Jyothi Hills, Panjal Road,
Vettikattiri PO, Cheruthuruthy , Thrissur,
Kerala 679531

Jyothi Engineering College
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A CENTRE OF EXCELLENCE IN SCIENCE & TECHNOLOGY BY THE CATHOLIC ARCHDIOCESE OF TRICHUR
JYOTHI HILLS, VETTIKATTIRI P.O, CHERUTHURUTHY, THRISSUR. PIN-679531 PH : +91- 4884-259000, 274423 FAX : 04884-274777
NBA accredited B.Tech Programmes in Computer Science & Engineering, Electronics & Communication Engineering, Electrical & Electronics Engineering and Mechanical Engineering valid for the academic years 2016-2022. NBA accredited B.Tech Programme in Civil Engineering valid for the academic years 2019-2022.

Face Mask Detection System For Covid 19

PROJECT REPORT

TEENA JOY P J	**(JEC17CS101)**
RESHMA R	**(JEC17CS081)**
VJ VISHNU	**(JEC17CS105)**
RONDY THOMAS	**(JEC17CS083)**

in partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY (B.Tech)

in

COMPUTER SCIENCE & ENGINEERING

of

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Under the guidance of

Dr. SWAPNA B SASI

June 2021

Department of Computer Science & Engineering

Jyothi Hills, Panjal Road,
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CREATING TECHNOLOGY LEADERS OF TOMORROW

DECEMBER 2020

Department of Computer Science & Engineering

Department of Computer Science and Engineering

JYOTHI ENGINEERING COLLEGE, CHERUTHURUTHY

THRISSUR 679 531

DECEMBER 2020

BONAFIDE CERTIFICATE

This is to certify that the Project report entitled **Face Mask Detection System For Covid 19** submitted by **TEENA JOY P J (JEC17CS101) RESHMA R (JEC17CS081) VJ VISHNU (JEC17CS105) RONDY THOMAS (JEC17CS083)** in partial fulfillment of the requirements for the award of **Bachelor of Technology** degree in **Computer Science and Engineering** of **A P J Abdul Kalam Technological University** is the bonafide work carried out by her under our supervision and guidance.

Dr. Swapna B Sasi	**Mr. Shaiju Paul**	**Dr. Saju P John**
Project Guide	Project Coordinator	Head of The Dept.
Associate Professor	Assistant Professor	Professor
Dept. of CSE	Dept. of CSE	Dept. of CSE

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www.jecc.ac.in | E-mail : info@jecc.ac.in

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3. **Design/Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. The graduates shall have sound knowledge of Mathematics, Science, Engineering and Management to be able to offer practical software and hardware solutions for the problems of industry and society at large.
2. The graduates shall be able to establish themselves as practising professionals, researchers or Entrepreneurs in computer science or allied areas and shall also be able to pursue higher education in reputed institutes.
3. The graduates shall be able to communicate effectively and work in multidisciplinary teams with team spirit demonstrating value driven and ethical leadership.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. An ability to apply knowledge of data structures and algorithms appropriate to computational problems.
2. An ability to apply knowledge of operating systems, programming languages, data management, or networking principles to computational assignments.
3. An ability to apply design, development, maintenance or evaluation of software engineering principles in the construction of computer and software systems of varying complexity and quality.
4. An ability to understand concepts involved in modeling and design of computer science applications in a way that demonstrates comprehension of the fundamentals and tradeoffs involved in design choices.

COURSE OUTCOMES (COs)

C410.1 The students will be able to analyse a current topic of professional interest and present it before an audience.

C410.2 Students will be able to identify an engineering problem, analyse it and propose a work plan to solve it.

C410.3 Students will have gained thorough knowledge in design, implementations and execution of Computer science related projects.

C410.4 Students will have attained the practical knowledge of what they learned in theory subjects.

C410.5 Students will become familiar with usage of modern tools.

C410.6 Students will have ability to plan and work in a team.

ACKNOWLEDGEMENT

We take this opportunity to express our heartfelt gratitude to all respected personalities who had guided, inspired and helped us in the successful completion of this interim project. First and foremost, we express my thanks to **The Lord Almighty** for guiding us in this endeavour and making it a success.

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ABSTRACT

The COVID - 19 pandemic is devastating mankind irrespective of caste, creed, gender, and religion. Until a vaccine is discovered, we should do our bit to constrain the expanse of the coronavirus. Using a face mask can undoubtedly help in managing the spread of the virus. COVID - 19 face mask detector uses or owns Facemasknet, deep learning techniques to successfully test whether a person is with wearing a face mask or not. The manuscript presents three-class classification namely person is wearing a mask, or improperly worn masks or no mask detected. Using our deep learning method called Facemasknet, we got an accuracy of 98.6 works with a live video stream. Cases in which the mask is improperly worn are when the nose and mouth are partially covered. Our face mask identifier is least complex in structure and gives quick results and hence can be used in CCTV footages to detect whether a person is wearing a mask perfectly so that he does not pose any danger to others. Mass screening is possible and hence can be used in crowded places like railway stations, bus stops, markets, streets, mall entrances, schools, colleges, etc. By monitoring the placement of the face mask on the face, we can make sure that an individual wears it the right way and helps to curb the scope of the virus.

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List of Figures

List of Abbreviations

HOG	: *HistogramOfOrientedGradients*
SVM	: *SupportVectorMachine*
BLE	: *BluetoothLowEnergy*
KLT	: *Kanade˘Lucas˘Tomasi*
DNN	: *DeepNeuralNetwork*
CNN	: *ConvolutionNeuralNetwork*
GPS	: *GlobalPositioningSystem*
GSM	: *GlobalSystemforMobileCommunications*
YOLO	: *YouOnlyLookOnce*
FFT	: *Fast Fourier Transformation*

CHAPTER 1
INTRODUCTION

1.1 Overview

The pandemic situation has taken over the world and has made the conditions worst hence wearing face mask has emerged as one of the best methods to prevent the spread of COVID-19. Furthermore, many public service providers require customers to use the service only if they wear masks correctly. Here, we propose a face mask detection system based on real time image analysis using open cv and keras with webcam, which will detect the full presence of mask as mask with 100 percentage and no mask detection in case of absence of mask on the face. .It propose an efficient computer vision based approach focused on the real-time automated monitoring of people to detect face masks in public places.

In this pandemic period using CCTV we can keep a track on human to wear face mask at public places, this report provides a pinpointing solution. By using CCTV and drones we can keep a track on human activities at public places and henceforth we can compute and monitor the wearing of face masks and it's violations across the city. This methodology restricts the people from violating COVID-19 guidelines. Recently all countries in the world are in the lockdown period and this has imposed the citizens to be at home but as time passes people will tend to visit more and more public places, religious places and tourist destinations, so in those circumstances this system to monitor the proper wearing of face mask will be beneficial all around the world.

With the help of already installed CCTV and the technologies like computer vision and Deep Learning we can keep a track on humans and compute the monitoring of wearing face masks properly. By this we can get an overview of people violating the law and concerned authorities can take the actions accordingly.

1.2 Objectives

The main objective of this project is to develop a Face Mask Detection System which helps the people and police to follow Covid 19 protocols easily and efficiently with the help of Artificial Intelligence technology, mainly Image Processing.

1.3 Data Description

The main dataset for this project is taken from an open source platform known as Github and Kaggle. The three main datasets are mask detect.model ,caffee model and deploy.prototxt. These pre-trained CNN models have been trained with seven lakh plus dataset and images for better accuracy. Resnet101 and MobileNetv2 is used with deep learning models to improve processing speed and accuracy.

1.4 Organization of the project

The report is organised as follow:

- **Chapter 1 : Introduction** Gives an introduction to "Face Mask Detection System for Covid-19" ".
- **Chapter 2 : Literature Survey** Summarizes the various existing techniques that help in achieving the desired result.
- **Chapter 3 : Problem Statement** Discuses about the need for the proposed system
- **Chapter 4 : Project Management** Deals with an effective project management model to implement this project.
- **Chapter 5 : Proposed System** Describes the various steps involved to produce this project.
- **Chapter 5 : System Requirements & Specification**Describes the various technologies needed for implementation.
- **Chapter 6 : Conclusion** Concludes with the future scope of implementation.
- **References** Includes the references for the project.

CHAPTER 2
LITERATURE SURVEY

2.1 Other Similar Systems

Since Covid 19 pandemic is a novel scenario, there are only few such existing systems. In recent years, object detection techniques using deep learning models are potentially more capable than shallow models in handling complex tasks and they have achieved spectacular progress in computer vision. Few to be mentioned are The Viola – Jones object detection system, Human tracking and crowd management and BLE Technology.

- **Face Detection:**

  The problem to be solved is detection of faces in an image. A human can do this easily, but a computer needs precise instructions and constraints. To make the task more manageable, Viola–Jones requires full view frontal upright faces. Thus in order to be detected, the entire face must point towards the camera and should not be tilted to either side. While it seems these constraints could diminish the algorithm's utility somewhat, because the detection step is most often followed by a recognition step, in practice these limits on pose are quite acceptable.

- **Object Tacking:**

  In videos of moving objects, one need not apply object detection to each frame. Instead, one can use KLT algorithm to detect salient features within the detection bounding boxes and track their movement between frames. Not only does this improve tracking speed by removing the need to re-detect objects in each frame, but it improves the robustness as well, as the salient features are more resilient than the Viola-Jones detection framework to rotation and photometric changes.

- **Human Tacking**:

  The study proposes a method to manage the crowd by keeping in track of the people in a given location. A monitoring system was developed using Raspberry Pi 3 board consists of ARMv8 CPU that detects the human heads and provide a count of people in the region using OpenCV-Python. A Haar cascade classifier has been trained to detect human movements. The stages of the cascade are based on

AdaBoost algorithm. Crowd dynamics characteristics such as speed, density, flow of the crowd are determined. Human tracking is achieved by calculating the histogram of each person. The motion trail indicated for each person helps in detection of suspicious movement of any individual. The outcomes of these experiments would suggest strategies to manage the high density of crowds.

