Project Title:

Face Detection and Recognition in image & video

Project Code: **Capstone 1**

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Submission Date: **6 Jan, 2020**

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Project Manager's Signature

Definition of Terms, Acronyms and Abbreviations

Term	Description
FD	Face Detection
SS	Surveillance system
NNO	Non-rigid Objects
FD&RS	Face Detection & Recognition System
FR	Facial Recognition

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Section 1

1. Introduction

1.1 Purpose of Document

Any student that have research and project on image processing will be read this document. And also any user read this document that will be used this purposed system.

1.2 Project Overview

We will develop the purposed system by using different method and best algorithm that are used for face detection and recognition. We will also care about image color mapping, image texture and image contrast and contour of face image in the picture and in motion videos. User will enter or input image to system then system will detect face in image that where face is located in image and recognize that image. The goals of system to detect, recognize and label of face from images and videos. The benefits are, no extra resources are used and hardware resources are simple.

1.3 Scope

Our System will provide the facilities that are: pre-processing in which include enhance the quality of face in image for detection and secondly provide face detection where face is located in image and then system recognize that image.

Our system will provide some functionalities that are:

- Input image and video from user
- Identify face in image and video
- Recognize face in image and video
- Label face in image and video

Our system will not provide dome functions or functionalities that are not part of our system to perform:

- Illumination conditions
- Pose orientation
- Facial expression
- Occlusion

2. Functional Requirements

The following list is basic requirements of FD&RS:

- Take image & video
- Pre-processing perform (e.g.: Histogram, Grayscaling)
- Detect Face in image and video
- Recognize Face in image and video
- Label Face in image and video

3. Non-functional Requirements

3.1 Performance Requirements

According to performance requirements the purposed system will work perfectly. It will not take more size in system memory and also execution time or system response will be fast approximately 2 to 3 seconds take for identifying face in providing image. Fast face detection algorithm like Adaboost, cascade and haar-cascade will be applying for detection of faces in images & videos via FD classifier.

3.2 ~~2~~ Safety Requirements

The purposed system will design according to less damage or risk except crash the system by illegal activities. And provide a safeguard documents for system if system not work and system crashing condition occur. Otherwise if problem occur then user can complain and development team will be work for further improvement. Also provide certification, privacy policies for safety requirements from illegal actions.

3.3 Security Requirements

Privacy policy documents will be providing to user for illegal use and standard use that complete the requirements of user or customer. Authentication is not implemented in this system because its only small clone and when this system will implement in industry then authentication will be required for security purpose and also for illegal activities of persons.

~~8.5 Business RulesList any operating principles about the product, such as which individuals or roles can perform which functions under specific circumstances. These are not functional requirements in themselves, but they might imply certain functional requirements to enforce the rules. Mention all users who will be accessing the software and describe their respective right~~

3.4 User Documentation

The small paper or document will be providing according to instructions that will help to user that how to use this software or system. All instructions according to software will be written in this document. With this small user manual, user will easily have used this software and understand the complete structure of system.

4. Justification

4.1 How project is Complex:

This system is complex because it's use complex algorithm to find and match face patterns. To identify face in images, Grayscaling conversion, histogram, and sometimes occlusion, pose orientation and illumination occur due to this detect face in images & videos is very complex.

4.2 How project is Innovative:

It's innovative because due to this daily routine life problem is solved. Like mobile FD password to enhance security of user & Crime rates is low and corps easily find unauthorized/suspicious person from hidden cameras in shopping moles or parks etc. by identifying face of person.

4.3 How project is Applicable:

Our project is applicable in many filed. In companies, this system used as a face detection attendance of company staff members. And also applicable in hidden security cameras for detect or find suspicious person and also clarify face of person from videos or images for legal use.

4.4 How project is Significant scope:

Its significant scope because the purposed system will provide pre-processing phase in which image conversion apply and histogram equalization that's are significant the scope of purposed project.

4.5 How project is Suitable size:

It's suitable size because not use extra financial resources in this project. And not required large team for development, also not required long term milestone deliverables. And also required minimum system hardware for running this system. So its size is very suitable overall.

5. Research Summaries

Design a system in which recognize human characters in e-comics by using CBIR system and EBGM recognition for identifying characters indexing **[1]**. They achieve a well performance CBIR system that is give 75% to 90% correct results and that recognize the characters of large volume of comic pages for easiness of comic readers. Briefly, it is inconvenient for comic readers to perform a scene search on large volume of comic pages. With the emergence of e-comics, computers could be designed to achieve the search task by comic characters indexing. For this characters indexing, a content-based image retrieval (**CBIR**) system developed for the sake of comic reader in which several detection & recognition algorithms implemented on training data set. Elastic Bunch Graph Matching (**EBGM**) recognition used in comic for identifying character. In addition, the CBIR system deployed also designed in such a way that, if being used continuously, the performance of recognition human characters will be enhanced.

