A PRELIMENARY REPORT

ON

"FACE MASK DETECTION SYSTEM USING AI"

SUBMITTED TO

THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE IN THE

PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE AWARD OF THE DEGREE OF

BACHELOR OF ENGINEERING (COMPUTER ENGINEERING)

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UNDER THE GUIDANCE OF

PROF. A. N. GHARU

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2021 – 2022

CERTIFICATE

This is to certify that the project entitled

"FACE MASK DETECTION SYSTEM USING AI"

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are a bonafide students of this institute and the work has been carried out by him / her under the supervision of **Prof. A. N. Gharu** and it is approved for the partial fulfilment of the requirement of Savitribai Phule Pune University, for the award of the degree of Bachelor of Engineering (Computer Engineering).

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At last we must express our sincere heartfelt gratitude to all the staff members of Computer Engineering Department who helped us directly or indirectly during this course of work.

Mr. Tejas Bansode
Mr. Abhijit Shermale
Mr. Darshan Shinde
Mr. Suraj Pawar

ABSTRACT

In current pandemic, Covid-19 has made us realize the importance of Face Masks and we need to understand the crucial effects of not wearing one, now more than ever. Right now, there are no mask detectors installed at the crowded places. But we believe that it is of utmost importance that at transportation junctions, densely populated residential area, markets, educational institutions and healthcare areas, it is now very important to set up face mask detectors to ensure the safety of the public. In this paper we have tried to build a two phased face mask detector which will be easy to deploy at the mentioned outlets. With the help of Computer Vision, it is now possible to detect and implement this on large scale. We have used CNN for the implementation of our model. The implementation is done in Python, and the python script implementation will train our face mask detector on our selected dataset using TensorFlow and Keras. We have added more robust features and trained our model on various variations, we made sure to have large varied and augmented dataset so that the model is able to clearly. identify and detection the face masks in real time videos. The trained model was tested on both real-time videos and static pictures and in both the cases the accuracy was more than the other designed models.

Keywords : Face Mask detection system , computer vision , deep learning.

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CHAPTER 1

INTRODUCTION

1.1 Motivation

In the last few years, we have seen Science and Technology advancing so much that now we are at a stage where, we know that with the right knowledge of the technology, the humans can achieve things that seemed nearly impossible just a few decades ago. Now, we have the advancing technologies and knowledge of Machine Learning and Artificial Intelligence, which has been proven to ease our lives from the micro levels to big impossible tasks. In the last few years, there has been a rise in the onset of algorithms that have been proven to be the solution to our complex, life threatening problems. One such field is the image and object detection, which has helped us find and spot people and things with just one click.

Computer Vision plays a crucial role in our lives now. Who would have thought that while sitting in one city you can easily spot the people in the other cities? It's almost unimaginative how Computer vision is now a very innovative aspect of the technology.

In 2019, the whole world witnessed the onset of the deadly Corona Virus, which now, still after almost a year has not left us and is still making the human race fight for its existence. In between the survival fights, we have realized how technology is very much our only life saver. From extensive internet facilities to 24/7 services online, technology has been our true companion in these hard times.

But even when we have everything present at one click, there can't be no lives outside. In the past few months every country, every state has found its own new norms to fight the pandemic. And no matter what we do, we do need to step outside to survive. Schools, Offices, Colleges, Markets, Transportation, are the few crucial check points for any country. As much as we ask the public to be safe, the people miss their [without any restrictions lives. And so, it is now very important to closely watch the public and make them understand the importance of the tiny and small details of survival kit.

One such crucial factor is the extensive usage of face masks in our lives. Studies have proven that with the help of use of face masks, we can lower the chances of catching the Corona Virus by 80 to 85%, if it's used properly. But, even so, it is nearly impossible to enforce the face masks completely on the human race.

With the help of AI and Computer Vision, we have the best chance at enforcing the mask policy on the humans. With the help of our system, we aim on detecting the presence of face masks on static images and real time videos. Object detection, Classification, Regression, image and object tracking and analysis are our key aspects of the paper. We are aiming at a two phased CNN face mask detector. The first phase is the training phase wherein we have trained our model and the second phase the application, where the masks are detected with "with" or "without masks" tags. Other than the images we also aim to implement this on the real time videos, where the real time faces are detected, tracked and the data about the faces with or without masks is returned.

Our paper can be of crucial help at the Stations, airports, Markets, Hospitals, Offices, Schools and many more, where the crowd can be monitored in real time.

1.2 Problem Definition

Wearing a mask in public places is an effective way to keep the communities safe as a response to the covid-19 pandemic. We open sourced a face mask detection system created by neutral that uses AI detect if people are wearing masks or not. Focused on making our face mask detector ready for real-world applications, such as CCTV cameras, where faces are small, blurry, and far from the camera.

To ensure that the mask rule is been followed there needs to be an automatic technique that can provide highly accurate intelligent system for face mask detection through image processing.

CHAPTER 2

LITERATURE SURVEY

The existing models have used deep learning but they lack the variation in the dataset which means that their model is not that efficient when it comes to real time images and videos. Deep learning technique has been useful for big data analysis work focuses on some commonly implemented deep learning architectures and their applications. Deep learning can be used in unsupervised learning algorithms to process the unlabeled data. A CNN model for speedy face detection has been introduced by Li et al [8] that evaluates low resolution an input image and discards non-face sections and accurately processes the regions that are at a greater resolution for precise detection.

Our model is a trained custom deep learning and computer vision model which can detect if a person is wearing a mask or not. Our model has not used morphed or unreal masked pictures in the dataset. Our model is very accurate as we have used MobileNetV2 architecture, it has made the model computationally efficient too. This made it easier to deploy the model to embedded system. We can use this face mask detection system in places that require face mask detection in view of the current pandemic. The model can be deployed at Airports, Railway Stations, Offices, Schools and other public places.

CHAPTER 3

SOFTWARE REQUIREMENTS SPECIFICATION

3.1 Introduction

3.1.1 Project Scope

The purpose of the face mask detection system is to detect a person are with face mask or without face mask and informing to authority and applying penalties on to the person then send message onto that persons mobile to reduce the spread of COVID-19 This system is based upon Convolutional Neural Network (CNN) which allows us to scan image by using CCTV and classify person wear mask or not.

