Application for Safety of Citizens

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Abstract: **In 21st century, where mobile and information technology have become an integral part of our lives. A new area where mobile integrated with technology is useful for crime reporting and to ensure their own safety. So taking this into consideration, this paper discusses an application for the users so that they have some extra safety or we can say they can have their safety in their own hand. In this application, user can send SOS call and SMS to one of their contact. They can also share their live location through the application. User can check the crime rate of their current location. So the basic aim of this application is our user's safety.**

Keywords: **Safety, API, Cops, Crime.**

1. Introduction

In today's era mobile technology can be used in many other fields and applications such as Gaming, Maps, Email, Messaging, and Photography and so on. One such area is crime area detection, storing crime reports and provide safety. This paper focuses on overcoming the disadvantages of existing applications by providing a method for verifying the incident. The application will provide the general users with the facilities like reporting any incidents, send live location to emergency contacts. Moreover, it will also provide an alternate safe path on user's demand before entering the crime area. If we have an application which will provide many features for safety of an individual, that application will help us in any emergency situation to send an emergency alert to one of the user's contact. Application can have algorithm to predict the crime rate of the current location and have image processing algorithms to categories the evidence into different categories.

2. Literature Survey

A. Existing system

In the present scenario filing an FIR/complaint is a hectic task since one must go through a very huge process for justice. In general, to file an FIR/complaint one must search for a nearby police station and have to wait until a cop takes upon the request and either we have to recite or have to give it as a written statement. Certainly this takes nearly a day of an individual's time. In this busy world, it's quite tough to give up on our routine works. The existing system of filing complaints/FIR affects our daily routine, makes us spend a lot of our precious time in it. Filing an FIR, meanwhile we could have done three. Mainly could give a lot of chances and time for verdicts to easily escape from cases making their pre bails ready or even

for absconding. To avoid such miserable situations we have designed an app that makes everything happen in just few minutes.

B. Drawbacks of the system/previous methods

In existing system, once user reaches police station he/she needs to describe whole incident in front of them and then police will write all the details. The applications which are on play-store regarding safety and security of citizen, it does not provide crime rate of the current location of user

There are no such applications which will send SOS calls as well as messages to emergency contact list of that specific user when the phone gets shake. No such applications provide all the functionalities for safety at a time that includes our live tracking features which will help you to track the location of beloved ones. Object detection like knife, gun and person is not provided in other applications.

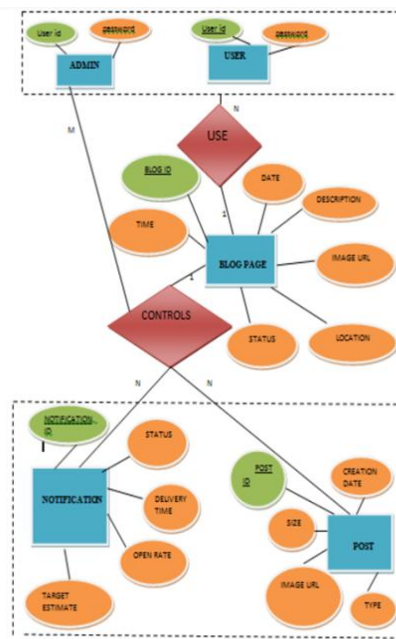### C. Existing system modeling

Fig. 1. Entity relationship diagram

D. Problem definition

As of today, the reporting system in the country is must be reported personally. The concern citizen must go to the nearest police station to report a crime or incident or the person need to call the nearest police station for faster action of the authority.

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As a result, the possibility of neglecting of reporting the crime by the concern citizen is enormous.

The citizen neglect to report incidents to less hassle and because of unknowledgeable in law. The authorities also lack in spreading the police station hotline in communities, most of the people in the community don't know the nearest police station hotline. The police station must have cell phone number hotline for the complainant that is only using promo loads. Some of complainants are not familiar with the place and didn't know where the police station is.

So, the main motto of our project is:

"Your safety in your hands".

E. Requirement specification

1) Functional

The software automatically validates the users by their Aadhar Number.

The software application should be properly integrated with person and gun detection API

Sign-up and register page

Logging with Aadhar and verification

Phone number verification

Allow access to the GPS

Crime rate prediction of a particular area.

