AI Enabled Social Distancing

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1. Introduction

1.1 Purpose

The purpose of this project is to make sure that spread of the pandemic in various sectors like church ,temple,shops etc decreases to a certain extent and also reduce burden on government bodies and hospitals. Since the vaccine has not been discovered yet and the number of cases are rising it is now the only possible solution available along with sanitization.This project will also help in categorizing the dangerous and risk prone areas and enable officials to deploy resources according to the category of the zone.

1.2 Document Conventions

- Normal Text :- Times New Roman (Font Size :- 12)
- Headings :- Times New Roman (Font Size :- 23)
- Sub Headings :- Times New Roman (Font Size :- 17)

1.3 Intended Audience and Reading Suggestions

Mainly Small Businessman, wine shop owners, schools and colleges, Government offices. Help our police force to maintain law and order of social distancing.Can be used in Temples, Mosques, church and other religious places, where maintaining social distancing is a very difficult problem for the government.

At this time it is very necessary to make this kind of innovation and project to fight against COVID-19 .This project basically tells us where we are breaking the rule of 6 feet distance by mistake or intentionally. It can be implemented for thousands of people but it might not be scalable to implement for millions/billions of people as it will require a huge amount of cost and electricity , which I think no country can afford . This is a very good project if we are thinking about implementing it in a society and can distribute the total cost among the people of the society.

1.4 Product Scope

As it is already discussed above that this project is scalable to only thousands of people not more than that but the requirement is to implement it for billions of people , if we talk about India there are 130 crore people and if we are implementing this project for 100k persons then it is of no use .

Then the Government should take initiative to make use of a camera that is placed at the center of the area and then by rotating can swipe the area like the radius of the circle .

However in this case the efficiency will be less than 25% but still we can think of it as a valid / reasonable solution.

2. Overall Description

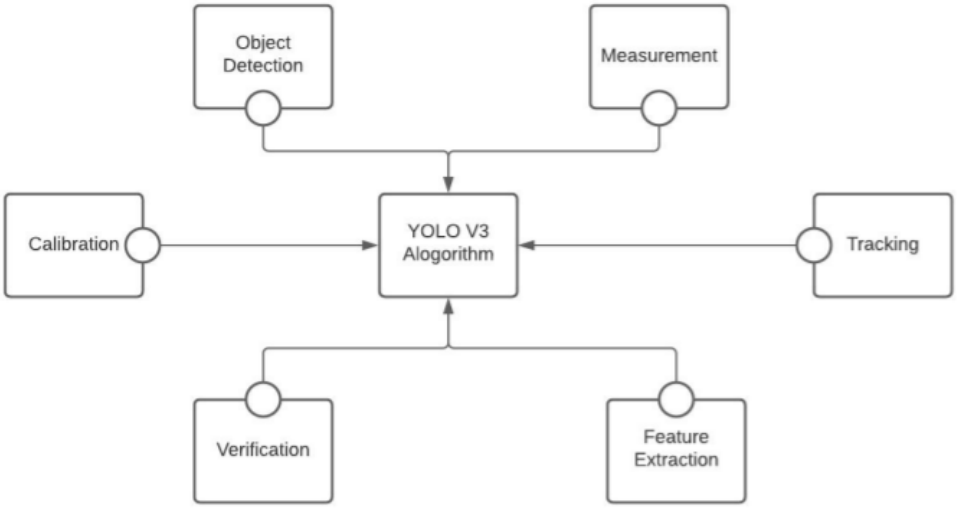
2.1 Product Perspective

This is a whole new project which we will be trying to develop.

The major component for this project are :-

1) Object Detection
2) Measurement
3) Tracking
4) Feature Extraction
5) Verification
6) Calibration