3.1.2 User Classes and Characteristics

Admin

1. The purpose of this role is to manage back-end on to the database.
2. He/she will also monitoring the overall system.

3.1.3 Assumptions and Dependencies

1. We have assumed that same person be try to enter in a campus everyday.
2. If person wear mask then it's ok.
3. If person put hand on mouth then siren goes on.
4. If person not wear a mask then by using CNN algorithm we can detect face and sends pop-up message onto that persons mobile.

3.2 Functional Requirements

3.2.1 Maintainability

The system requires minimal maintenance which include updation of persons details, dataset and other dependencies.

3.2.2 Portability

The system is designed keeping portability is the prime motive in the mind and is available on any devices.

3.2.3 Availability

The system is available on all low end to high end pc's.

3.2.4 Accessibility

The interface of the system is designed for only admin and he can accessed with ease.

3.3 External Interface Requirements

3.3.1 Software Interfaces

It allow system to scan images and take the correct decision according to the condition.

3.4 Non Functional Requirements

3.4.1 Performance Requirements

Performance consideration: Scanning latency should be minimal and system not consume extensive processor. It makes use of multithreading to avoid system consuming main U.I thread memory.

3.4.2 Safety Requirements

Privacy: All the data is being stored in secured and encrypted way.

3.4.3 Security Requirements

The credentials of each person is being securely stored into the Firebase Authentication system using hashing.

3.4.4 Software Quality Attributes

1. Usability:

   The system is user friendly and easy to use.

   a) Learn-ability: The working of the system should be easily understood .
   b) Operability : The system should be efficiently operated .

2.Performance Efficiency:

   The system should not consume extra CPU Usage and should not hamper overall system performance.

   a) Time behaviour :It should behave appropriately and response in minimal time under stated conditions.
   b) Resource Utilization : The system gets things done in the right manner with the minimal computing resources.

3.Compatibility:

The system works satisfactorily together on different devices with different hardware and software specifications considering all the basic requirements are satisfied.

a) Coexistence: The system would be visible to everyone as it is designed.
b) Inter-Operability: The system should effectively communicate with other services

4.Reliability:

The reliability of system is judged by providing specifies input and check whether it performance as expected under specified conditions.

a) Availability: the system would be available 24 x 7.

5.Portability:

The system is designed keeping portability as the prime motive in the mind it is available on any low-end pc.

a) Install-ability : The system requirement are minimal so it would be installed in any device.
b) Adaptability: The system will adapt itself with all the new versions by providing frequent updates.

3.5 System Requirements

3.5.1 Database Requirements

Image Database: It stored images which will be used to classify masked and without masked person and to detect the face.

3.5.2 Software Requirements (Platform Choice)

Operating System: It requires windows 7 operating system and above version.

Language: Python

IDE: VSCode / Pycharm

3.5.3 Hardware Requirements:

Processor: Minimum i3 and above

RAM: 1GB or More

HDD: 256 GB or more

3.6 Analysis Models

Stage 1: Planning and Requirement Analysis

Requirement Elicitation:

This step involved understanding the stakeholder and their expectations. It involved reading and watching the testimonials of teachers and students. It involved interactions with teachers and students. COVID-19 gave us the glimpse of the lack of infrastructure and technical expertise in teaching

Stage 2: Defining Requirements

Our main objective was to design a cost effective solution hence this will helped as in eliminating the convolutional neural network as a technology. We were left ANN , ANN required minimal software and hardware requirement and to much mi-ore time with low accuracy as compare to CNN. We chose visual studio code and pycharm as a platform due to its availability and cost effectiveness.

Stage 3: Designing Architecture

It described Dataflow, Architecture and Interface design. Based on the refined requirement, there are two levels of design architecture

1. High-Level Design Architecture.

   This diagram depicted the envisioned structure of the software system. It provides an abstract view of the system, which gives us an idea about the overall system but hides the technical details of the system. Activity Diagram, UI Wireframe and Design System were designed using this information. It is a conceptual view of the system and provide Logical or conceptual part, Process, Physical and Module overview.

2. Low-Level Design Architecture

   It showcases the technical details of the system and all the component level features of the system. Class Diagrams and other UML Diagrams are designed using this. Here, Modules are further explored and break down into its fundamental units. Usually Class diagrams and component diagrams are made using this design architecture.

Stage 4: Development

This phase is the actual implementation part of application. Technology stack is chosen as per team expertise and requirements. Modules are designed as per SRS and Design Documentation.

Stage 5: Testing and Integration

We are planning to carry out unit testing at every stage of development. After the completion of the core module and integration of all the modules, integrated testing will be carried out to check for possible compatibility issues and functionality. Test cases needed to be defined depends on the inter-module interaction, User- Device interaction, Network conditions and other scenarios being kept in mind.

Stage 6: Deployment and Maintenance

This system would be deployed on browser. Since our system is still in its earlier phase a lot of assets would be missing due to uncertainty demand by user. Our system would be continuously evolving with high accuracy and user can expect updates and schedule maintenance. Would be carried out accordingly.

3.7 System Implementation Plan

System implementation plan is a representation of the project in structured formant. The system implementation plan will serve as baseline for monitoring the different task in the project.

Name	**Begin Date**	**End Date**
Group Formation	26/08/2021	28/08/2021
Abstract Idea Video Submission	14/09/2021	15/09/2021
Topic Finalization & Guide Allocation	30/09/2021	01/10/2021
Project Meeting with Coordinator	14/10/2021	14/10/2021
Synopsis Preparation	15/10/2021	18/10/2021
Submission of Synopsis & Base Paper	18/10/2021	18/10/2021
Project Meeting with Coordinator	20/10/2021	20/10/2021
Submission of Final Synopsis & PPT	20/10/2021	20/10/2021
Project Review 1	21/10/2021	22/10/2021
Meeting with Guide (coordinator for Review 2)	12/11/2021	12/11/2021
Preparation of Review 2 PPT & Report	17/11/2021	25/11/2021