Design the system that's perform ' Real Time Face Detection ' in which it recognize the face of suspect or criminal in real time and inform to its nearby police headquarters, secondly Sketch for Match - CBIR' using sketches **[2]**. By using Eigen-face detection algorithm, In this algorithm we manage 3 different things to extract the pixels of the face so as to calculate and store it in database. First, it identifies the pixels in a particular face region, plot it apparently using graphics and manage the neighboring pixels to configure the pixels accurately. To extract from a particular region two algorithms are used precisely i.e. Harr-cascade classification and edge detection algorithm. We

developing system in which we enhance the technology of CCTV cameras in which it provides an alert system for the security forces (police departments) in real time through which they can spontaneously take action for that. We are proposing efficient sketch base software through which we can easily retrieve the picture of suspected person from the eyewitness.

In this, we research Weber's Local Descriptor (WLD) for sexual orientation acknowledgment to design biometric system to judge sexual orientation **[3]**. WLD is a surface descriptor that performs superior to anything other comparative descriptors yet it is all encompassing because of it is extremely development. WLD as a local descriptor results in much improvement in recognition accuracy for gender recognition problem. From WLD we will acquire the critical properties of face pictures. Here an approach for building up a programmed framework to characterize sexual orientation from a facial picture utilizing Neural Network Classifier displayed. The huge highlights are permitted to sustain as contribution to the neural system. The tests are performed on given database and the exactness of the framework is processed for the database. They achieve a gender recognition based system that produce good results as complicated systems.

In this, we design a face recognize system by using LBP (Local Binary Pattern) technique and LBP histogram and texture information **[4]**. Face detection and recognition are still a very difficult challenge. In this, a novel approach is presented to face recognition, which considers both shape, and texture information to represent the face. The face area is first, divided into small regions from which Local Binary Pattern (LBP) histograms are extracted and concatenated into a single, spatially enhanced feature histogram efficiently representing the face image. Extensive experimental research proves the superiority of the proposed method in respect of its simplicity and efficiency in very fast feature extraction. They achieved that experimental results clearly show that facial images can be seen as a composition of micro patterns such as flat areas, spots, lines and edges which can be well described by LBP.

Design a generic pipeline for a face recognition system capable of creating or cleaning datasets when videos or images come from a finite set of identities **[5]**. In this, we proposed and achieved a generic pipeline for face recognition systems capable of creating, cleaning and recognizing faces. We proposed a semi-supervised solution based on a CNN model with center loss that speeds-up the faces labeling process in a video composed of a finite set of identities. With this pipeline, we showed that cleaning a dataset is a fully automatable process and improves the performance of the system. Attention must be paid to the characteristics of the videos used for training the recognition model: videos with low pose variability can lead to poor recognition performance. In the future, we will work in creating a large-scale faces dataset from videos, exploiting the proposed data set creation pipeline.

Design the system for car in which functions perform by human face recognition **[6]**. A vehicle key is the only way to start the car or to provide ignition to the engine. The face recognition based car ignition system literally replaces the car ignition by replacing the key with specific user face. While dealing with the topic the objective arises, is the achievement of luxurious features and the safety concern, which can be achieved by means of the automotive electronics. In this paper, we

are proposing facial recognition system by embedding face detection and face tracking system algorithm found in MATLAB with use of Raspberry pi B. The option of facial recognition and detection have been taken into consideration just because it is widely used in the interactive user interface and plays a crucial role in computer vision. Mainly the use of Haar-like feature has been used to detect and recognize the face of the authenticated user to achieve the secure environment for ignition. There is a strong need for robust and efficient face detection algorithm. The main objective of car ignition in secure environment is associated with the face of an individual.

Design the system in which random keypad implement for ATM security **[7]**. Authenticating user is the important aspect in ATM security. Password is most important thing to provide security in any system password having two very first is text way and second is graphical way. We proposing both security feature text base word and graphical password graphical password include face recognition for detect the face but it is second process. The first process is text password, which include random number. We design this system to minimize the shoulder surfing attack with the help of random keypad and face recognition method. It works as ATM system this type of keypad more powerful as compare to normal keypad. They achieved the system that will be used in ATM machine for strong password.

Design the system in which histogram implemented at various scale for face detection **[8]**. Various methods or experiments can be used for face recognition and detection however two of the main include an experiment that evaluates the impact of facial landmark localization in the face recognition performance and the second experiment evaluates the impact of extracting the HOG features from a regular grid and at multiple scales. The Histogram of Oriented Gradients significantly outperform other existing methods like edge and gradient based descriptors. We study the influence of each stage of the computation on performance, concluding that fine-scale gradients, fine orientation binning, relatively coarse spatial binning, and high quality local contrast normalization in overlapping descriptor blocks are all important for good results. Comparative experiments show that though HOG is simple feature descriptor, the proposed HOG feature achieves amazing results with much lower computational time.