Component Diagram :-



2.2 Product Functions

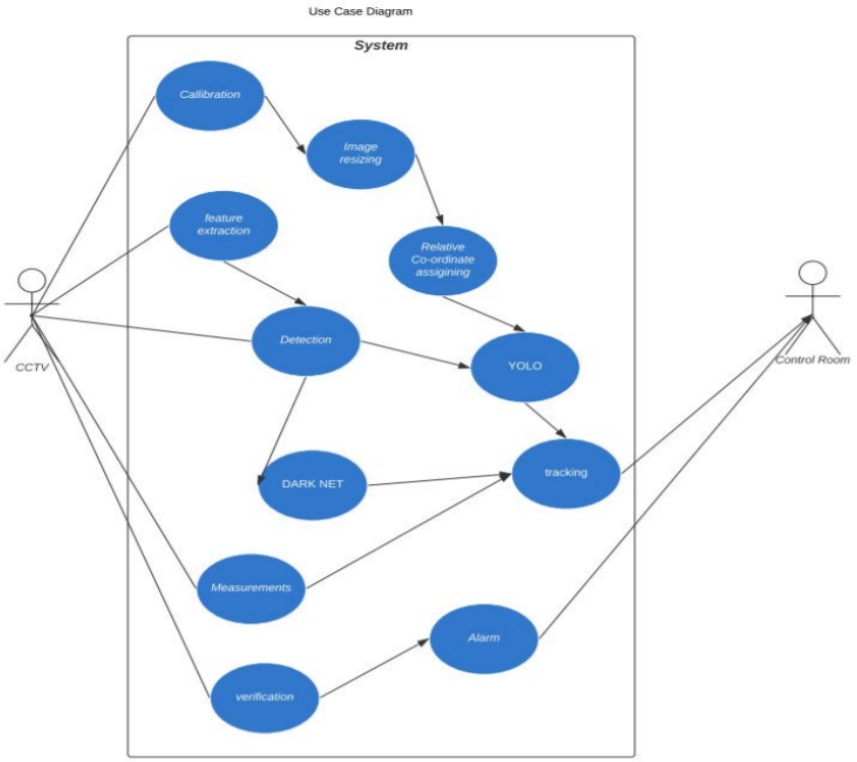
1) Calibration :-
    a) Calibration is the first step of the pipeline, which works by computing the transform into a box view.
2) Detection of Objects :-

a) Detection is the second step of the pipeline that involves applying a pedestrian detector to the perspective views to draw a bounding box around each pedestrian.

3) Measurement of Distance :-
   a) This is the third step of the pipeline, where the (x, y) location of the bounding box for each person has been estimated in the box view.
4) Feature Extraction :-
   a) Feature Extraction is the fourth step of the pipeline , which works after objects have been identified .
5) Tracking:-
   a) Tracking is the fifth step of the pipeline . In this module we are assigning the human beings relative spatial 2D coordinates with respect to the closest person i.e. the largest possible image .
6) Verification :-
   a) Verification is the sixth and the last step of the pipeline . As in the above module we have find all the possible edges i.e. n*(n-1)/2 edges with n persons.

2.3 User Classes and Characteristics

Use Case Diagram :-



2.4 Operating Environment

The hardware components that we will need for this project are :-

- Camera :- It is the heart and soul of our project and does almost everything we need
- Battery :- It is required to make the camera in working condition
- Alarm siren :- It displays the result of all the calculations that are done every 3 seconds (It is the time lapse between any 2 consecutive calculations and image capture)
- Windows 7 and above
- Open CV
- Yolo V3 Architecture

2.5 Design and Implementation Constraints

Occlusion of pedestrians detected by the camera may happen if there is too much crowd, thus calculation of pedestrian density threshold will be affected. Expensive high definition cameras have to be deployed in numbers depending upon the area of the place to be monitored. People don't want to get monitored as there is a sense of insecurity of data theft due to rising cases of cybercrimes in the world.

2.6 User Documentation

1) Learning OpenCV :- https://opencv.org/
2) YOLO V3 Architecture :-
    a) https://pjreddie.com/darknet/yolo/
    b) https://viso.ai/deep-learning/yolov3-overview/
3) Learning Keras :- https://keras.io/
4) Youtube Video :-
    a) https://www.youtube.com/watch?v=vRqSO6RsptU
    b) https://www.youtube.com/watch?v=Grir6TZbc1M
5) Image Processing:- https://scikit-image.org/

2.7 Assumptions and Dependencies

1. For detection purposes we assume any part of the human body like face, lower body etc as a human object.
2. To calculate the distance between the objects we take the distance between the centroid of the objects.(using euclidean formula)
3. Also the prediction which we are making will not always be 100% accurate as it will depend on the various factors of that area like luminance intensity of that area, crowding of people,proximity to make cameras etc. So, there will be roughly a percentage of 2-3%
4. For objects to work properly at night properly there should be a minimum luminance of 25-36MW.

3. External Interface Requirements

3.1 User Interfaces

- Video from system connected Webcam
- Video from Local saved Video File
- Video from HTTP Stream
- Video from RTSP Stream

3.2 Hardware Interfaces

The hardware components that we will need for this project are :-

- Camera :- It is the heart and soul of our project and does almost everything we need
- Battery :- It is required to make the camera in working condition
- Alarm siren :- It displays the result of all the calculations that are done every 3 seconds (It is the time lapse between any 2 consecutive calculations and image capture)

3.3 Software Interfaces

- It should be able to use a webcam or other cameras available in today's market and detect the person.
- Should be able to alarm and inform the responsible authorities when social distancing is not being followed.
- Should be able to work unfavourable conditions, in places where the images are not very clear and has dim light

3.4 Communications Interfaces

The requirements associated with any communications functions required by this product include web browser, network server communications protocols, electronic forms, and so on. The communication standard that is used is HTTP.

In our project HTTP is used :- HTTP is a "stateless" request/response system. The connection is maintained between client and server only for the immediate request, and the connection is closed. After the HTTP client establishes a TCP connection with the server and sends it a request command, the server sends back its response and closes the connection.