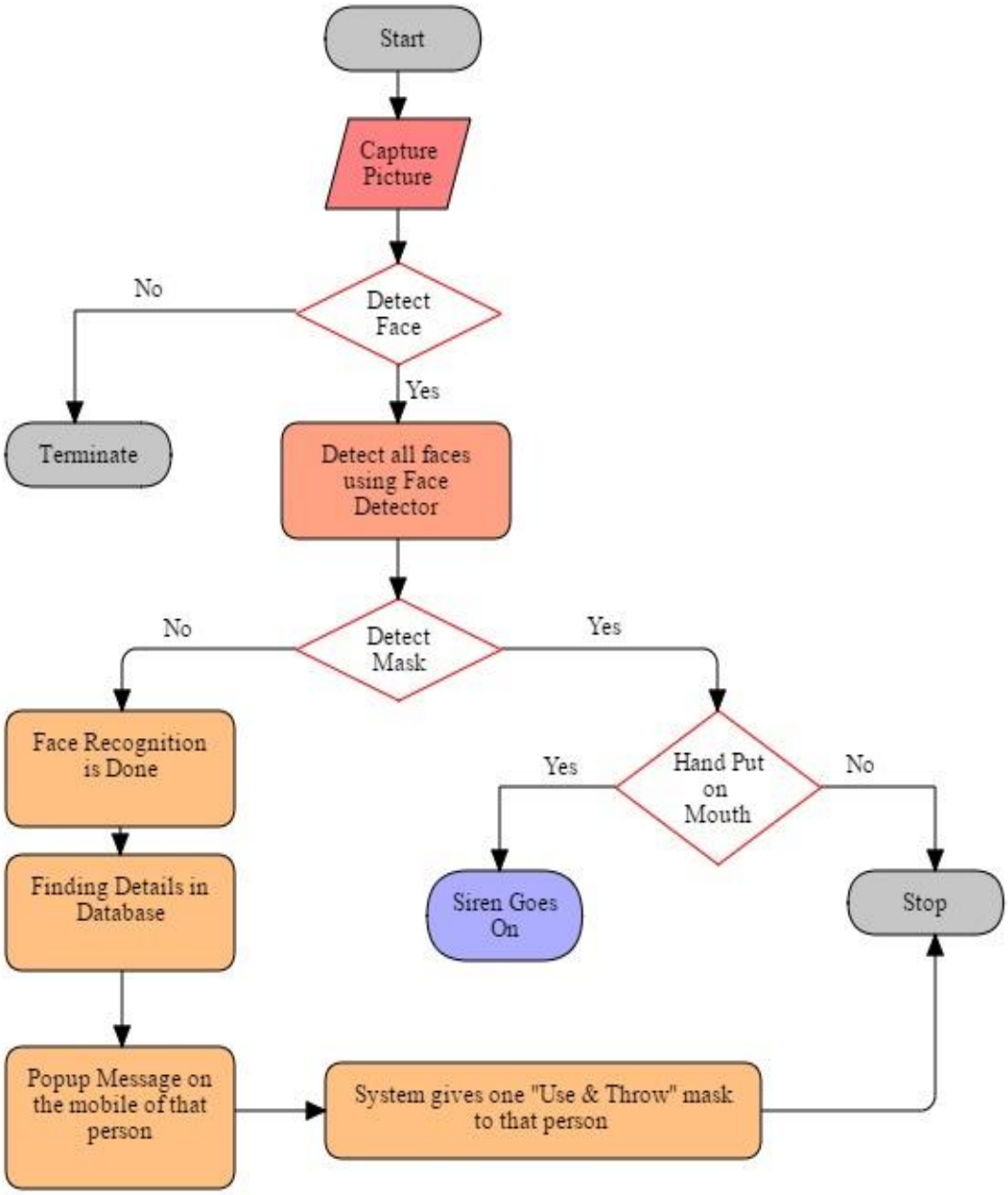
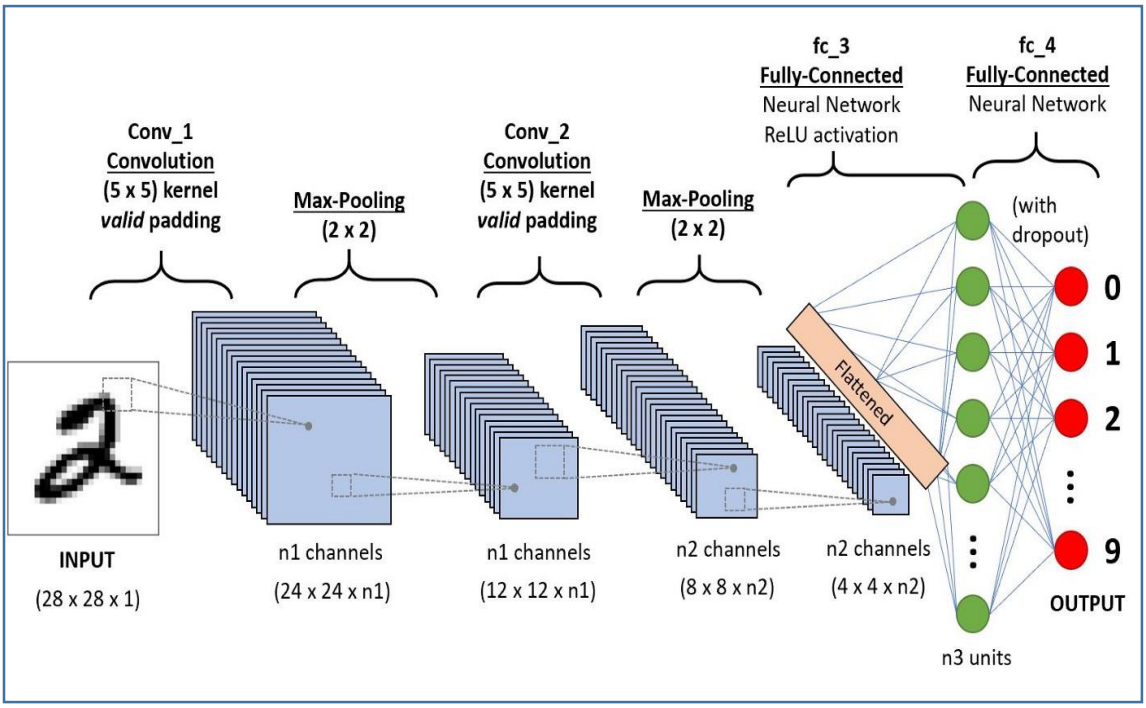


Fig 3.7.1: Flow Chart

3.8 Algorithms

Convolutional Neural Network (CNN)

A Convolutional Neural Network (CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets have the ability to learn these filters/characteristics.