In this, we Design the image-based face detection and recognition system **[9]**. Face recognition from image or video is a popular topic in biometrics research. Many public places usually have surveillance cameras for video capture and these cameras have their significant value for security purpose. It is widely acknowledged that the face recognition have played an important role in surveillance system as it does not need the object's cooperation. The actual advantages of face-based identification over other biometrics are uniqueness and acceptance. As human face is a dynamic object having high degree of variability in its appearance, that makes face detection a difficult problem in computer vision. In this field, accuracy and speed of identification is a main issue. The goal of this paper is to evaluate various face detection and recognition methods, provide complete solution for image based face detection and recognition with higher accuracy, better response rate as an initial step for video surveillance. Solution is proposed based on performed tests on various face rich databases in terms of subjects, pose, emotions, race and light.

In this report, design the system for ATM credit card security from unauthorized person via face recognition of cardholder and the study of different facial recognition techniques is presented **[10]**. The different techniques such as Linear Binary Pattern, Eigen faces, Fisher faces is explained. The comparative study of various techniques mentioned above is presented in this report. Fisher faces have been chosen because it recognizes face faster compared to other two techniques. The proposed system provides high level of security, which includes OTP generation and facial recognition. The applications of the system is identified and presented. The proposed system provides more application and security compared to regular system. They want to achieve the better security purpose of Bank account holder for cash withdraw via ATM machine.

6. Hardware Software Requirement

Hardware:
This system has been run and tested on following configuration
Here is a list of minimum hardware requirements are:

- Processors: Intel Atom® processor or Intel® Core™ i3 processor.
- Disk space: 1 GB or more.
- RAM: minimum 1 GB or more

Software:
Software requirements that are necessary for this system are:

- Operating systems: Windows* 7 or later, macOS, and Linux but better is window 10 pro latest.
- Python* versions: 3.7.2.
- OpenCV: 4.0.1
- PyQt-Py: 5.11
- React.js with npm module

7. Assumptions and Dependencies

The dependencies of purposed system:
We don't expect to integrate into the system so project has no dependencies on external factors. No include any component that are developed by another project. But some software dependencies are including in which system dependencies (like system requirements) and software dependencies (like version etc.).

8. System Architecture

The system architecture is:

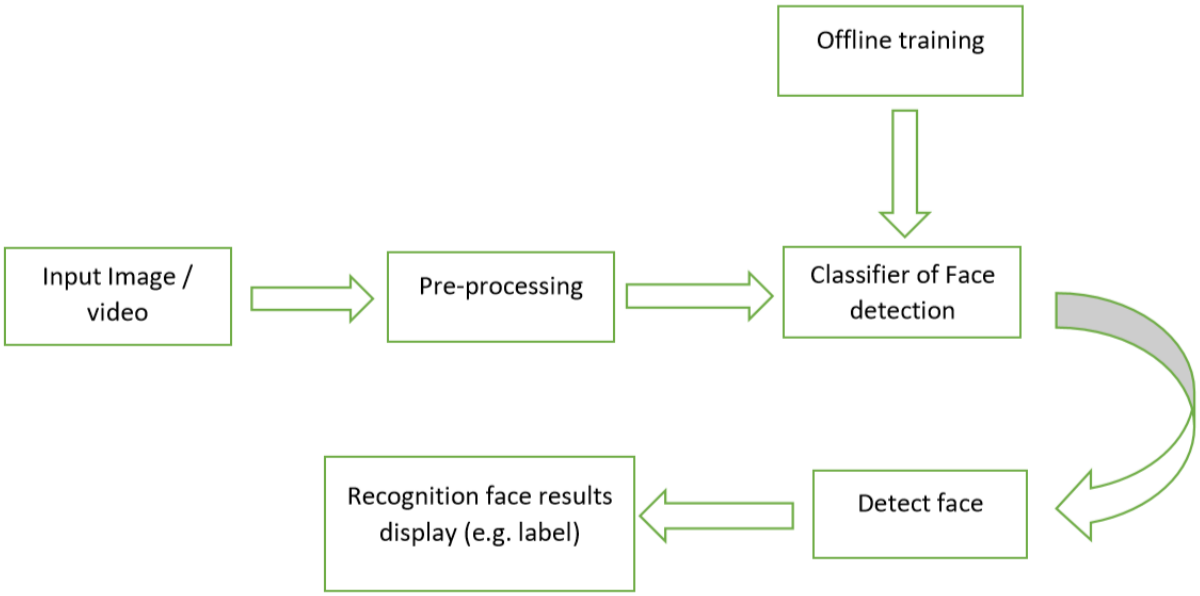


Fig 1. System Architecture

According to system architecture, we provide training data or input image to system. The system performs pre-processing (e.g. histogram, Grayscaling of images etc.) and then algorithm run to classifier detect faces in images or videos. After localization of face in training data the system will recognize face and also display results as by labeling face.