- **Single Shot Detector (SSD) And Real Time Screening System:**

  The study adopts a combination of lightweight neural network MobileNetV2 and Single Shot Detector(SSD) with transfer learning technique to achieve the balance of resource limitations and recognition accuracy so that it can be used on real-time video surveillance to monitor public places to detect if persons wearing face mask and maintaining safe social distancing. The solution uses neural networking models to analyze Real-Time Streaming Protocol (RTSP) video streams using OpenCV and MobileNet V2.

- **Bluetooth Low Energy Technology(BLE):**

  Bluetooth Low Energy is a wireless personal area network technology designed and marketed by the Bluetooth Special Interest Group aimed at novel applications in the healthcare, fitness, beacons, security, and home entertainment industries. Using proven Bluetooth Low Energy technology (BLE), each digital badgeholder continuously monitors social distancing across the workplace and enables rapid contact tracing in the event a team member becomes infected. When the wearable detects a colleague is within approximately 6 feet / 2 meters of another colleague, it prompts the users with a visual beacon to establish a safe distance

- **GSM Passive Coherence Tracking:**

  GSM-based passive coherent location (PCL) system, consists of associate degree antenna and signal process that's custom-made to the GSM wave shape and to focus on following supported multi-hypothesis following. It will use multiple GSM base transceiver stations (BTS) as illuminators. the most options of this technique are: coincidental reception of multiple BTS, most angular discrimination by employing a linear array, and fusion of multiple bistatic systems to boost accuracy and backbone.

2.2 Viola-Jones Object Detection System

The Viola–Jones object detection [1]framework is an object detection framework which was proposed in 2001 by Paul Viola and Michael Jones. Although it can be trained to detect a variety of object classes, it was motivated primarily by the problem of face detection. In

Figure 2.1: Haar features applied on relevant parts of face

this method, the model can be trained to detect any object, but is especially common for facial detection and is more accurate and faster. The problem to be solved is detection of faces in an image. A human can do this easily, but a computer needs precise instructions and constraints. To make the task more manageable, Viola–Jones requires full view frontal upright faces. Thus in order to be detected, the entire face must point towards the camera and should not be tilted to either side. While it seems these constraints could diminish the algorithm's utility somewhat, because the detection step is most often followed by a recognition step, in practice these limits on pose are quite acceptable.

This algorithm helps us detect features of a face in a particular frame of a video sequence. This is the first object detection framework which gives a competition to real time detection rates. Paul Viola and Michael Jones are the ones who introduced this algorithm. They made this algorithm mainly by the issue of face detection. There are four steps which have to be followed to detect a face. Firstly, we train the system with the haar features. Haar features are a kind of rectangular boxes which are black and white.

2.2.1 Haar Features

Haar-like features are digital image features used in object recognition. They owe their name to their intuitive similarity with Haar wavelets and were used in the first real-time face detector. All human faces share some similar properties. These regularities may be matched using Haar Features. Haar features are sequence of rescaled square shape functions proposed by Alfred Haar in 1909.The key aspect in face recognition is detecting relevant features in human face like eyes, eyebrows, nose, lips and the algorithm used is called as Viola-Jones Algorithm.

2.2.2 Cascading

This step is introduced to speed up the process and give an accurate result. This step consists of several stages where each stage consists of a strong classifier. All features are grouped into several stages. It detects faces in the frame by sliding a window over a frame. When an input is given it checks for certain classifier in the first stage and then so on. But it is passed to the successive stage if and only if it satisfies the preceding stage classifier. An image representation called the integral image evaluates rectangular features in constant time, which gives them a considerable speed advantage over more sophisticated alternative features. Because each feature's rectangular area is always adjacent to at least one other rectangle, it follows that any two-rectangle feature can be computed in six array references, any three-rectangle feature in eight, and any four-rectangle feature in nine. A cascade of gradually more complex classifiers achieves even better detection rates. The evaluation of the strong classifiers generated by the learning process can be done quickly, but it isn't fast enough to run in real-time. For this reason, the strong classifiers are arranged in a cascade in order of complexity, where each successive classifier is trained only on those selected samples which pass through the preceding classifiers. If at any stage in the cascade a classifier rejects the sub-window under inspection, no further processing is performed and continue on searching the next sub-window. The cascade therefore has the form of a degenerate tree. In the case of faces, the first classifier in the cascade – called the attentional operator – uses only two features to achieve a false negative rate of approximately 0

2.3 Human Tracking And Crowd Management System

[4]Real time crowd analysis represents an active area of research within the computer vision community in general and scene analysis in particular. Over the last 10 years, various methods for crowd management in real time scenario have received immense attention due to large scale applications in people counting, public events management, disaster management, safety monitoring and so on. Although many sophisticated algorithms have been developed to address the task; crowd management in real time conditions is still a challenging problem being completely solved,particularly in wild and unconstrained conditions. The intelligent monitoring technology has been developing in recent years and human tracking has made a lot of progress. The study proposes a method to manage the crowd by keeping in track of the people in a given location. A monitoring system was developed using **Raspberry Pi 3** board consists of **ARMv8 CPU** that detects the human heads and provide a count of people in the region using OpenCV-Python. A Haar cascade classifier has been trained to detect human movements. The stages of the cascade are based on AdaBoost algorithm. Crowd dynamics characteristics such

as speed, density, flow of the crowd are determined. Human tracking is achieved by calculating the histogram of each person. The motion trail indicated for each person helps in detection of suspicious movement of any individual.

2.3.1 AdaBoost Algorithm

Ada-boost or Adaptive Boosting is one of ensemble boosting classifier pro-posed by Yoav Freund and Robert Schapire in 1996. It combines multiple classifiersto increase the accuracy of classifiers. AdaBoost is an iterative ensemble method.AdaBoost classifier builds a strong classifier by combining multiple poorly perform-ing classifiers so that you will get high accuracy strong classifier. The basic conceptbehind Adaboost is to set the weights of classifiers and training the data sample ineach iteration such that it ensures the accurate predictions of unusual observations.Any machine learning algorithm can be used as base classifier if it accepts weightson the training set.

2.3.2 Supervised Lerning Methods

Counting by detection methods: A window of suitable size slides over the entire scene (video/image) to detect people. After detection, researchers came up with various methods using the concepts of histogram of oriented gradients (HOG), shapelet, Haar features, and edgelet. Various machine learning strategies are exploited by researchers, but most of these methods fail over highly crowded scenes. An excellent 3D shape modeling is used by Zhao et al., reporting much better results as compared to SOA. The same work is further enhanced by Ge and Collins. Some papers addressing counting by detection methods can be explored in the references.

2.3.3 Regression based method

The high density and cluttered problem faced by the aforementioned method is excellently addressed by this method. Regression based methods work in two steps: feature extraction and regression modelling. The feature extraction methods include subtraction of background, which is used for extracting the foreground information. Better results are also reported while using Blobs as a feature. Local feature include extracting edge and texture information from data. Some of the local features used are Gray level co-occurrence matrices (GLCMs), Local binary pattern (LBP), and HoG. In the next stage mapping is performed from the extracted features through regression methods including Gaussian process regression, linear regression, and ridge regression. An excellent strategy is adapted by Idrees et al. by combining Fourier transform

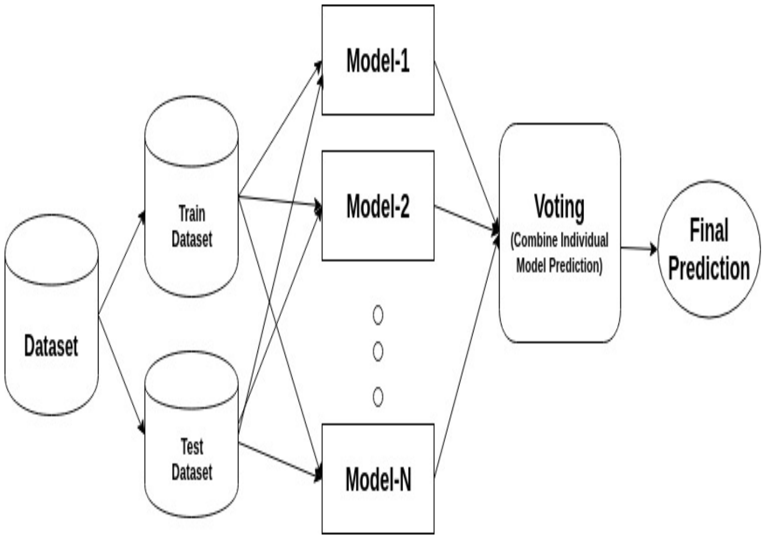


Figure 2.2: Adaboost Classifier In Python

and SIFT features. Similarly, Chen et al. extract features from sparse image samples and then mapping it to a cumulative attribute space. This strategy helps in handling the imbalanced data. Some more methods addressing counting problem can be explored.

2.3.4 Estimation

A method incorporating the spatial information through linear mapping of local features is introduced by Lempitsky et al. The local patch features are mapped with object density maps in these methods. The authors develop the density maps by a convex quadratic optimization through cutting plane optimization algorithm. Similarly, Pham et al. suggest a non-linear mapping method through Random Forest (RF) regression from patches in the image. The lastly mentioned method solve the challenge of variation invariance faced previously. Wang and Zou's work explores the computational complexity problem through subspace learning method. Similarly, Xu and Qiu apply RF regression model for head counts.