- Convolutional Operation
- RELU layer
- Pooling
- Flattening
- Full Connection

CHAPTER 4

SYSTEM DESIGN

4.1 System Architecture

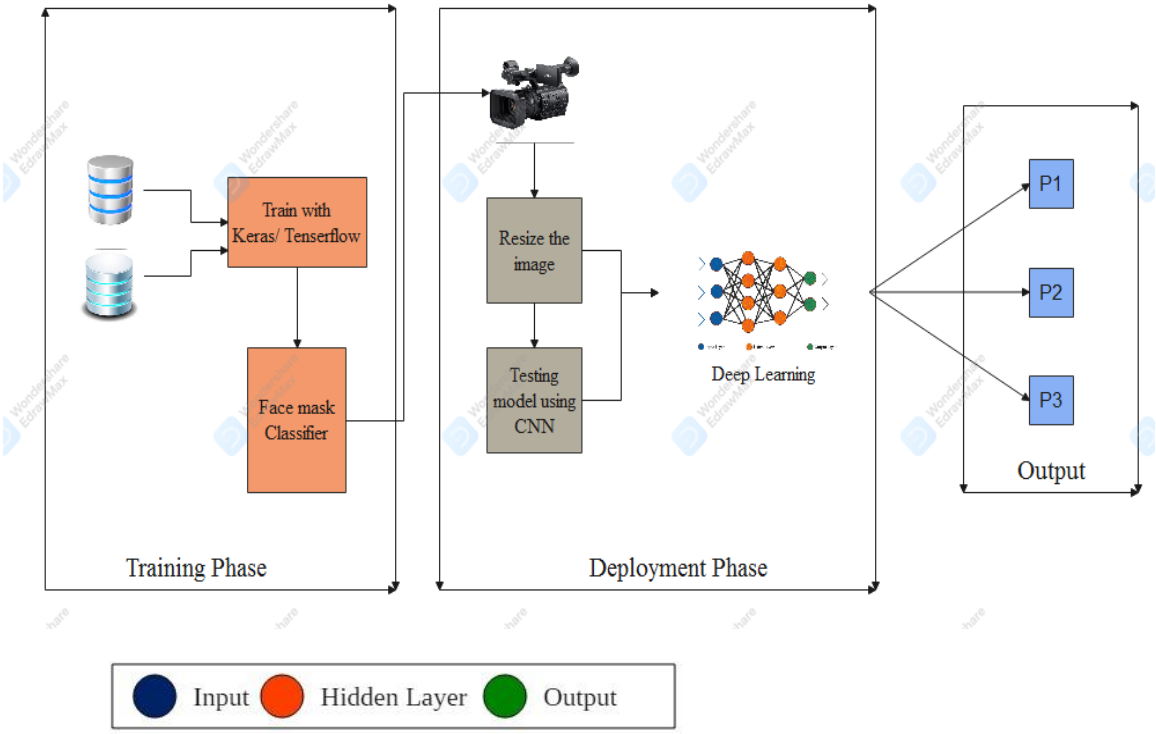


Fig. 4.1 System Architecture

4.2 Data Flow Diagrams

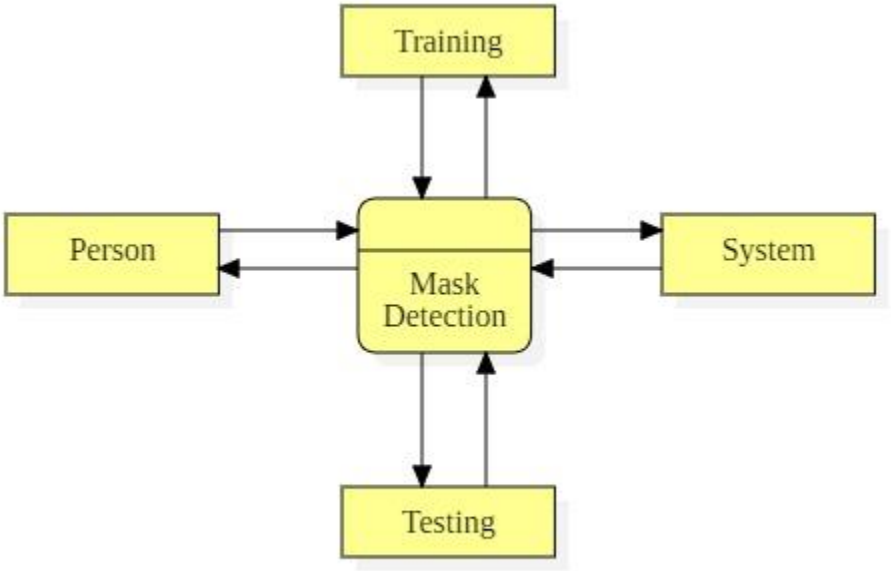


Fig 4.2.1 DFD Level 0

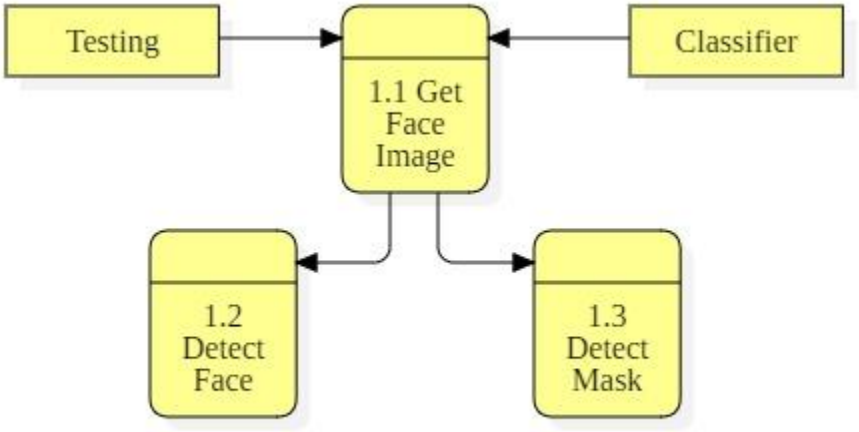


Fig. 4.2.1 DFD Level 1

4.3 UML Diagrams

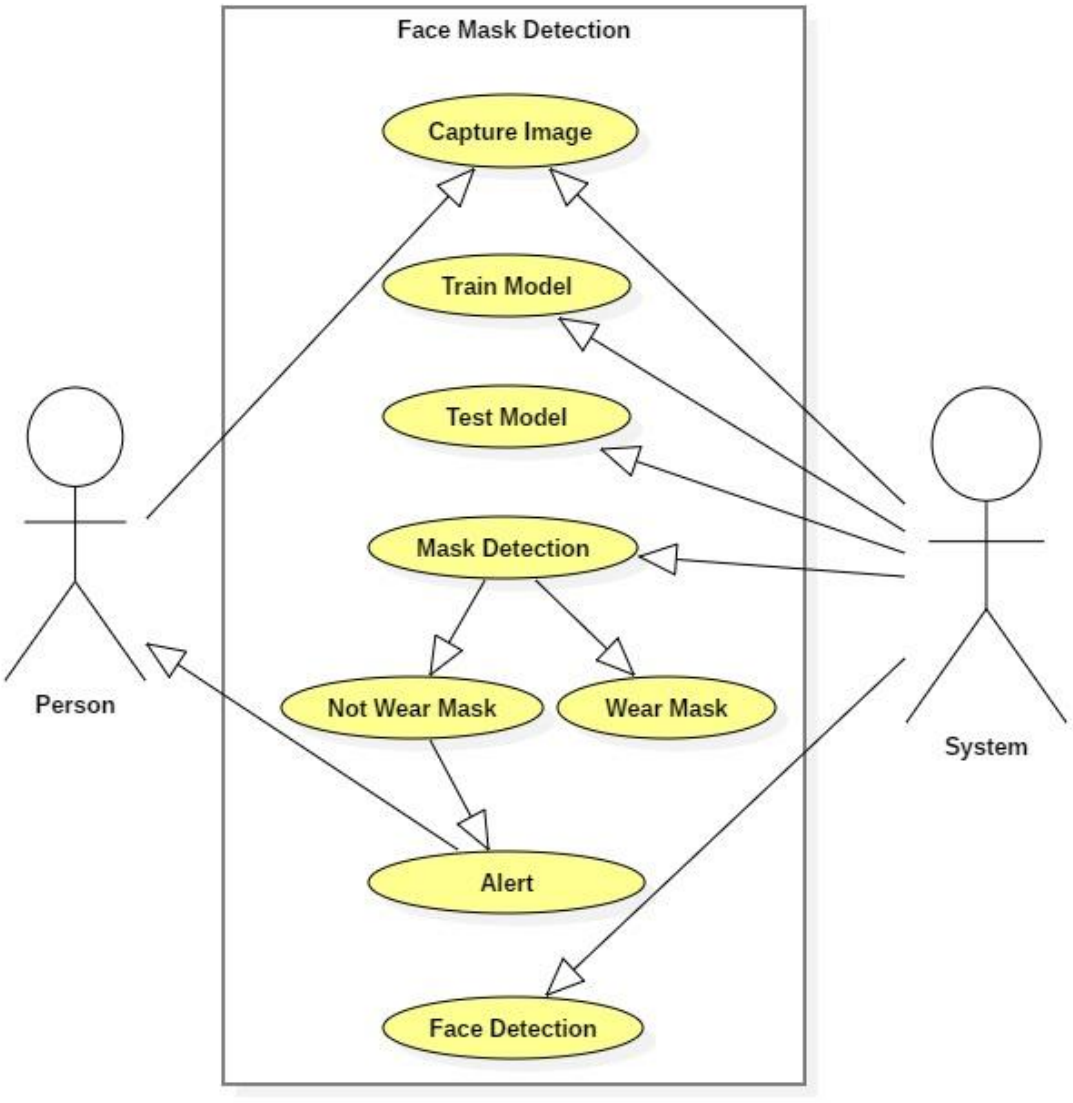


Fig. 4.3.1 Use Case Diagram

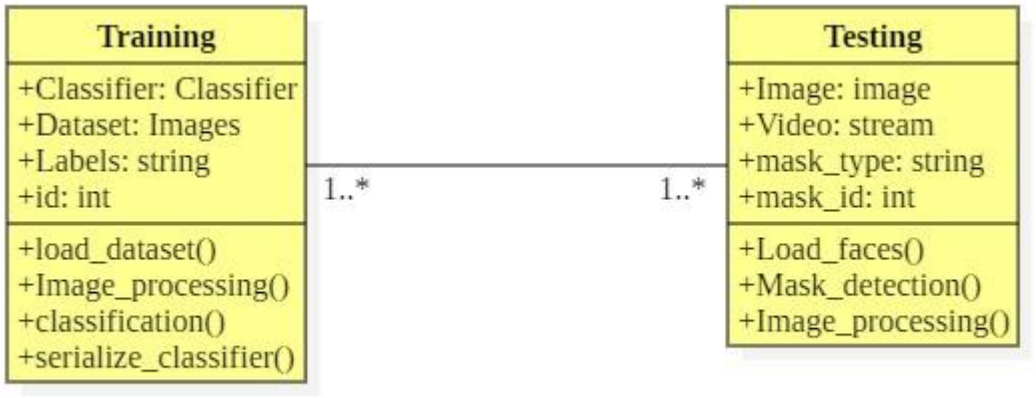


Fig 4.3.2 Class Diagram

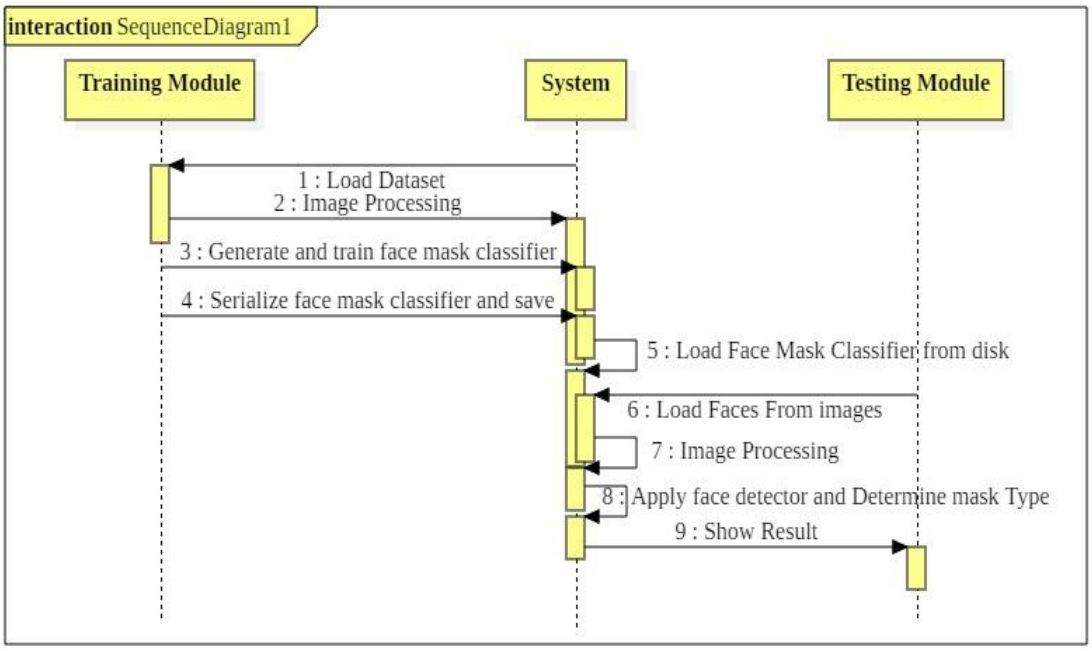


Fig 4.3.3 Sequence Diagram

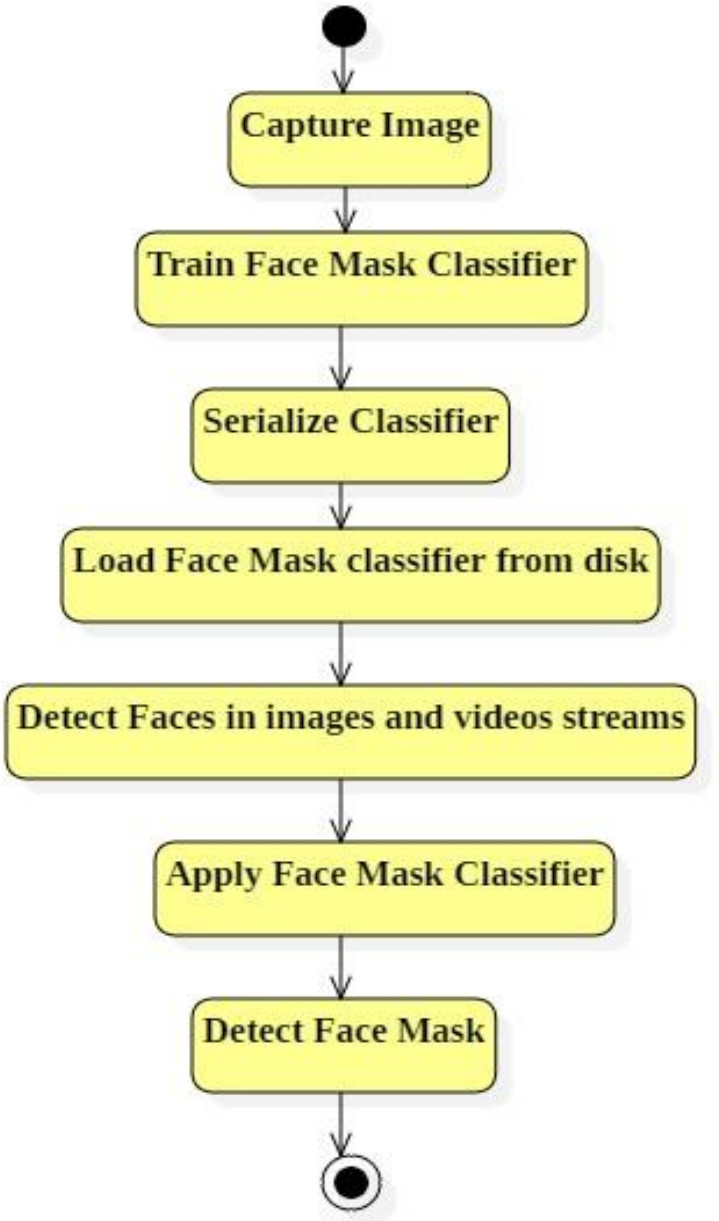


Fig.4.3.4 Activity Diagram

CHAPTER 5

OTHER SPECIFICATION

5.1 Advantages

As a key element in facial imaging system, such as face mask recognition and face mask analysis, face mask detection creates various advantages for users.

- Improved security

  Face detection improves surveillance efforts to track down criminals and terrorists. Personal security is also enhanced since there is nothing for hackers to steal and change, such as passwords.