The Data Flow Diagram of system is:

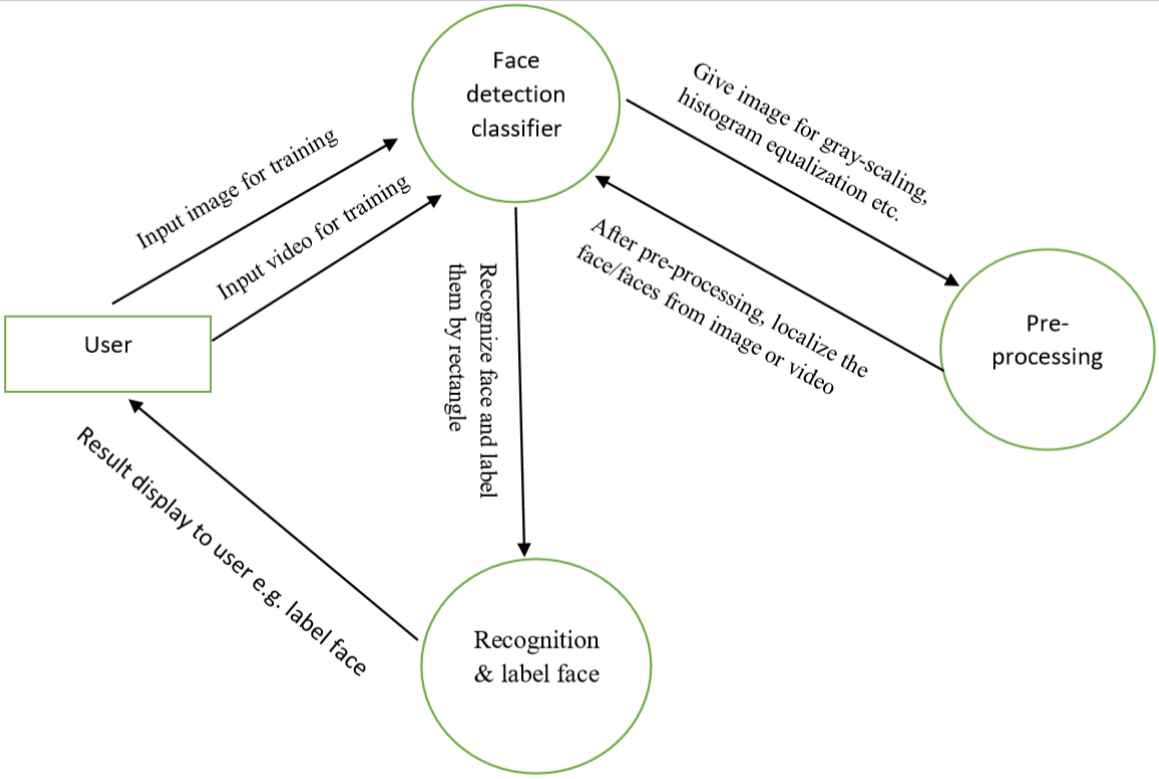


Fig 2. Data Flow Diagram

9. Use Cases

9.1 Use Case Diagrams

The use case diagram of purposed system is:

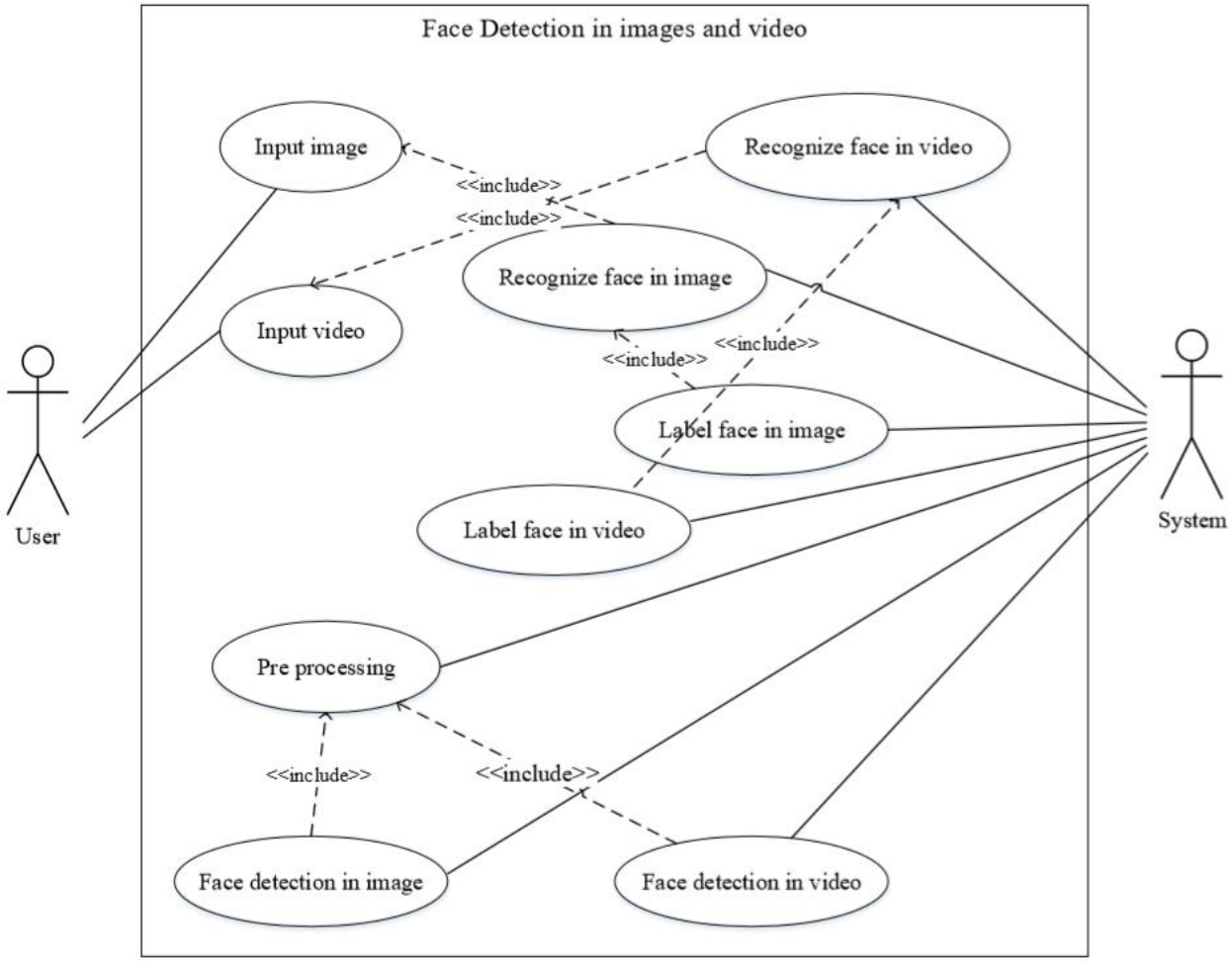


Fig 3. Use case diagram

9.2 Use Case Description

The Use cases of purposed system descriptions are:

1: Input image		
Actors: User		
Feature: Take input image from user		
Use case Id:	1	
Pre-condition:	Input images with fixed size are location same folder and waiting the user to execute this method.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.~~1~~	User enter/input image in system	System take image as input from user and perform further procedure.
Alternate Scenarios:		
1a: System does not receive image. **2a:**System not working correctly.		
Post Conditions		
S~~S~~tep#	**Description**	
1.~~1~~	Pre-processing of image	
2.~~2~~	Histogram, Grayscaling of image	
~~n~~		
Use Case Cross referenced	-	
User Interface reference	GUI for input image to system	
Concurrency and Response Give an estimate of the following ♦ Number of concurrent user is 1. ♦ Use case response after start system.		

2: Input video		
Actors: User		
Feature: Take input video from user		
Use case Id:	2	
Pre-condition:	Input video are location same folder and waiting the user to execute this method.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.1	User enter/input video in system	System take video as input from user and perform further procedure.
Alternate Scenarios:		
1a: System does not receive video. **2a:** System not working correctly. **3a:** System does not support video type.		
Post Conditions		
SStep#	**Description**	
1.1	FD classifier working	
Use Case Cross referenced	-	
User Interface reference	GUI for input video to system	
Concurrency and Response Give an estimate of the following ♦ Number of concurrent user is 1. ♦ Use case response after start system.		

3: Pre-processing		
Actors: System		
Feature: Conversion of image in Grayscaling, histogram of images and more etc.		
Use case Id:	3	
Pre-condition:	Input video image.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.1	User entered or input already image	System perform gray-scaling of image and histogram as well as perform check contrast of image.
Alternate Scenarios:		
1a: System does not receive image. **2a:** user does not enter image		
Post Conditions		
SStep#	**Description**	
1.1	Detect Face in image/video.	
Use Case Cross referenced	-	
User Interface reference	GUI of pre-processing phase	
Concurrency and Response Give an estimate of the following ♦ Number of concurrent user is 1. ♦ Pre-processing perform after input user to system		

4: Face detection in image		
Actors: System		
Feature: localize face or find location of face in input image		
Use case Id:	4	
Pre-condition:	Input image are location same folder and waiting the user to execute this method. And pre-processing phase also done.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.~~1~~	Input image in system. And pre-processing phase done.	System will detect face/faces in image. System will detect location of face in entered image.
Alternate Scenarios:		
1a: System does not receive image. **2a:** Image quality not good so face not see and detect.		
Post Conditions		
S~~S~~tep#	**Description**	
1.~~1~~	Face recognize in image.	
Use Case Cross referenced	-	
User Interface reference	GUI of detect face phase	
Concurrency and Response Give an estimate of the following ♦ Number of concurrent user 1. ♦ Detect face after pre-processing		