4. System Features

4.1 System Feature 1

1) Calibration
2) Detection of Objects

3) Measurement of Distance
4) Feature Extraction
5) Tracking
6) Verification

4.1.1 Description and Priority

Feature Name	Description	Priority	Rating	Risk
Calibration	In this process, the simplest calibration method involves selecting four points in the perspective view and mapping them to the corners of a rectangle in the box view. The process assumes that every person is standing on the same flat ground plane.	Medium	Benefit	5
Detection of Objects	For this process, the company used an open-source pedestrian detection network based on the DNN architecture.	High	Benefit	8
Measurement of Distance	The last step is to compute the box view distance between every pair of people and scale the distances by the scaling factor estimated from calibration. The people whose distance is below the minimum	High	Cost	9

	acceptable distance has been depicted in red, and the rest are coloured as green, and a line is drawn between the people to emphasize this measure.			
Feature Extraction	This module separates the human beings from all the other objects that are captured in the image . In this we are making use of Dark Net Architecture for making our work easier . We are using edge detection for implementing this work.	High	Benefit	7
Tracking	In this module we are assigning the human beings relative spatial 2D coordinates with respect to the closest person i.e. the largest possible image . Treat them as vertices of the complete polygon with n vertices , where n is the number of vertices it possess and it will therefore have n*(n-1)/2 edges	Medium	Benefit	6

Verification	As in the above module we have find all the possible edges i.e. n*(n-1)/2 edges with n persons , Therefore , we now check for all the possible edges and then validate , if(distance >= 6feet) -> green box else red box	Low	Benefit	3

4.1.2 Stimulus/Response Sequences

Sno	Test ID	Test Case Scenario	Test Condition	Expected Result	Actual Result	Test Status
1	OI001	Object Identification	When sufficient light is there	Objects are identified properly	Objects are identified properly with confidence > 98%	Pass
2	OI002	Object Identification	When insufficient light is there	Objects are identified properly	Objects are identified properly with confidence > 78%(approx)	Pass

3	OC001	Object classification	Only humans must be extracted	Our input data contains only humans	Input data must contains data of humans only with confidence > 90%	Pass
4	ICP001	Identification of closest person	Person with largest image	We are able to identify the person correctly	Identification of person must be done with confidence > 95%	Pass
5	RSC001	Relative Spatial 2D coordinate calculation	Assigning proper 2D coordinate with respect to the closest person	All the persons are assigned 2D coordinates successfully	Coordinates must be assigned with confidence > 85%	Pass
6	CDP001	Calculating the distance between every pair of persons	If there are n persons then n(n-1)/2 distances must be calculated	Distance is calculated successfully	Distance must be calculated with confidence == 100%	Pass

7	AB001	Assigning boxes	If distance > 6feet -> green box Else Red box	All the boxes are assigned successfully	Boxes must be assigned with confidence > 98%	Pass
8	CNV001	Count	Count boxes	Violation	Violation must be	Pass

4.1.3 Functional Requirements

As this is very challenging task for all our team members , to make it easy only a bit we have divided the project into 7 modules

- Detection of Objects
- Measurement of Distance
- Calibration
- Feature Extraction
- Verification
- Tracking

To implement all these different modules we have make use of DarkNet architecture , YOLO algorithm and OpenCV

5. Other Nonfunctional Requirements

5.1 Performance Requirements

1. When sufficient light is there, objects can be identified properly with confidence > 98%
2. Assigning proper 2D coordinate with respect to the closest person,Coordinates must be assigned with confidence > 85%
3. If there are n persons then n(n-1)/2 distances must be calculated, Distance must be calculated with confidence == 100%

5.2 Safety Requirements

1) Safety of the Camera that are installed on the street , because they are our point of contact and if any breakdown happens in our camera then everything is lost
2) We should provide safety to the alarm system as well because that will also be present on the streets , so equal and high chances of getting damaged

5.3 Security Requirements

1) Making our system hack proof , So that only registered users can access the data and make changes if they want / necessary
2) Providing the encrypted way to transfer data from the camera to the system for monitoring the social distancing system and then generating the report

5.4 Software Quality Attributes

Non-functional requirements—can be divided into two main categories:

- This project is safe , usable and observe its surrounding every 3 seconds at the run time
- Project is testable, maintainable, extensible and scalable
- The product should also have following properties adaptable, available, correctness, flexibility, interoperability, maintainability, portability, reliability, reusability, robustness, testability, and usability. .

5.5 Business Rules

1) **Entrepreneurs are Everywhere:-** We have found out the opportunity of our start up in these pandemic and start up help countries to develop good health care for everyone.And also provide a two times protection to the countries by providing them AI Enabled Social Distancing System.
2) **Entrepreneurship is Management:-** In the beginning of the project we found out how much management is important.
3) **Build-Measure-Learn:-**As we are doing implementation of the project most of us are on different pages in part of the technology stack that we know . But when we go for the implementation we just start making the project and then everyone just learns about the technology as we go for the implementation.
4) **Validated Learning:-**As our project is made in different modules so validation is very important so when we are making one module some other member does the validation part of the project. So as we are making the project we learn about how important validation is for these types of projects.