2) User interfaces

This section provides a detailed description of all inputs into and outputs from the system. It also gives a description of the hardware, software and communication interfaces and provides basic prototypes of the user interface. A first-time user of the mobile application should see the log-in page when he/she opens the application, if the user has not registered, he/she should be able to do that on the log-in page. If the user is not a first-time user, he/she should be able to see the story page directly when the application is opened here the user chooses the type of story he wants to see. Every user should have a profile page where they can edit their e-mail address, phone number and password.

3) Non-Functional

Scalability

- Application should support increasing number of users.
- Application should support adding new functionalities and features

Reliability

- The application shall be completely operational all the time.
- Down time after a failure shall not exceed certain hours and users should get notified about this.

Usability

- Normal persons should be able to use the app without any instructions
- The users who already knows about the app should able to view and locate to functionalities within few seconds

Performance

- The application should be able to support X simultaneous users.

- The application should work in online as well as offline mode simultaneously.

Security

- The user's data should remain private.
- Only the concern users should login.

Supportability

- The application should be able to accommodate new functionalities.
- Application should support all the operations and readiness needs throughout the life-cycle of an app at an affordable cost.

3. Proposed System

A. Proposed solution

Our system tends to provide security to each and every citizen. The main motto of our system is "Your safety in your hands". So our system is the combination of different domains such as Image Processing, Machine Learning and Android/iOS development. These different domains are put together in a single mobile application using different APIs (Application Programming Interface). And the mobile application is developed using Flutter. We chose Flutter; since Flutter is a cross platform development technology, and we can deploy our application on Android and iOS mobile phones. The mobile application is for the citizens, which they can use whenever required. We have different features in our mobile application such as:

1) Shake your mobile

This acts like an emergency signal. When a person is in difficulty and want to inform someone, the user can directly shake his/her mobile and the notification will be sent to your emergency contact number, which we will be receiving from the user, at the time of registration in the application. Basically, user have to input different details and an emergency contact number, while registering into the application.

2) Sharing live location and tracking

When the user will shake the mobile, a notification with the payload as latitude and longitude, will be sent to the emergency contact number, such that the person who is added as the emergency contact, will be able to get the location of that user and can track the location of the person who is in difficulty.

3) Crime Prediction at current location or any other location, too

The user who is using our application, can watch the location he is walking on, is safe for him or not, which means that using Machine Learning, we are retrieving the user's location and predicting the number of crimes happen on that particular road, and giving the user real-time scenario, using Google Maps, that the particular location is safe for him or not.

Apart from current location, user can also search for any location he wants, that whether the entered location is safe for someone or not.

4) Register the crime report

Users can report a certain crime through our app, which will be directly reported to the cops.

5) Weapon detection

This feature is done using Image Processing, the image or the video captured through the app, can detect the weapons and thus, a person can report that captured image or the video to the cop.

6) View past reports

Users can see the earlier reports.

7) Chat-bot for support

Users can, if they want support or how to use the application, ask the chat-bot for help.

Apart from mobile application, we have developed a website for the cops. The features of the website are:

1. *Login:* Cops can register and login into the website.
2. *View Crime reports:* The reports submitted by the users can be viewed into this website.
3. *Send important notification:* Cops can send important notifications to the users.

B. Crime Intensity prediction

Under this title, we would be explaining how we built the prediction algorithm to predict a safe percentage by considering different factors. Crimes are common social issues which affect the quality of life and economic growth of person and community. In those days, how to deal with crime is one of the hot problems.

Thus, it is necessary to study the factors and relations between different crimes and to find a way to accurately predict and avoid these crimes. We will try to predict the safe percentage of a user based on historical crime-related data. We have designed an algorithm to solve the mentioned problem. We have adopted machine learning and data science technology to get the solution.

We tried to obtain all possible interesting expected patterns based on the crime variables. We applied some classification model to get the result. Next part will explain designing of this algorithm. So this algorithm consists of three stages:

1. Pre-processing stage
2. Processing stage
3. Post-processing stage

1) Pre-processing stage

This is the first and very important step in the machine learning algorithm. In this stage, we primarily remove unwanted, irrelevant and redundant information. Apart from this, we are trying to get clean, useful data or information by omitting of unreliable and noisy data. This stage includes cleaning, normalization, integration, transformation, feature extraction etc. This stage may effect on final accuracy of the algorithm. The final product of this stage is training data.

