CA326 3rd Year Project

Functional Specification

Class Attendance and Face Mask Detection

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Finished Date: 07/12/2021

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1. Introduction

1.1 Overview

The general area covered by this project is that of machine vision, in particular facial recognition. The problem we wish to tackle is to record student attendance in classes using facial recognition technologies and determine if they are following COVID19 safety guidelines by complying with face mask rules. This system will be beneficial to schools and colleges as there is a lack of a useful and simple manner in which to track both student attendance and how well COVID19 mask rules are followed in their environment.

1.2 Business Context

The businesses which would benefit from the deployment of our project would be those in education such as schools or colleges. While the uses of our project could expand beyond these businesses, these are what the project is aimed at.

1.3 Glossary

Machine Vision - Machine learning is the study of computer algorithms that can improve automatically through experience and by the use of data.

Facial Recognition - Facial recognition system is a technology capable of matching a human face from a digital image or a video frame against a database of faces by pinpointing and measuring facial features from a given image.

Database - A database is an organized collection of data stored and accessed electronically from a computer system.

Use Case Scenario - A use case is a set of steps that are required to accomplish a specific task or goal.

GDPR guidelines - The General Data Protection Regulation 2016/679 is a regulation in EU law on data protection and privacy in the European Union and the European Economic Area.

System Architecture - A system architecture is the conceptual model that defines the structure, behavior, and more views of a system.

High Level Design (HDL) - Explains the architecture that would be used in the development of a system. Provides an overview of the system identifying the main components of the system

Context Diagram - Displays the interactions between a system and external actors that the system with interact with.

Data Flow Diagram (DFD) - Represents the flow of data through a system. Provides information about the inputs and outputs of each entity.

GANTT Chart - A Gantt chart is a type of bar chart that illustrates a project schedule and also shows the dependency relationships between activities.

2. General Description

2.1 Product / System Functions

The way in which our project functions is that it utilises a camera and facial recognition technology model which would be trained to recognise an individual's face in a classroom environment. This would then log that particular individual's attendance in class, and then using a mask detector script, to log whether or not they were wearing a face mask as per government guidelines.

2.2 User Characteristics and Objectives

The only expertise our system requires is that the users must be familiar with the basic operations of a camera. Otherwise our system should require no expertise or involvement from the user point of view.

2.3 Operational Scenarios

Use Case 1	Attendance Taken
Actor(s)	Lecturer and Students
Use Case Overview	At the start of class the lecturer sets up the camera and runs the facial recognition script. The facial recognition system will run on the live stream via the camera and perform face detection on each frame of the video. The still frames will be matched against a database of student images. If the frame matches images stored in the database the student's attendance is marked present and stored. If the image is not matched their presence is marked absent..
Subject Area	Facial Recognition script
Trigger	Lecturer runs face recognition script on the live webcam stream
Preconditions	● Webcam is on ● There are students present in the class ● Face recognition script is running
Success End Conditions	All students are marked as present or absent

Failed End Conditions	A student's attendance mark is left blank The system has failed to recognise a student	
Termination Outcome	● Class attendance list is populated. ● Lecturer stops the facial recognition system	
Primary Actor(s) **Secondary Actor(s)**	Lecturer Students	
Description	**Step**	**Action**
	1	Lecturer turns on webcam stream
	2	Lecturer runs facial recognition software
	3	Recognition software acts on the live stream taking frames from the stream
	4	Face detection script is run on each frame
	5	Frames are matched against a database of student images
	6	If the frame matches images in database the student's attendance is marked present
	7	If the frame does not match images in database the student's attendance is marked absent

Extension	**Step**	**Branching Action**
	1	If the stream is not running the facial recognition system returns a no input error
Alternative Flow	**Step**	**Branching Action**
	1	A student in the class list is not marked present or absent.
	2	Lecturer is alerted of the issue
	3	Student is marked as N/A or inconclusive

Use Case 2	Mask Detection
Actor(s)	Lecturer and Students
Use Case Overview	At the start of class the lecturer sets up the camera and runs the mask detection software. The detection system will run on the live stream via the camera and perform mask detection on each frame of the video. The still frames will be matched against a database of student images and a database of student images with masks. If the frame matches images stored in the database without masks the student is marked as not compliant. If the image is matched in the database with masks they are marked as compliant.
Subject Area	Mask detection script
Trigger	Lecturer runs mask detection script on the live webcam stream