6. Other Requirements

Appendix A: Glossary

YOLO : You Only Look Once
Definition : Real-time object detection algorithm, which is one of the most effective object detection algorithms that also encompasses many of the most innovative ideas coming out of the computer vision research community.

CNN : Convolutional Neural Network
Definition : CNN, or ConvNet is a class of deep neural networks, most commonly applied to analyzing visual imagery.

Appendix B: To Be Determined List

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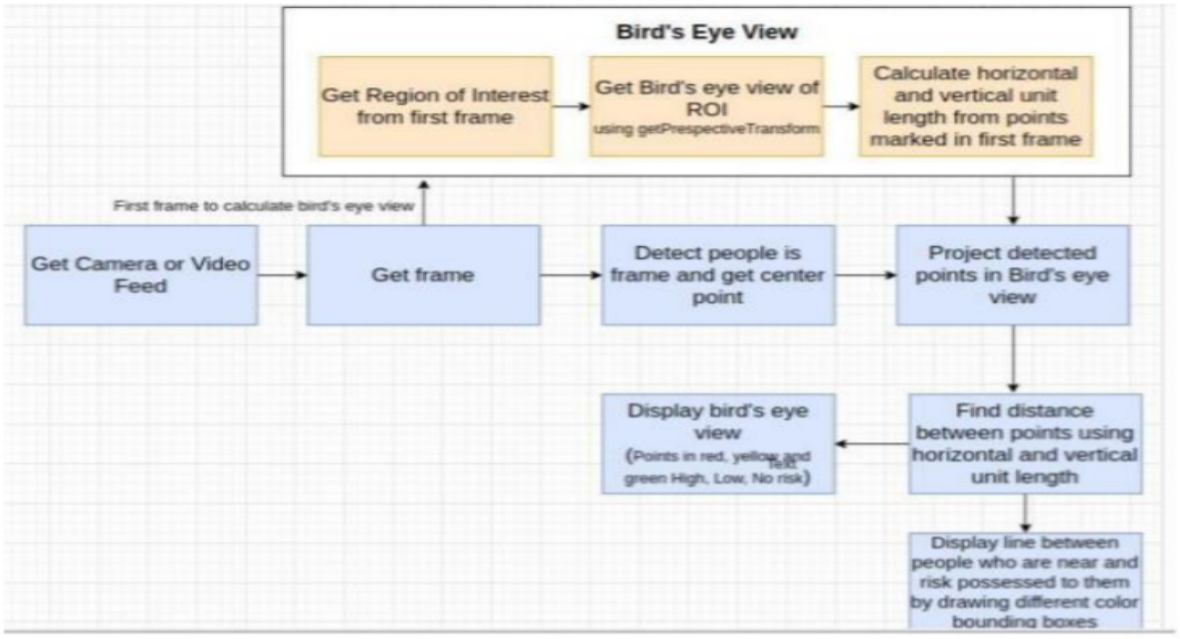
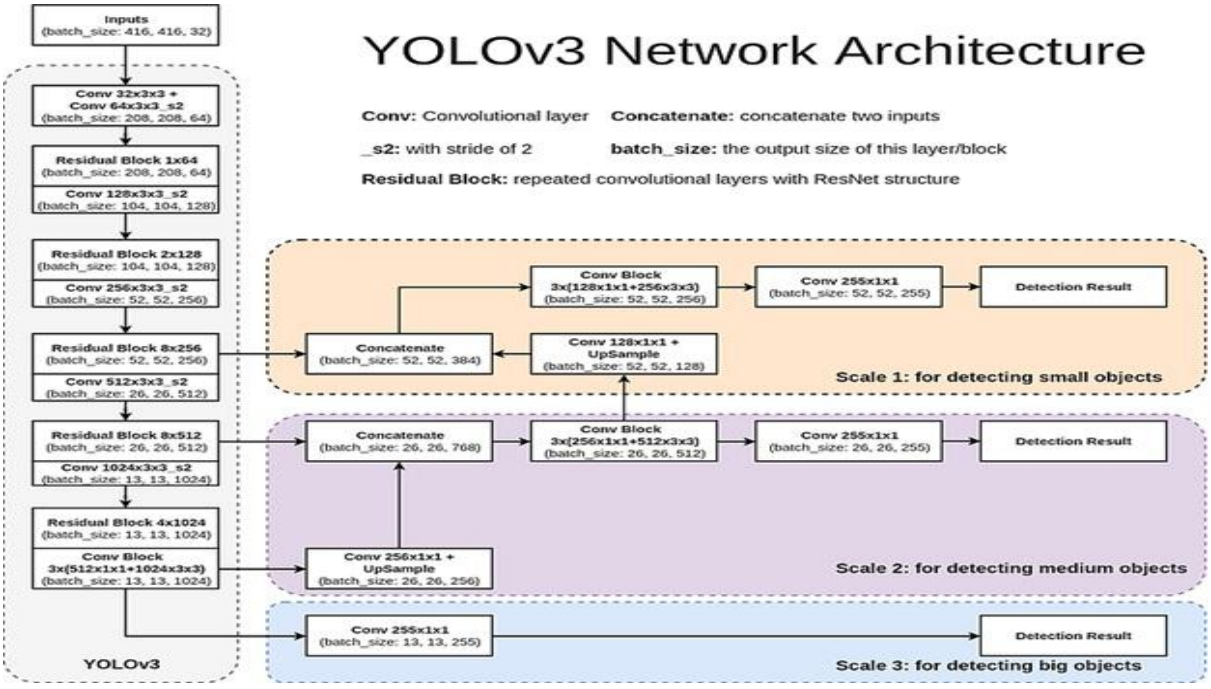
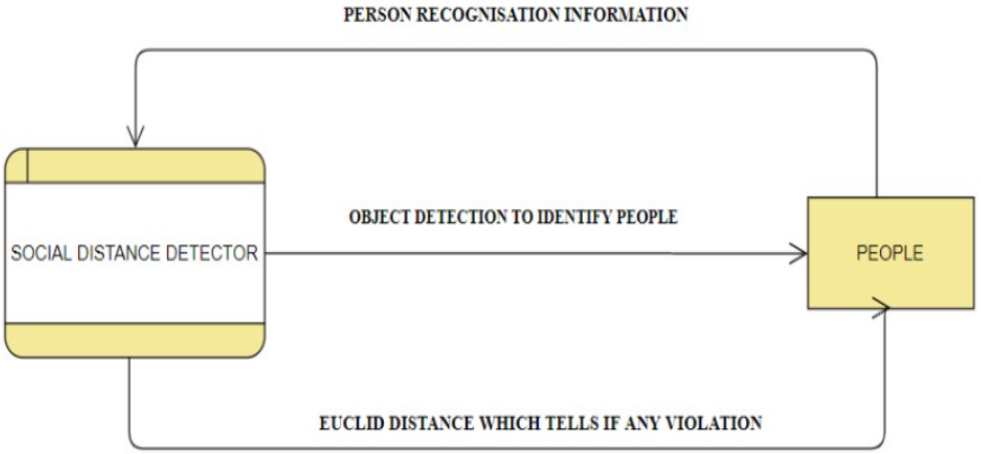
7. Architecture Diagram