2.4 Bluetooth Low Energy Technology(BLE)

[6]Contact tracing is of paramount importance when it comes to preventing the spreading of infectious diseases. Contact tracing is usually performed manually by authorized personnel. Manual contact tracing is an inefficient, error-prone,time-consuming process of limited utility to the population at large as those in close contact with infected individuals are informed hours, if not days, later. This paper introduces an alternative way to manual contact tracing. The proposed Smart Contact Tracing (SCT) system utilizes the smartphones Bluetooth Low Energy

(BLE) signals and machine learning classifier to accurately and quickly determined the contact profile. [3]

With its low-cost and low-power features, Bluetooth® Low Energy technology has become the foundation for a wide range of applications. One example is using Bluetooth beacons to create a real-time location system, which is a positioning system that can monitor the whereabouts of equipment or people.Using Bluetooth technology for contact tracing and social distancing is a way to effectively monitor and slow the spread of easily transmitted illnesses to encourage safe practices. Each employee receives a wearable bracelet or tag. The tags can communicate with one another autonomously and alert employees when they are within a given proximity to another tag, thus ensuring proper social distancing. The tag can also collect data when interactions occur such that if an employee tests positive for a given illness, the data can help determine who else may have been exposed. Using proximity detection rather than location detection protects the wearer's privacy by not using actual GPS location data.

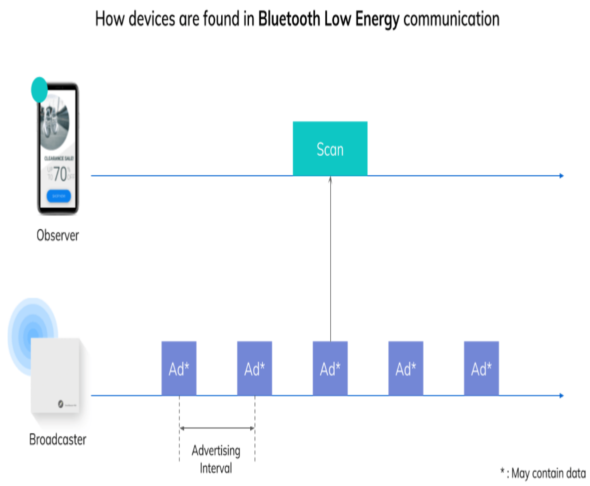


Figure 2.3: BLE Made Simple

BLE provides a short-range communication over the 2.4 GHz ISM band. It is ubiquitous and has been adopted by many smart devices (e.g., smartwatches, earphones, smart thermostats, etc.) as the main communication platform [21]. Furthermore, BLE is readily available in most modern smartphones regardless of the operating system. There are two modes of communication available with BLE: 1) non connectable advertising, and 2) connectable advertising. The latter advertising mode allows another device to request a connection by sending a CONNECT REQ packet on the advertising channels.

2.4.1 Smart Contact Tracing System(SCT)

There are two major phases with our SCT system,the interaction phase and the tracing phase. The interaction phase focuses on the following two main components: 1) privacy-preserving signature protocol, and 2) precise proximity sensing; whereas the tracing phase aims to provide an efficient signature matching. The interaction phase involves the day to day activities in public locations, such as workplaces, public transports, grocery stores, outdoor parks, etc. The contact tracing application starts automatically when it detects the user is in the public location.

All the generated signatures and observed signatures will be stored inside the user's local storage. Since the signature does not contain any information about the owner, there is no way for the user to trace or identify the original owner of the observed signatures. Furthermore, the signatures are deleted from the local storage permanently once it is expired. We define the expiration period for each signature based on the virus spreading time frame recommended by the health authorities. For instance, for COVID-19 the expiration period should be 14 days from the day the signature was recorded. After 14 days, the corresponding signature will be deleted.

2.4.2 Smartphone and Embedded Sensors

The intimacy of smartphones in our everyday life motivates us to adopt the smartphone for contact tracing purposes. However, there are privacy concerns about using such an intimate device for contact tracing. Many users might worry that their sensitive information which resides in the smartphone will be exposed to the public during the contact tracing. Our introduced SCT uses the non-connectable advertising mode, hence, none of the neighboring devices are able to connect to the user's device to retrieve any information. Furthermore, we are using a unique environmental signature that contains no information about the user's identity.

Research efforts that tried to address this privacy issue provide better encryption methodologies. However, none of the works discuss the contact tracing in private and public locations. While most users might willingly to participate in contact tracing in the public locations in a hope to flatten the disease spreading curve, they might feel a bit uncomfortable to let the contact tracing application running when they are having their private time in the private location (e.g., home, sleeping room, car, etc.). Future work can be conducted using the embedded sensors on the smartphone to check if the user is in the private or public location. Then, we can use this information to turn on and turn off the contact tracing application accordingly.

2.4.3 Interaction Phase

The interaction phase involves the day to day activities in public locations, such as workplaces, public transports, grocery stores, outdoor parks, etc. The contact tracing application starts automatically when it detects the user is in the public location. The application executes the following functions:

i. **Signature generation**: The smartphone scans for the ambient environmental features. These features are selectively processed to generate a unique signature that can be fit into the 31 bytes advertising payload. The signature willbe updated every few minutes.

ii. **Signature broadcasting**: The smartphone broadcasts the advertising packet containing the unique signature periodically according to the advertising interval of Ta. The packet is broadcasted through the non-connectable advertising channels.

iii. **Signatures Observation**: The smartphone scans the three advertising channels to listen for the advertising packet broadcast by the neighboring smartphones. The scanning is performed in between the broadcasting event.

iv. **Proximity sensing**: The smartphone measures the RSS values and uses them to estimate how close it is to the neighboring smartphones. It is assumed to be in proximity when the distance is less than 2 m.

2.4.4 Tracing Phase

All the generated signatures and observed signatures will be stored inside the user's local storage. Since the signature does not contain any information about the owner, there is no way for the user to trace or identify the original owner of the observed signatures. Furthermore, the signatures are deleted from the local storage permanently once it is expired. We define the expiration period for each signature based on the virus spreading timeframe recommended by the health authorities. For instance, for COVID-19 the expiration period should be 14 days from the day the signature was recorded. After 14 days, the corresponding signature will be deleted.

If a user is diagnosed with an infectious disease, they can upload all the signatures to the signature database. In fig, user A uploaded all his signatures to the signature database after he became an infected individual. The database will distribute the signature to all the users' smartphones. The signature matching computation is taken placed on each individual smartphone and a local alert is triggered when there is a match. The local alert means that the alert is triggered by the smartphone's program itself, not the centralized alert sent by the server. The server is only used to distribute the data. No program/code is executed on the server to find the close contact. In this way, we can protect the user from revealing their identity and to ensure that none of the match cases can be eavesdropped by malicious hackers. Besides signature matching, the application also performs the classification to classify the potential risk of a user according to the time and distance the user spent with the infected individual.

2.4.5 Proximity Sensing And Classification

Proximity sensing has been employed in many scenarios, including identification of the user's proximity to museum collection, and gallery art pieces [. There are also works study the proximity detection in dense environment, or proximity accuracy with filtering technique. However, most of these works study the proximity detection between a human and an object attached to a BLE beacon. There is no work studying the proximity sensing between the devices carried by humans.

Given the distance, then we can determine if the user follows the safe physical distance as recommended by the health authorities. An alert is sent to remind the user if they violate the physical distance rule. In the distance estimation context, accuracy indicates how close an estimated value to the true value. In other words, the error between the estimated value and true value is close to zero for an accurate estimation. Precision, on the other hand, tells if any two estimated values fall into the same region given similar measurement input (i.e., the RSS value). For contact tracing purposes, an accurate distance estimation is not that critical as compared to precise proximity sensing. We do not need an accurate estimation to tell if the user is in proximity to the infected individual. Rather, a precise estimation is more critical in determining the risk of a user. In particular, we consider that a user belongs to the high-risk group when the user is in close proximity (i.e., d 2m) with the infected individual, otherwise, the user is considered to be in the low risk group.

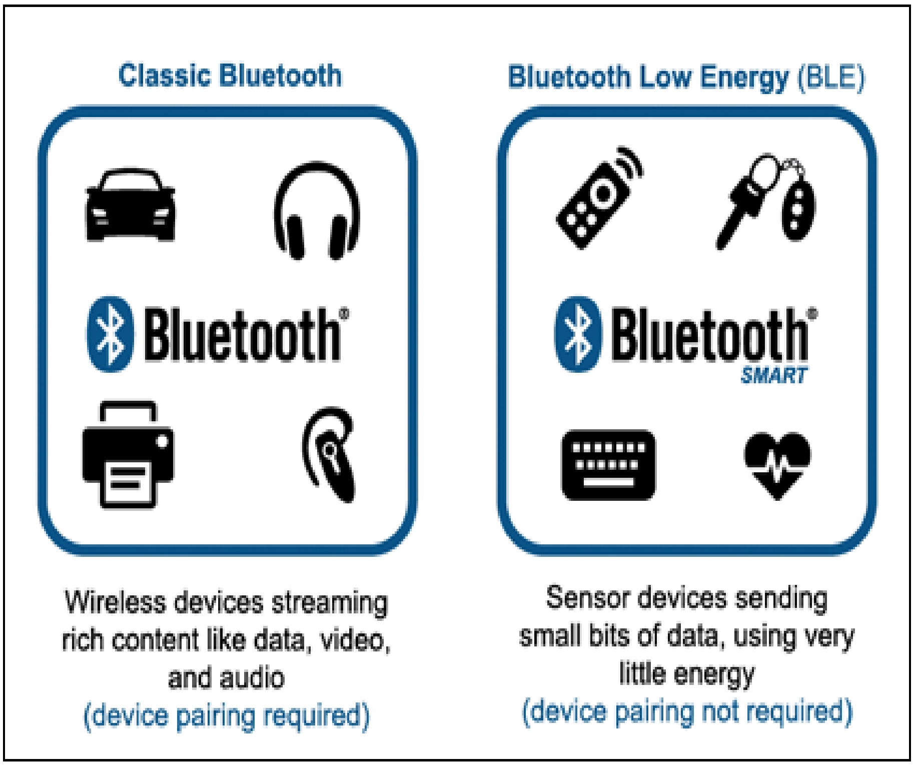


Figure 2.4: Bluetooth Low Energy Technology

2.5 Development of Location Detection and Human Tracking Application via GPS and GSM Service

With the development and awareness of social affairs concerning locating missing person and location detection services has been widely on demand. [2]This paper explains the design and experiment of incorporating the GPS GSM network positioning technology to deliver a locationbased service for tracking and detecting human. In this study, GPS and GSM feature were utilized to emulate the tracking and detection process. Integration of this technology is supported by the use of several applications, devices and services. The proposed model comprises of GPS sender and receiver, GSM service and provider. With the extensive use of smartphones and mobile applications, this model is useful to identify the location of a person in a public area and may benefit parents in monitoring and tracking their children whereabouts. This paper, presented the methods adopted in developing of the initial prototype as a pilot study. The result of the evaluation discussed recommendations for further improvement in the prototype development. This shall be achieved by adding specific values for a better outcome. A detail result on the improvement will be discussed in the next paper. The purpose of this study is to share this information with other researcher and to foresee ways to improve the current processes hence the same study can be initiated and explored by others. A further enhancement of this service shall be proposed and another set of evaluation should be performed thus there be a potential for application commercialization.