5: Face detection in video		
Actors: System		
Feature: localize face or find location of face in input video		
Use case Id:	5	
Pre-condition:	Input video are location same folder and waiting the user to execute this method.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.~~1~~	Input video in system. And pre-processing phase done.	System will detect face/faces in video during running of video. System will detect location of face in entered image.
Alternate Scenarios:		
1a: System does not receive video. **2a:** System does not support video type.		
Post Conditions		
S~~S~~tep#	**Description**	
1.~~1~~	Recognize face in video.	
Use Case Cross referenced	-	
User Interface reference	GUI of detect face phase	
Concurrency and Response Give an estimate of the following ♦ Number of concurrent user 1 ♦ Detect face in video after pre-processing		

6: Recognize face in image		
Actors: System		
Feature: Recognize face in image		
Use case Id:	6	
Pre-condition:	Input image in system and detect face in image.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.1	Face detection classifier work and algorithm run for face recognition	System will recognize the face. Identify that is really face or not.
Alternate Scenarios:		
1a: System does not receive image. **2a:** System not working correctly. **3a:** System does not detect face correctly.		
Post Conditions		
SStep#	**Description**	
1.1	Label the face with rectangle or circle in image.	
Use Case Cross referenced	-	
User Interface reference	GUI of detect face phase	
Concurrency and Response Give an estimate of the following ♦ Number of concurrent user 1 ♦ Recognize face in image after pre-processing		

7: Recognize face in video		
Actors: System		
Feature: recognize face in video		
Use case Id:	7	
Pre-condition:	Input video are location same folder and waiting the user to execute this method. Also detect face in video.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.1	Face detection classifier work and algorithm run for face recognition.	System will recognize the face. Identify that is really face or not.
Alternate Scenarios:		
1a: System does not receive video. **2a:** System not working correctly. **3a:** System does not support video type. 4a: System does not detect face/faces in video.		
Post Conditions		
SStep#	**Description**	
1.1	Label Face in video.	
Use Case Cross referenced	-	
User Interface reference	GUI of detect face phase	
Concurrency and Response Give an estimate of the following ♦ Number of concurrent user 1. ♦ Detect face in video after pre-processing		

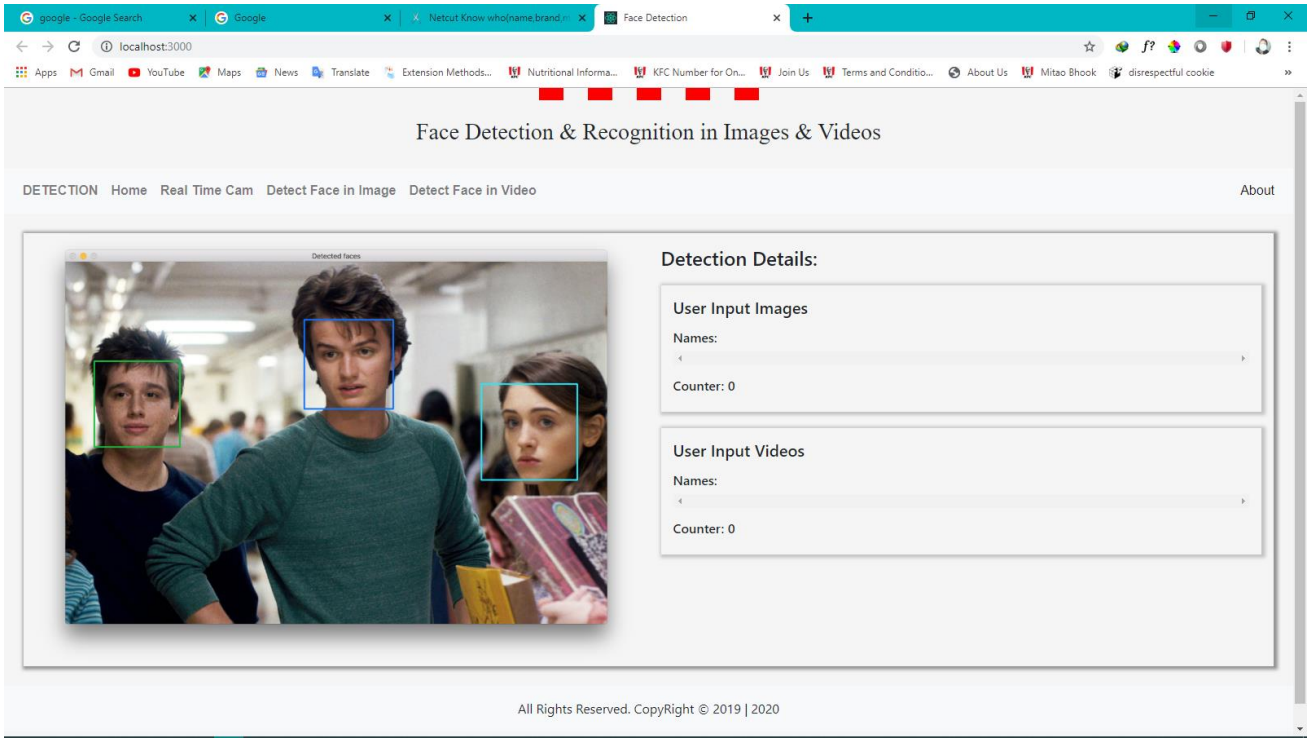
8: Label face in image		
Actors: System		
Feature: label face in image via rectangle		
Use case Id:	8	
Pre-condition:	Input image are location same folder and waiting the user to execute this method. And Detect face in image by applying face detection classifier.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.~~1~~	User enter/input image in system	System take image as input from user and detect and recognize face in image also label the face via circle or rectangle.
Alternate Scenarios:		
1a: System does not detect face in image so not label. **2a:** System not working correctly.		
Post Conditions		
S~~S~~tep#	**Description**	
1.~~1~~	User see recognize and label face in image.	
Use Case Cross referenced	-	
User Interface reference	GUI see in which face label in image	
Concurrency and Response Give an estimate of the following ♦ Number of concurrent user 1 ♦ After face recognition label the face in image		

