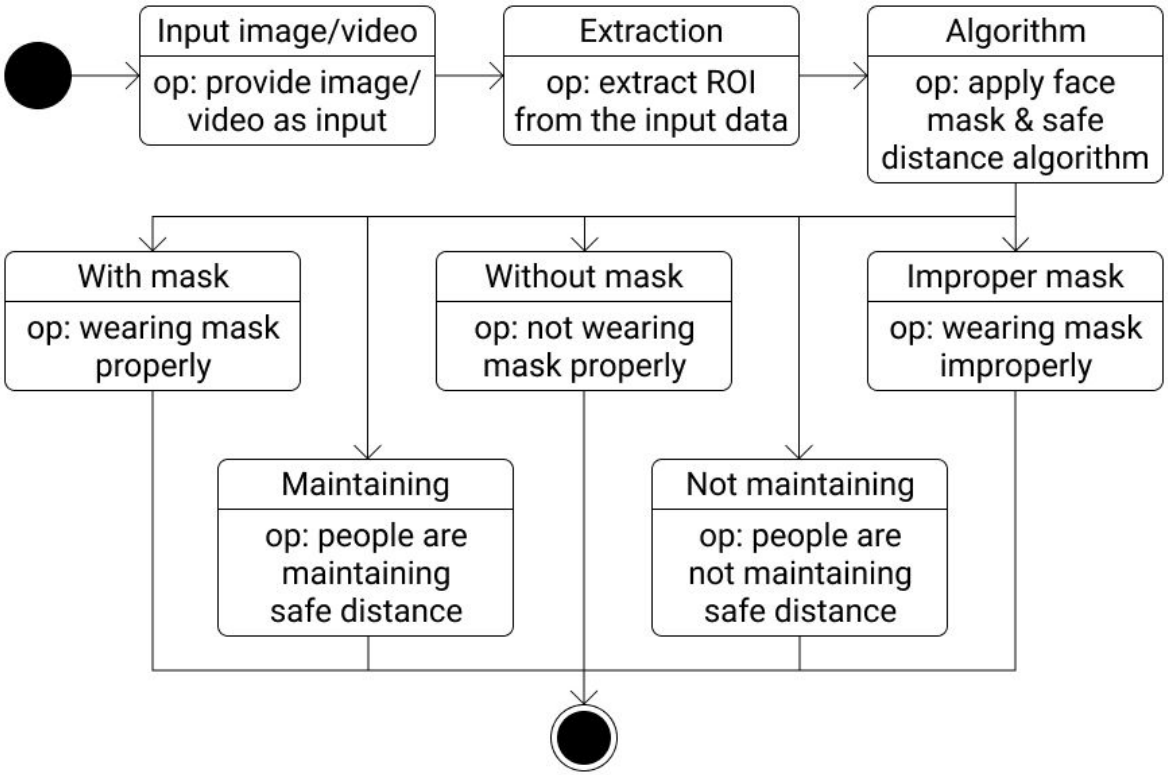
Sequence Diagram



Activity Diagram



State Diagram



Software Requirements Specification

Functional Requirements

- The input is classified as mask, improperly worn mask and without a mask.
- When input feed is more than one person, the model should also detect if there is a sufficient distance of 2 meters between them or not.