Preconditions	● Webcam is on ● There are students present in the class ● Mask detection script is running	
Success End Conditions	All students are marked compliant or non-compliant	
Failed End Conditions	A student's compliance mark is left blank The system has failed to recognise a student compliance with mask rules	
Primary Actor(s) **Secondary Actor(s)**	Lecturer Students	
Description	**Step**	**Action**
	1	Lecturer turns on webcam stream
	2	Lecturer runs mask detection software
	3	Detection software acts on the live stream taking frames from the stream
	4	Mask detection script is run on each frame
	5	Frames are matched against a database of student images with masks
	6	If the frame matches images in database the student is marked as compliant

	7	If the student in the frame matches images in database without the student is marked non-compliant
Extension	**Step**	**Branching Action**
	1	If the stream is not running the mask detection system returns a no input error
Alternative Flow	**Step**	**Branching Action**
	1	A student in the class list is not marked compliant or non-compliant
	2	Lecturer is alerted of the issue
	3	Student is marked as N/A or inconclusive

2.4 Constraints

The constraints placed upon the design team include:

- **Ethical Constraints:** As our application processes facial images at its core, it is necessary to work within the ethical and GDPR guidelines when dealing with this type of data.
- **Speed Requirements:** The team must complete the project within the timeframe of 5pm Friday 4th March 2022 as this is when the submission of final project deliverables are due.
- **Industry Protocols:** When dealing with facial data the team must work within the guiding industry protocols in order to handle the data in a fair, transparent and safe manner.

3. Functional Requirements

1. Recognise an individual's face

- **Description -** The ability of the system after training to be able to identify an individual when presented with the face.
- **Criticality -** This is an essential requirement of the system.

- **Technical issues -** If the system model has not been trained with enough data it may not recognise an individual's face.
- **Dependencies with other requirements -** Has a close dependency with the second requirement as it stores the information found in this requirement in the database.

2. Store an individual's attendance as present or absent in database

- **Description -** The ability of the system to store whether an individual is present or absent in the database based on the information acquired in the first requirement.
- **Criticality -** This is also an essential requirement for the system along with the first requirement.
- **Technical issues -** A student is present but may not be marked present in the database.
- **Dependencies with other requirements -** Has a very close dependency with the first requirement as without it, there is no information to store in the database.

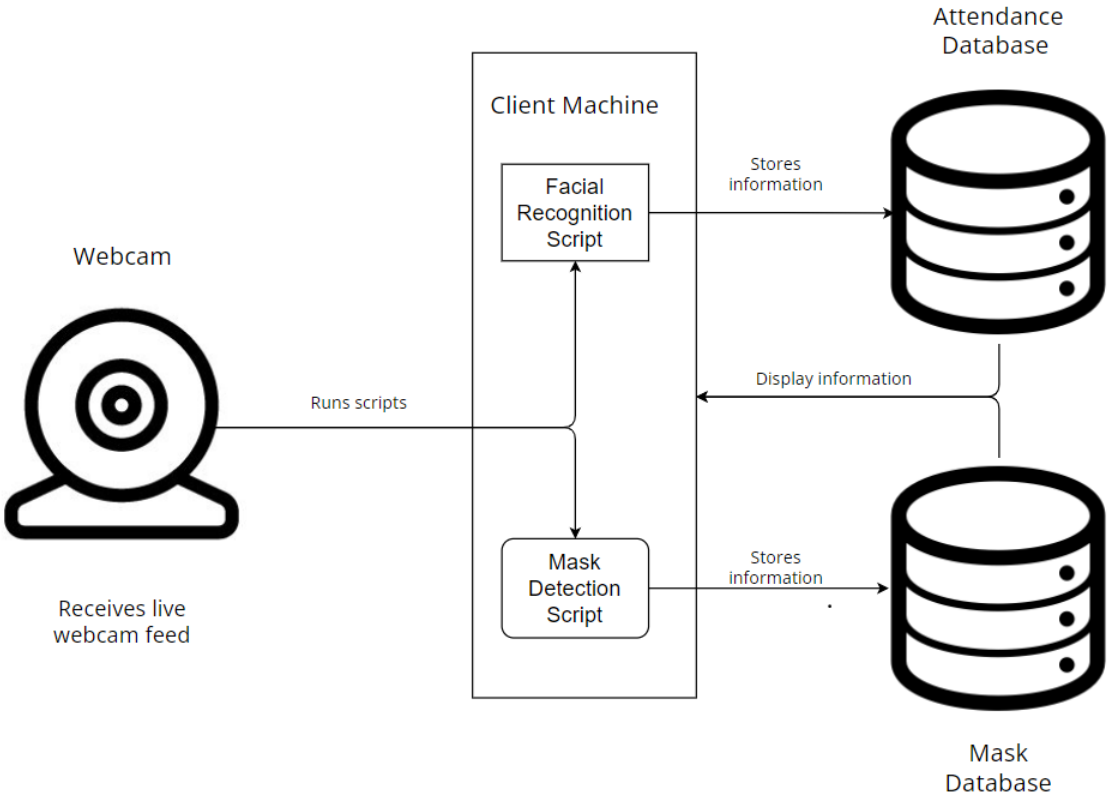
3. Detect if an individual is wearing a mask