9: Label face in video		
Actors: System		
Feature: label face in video via rectangle		
Use case Id:	9	
Pre-condition:	Input video are location same folder and waiting the user to execute this method. And Detect face in image by applying face detection classifier.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.~~1~~	User enter/input video in system.	System take video as input from user and detect and recognize face in video also label the face via circle or rectangle.
Alternate Scenarios:		
1a: System does not receive video. **2a:** System does not detect face so not label the face.		
Post Conditions		
SS~~S~~tep#	**Description**	
1.~~1~~	User see recognize and label face in video.	
Use Case Cross referenced	-	
User Interface reference	GUI see in which face label in video	
Concurrency and Response Give an estimate of the following ♦ Number of concurrent user 1 ♦ After face recognition label the face in video		

10. Graphical User Interfaces

Give a detailed account of user interfaces included in this project.

<User Interface Id: Title>	
Interface Id.	1
Use case Reference	Input image & video, detect face in image and video, label detected faces

Snapshot
The Label snapshot of User Interface is: 

Data dictionary reference

Label	**Data dictionary identifier**
1~~1~~	Input training data(image / video)
2~~2~~	Detect faces in image or video
3~~...~~	Recognize & labeling face
~~n~~	

11. High Level Design

11.1 ER Diagram

Purposed System has no database so ERD diagram not include

11.2 Data Dictionary

The data dictionary includes data flow diagram data of definitions that are:

11.2.1 Data 1

First of all user input training data to system either image or video. The system take input from user and perform next pre-processing.

11.2.2 Data 2

After getting input from user, the system would perform image histogram equalization, conversion in Grayscaling and much more like contrast.

11.2.3 Data 3

After pre-processing system will localize the faces from required training input data.

11.2.4 Data 4

After localization of faces from training data system will recognize and labeling.
~~*The notation to develop content description is given below.*~~

~~**Data construct**~~	~~**Notation**~~	~~**Meaning**~~
	~~=~~	~~*is composed of*~~
~~*Sequence*~~	~~+~~	~~*and*~~
~~*Selection*~~	~~[|]~~	~~*either-or*~~
~~*Repetition*~~	~~{}^{n}~~	~~*n repetitions of*~~
	~~( )~~	~~*optional data*~~
	~~* … *~~	~~*delimits comments*~~

~~*<9.n Data n>*~~

< Data 1>	
Name	Input training data(image / video)
Alias	None

Where-used/how-used	import cv2
	
	# Save image in set directory
	# Read RGB image
	image = cv2.imread('g4g.png')
	
	# Output image with window name as 'image'
	cv2.imshow('image', image)
	
	# input video
	
	cap = cv2.VideoCapture('chaplin.mp4')

Content description	User input training data to system either image or video. The system take input from user and perform next pre-processing.
Supplementary information	-

< **Data 2**>	
Name	Pre-processing
Alias	Conversion of images
Where-used/how-used	image = cv2.imread(imagePath) gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY) # detect pedestrian in pic peds = pedsCascade.detectMultiScale(gray, scaleFactor=1.3, minNeighbors=9, minSize=(30, 30))
Content description	After getting input from user, the system would perform image histogram equalization, conversion in Grayscaling and much more like contrast.
Supplementary information	-