C. Merging of data

We have used Toronto dataset to examination the algorithm. There are datasets which are related to crime:

1. *Crime dataset:* The shape of this data is (206436, 29) means 206436 number of rows and 29 columns. Columns are index, event_unique_id, occurance_date, reported date. Premise type, offence, occurrence day of year, occurrence day of week, occurrence hour etc. This is data of all crimes like break and enters, assault, Robbery etc.

2. *Homicide data:* This data consists of thousands of rows and 13 columns. Data is about homicide crimes like shooting. As we are dealing with crime, we have to merge the both mentioned data on some common columns. Thus we have got merged data and we can use this data in the next steps.

D. Data-cleaning

Merged data is not complete data, there are some missing values in some columns. If we don't properly deal with these missing values, it would affect the accuracy badly. So we removed these values. In the occurance_year column, we got some outliers so we considered the data between 2014 and 2019 besides, we did not found any noisy or inconsistent values.

1) Data modelling/encoding/transformation

From the above step, we got data which clean and clear. In machine learning, we deal with numerical values but in clean data, we got columns who have an object data type. So label encoding and factorization method are used to convert this object into a numerical value. Once this is done, we have changed some column name to avoid the naming collisions and confusion. We have saved the mapping of object data and its corresponding numerical value in the text file for future prediction.

We transformed some data to get a better result. We have done with some groups in the occurance_hour column and occurance_date column

2) Feature extraction

Once we got clean, numerical, transformed and encoded data, we were standing on the edge of feature extraction. We extracted the feature which could be used in the prediction model. Thus we reduced the data. We prepared three different CSV file/data file by considering the different features. This data file used in different prediction section and we applied some techniques to get the final prediction.

3) Data preparation: We have prepared mainly three kinds of the data file

1. *Crime type:* This data file is nothing but the clean data which we got from the above step. We renamed that data-file to crime type. There are columns like latitude, longitude etc. are the independent columns and offence type is the dependent column or target column.
2. *Crime prediction:* we prepared this file by process of up sampling. This file would play an important role in crime yes-no prediction. Primarily the crime type data file is the collection of crimes with detailed information. So we up sampled the data using one our methodology and we succeeded to insert that crime-free data. Thus crime prediction data file has a target column of crime including value 0 and 1.
   Crime-0: This for crime-free information
   Crime-1: information of crime happened.
3. Crime neigh: This data file is prepared to get neighboring information and from this data, we predicted crime intensity by observing the neighboring values.

Crime neigh data file consist of the columns like longitude, latitude, crime type etc.

4) Processing stage

In Processing Stage, the generated event combinations will be analyzed to produce possible configuration. The system decides the most suitable combination with the help of previous data. Therefore producing the set of locations with the set of possible events. This stage also considered as Data Analysis stage.

We conducted some statistical or graphical analysis to know the relationship between attribute, dependency, trend and most important thing how this feature contributes to the prediction. To get a better understanding we have created different graphs. These graphs clearly show how crime varies with the respect to a specific variable/attribute.
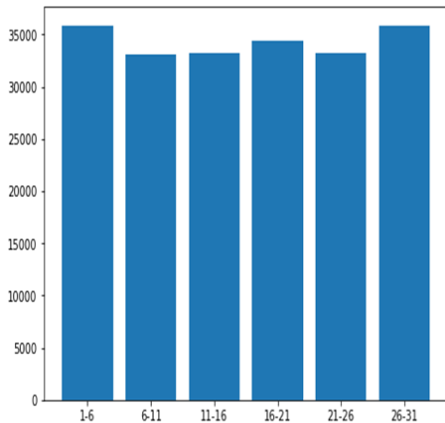

Fig. 2. Bar-plot (crime numbers vs. occurrence day). Data varying with respect to occurrence date of crime which gives idea that large number of crime happened at the starting of month and at ending of month. (x-axis: occurrence day of month, y-axis: Number of crimes)
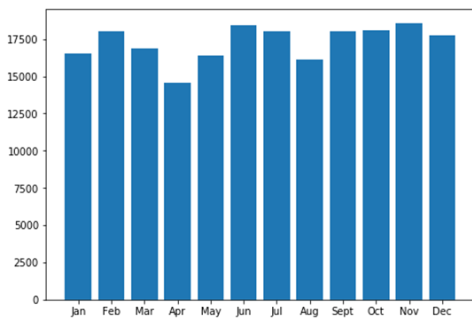