Many cases of missing person in a public area were reported and fast detection is highly demanded. This situation may be commonly seen in the after effect of natural disasters, earth quake, tsunami and others. Other scenario where people is always on the move, for instance annual Hajj seasons where there are too many people move in groups from one location to another may leads to tendency of missing a group members including spouse, siblings or friends. Thus getting hold of one person may be difficult to be performed without the aid of automated process or tools. While missing person case is another popular daily newspaper storyline. This situation occurs all over the globe. Hence with the Social responsibility and awareness of the community concerning this issue, a study on developing the service model via GPS and GSM technology were conducted.

The huge population of smartphones users all over the world is the reason being why these services is adopted in this study. Generally in this study will involve the use of smartphones and the telecommunication services. With the Global Positioning System (GPS) as a medium using the satellite-based navigation system, it will provide the latitude longitude of the device. This system comprise of a database of every registered routes and location recorded on the map. The Global System for Mobile (GSM) technology is adopted to transmit voice and text to complement the proposed prototype, this is to for the purpose of supporting emergency cases. GSM service is widely used as communication medium where sending and receiving process occur via a device from remote locations.

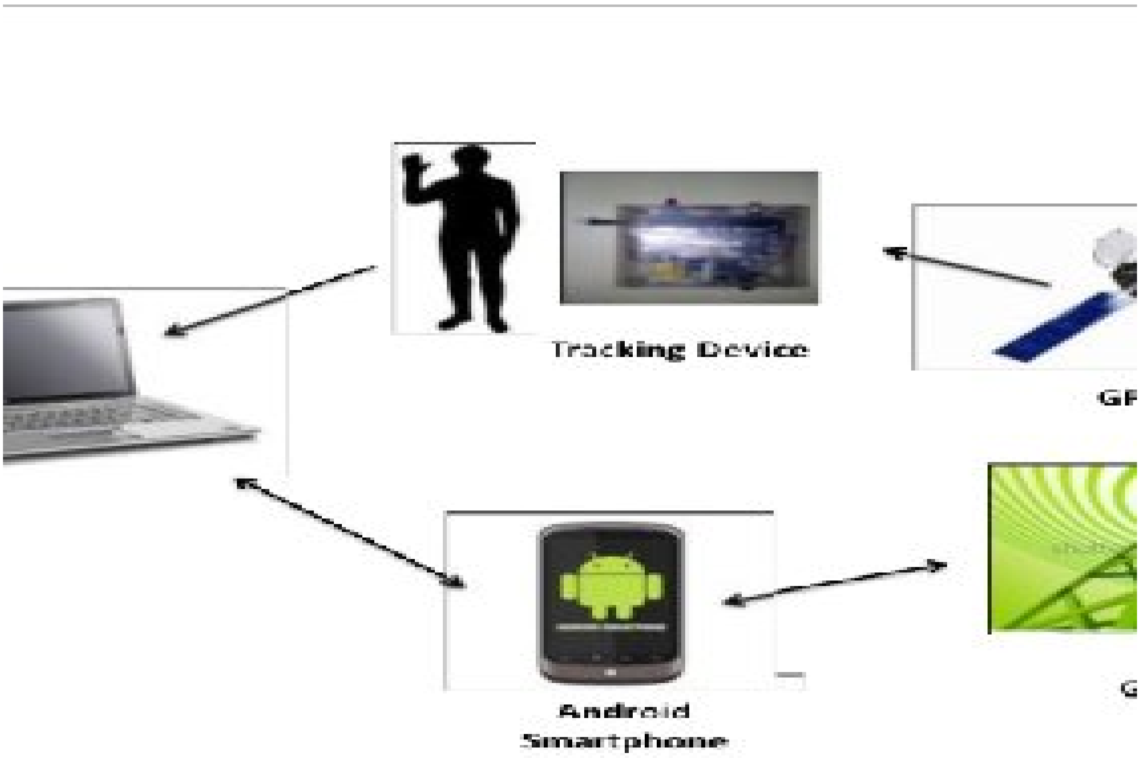


Figure 2.5: The System Architecture

2.5.1 What Is Human Tracking

The Human Tracking and Detection service comprise of combination of a devices and application to perform the tracking and detecting process.[5] Two devices are required to achieve this. Device A will is use to send signals, this is known as the tracking device. While device B is used as receiver consists of an android smartphone. The detail requirement of each of the devices is as follows:

i. Human Tracking and Detection device (Device A)

a. Sending the coordinate b. Sending panic alert with Real-time voice message

ii. Smartphone user (Device B)

a. View coordinates via Location Identification Application b. Receiver can receive coordinate c. Receiver can receive Real-time voice message d. Receiver can send message request to the Sender device

2.5.2 Why Human Tracking And Detection

Identifying and locating a person in an infinite public area is not easy. What more if it is done manually. This may be the after effect situation where the occurrence of natural disaster such as earthquake, huge flood and others. According to reports in Malaysian tabloids, on average there are four (4) missing person daily reported. Many of the missing persons identified were aged below eighteen (18) years old .

A gadget to prevent this is needed thus a person's location can be tracked and detected. In emergency cases where phone call is impossible, a device may save life. Many have been looking for solution as a service to inhibit situation. With this issue to solve, with the widely use existing GPS GSM technology, a pilot study is conducted to experiment the development of a human tracking and detection application prototype.

2.5.3 GSM

Global Positioning System (GSM).The use of GSM gained its popularity by more than 200 countries in the world since early 2000 and by 2005 this technology has been subscribed by more than 1.5 people which represents 78the world market. Based on the result of the study, Sohn et al. on Mobility detection using GSM traces, proved that GSM sensor is best used to detect high level activity on mobile phones in any location. Hence this sensor is adopted in this study to suit the purpose. Sameer Darekar, Atul Chikane, Rutujit Diwate, Amol Deshmukh, and Prof. Archana Shinde in 2012, have developed a Multi-Tracking system to trace objects using GPS and GSM technology. They have recommended many other areas of study to be conducted such as tracking movable assets, antitheft vehicle and managing transportation may be applied in the future