Non-Functional Requirements

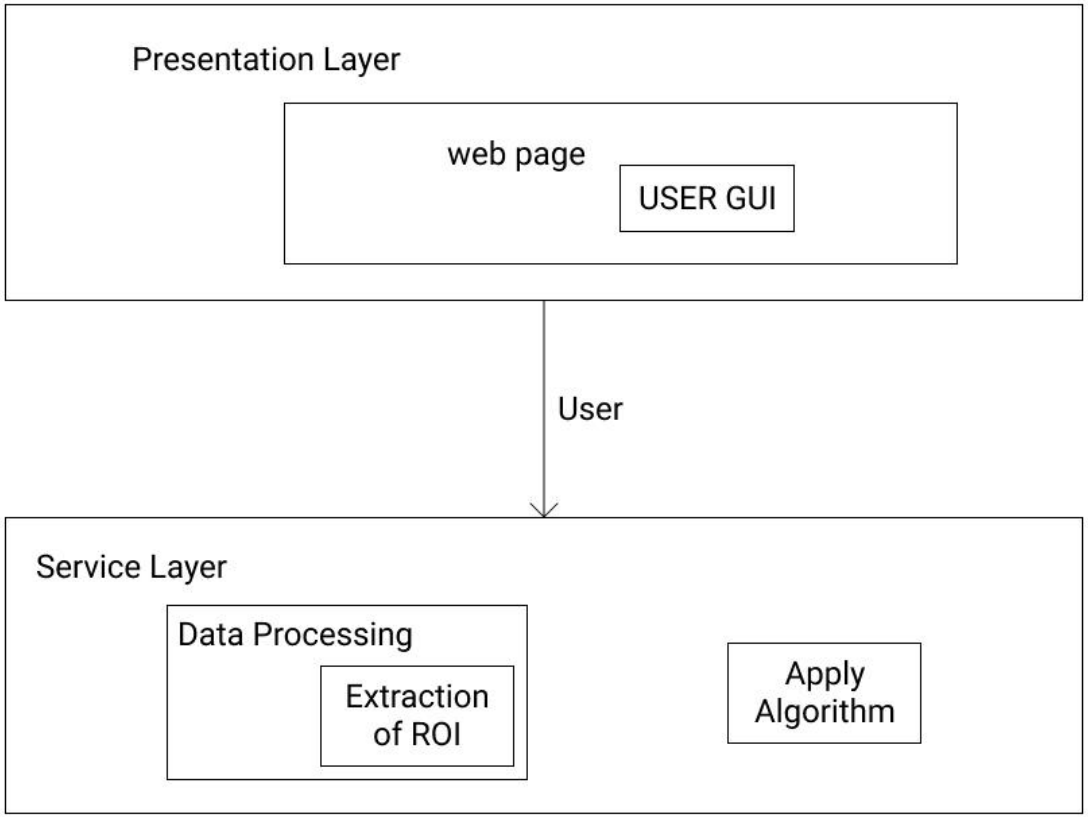
- Accuracy: The accuracy of the model should be more.
- Robustness: The system should gracefully handle all the exceptions which may occur during run time.