- Easy to integrate

  Face mask detection and recognition system is easy and straightforward to integrate and most of the solutions are compatible with the security software.

- Automated identification

  In the past, identification was manually performed by a person, this was an efficient and frequently inaccurate. Face mask detection allows the identification process to become automated, thus it saves time and increasing accuracy.

- Cost Effective

  As we have seen that there is no such use of expensive hardware or expensive bigger machineries. So, this project can be so much cost effectively to any organisation or any workstation.

5.2 Limitations

- Poor Image Quality Limits Facial Recognition's Effectiveness

  Image quality affects how well face mask recognition algorithms work. The image quality of scanning video is quite low compared with that digital camera. Even high-definition video is 1080p usually, it can 720p. These values are equivalent to 2MP and 0.9MP respectively.

- Small Image Sizes Make Facial Recognition More Difficult

  When a face mask detection system finds out a face in an images from a video then the size of that face is compared with the enrolled images. size affects how perfect the face will be recognized. Already small size image, coupled with a target distance from the camera, means the detected faces is only 100 to 200 pixels.

- Different Face Angles Can Throw Off Facial Recognition's Reliability

  The relative angle of the targets face influences the recognition score perfectly. When a face is enrolled in the recognition tool, usually multiple angles are used. Anything less than a front view affects the algorithms capability to generate a template for the face.

- Data Processing and Storage Can Limit Facial Recognition Tech

  Even though high-definition video it is quite low in resolution compared with digital images, it still occupies significant amounts of disk space. Processing every frame of video is an enormous undertaking, so usually only a fraction (10 percent to 25 percent) is actually run through a face mask detection system.