Fig. 3. Bar-plot (crime numbers vs. month): Number of crimes in different months (between 2014 to 2019 Toronto data). (x-axis: occurrence month, y-axis: Number of crimes)
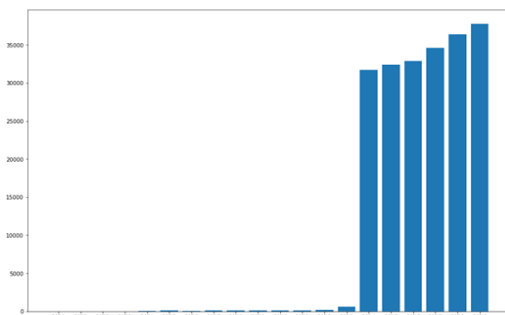

Fig. 4. Bar-plot (with respect to year) crime committed variation from 2000 to 2019 Toronto data. (x-axis: occurrence year, y-axis: Number of crimes)
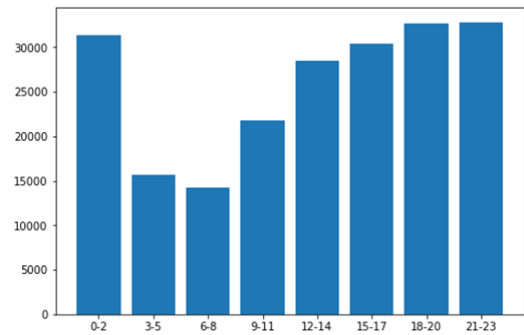

Fig. 5. Bar-plot (hour vs. crime numbers): Graphical representation of how occurrence hour related to number of crimes.

Apart from this we conducted and analyzed information with the help of group function etc. and transformed in standard form using some standard techniques like a min-max scalar, standard transformation. We got clarity by observing the data information like min value, max value, standard deviation etc.

5) Post-processing stage

In the Post-processing Stage the set of events are filtered into interesting and important events. In this stage, we ran different algorithms for classification like naive Bayes, Random forest and other. Depending on the confusion matrices and accuracy we decided the correct algorithm.

1. *Step-1:* We found the weather crime would occur or not with help of crime prediction data file and random forest classification algorithm. We got an accuracy of 95+% .we calculated this accuracy by splitting data in to train and test .Another factor which contributed in the accuracy section is confusion matrices.

2. *Step-2:* If the prediction of the above step is zero then that area would be a safe area.

    Else: We calculated the crime intensity or safe percentage depending on the following factor:

    Step 2.1: We calculated the type of crime on the bases of input which includes location, latitude, longitude, neighborhood, time, day and other attributes. So here we assigned the weights to the crime with the help of FBI document and other crime reports (written by a higher authority). From here we got one prediction. We predicted type of crime and here we got accuracy of 70+%.That is pretty fine results.

    Step 2.2: With the help of crime neigh we calculated data points which are in r(r is a suitable number) km radius and from that data point we were trying to build probabilistic function of top n (here we have taken n=3) result. Let's top 3 special count be x1,x2,x3 and associate weights are w1,w2,w3..With the help of this formula we calculated the prediction:

    prediction_neighbour=
    $$((x1*w1)+(x2*w2)+(x3*w3))/((x1+x2+x3)*10) \quad (1)$$
    Special count x1 can be defined as ratio crime count of top crime within that radius to crime count of top crime in complete data.x1,x2,x3 are the part of probability function which satisfies below rule if we have six type of crime.

x1+x2+x3+x4+x5+x6=1   (2)

Note: we have taken 10 in the denominator because weights which we have assigned are out of 10

Step 2.3: we calculated the crime threat in the current year with the help of historical data and regression.

Step 2.4: we would return the final threat prediction by considering the above three predictions. We took the average of step 2.1 and step 2.2 then considering the 2.3 predictions we got the result.

Once done with the final accuracy, Flask plays crucial role to transport this accuracy to Flutter app.

6) Detection and recognition

As Human visual system is fast and accurate, it can detect different objects in the image and can be easily recognized. Object detection techniques inspired by the human visual system.