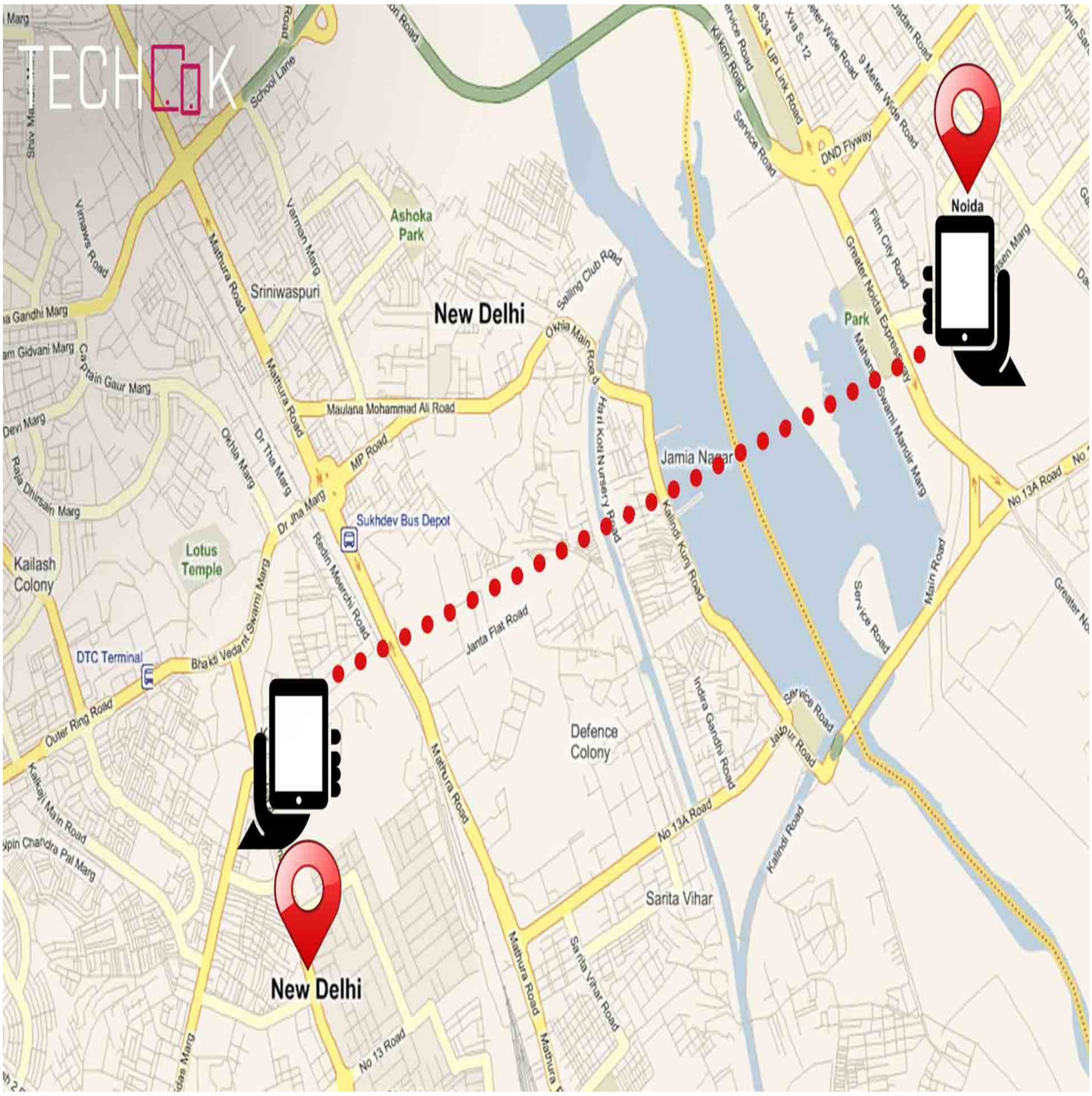


Figure 2.6: Location On Map

2.5.4 Service Model

For this service to work, a wireless internet connection is required for both the tracking and mobile phone devices. The tracking device will set on the LED to indicate a start (ON and OFF) indicator in approximately ten (10) seconds. Coordinate is then sent to the specific smartphone as the receiver via a service provider server. The receiver then will receive an SMS from the tracking device with a specific alert message and attached the link to the coordinate of the senders' location. The receiver on smartphone then will be able to click on the link and retrieve the location via a map application which gets the information from the GPS database service. The tracking device also transmits the voice signal to provide detail situation from the senders' device.

To achieve the development of this service, the Spiral model is adopted. This combines the idea of iterative development with the systematic and controlled aspects of the waterfall model. It involves incremental releases of the product, or incremental refinement through each of iteration around the spiral. Hence testing and refining is concurrently on-going.The process includes, initial study, design, development and evaluation which is performed iteratively along the pilot study. This method has been applied by many researcher and system developer with proven success.

To develop the tracking device a microcontroller board, Arduino Uno AT model is customized. The GPS and GSM module is embedded onto the board. This is to enable the tracking and detection to occur. An additional ON/OFF button is embedded to the board to trigger the start and end of alert message from the device. In addition a mini microphone was attached to the board, this is to allow the voice data transmitted to the receiver.

Hardware	Software
Tracking device A i. Micro Controller : Arduino Uno ATmega328 GSM Module ii. Arduino Shield GSM iii. GPS Module : EM406A iv. Mini Microphone v. ON/OFF button	i. Arduino C
Mobile phone	Short Messaging Service SMS

Figure 2.7: Table I: components of tracking and detecting service

In this experiment, Arduino board is selected due to its flexibility in transmitting analog and digital signal. It allows connection to a personal computer via USB and it is able to run on a stand-alone mode. A range of several programming languages is allowed to enable the communication process with other devices. Overall this model is cost effective to run the pilot study.

Another device to run this service model is a mobile phone. For the purpose of this study, the mobile phone model used is Samsung Galaxy A8. The communication service subscribed on this mobile phone is DiGi. The phone should be equipped with a Wi-Fi connection by a service provider. This receiving device will be detecting signals sent from the tracking device. Data sent includes the coordinate location of the senders' device and an alert message defaulted set from the senders end. In addition the coordinate was sent via a URL link to the Google applications map received via a Short Messaging Service (SMS). Besides the coordinate and text message, the senders device also allows the transmission of voice data. This is transmitted by an installed microphone component on the Arduino board. This allows the default mobile phone capabilities to receive voice data. The purpose of this is to help receiver to judge if the situation from the senders device if it is genuine or otherwise. This is really helpful when emergency condition occurs.

At the point of this writing, the human tracking and detecting model has gone through the pilot testing stage. For the purpose of this testing, the developed prototype is put on an integration tests. This is to test Device A : Senders Device (Customized Arduino Board) on its success to communicate to Device B : Receiving Device (Mobile Phone) Based on the project planned and the proposed design the following are the features to be tested:

i. Accuracy of the GPS system in getting coordinate

ii. Availability of the GSM system to sending report to the user

iii. Efficiency of the GPS and GSM to receive and sending data To achieve the evaluation phase, several tests was planned. In this pilot study the integration test was successfully performed and the result was recorded. This test was run by the developer evaluate the working of each module and its integration on devices and application.

The first is the type of device used, as there are various types mobile phones available in the market. This mobile phone types act as receiver may reflect the test result, hence in the future the type and model of the mobile device should be clearly identified and tested. The second is the telecommunication carrier . This may augment the result as there are many different telecommunication carrier available in the country. While different telecommunication link may lead to different readings during evaluation. The third source tested is the range of the distance between the senders' and the receiving device. This is to evaluate if the location of the sender and receiver distance if it effects the overall result. For this pilot study the distance involved during the testing is approximately 1 kilometer. In the future a different range of distance should be tested to identify if there is an impact to the result of the test.

CHAPTER 3

PROBLEM STATEMENT

The world is going through the tough times of COVID-19 pandemic.Using a face mask can undoubtedly help in managing the spread of the virus. When you wear a mask, you protect others as well as yourself. COVID-19 spreads mainly from person to person through respiratory droplets. These respiratory droplets travel in the air when you cough, sneeze, talk, shout etc.. So masks are the key measure to suppress the transmission and save lives.We propose a real-time Face Mask Detection system to detect whether the person is wearing a mask properly or not. The main objective of this project is to develop a Face Mask Detection System which helps the people and police to follow COVID-19 protocols easily and efficiently with the help of AI.

CHAPTER 4
PROJECT MANAGEMENT

4.1 Introduction

Project management is the discipline of planning, organizing, securing, managing, leading, and controlling resources to achieve specific goals. A project is a temporary endeavor with a defined beginning and end (usually time-constrained, and often constrained by funding or deliverables), undertaken to meet unique goals and objectives, typically to bring about beneficial change or added value. The temporary nature of projects stands in contrast with business as usual (or operations), which are repetitive, permanent, or semi-permanent functional activities to produce products or services. In practice, the management of these two systems is often quite different, and as such requires the development of distinct technical skills and management strategies.

In our project we are following the typical development phases of an engineering project:

1. Initiation
2. Planning and Design
3. Execution and Construction
4. Monitoring and Controlling Systems
5. Completion

4.1.1 Initiation

The initiating processes determine the nature and scope of the project. The initiating stage should include a plan that encompasses the following areas :

1. Analysing the business needs/requirements in measurable goals
2. Reviewing of the current operations
3. Financial analysis of the costs and benefits including a budget
4. Stakeholder analysis, including users, and support personal for the project

4.1.2 Planing and design

After the initiation stage, the project is planned to an appropriate level of detail (see example of a flow-chart). The main purpose is to plan time, cost and resources adequately to estimate the work needed and to effectively manage risk during project execution. As with the initiation process, a failure to adequately plan greatly reduces the project's chances of successfully accomplishing its goals.

- Determining how to plan
- Developing the scope statement
- Selecting the planning team
- Identifying deliverables and creating the work breakdown structure
- Identifying the activities needed to complete those deliverables
- Developing the schedule
- Risk planning

4.1.3 Execution

Executing consists of the processes used to complete the work defined in the project plan to accomplish the project's requirements. The execution process involves coordinating people and resources, as well as integrating and performing the activities of the project in accordance with the project management plan. The deliverables are produced as outputs from the processes performed as defined in the project management plan and other frameworks that might be applicable to the type of project at hand.

4.1.4 Monitoring & controlling

Monitoring and controlling consists of those processes performed to observe project execution so that potential problems can be identified in a timely manner and corrective action can be taken, when necessary, to control the execution of the project. The key benefit is that project performance is observed and measured regularly to identify variances from the project management plan.

4.2 System Development Life Cycle

The Systems development life cycle (SDLC), or Software development process in systems engineering, information systems, and software engineering, is a process of creating or altering information systems, and the models and methodologies that people use to develop these systems. In software engineering, the SDLC concept underpins many kinds of software development methodologies. These methodologies form the framework for planning and controlling the creation of an information system.

The SDLC phases serve as a programmatic guide to project activity and provide a flexible but consistent way to conduct projects to a depth matching the scope of the project. Each of the SDLC phase objectives is described in this section with key deliverables, a description of recommended tasks, and a summary of related control objectives for effective management. The project manager must establish and monitor control objectives during each SDLC phase while executing projects. Control objectives help to provide a clear statement of the desired result or purpose and should be used throughout the entire SDLC process.

4.2.1 Spiral Model

We have used the Spiral model in our project. The Spiral model incorporates the best characteristics of both- waterfall and prototyping model. In addition, the Spiral model also contains a new component called Risk Analysis, which is not there in the waterfall and prototype model. In the Spiral model, the basic structure of the software product is developed first. After the basic structure is developed, new features such as user interface and data administration are added to the existing software product. This functionality of the Spiral model is similar to a spiral where the circles of the spiral increase in diameter. Each circle represents a more complete version of the software product. The spiral is a risk-reduction oriented model that breaks a software project up into main projects, each addressing one or major risks. After major risks have been addressed the spiral model terminates as a waterfall model. Spiral iteration involves six steps:

1. Determine objectives, alternatives and constraints.
2. Identify and resolve risks.
3. Evaluate alternatives.
4. Develop the deliverables for the iteration and verify that they are correct.
5. Plan the next iteration.