- **Description -** The ability of the system after training to be able to identify whether an individual is wearing a face mask .
- **Criticality -** While not quite as important as the first two requirements, this is still a very important requirement of the system.
- **Technical issues -** If an individual is wearing a mask in an improper manner the system may not be able to identify it.
- **Dependencies with other requirements -** Depends on the first requirement as for the system to identify if an individual is wearing a mask, it must first identify the individual's identity. Also has a dependency with the fourth requirement as it stores the information found in this requirement in the database.

4. Store whether an individual is wearing a mask in database

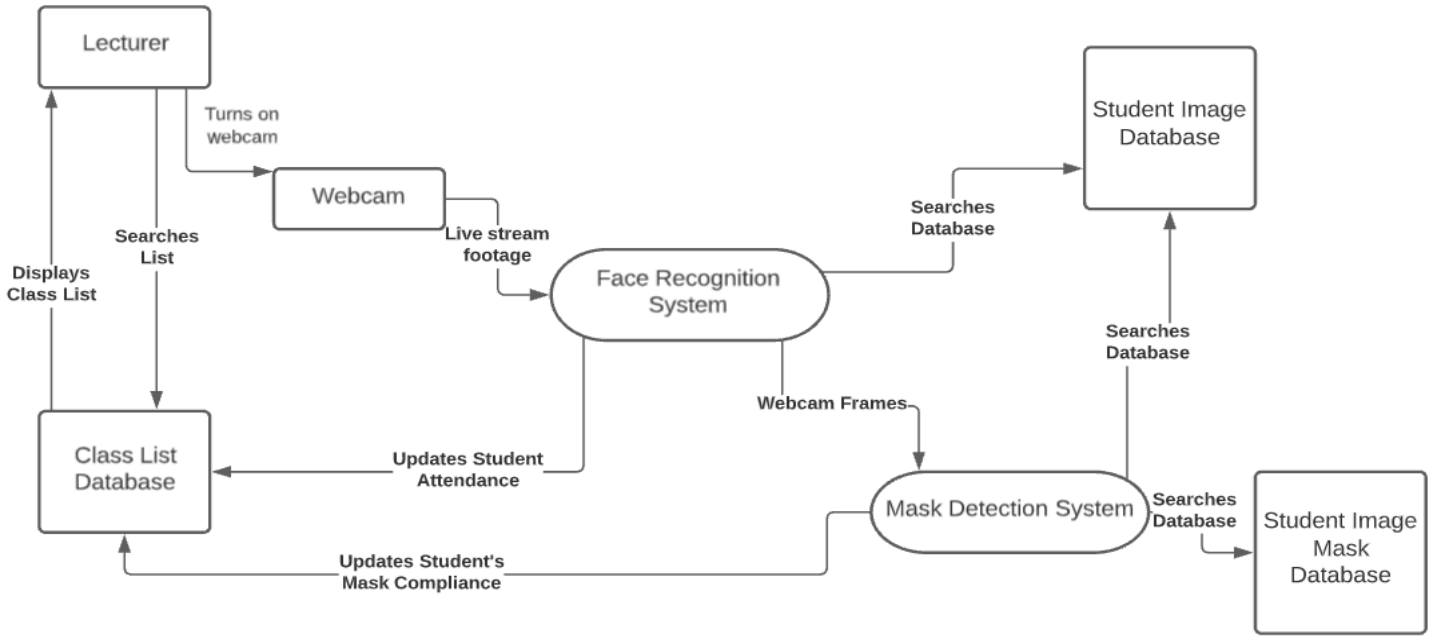
- **Description -** The ability of the system to store whether an individual is wearing a mask in the database based on the information acquired in the first requirement.
- **Criticality -** Along with the third requirement, this is an important requirement.
- **Technical issues -** A student may be wearing a mask but may not be marked as such in the database.
- **Dependencies with other requirements -** Has a very close dependency with the third requirement as without it, there is no information to store in the database.