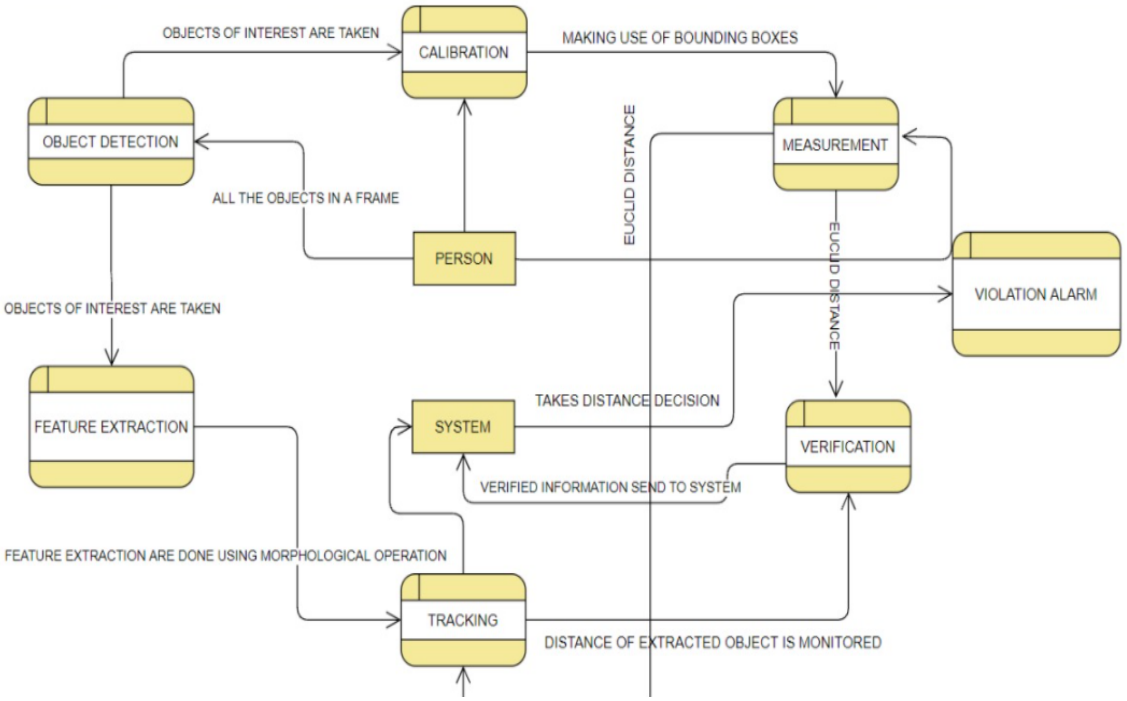


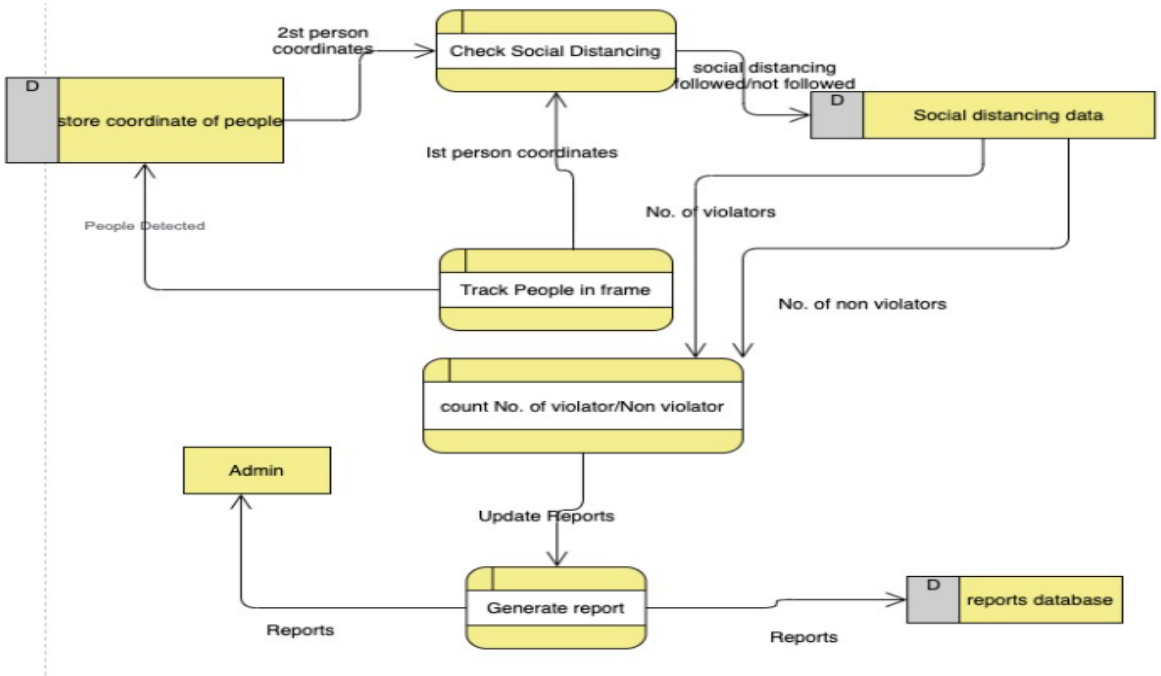


8. Data Flow Diagram

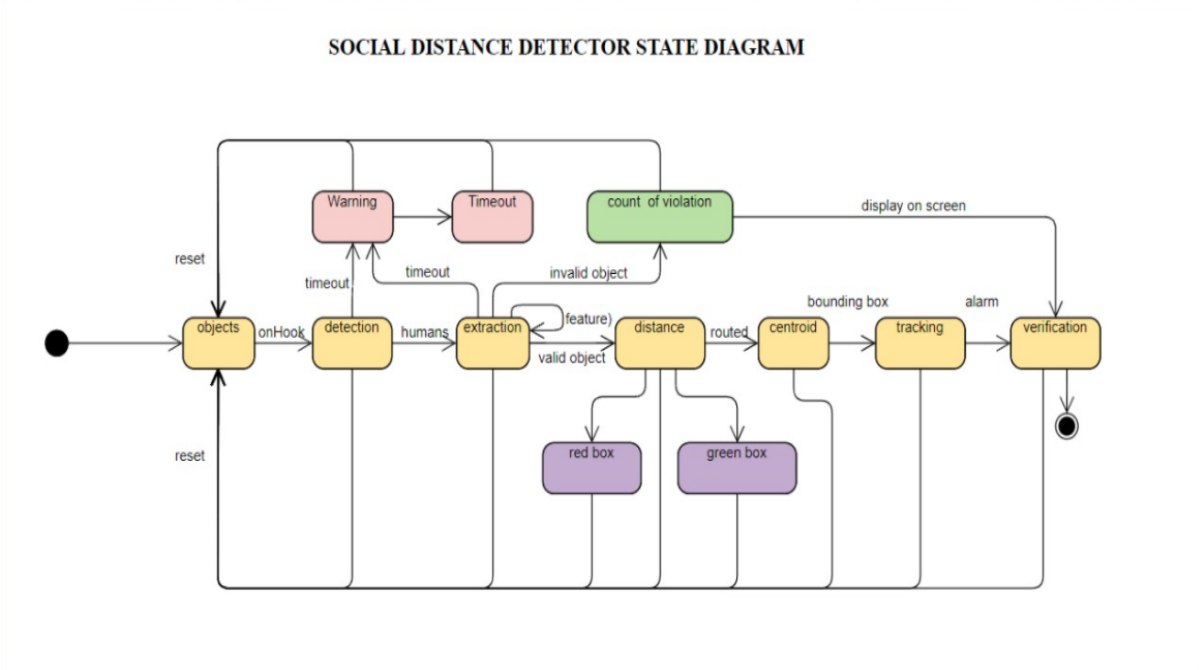
SOCIAL DISTANCE DETECTOR DFD LEVEL-1