6. Commit to an approach for the next iteration.

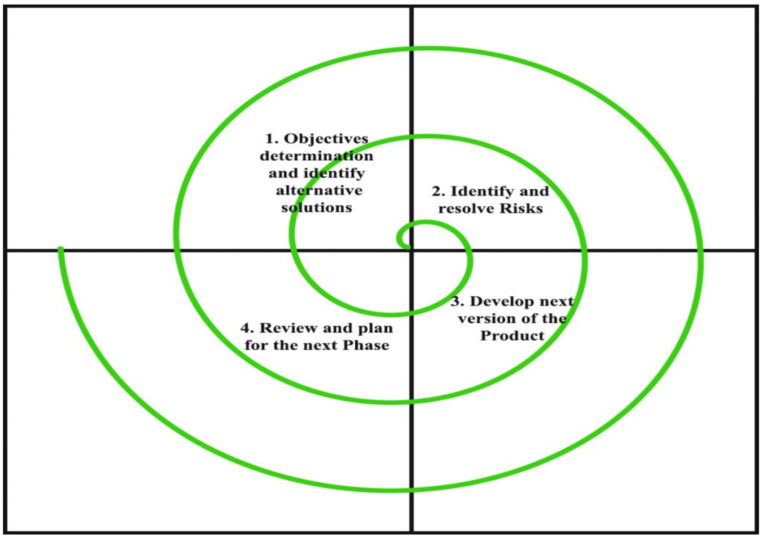


Figure 4.1: Spiral Model

CHAPTER 5
METHODOLOGY

5.1 System Requirements & Specifications

5.1.1 Windows 10

Windows 10 is a series of personal computer operating systems produced by Microsoft as part of its Windows NT family of operating systems. It is the successor to Windows 8.1 and was released to manufacturing on July 15, 2015, and to retail on July 29, 2015. Windows 10 receives new builds on an ongoing basis, which are available at no additional cost to users. Mainstream builds of Windows 10 are labeled version YYMM with YY representing the year and MM representing the month of release. For example, the latest mainstream build of Windows 10 is Version 1809. There are additional test builds of Windows 10 available to Windows Insiders. Devices in enterprise environments can receive these updates at a slower pace, or use long-term support milestones that only receive critical updates, such as security patches, over their ten-year lifespan of extended support.

5.1.2 Python 3.6.2

Python is a dynamic object-oriented programming language that can be used for many kinds of software development. It offers strong support for integration with other languages and tools, comes with extensive standard libraries, and can be learned in a few days. Many Python programmers report substantial productivity gains and feel the language encourages the development of higher quality, more maintainable code.

Python runs on Windows, Linux/Unix, Mac OS X, OS/2, Amiga, Palm Handhelds, and Nokia mobile phones. Python has also been ported to the Java and .NET virtual machines. Python is distributed under an OSI-approved open source license that makes it free to use, even for commercial products.

5.1.3 SCIKIT-learn

Scikit-learn provides a range of supervised and unsupervised learning algorithms via a consistent interface in Python. It is licensed under a permissive simplified BSD license and is distributed under many Linux distributions, encouraging academic and commercial use. The library is built upon the SciPy (Scientific Python) that must be installed before you can use scikit-learn. This stack that includes:

1. NumPy: Base n-dimensional array package
2. SciPy: Fundamental library for scientific computing
3. Matplotlib: Comprehensive 2D/3D plotting
4. IPython: Enhanced interactive console
5. Sympy: Symbolic mathematics
6. Pandas: Data structures and analysis

Extensions or modules for SciPy are conventionally named SciKits. As such, the module provides learning algorithms and is named scikit-learn.

5.1.4 Pandas

In computer programming, pandas is a software library written for the Python programming language for data manipulation and analysis. In particular, it offers data structures and operations for manipulating numerical tables and time series. The name is derived from the term "panel data", in econometrics term for data sets that include observations over multiple periods for the same individuals. Pandas is an open-source, BSD-licensed Python library providing high-performance, easy-to-use data structures and data analysis tools for the Python programming language. Python with Pandas is used in a wide range of fields including academic and commercial domains including finance, economics, statistics, analytics, etc

5.1.5 Jupyter Environment

JupyterLab is a web-based interactive development environment for Jupyter notebooks, code, and data. JupyterLab is flexible: configure and arrange the user interface to support a wide range of workflows in data science, scientific computing, and machine learning. JupyterLab is extensible and modular: write plugins that add new components and integrate with existing ones.

5.2 Proposed System

A real time face mask detection system which detects whether the person on the webcam is wearing a face mask or not. The results are tested using a live video stream as an input to the face mask detector. By monitoring the placement of the face mask , we can make sure that an individual wears it in the right way and helps to curb the scope of the virus.

5.3 Modules

5.3.1 Module 1: Loading pre-trained CNN models

1. **MobileNetv2**

   MobileNetV2 is a convolutional neural network architecture that seeks to perform well on mobile devices. It is based on an inverted residual structure where the residual connections are between the bottleneck layers. The intermediate expansion layer uses lightweight depthwise convolutions to filter features as a source of non-linearity. As a whole, the architecture of MobileNetV2 contains the initial fully convolution layer with 32 filters, followed by 19 residual bottleneck layers.

2. **ResNet101**

   ResNet-101 is a convolutional neural network that is 101 layers deep. You can load a pretrained version of the network trained on more than a million images from the ImageNet database. The pretrained network can classify images into 1000 object categories, such as keyboard, mouse, pencil, and many animals. As a result, the network has learned rich feature representations for a wide range of images. The network has an image input size of 224-by-224. For more pretrained networks in MATLAB®, see Pretrained Deep Neural Networks.

5.3.2 Module 2: Training

.

1. **Real time video stream is given to webcam as input**

   Video data is a common asset which is used everyday, whether it is a live stream in a personal blog or security camera in a manufacturing building. In a nutshell, video processing can be seen as a sequence of operations done for each frame. Each frame includes processes of decoding, computation and encoding.

2. **Image to array conversion is performed to obtain pixel values as Numpy arrays**

   OpenCV images are stored as three-dimensional Numpy arrays. When you read in digital images using the library, they are represented as Numpy arrays. The rectangular shape of the array corresponds to the shape of the image.

3. **Loop over the frames to detect face and mask**

   Nested Loops and Image Processing. Use nested loops to demonstrate how to do simple image processing, by iterating through each pixel in an image and making some changes.

5.3.3 Module 3: Testing

1. Generate bounding boxes around the face with Green and Red frames
2. Display probability of prediction
3. Send alert / notification to local authority if mask is not detected

5.4 CNN

In the past few decades, Deep Learning has proved to be a very powerful tool because of its ability to handle large amounts of data. The interest to use hidden layers has surpassed traditional techniques, especially in pattern recognition. One of the most popular deep neural networks is Convolutional Neural Networks The convolution layer is the core building block of the CNN. It carries the main portion of the network's computational load. This layer performs a dot product between two matrices, where one matrix is the set of learnable parameters otherwise known as a kernel, and the other matrix is the restricted portion of the receptive field. The kernel is spatially smaller than an image but is more in-depth. This means that, if the image is composed of three (RGB) channels, the kernel height and width will be spatially small, but the depth extends up to all three channels.

Working

One of the main parts of Neural Networks is Convolutional neural networks (CNN). They are made up of neurons with learnable weights and biases. Each specific neuron receives numerous inputs and then takes a weighted sum over them, where it passes it through an activation function and responds back with an output.

layers

There are three types of layers that make up the CNN which are the convolutional layers, pooling layers, and fully-connected (FC) layers. When these layers are stacked, a CNN architecture will be formed.

5.5 Opencv

Open CV is the most popular library for computer vision.OpenCV uses machine learning algorithms to search for faces within a picture. Because faces are so complicated, there isn't one simple test that will tell you if it found a face or not. Instead, there are thousands of small patterns and features that must be matched.

The algorithms break the task of identifying the face into thousands of smaller, bite-sized tasks, each of which is easy to solve. The OpenCV cascade breaks the problem of detecting faces into multiple stages.For each block, it does a very rough and quick test. If that passes, it does a slightly more detailed test, and so on.The algorithm may have 30 to 50 of these stages or cascades, and it will only detect a face if all stages pass. The advantage is that the majority of the picture will return a negative during the first few stages, which means the algorithm won't waste time testing all 6,000 features on it. Instead of taking hours, face detection can now be done in real time.