4. System Architecture

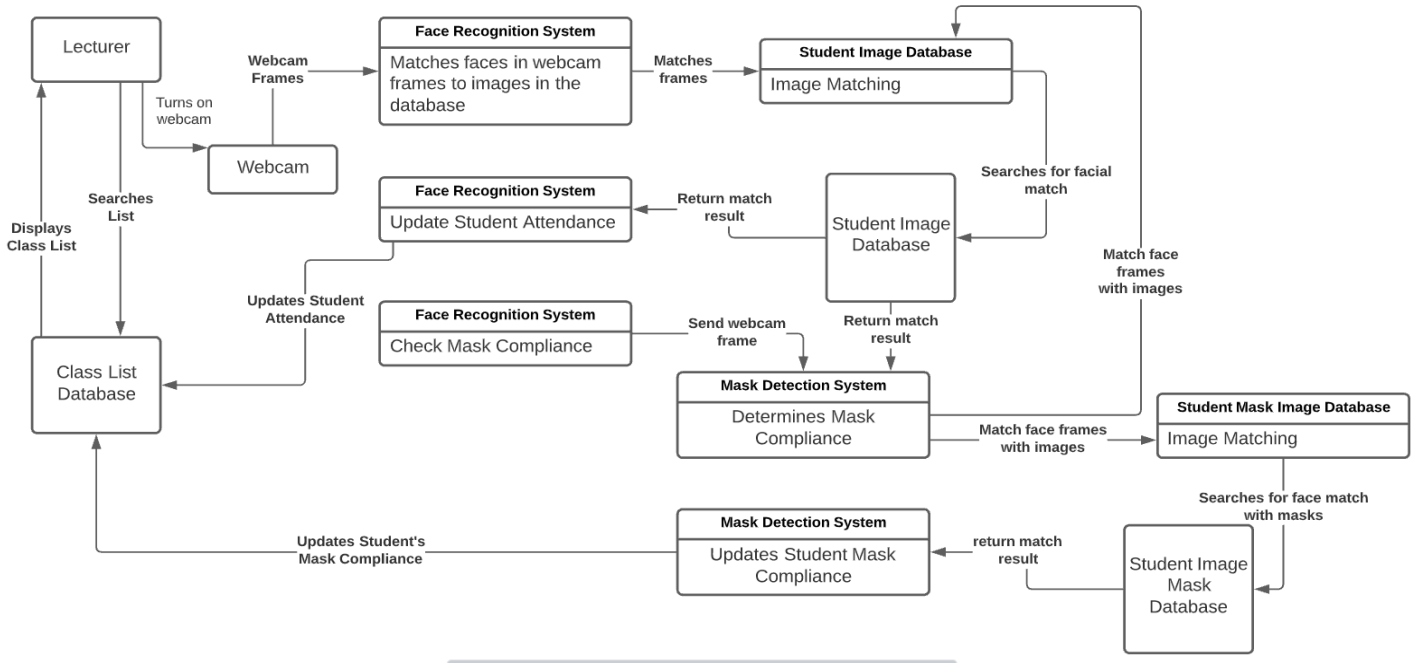


5. High-Level Design

5.1 Context Diagram



5.2 Data Flow Diagram (DFD)



5.3 High Level Design (HLD) Description

- Lecturer sets up the webcam for a live stream of the class that is sent to the facial recognition system
- The system takes the frames from the live webcam and using the faces from each frame matches the face to images from the student image database.
- The system updates the student's attendance based on finding a match or not.
- The mask detection system then determines if the student is wearing a mask.
- The student's mask compliance is updated on the class list database by the system.

6. Preliminary Schedule

6.1 GANTT Chart