5.3 Applications

- Airports

  The Face Mask Detection can be used at airports to detect travellers without masks. Face data of travellers can be captured in the system at the entrance. If a traveller is found to be without a mask, their picture is sent to the airport authorities so that they could take quick action. If the person's face is already stored, like the face of an airport worker, it can send the alert to the worker's phone directly.

- Hospitals

  Using Face Mask Detection System, Hospitals can monitor is their staff wearing masks in their shift or not. If any health worker is found without a mask, they will receive a notification with a reminder to wear a face mask. Also, if quarantine people who are required to wearing a mask, the system can keep an watch and detect if the mask is present or not and send notification automatically or report to the authorities.

- Offices

  Offices can be used the Face Mask Detection System to detect is people are maintaining safety standards at work or not. It monitors employee without masks and sends them a reminder to wear a face mask. The reports can be downloaded or sent an email at the end of the day to capture people who are not accepting with the regulations or the requirements.

CHAPTER 6

CONCLUSION

6.1 Conclusion

We have developed the system which can monitor the area through the real-time camera, without any additional devices. The proposed system is a simple real-time video analyzer. It has the potential to check whether the people wear masks or not. It can be installed in any supermarkets and public places. This helps us to defeat the widespread of COVID-19 virus. Because wearing masks reduces the community spread of COVID-19 virus.

We can use this for many other options like checking and verifying all the customers have wearing facemask. The system thoroughly checks the persons who enter through the main gate. We can process the video recorded and find whether the person is wearing a facemask or not. If the person wears his/her facemask, the door will open; otherwise it may say some error command like "please wear your facemask".

6.2 Appendix A

NP Type

In computational complexity theory, NP (nondeterministic polynomial time) is a complexity class used to classify decision problems. NP is the set of decision problems for which the problem instances, where the answer is “yes”, have proofs verifiable in polynomial time by a deterministic Turing machine.

There are two types of NP:

1. NP Hard

   A problem is NP-Hard if an algorithm for solving it can be translated into one for solving any NP-problem (non deterministic polynomial time) problem. NP-hard therefore means "at least as hard as any NP-problem," although it might, in fact, be harder.

2. NP Complete

   In computational complexity theory, a problem is NP-complete when it can be solved by a restricted class of brute force search algorithms and it can be used to simulate any other problem with a similar algorithm.

P Type

A problem is assigned to the P (polynomial time) class if there exists at least one algorithm to solve that problem, such that the number of steps of the algorithm is bounded by a polynomial in n, where n is the length of the input.

6.3 Appendix B : Plagiarism Report

6.3.1 Abstract

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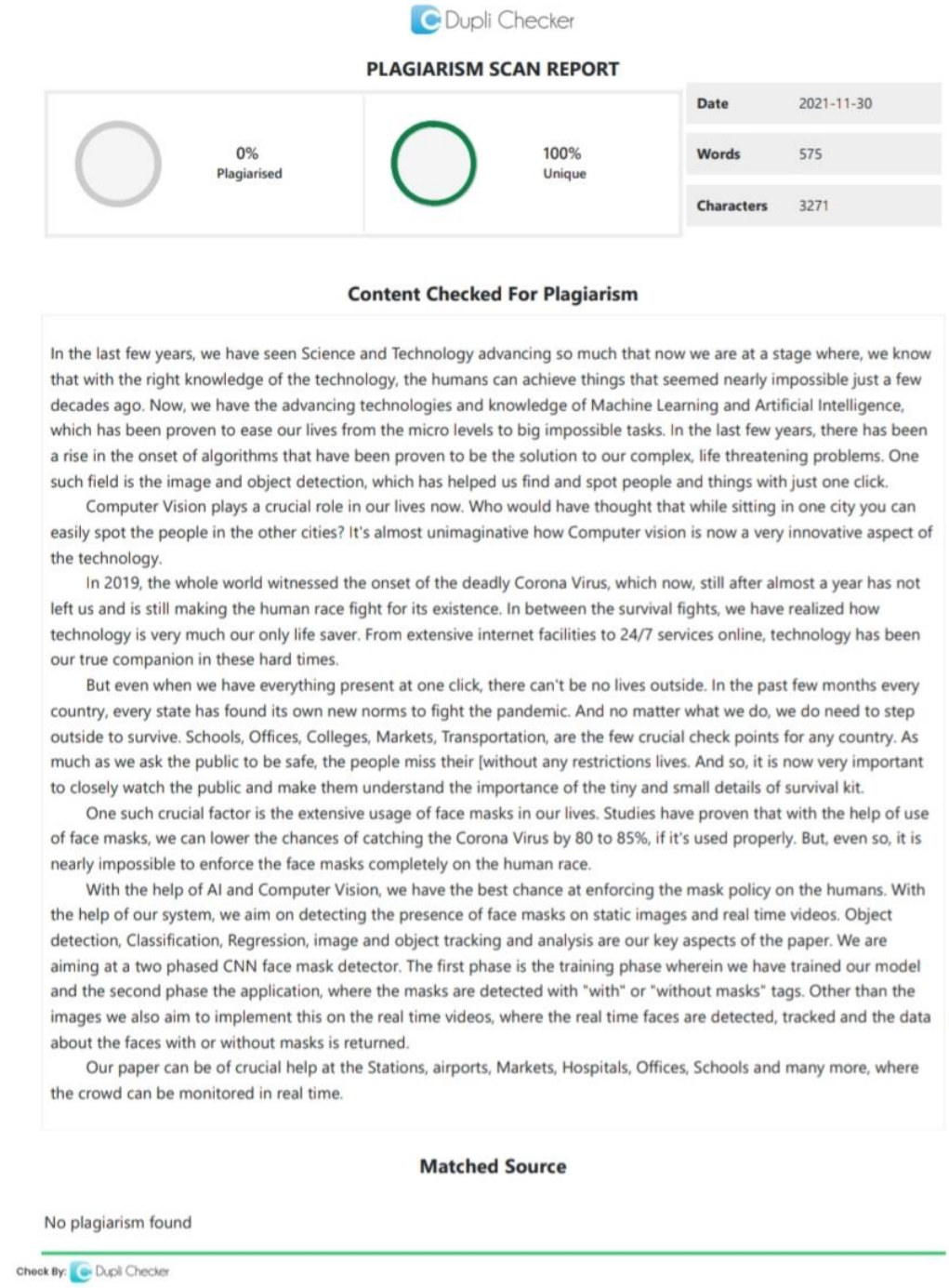
6.3.2 Introduction



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6.3.3 Literature Survey

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6.3.4 SRS Specification

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3.2.1 Maintainability

The system requires minimal maintenance which include updation of persons details, dataset and other dependencies.