5.6 Data Flow Diagrams

5.6.1 Data Flow Diagram- Level 0

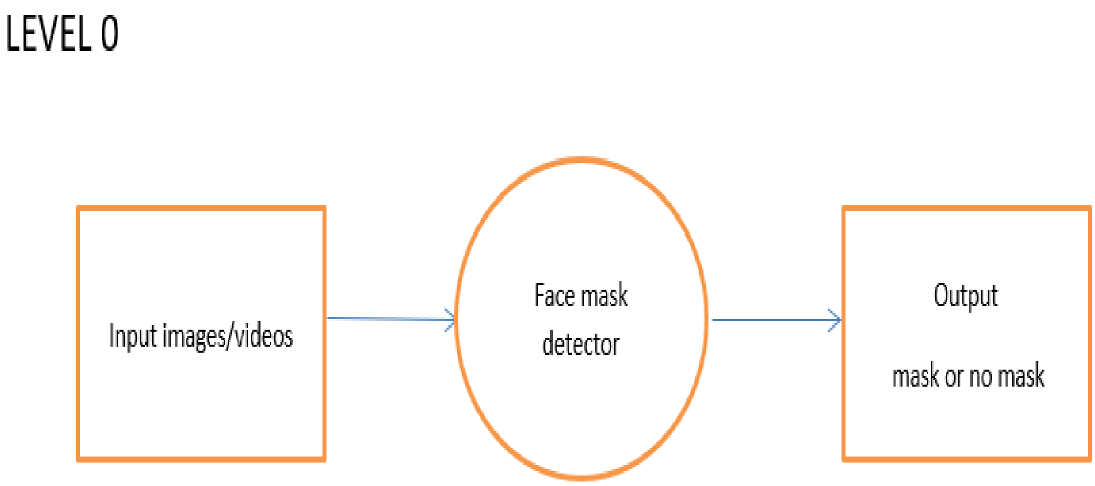


Figure 5.1: DFD- Level 0

5.6.2 Data Flow Diagram- Level 1

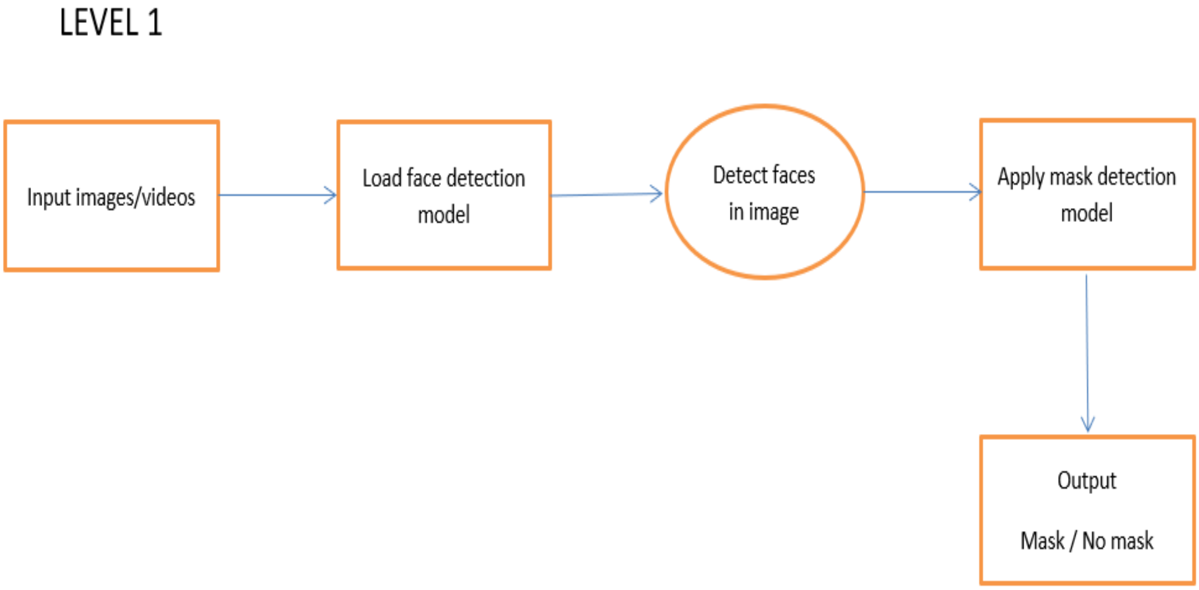


Figure 5.2: DFD- Level 1

5.6.3 Data Flow Diagram- Level 2

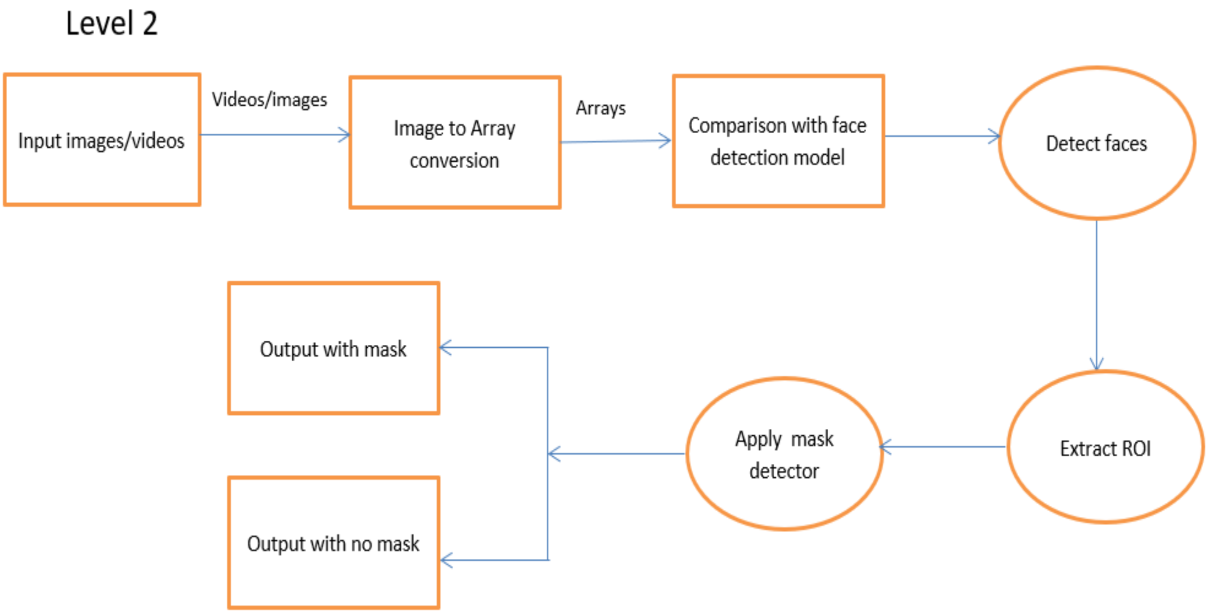


Figure 5.3: DFD- Level 2

5.7 Architecture

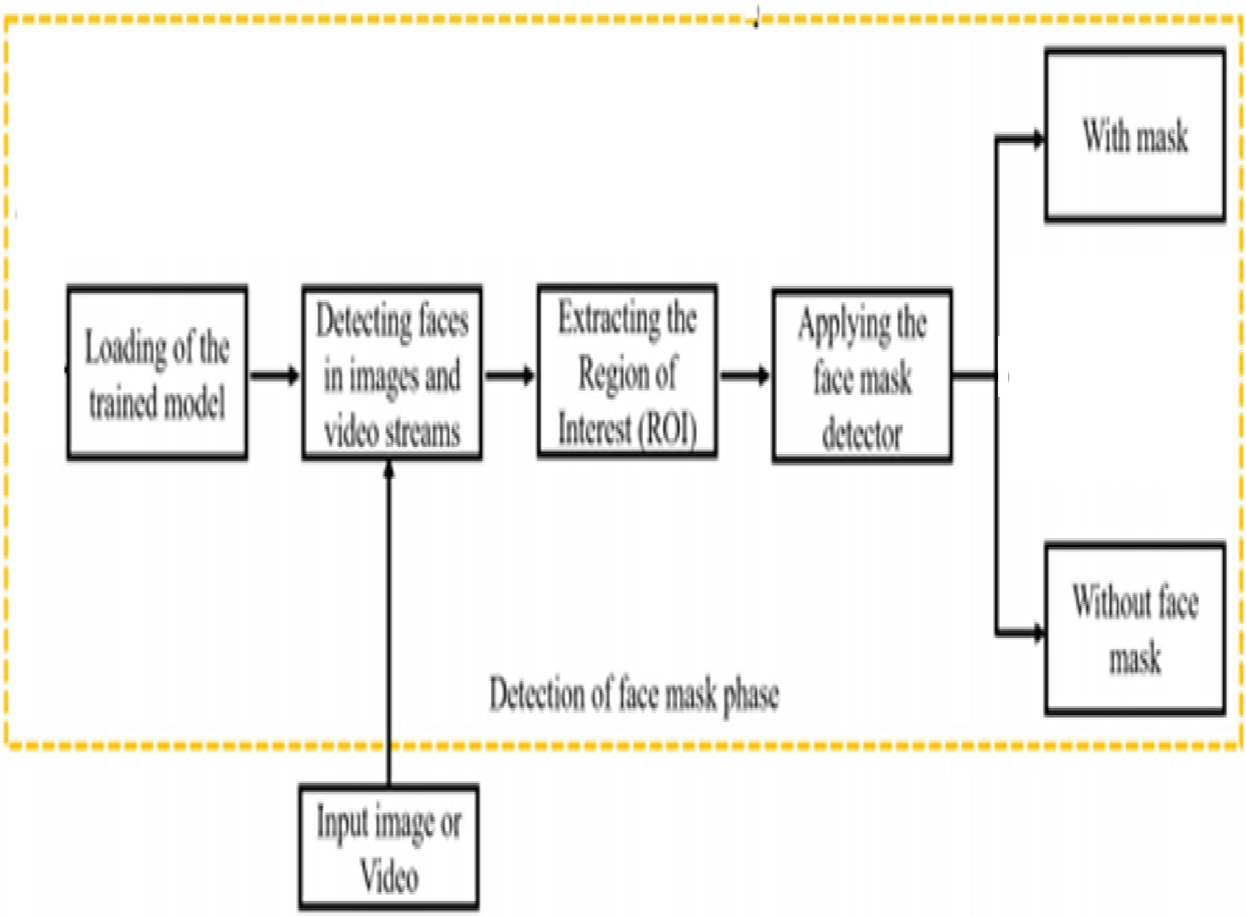


Figure 5.4: Architecture

5.8 Implemtation

1. Load libraries
2. Specify the path of face_detector and mask_detector model
3. Load the face detector model from disk (MobileNetv2)

```
prototxtPath = os.path.sep.join([args["face"], "deploy.prototxt"])
weightsPath = os.path.sep.join([args["face"],
    "res10_300x300_ssd_iter_140000.caffemodel"])
```