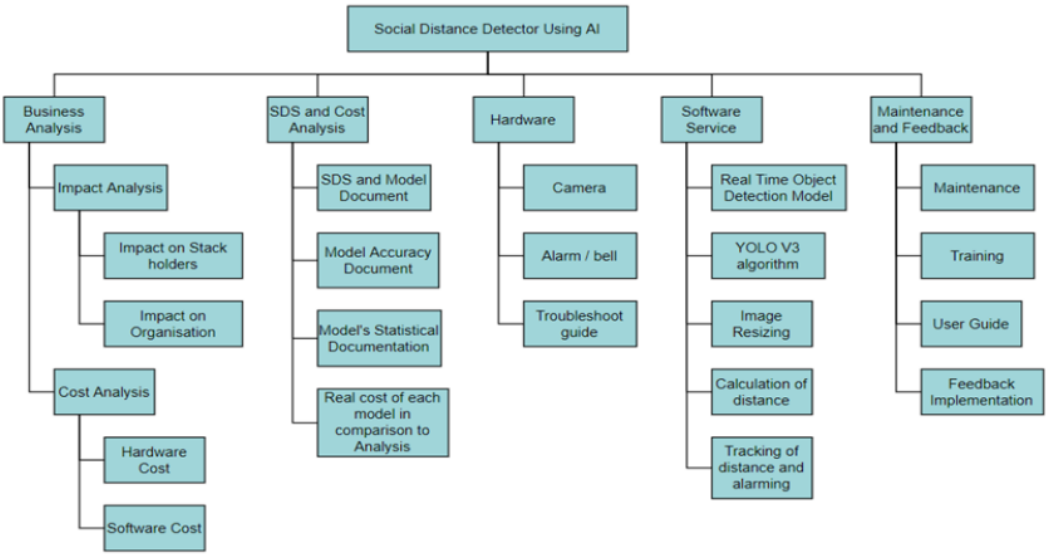


9. State Chart Diagram

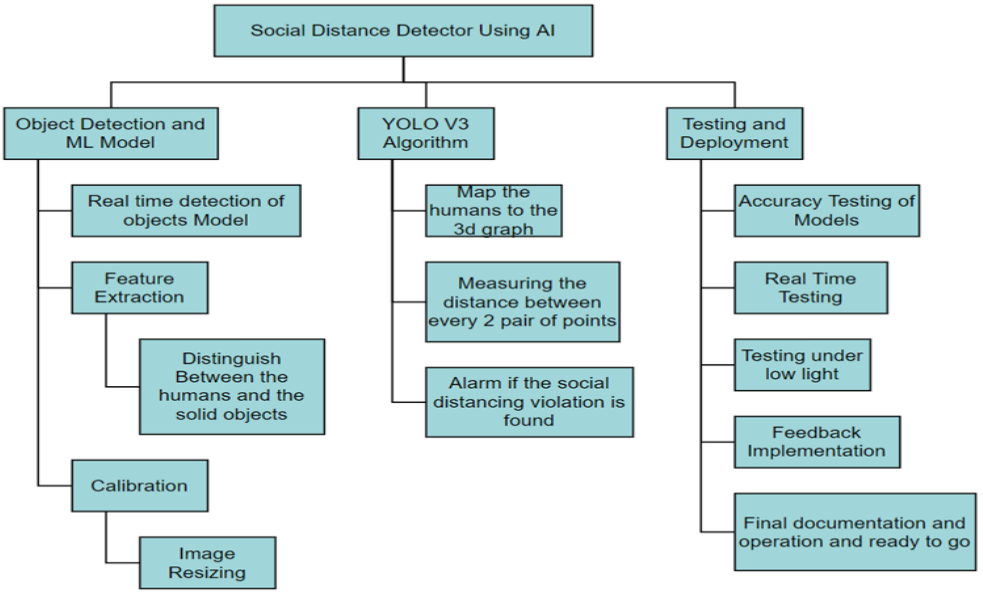


10. Work Breakdown Structure

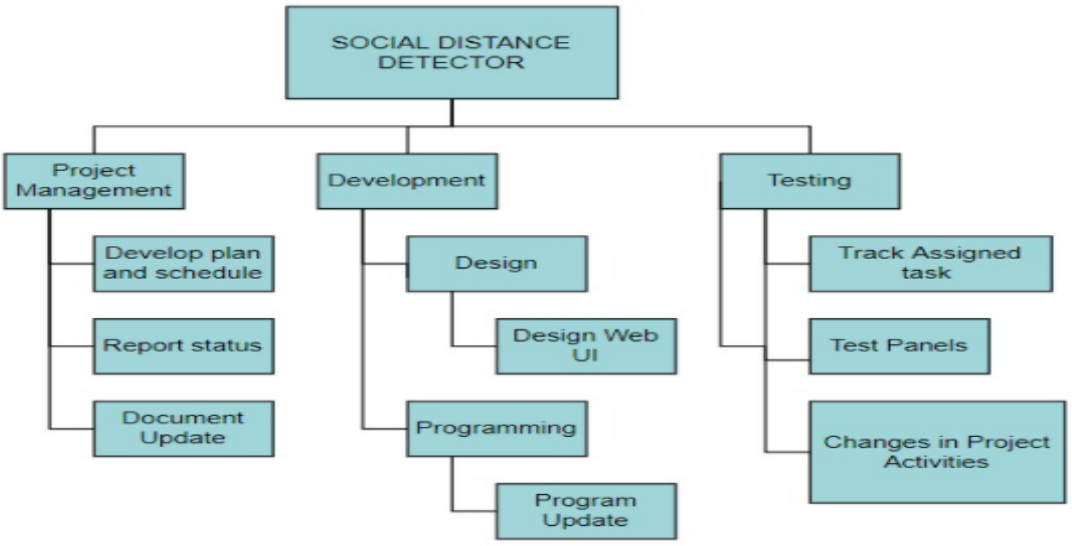