Project Planning / Scheduling

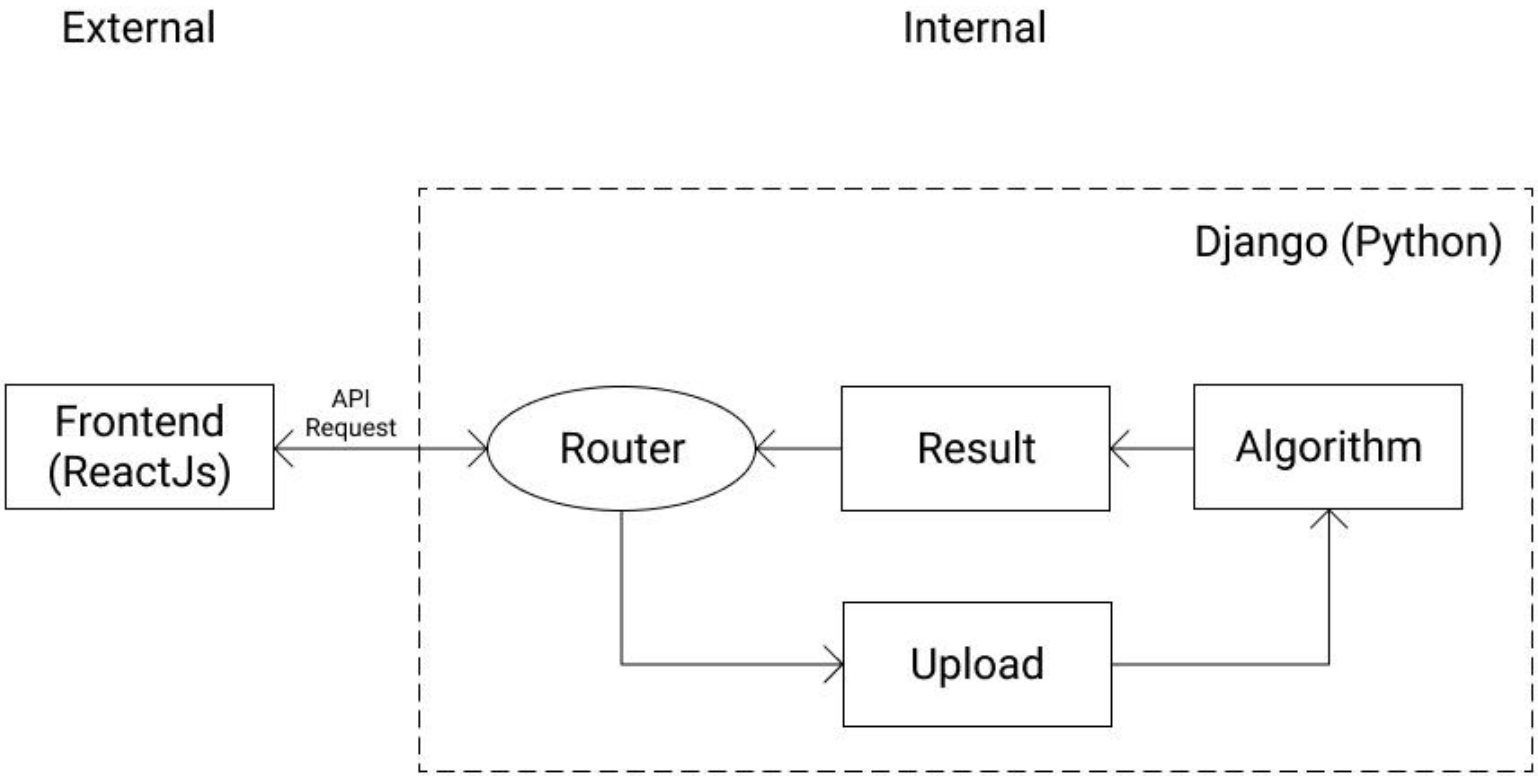
Gantt Chart

ID	Task Name	Start	Finish
1	Dataset Collection	20 Nov 2020	10 Dec 2020
2	Data Processing	11 Dec 2020	15 Dec 2020
3	Determine Model Architecture	16 Dec 2020	4 Jan 2021
4	Training Model	5 Jan 2021	4 Mar 2021
5	Optimizing Model	5 Jan 2021	4 Mar 2021
6	Testing Model	5 Jan 2021	4 Mar 2021
7	Deriving Results	5 Mar 2021	8 Mar 2021
8	Build User Interface	9 Mar 2021	29 Mar 2021