3.2.2 Portability

The system is designed keeping portability is the prime motive in the mind and is available on any devices.

3.2.3 Availability

The system is available on all low end to high end pc's.

3.2.4 Accessibility

The interface of the system is designed for only admin and he can accessed with ease.

3.3 External Interface Requirements

3.3.1 Software Interfaces

It allow system to scan images and take the correct decision according to the condition.

3.4 Non Functional Requirements

3.4.1 Performance Requirements

Performance consideration: Scanning latency should be minimal and system not consume extensive processor. It makes use of multithreading to avoid system consuming main U.I thread memory.

3.4.2 Safety Requirements

Privacy: All the data is being stored in secured and encrypted way.

3.4.3 Security Requirements

The credentials of each person is being securely stored into the Firebase Authentication system using hashing.

3.4.4 Software Quality Attributes

1. Usability:

The system is user friendly and easy to use.

a) Learn-ability: The working of the system should be easily understood .

b) Operability : The system should be efficiently operated .

2.Performance Efficiency:

The system should not consume extra CPU Usage and should not hamper overall system performance.

a) Time behaviour :It should behave appropriately and response in minimal time under stated conditions.

b) Resource Utilization : The system gets things done in the right manner with the minimal computing resources.

3.Compatibility:

The system works satisfactorily together on different devices with different hardware and software specifications considering all the basic requirements are satisfied.

a) Coexistence: The system would be visible to everyone as it is designed.

b) Inter-Operability: The system should effectively communicate with other services

4.Reliability:

The reliability of system is judged by providing specifies input and check whether it performance as expected under specified conditions.

a) Availability: the system would be available 24 x 7.

5.Portability: The system is designed keeping portability as the prime motive in the mind it is available on any low-end pc.

a) Install-ability : The system requirement are minimal so it would be installed in any device.

b) Adaptability: The system will adapt itself with all the new versions by providing frequent updates.

3.5 System Requirements

3.5.1 Database Requirements

Image Database: It stored images which will be used to classify masked and without masked person and to detect the face.

3.5.2 Software Requirements (Platform Choice)

Operating System: It requires windows 7 operating system and above version.

Language: Python

IDE: VSCode / Pycharm

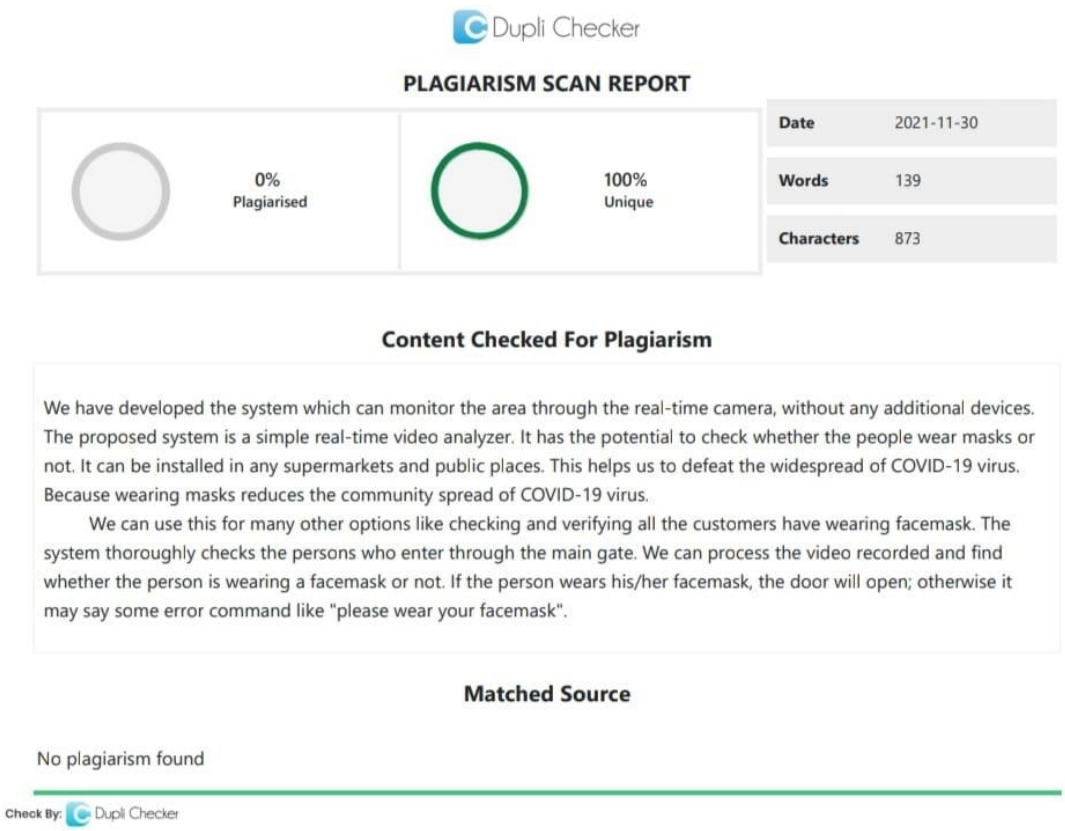
3.5.3 Hardware Requirements:

Processor: Minimum i3 and above

RAM: 1GB or More

HDD: 256 GB or more

6.3.5 Conclusion



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PLAGIARISM SCAN REPORT

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We have developed the system which can monitor the area through the real-time camera, without any additional devices. The proposed system is a simple real-time video analyzer. It has the potential to check whether the people wear masks or not. It can be installed in any supermarkets and public places. This helps us to defeat the widespread of COVID-19 virus. Because wearing masks reduces the community spread of COVID-19 virus.

We can use this for many other options like checking and verifying all the customers have wearing facemask. The system thoroughly checks the persons who enter through the main gate. We can process the video recorded and find whether the person is wearing a facemask or not. If the person wears his/her facemask, the door will open; otherwise it may say some error command like "please wear your facemask".

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