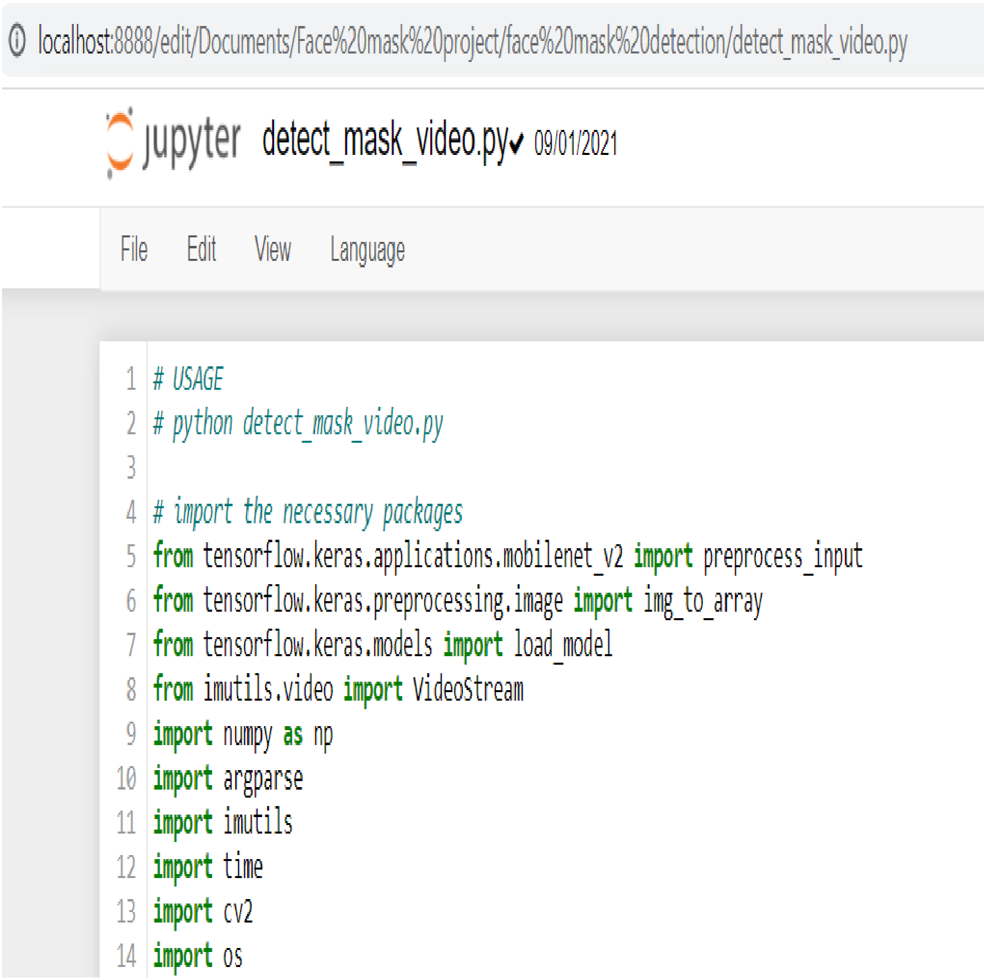
4. Load OpenCV to take live video streams
5. Load the mask detector model from disk
6. Loop over the frames from the video stream and detect faces in the frame to determine if they are wearing a face mask or not

```
net = cv2.dnn.readNet(prototxtPath, weightsPath)
```

)

Figure 5.5: Architecture

5.8.1 Packages




```
# USAGE
# python detect_mask_video.py

# import the necessary packages
from tensorflow.keras.applications.mobilenet_v2 import preprocess_input
from tensorflow.keras.preprocessing.image import img_to_array
from tensorflow.keras.models import load_model
from imutils.video import VideoStream
import numpy as np
import argparse
import imutils
import time
import cv2
import os
```

)

Figure 5.6: Packages

5.9 Function:Detect and predict mask()

Step 1: grab the dimensions of the frame and then construct a blob from it.

Step 2: pass the blob through the network and obtain the face detections.

Step 3: Initialize our list of faces, their corresponding locations, and the list of predictions from our face mask network.

Step 4: extract the confidence (i.e., probability) associated with the detection.

Step 5: filter out weak detections by ensuring the confidence is greater than the minimum confidence.

Step 6: compute the (x, y)-coordinates of the bounding box for the object.

Step 7: ensure the bounding boxes fall within the dimensions of the frame.

Step 8: extract the face ROI, convert it from BGR to RGB channel ordering, resize it to 224x224, and pre-process it.

Step 9: add the face and bounding boxes to their respective Lists.

Step 10: Only make a prediction if at least one face was detected

Step 11: return a 2-tuple of the face locations and their corresponding Locations.

Step 12 Determine the class label and colour we'll use to draw the bounding box and text.

Step 13 include the probability in the label

Step 14 display the label and bounding box rectangle on the output Frame

Step 15 show the output frame

CHAPTER 6

RESULTS

Given below is the result of real-time Face Mask Detection System for Covid-19.

6.0.1 Snapshots From Real Time Face Mask Detector

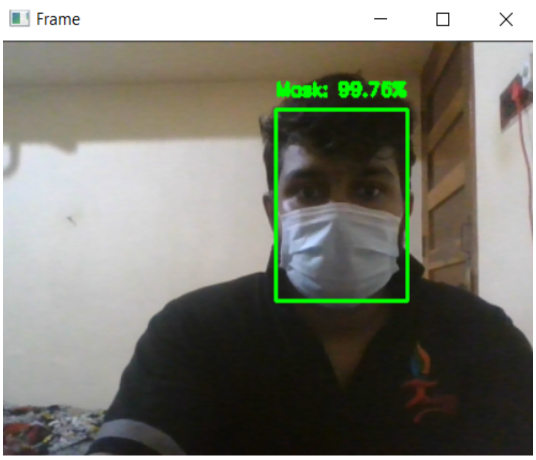
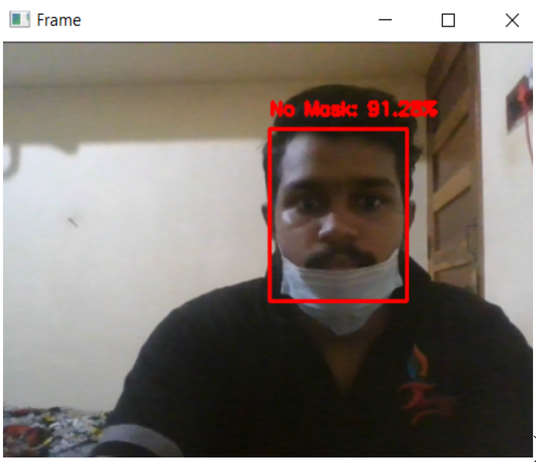
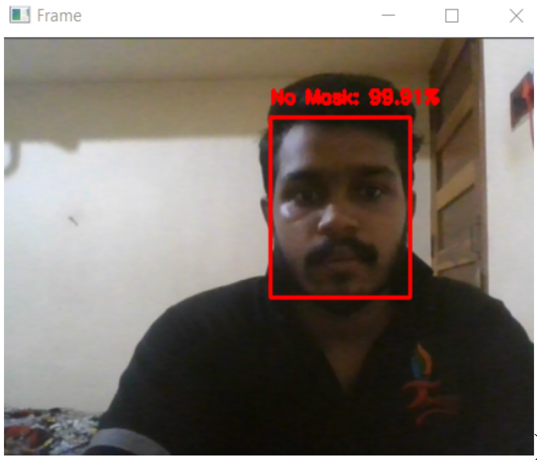


Figure 6.1: Detection Result 1



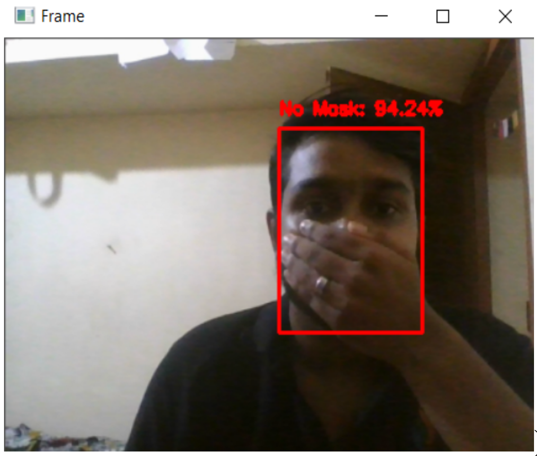
)

Figure 6.2: Detection Result 2



)

Figure 6.3: Detection Result 3



)

Figure 6.4: Detection Result 4

As one can see, the person wearing the face mask properly goes under the mask category and bounded by Green frames and others are in the Red frames.The probability of the bounding box is also mentioned there so by using this system we can monitor the people who violate COVID-19 guidelines. Once this Red count exceeds the threshold, notification can be given to police authorities. Thus, implementing this idea can reduce the on-ground efforts of the police. They can entirely focus on supervising conditions exclusively on those areas where conditions are unfavorable and thus, they can utilize time wisely and save energy for equitable situations.

CHAPTER 7

CONCLUSION AND FUTURE WORKS

Our work distinguishes face masks from live video streams. On training the model using Facemasknet, we got an accuracy of 98.6 was then implemented to images and live video streams. The faces were recognized in images and videos and these faces were extracted. Then, our face mask classifier was applied to achieve the required results. The green and yellow rectangular frame respectively represent the detected face and mask. Our face mask identifier is least complicated in structure and gives instantaneous results and hence can be used in CCTV footages to identify whether a person is wearing a mask correctly so that he does not pose any hazard to others. We are the first ones to perform a three-class classification and hence is uncommon. Mass screening is possible and hence can be used in crowded places like railway stations, bus stops, markets, streets, mall entrances, schools, colleges, etc. By monitoring the placement of the face mask on the face, we can make sure that an individual wears it the right way and helps to curb the scope of the virus. In this dangerous pandemic situation of COVID-19 and it's mutated strains, this project is of great social relevance. This system highly helps to control the spread of COVID-19 and reduce ground efforts of police and other authorities by avoiding crowding in public places.

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