Component Design



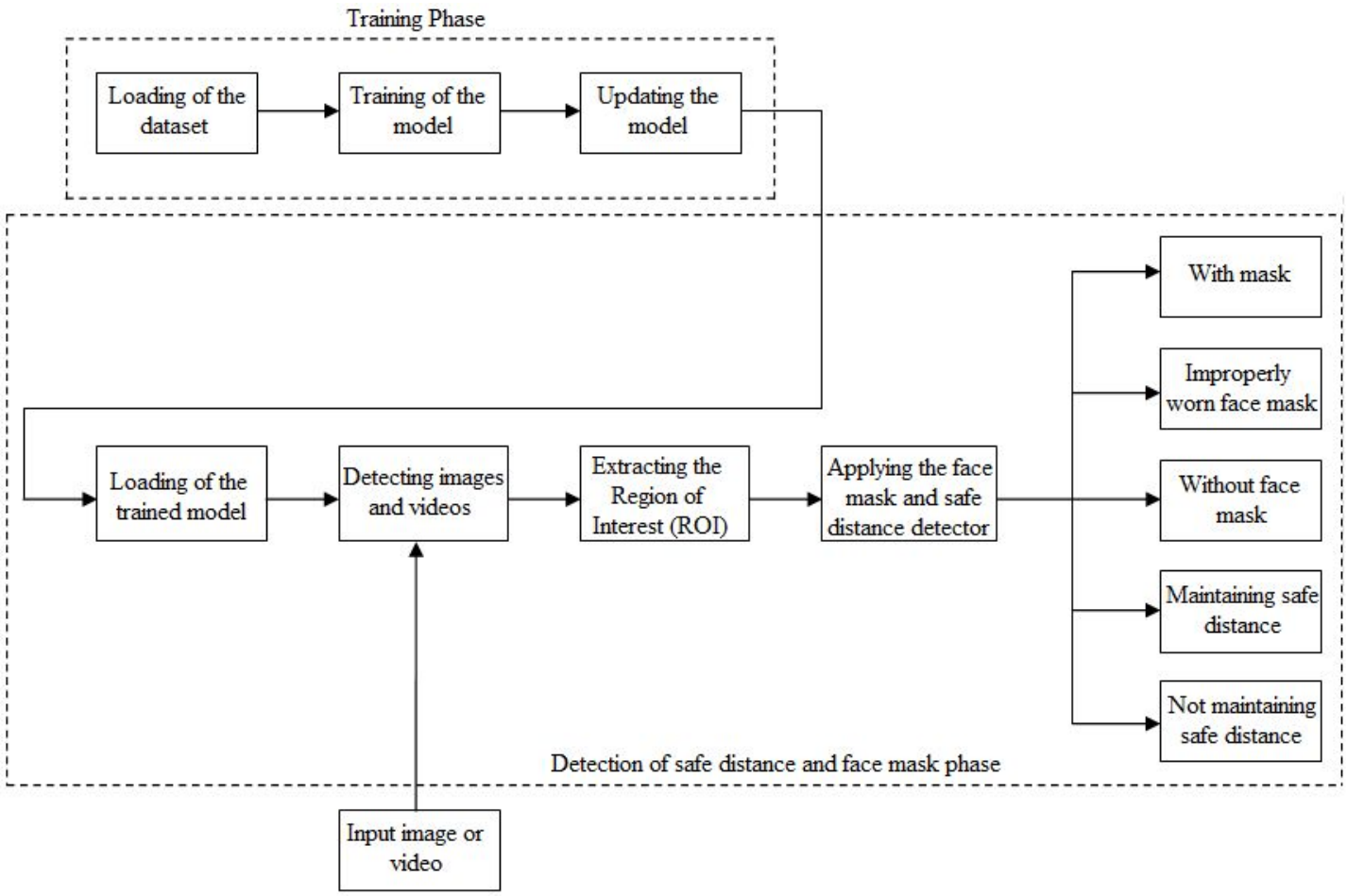
Interface Design



Data Structure Design

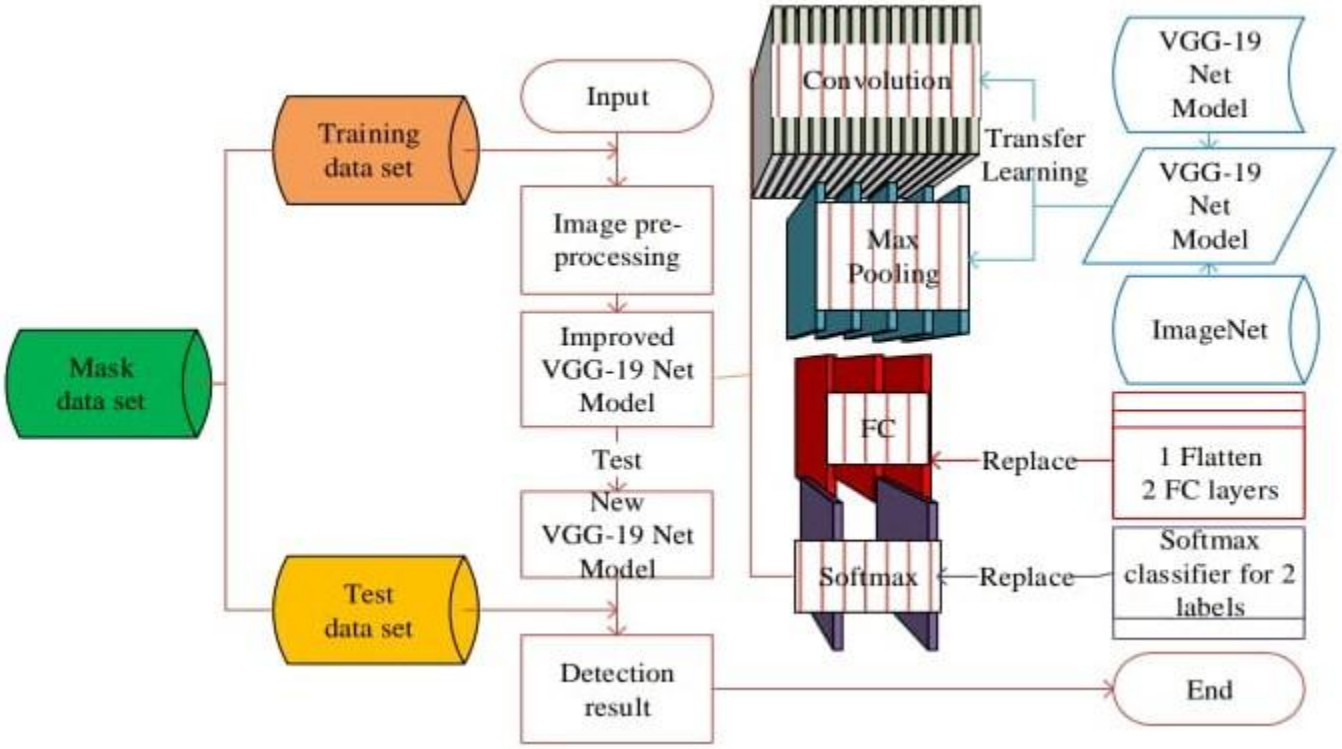
Numpy ndarray	An ndarray is a (usually fixed-size) multidimensional container of items of the same type and size. The number of dimensions and items in an array is defined by its shape, which is a tuple of N non-negative integers that specify the sizes of each dimension.
JSON	JSON (JavaScript Object Notation) is a lightweight data-interchange format. It is easy for humans to read and write. It is easy for machines to parse and generate.
Python Lists	List is a collection which is ordered and changeable. Allows duplicate members.
Python dictionary	Dictionary is a collection which is unordered and changeable. No duplicate members.
JWT	JSON Web Token (JWT) is an open standard (RFC 7519) that defines a compact and self-contained way for securely transmitting information between parties as a JSON object. This information can be verified and trusted because it is digitally signed. JWTs can be signed using a secret (with the HMAC algorithm) or a public/private key pair using RSA or ECDSA. It's used for Login Tokens.

System Design



Algorithm Design

Face Mask Algorithm



Algorithm Design Contd...

Safe Distance Algorithm

Step 1: Start

Step 2: Find the depth of each person as the camera image is a transferred view from 3d into 2d.

Using the formula $D=(H \times F) / P$

Step 3: Find the distance between people using euclidean distance formula $d=\sqrt{(x_2-x_1) / (y_2-y_1)}$

Step 4: End

Applications

- The structure of our model is least complex and gives quick results and hence can be used in CCTV.
- We can make sure that an individual wears it the right way and helps to curb the scope of the Coronavirus.
- Mass screening is possible and hence can be used in crowded places like railway stations, bus stops, Market areas, schools, colleges, corporate organisations, etc.

Conclusion

- Safe distance and face mask detection is a system that can detect if a person is wearing a mask, not wearing a mask or wearing it improperly.
- If there is more than one person in the frame then we can also know if those people are maintaining a safe distance of 2 meter or not.

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THANK YOU