DELIVERABLE BASED WBS



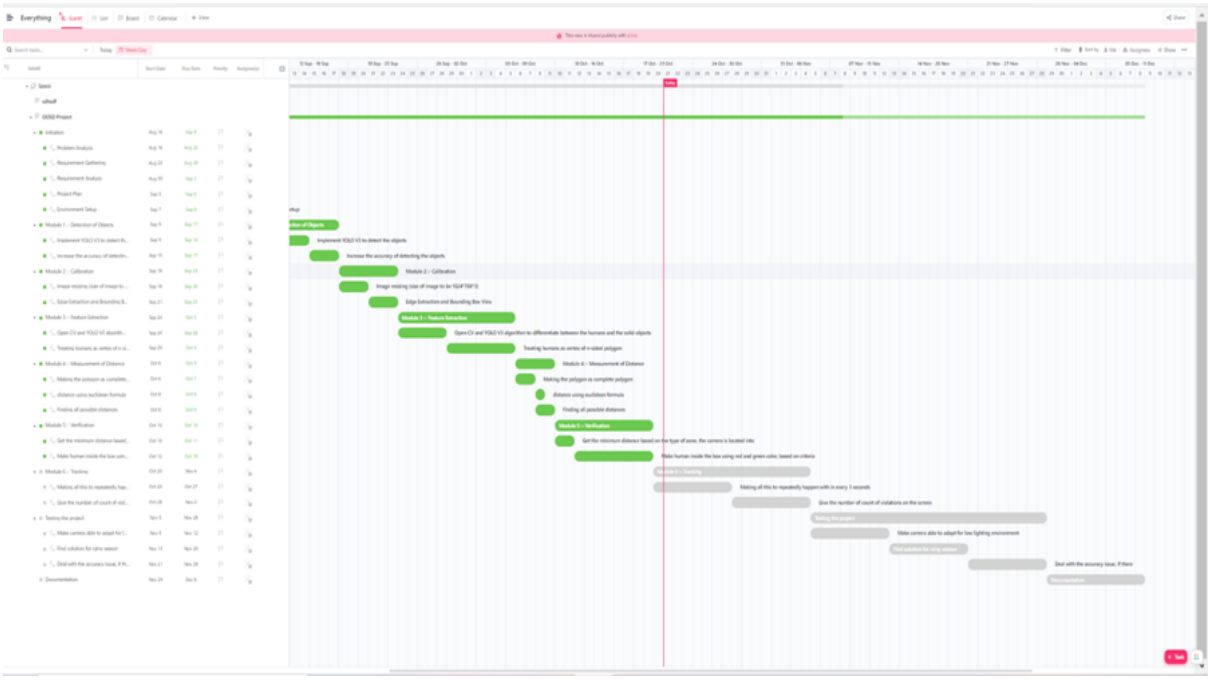
PHASED BASED WBS



RESPONSIBILTY BASED WBS



11. Gantt Chart



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