< **Data 3**>	
Name	Detect faces in image or video
Alias	Localize the face

Where-used/how-used	# Detect faces in the image
	faces = faceCascade.detectMultiScale(
	gray,
	scaleFactor=1.1,
	minNeighbors=5,
	minSize=(30, 30),
	flags = cv2.cv.CV_HAAR_SCALE_IMAGE
	)

Content description	After pre-processing system will localize the faces from required training input data.
Supplementary information	-

< **Data 4**>	
Name	Recognize & labeling face
Alias	Circle face

Where-used/how-used	# Draw a rectangle around the faces for (x, y, w, h) in faces: cv2.rectangle(image, (x, y), (x+w, y+h), (0, 255, 0), 2) cv2.imshow("Faces found", image) cv2.waitKey(0)
Content description	After localization of faces from training data system will recognize and labeling.
Supplementary information	-

The notation to develop content description is given below:

Data construct	Notation	Meaning
	=	Detectface = cv2.imread('g4g.png') + pre-processing()
Sequence	+	recognizeface = cv2.imread('g4g.png') + pre-processing()
Selection	[|]	Pre-processing = [contrast of image]
Repetition	{}^{n}	lebelFace = { detect | recognize }
	( ) * … *	

12. Requirements Traceability Matrix

Sr. #~~Feature~~	Feature	Use case ID	UI ID	Priority	Build Number	Use Case Cross reference (Related Use Cases)
1~~1~~	Get image as an input	1	1	4.5/5.0	1	-
2~~2~~	Get video as an input	2	1	4.5/5.0	2	-

3.	Convert image into gray-scaling , histogram of images	3	1	4.6/5.0	3	-
4.	Detect faces(localize) in image	4	1	4.7/5.0	4	-
5	Detect faces(localize) in video	5	1	4.7/5.0	5	-
6	Recognize detected faces from image	6	1	4.8/5.0	6	-
7	Recognize detected faces from video	7	1	4.8/5.0	7	-
8	Label the detected face from image	8	1	4.4/5.0	8	-
9	Label the detected face from video	9	1	4.4/5.0	9	-

13. Risk Analysis

13.1 Risk Identification

To detect face/faces some risks can be occur that are:

- Variant pose
- Illumination condition
- Occlusion
- Uncontrolled background

13.2 Risk Drivers

In risk drivers, we talk about user's input. User will be input to system and this image may be uncontrolled background, faces in this image are variant pose also may be this input image of user has in illumination condition So due to this we can feel or describe this is risk & maybe occur.

13.3 Percentage Impact of Risk Drivers

After more study & understanding about our purposed system, we conclude that 20 – 25% risk will be occur.

13.4 Risk Mitigation Plan

To minimize the risk we will plan for minimize it that are:

- Use an efficient algorithm for detect faces
- Pre-processing must be implemented
- Prevent variant training input data

14. Cost Estimation Sheet

The estimation cost of purposed system is:

1.	Software development cost	-

2.	**Packaged software**	-
3.	**Hardware**	Only PC/laptop needed to run this purposed system.
4.	**Network**	-
5.	**Client**	-
6.	**Misc.**	-
		Total cost = machine/PC needed

15. References

The references with complete details are:

Ref. No.	Document Title	Date of Release/ Publication	Document Source
KOLKATA – 700015	Face Detection	2015 – 2016	http://rcciit.org/students_projects/projects/cse/2018/GR2.pdf
U 08096	Image Based Face Detection System	14 June, 2009	http://www.peter-lo.com/Teaching/U08096/200912-B1.pdf
ISO 9001: 2008	Authentication using facial Recognition	Volume – 06 , 04 April 2019	https://www.irjet.net/archives/V6/i4/IRJET-V6I4105.pdf
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16. Appendices

Appendix A. Facial Recognition Survey Results

Following are the Facial Recognition questions asked in a recent AAMVA membership survey.
1. Do you have a facial recognition (FR) program? If so, when was the program implemented?
2. Did you complete a scrub of your data prior to full implementation?
3. What action do you take when it is determined through FR that a person has fraudulently applied for a driver license or ID card?
4. Who is your facial recognition vendor?
5. Do you use FR internally for anything other than credential issuance?
6. Do you share images or allow access to your FR database with other entities?
7. Do you require a specific number of identities before a criminal or administrative investigation is initiated?

8. Do you have an investigative unit within your agency? If yes, do you have fully sworn officers possessing powers of arrest? If no investigative unit, do you have an arrangement (formal or informal) with your state police/highway patrol to conduct criminal investigations?
Full survey results with detailed jurisdiction answers can be found in the American Association of Motor Vehicle Administrators knowledge bank at http://www.aamva .org/survey/web/knowledge-bank .aspx
The map on page 52 shows, at a glance, the jurisdictional adoption of FR.