Object detection/recognition is one of the important research topics along with wide applications and still challenging stuff in the field of computer vision. There are many machine learning algorithms and deep learning algorithms for object detection and recognition such as support vector machine, Convolution neural network, R-CNNs, YOLO(You only look once) etc. Among the different algorithms we had chosen YOLO methodology as it has comparatively more advantages listed below:

1. Process frames at the rate of 45 fps (larger network) to 150 fps (smaller network) which is better than real-time.
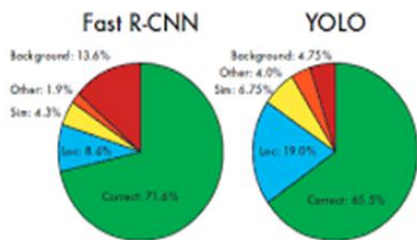2. The network is able to generalize the image better.

Fig. 6. YOLO performance

Table 1
Architecture of YOLO

*	Type	Filters	Size	Output
	Convolution	32	3*3	256*256
	Convolution	64	3*3/2	
1X	Convolution	32	1*1	128*128
	Convolution Residual	64	3*3	
	Convolution	128	3*3/2	64*64
2X	Convolution	64	1*1	64*64
	Convolution Residual	128	3*3	
	Convolution	256	3*3/2	32*32
8X	Convolution	128	1*1	32*32
	Convolution Residual	256	3*3	
	Convolution	512	3*3/2	16*16
8X	Convolution	256	1*1	16*16
	Convolution Residual	512	3*3	
	Convolution	1024	3*3/2	8*8
4X	Convolution	512	1*1	8*8
	Convolution Residual	1024	3*3	
	Avgpool	Global		
	Connected SoftMax	1000		

YOLO uses convolution neural network algorithm for detection. It has been trained on coco dataset for 80 classes including humans or person. It treats this problem as a regression problem. YOLO take input and scan the entire image and it divides up the image into a grid of 13 by 13 cells. Each of these cells is capable of predicting 5 bounding boxes. These boxes describe the rectangle that encloses an object. It uses a single convolutional layer which performs only once which makes it faster. YOLO architecture helps in the multi-labelled classification task. It also outputs a confidence score that informs us how accurate it is that the predicted bounding box actually encloses some object. Primarily This network divides the image into regions and predicts bounding boxes and probabilities for each region. This is working of YOLO and this is why YOLO is faster than other detection algorithms.

1. *Step 1:* We have collected the data from different sources like google images, online dataset etc. All these images were in the raw format so we were converted into an informative image. Once got those images we labelled those images and inserted into a labelled folder like a knife, gun etc. We had decided to train the model with custom train methodology of YOLO. For this methodology, we need the dataset with YOLO suitable annotations. YOLO annotations were created manually by dragging bounding boxes over the weapon. We have used some online tools and some standard git repository to get the proper annotations. Thus we created a clean, clear dataset with proper YOLO suitable annotations.

2. *Step-2:* We trained the model for weapon detection considering custom train YOLO methodology. We prepared configuration file with the proper value of batch size, epochs, subdivision, steps, etc. for training purpose along with object file which includes the labels and image location. Pre-trained weights help your custom object detector to be way more accurate and not have to train as long. We used Google-Cola GPU for training purpose. Thus we completed this training phase in lesser time.

3. *Step-3:* Testing and visualization were done with the help of the OpenCV library. As we were more interested to detect weapon and person, we used YOLO weights for detecting the person and custom YOLO weight (which we obtained from training phase) for detecting the weapons. Then we connected this detecting stuff with the Flutter app with the help of API which was designed with the help of FLASK technology.

E. Technology Justification

We have used different library for machine learning and computer vision some of them are listed below:

1. Numpy, pandas, matplotlib, collections, math. Random, statistics, bisect and other: For pre-processing data or cleaning data
2. Sklearn: For prediction, accuracy, train-test split, normalization etc.
3. Keras: For Neural network prediction

4. Joblib: For saving and retrieving data.
5. Json, Flask, and request, Open CV: for API
6. flutter_shake_plugin: A Flutter plugin to detect shaking of phone and support for vibration.
7. Geolocator: This plugin provides easy access to platform specific location services. Flutter plugin which provides geocoding features for forward and reverse geocoding.
8. Google_maps_flutter: This plugin is used to integrate Google Maps.
9. Sensors: This plugin is used to access Android and iOS accelerometer and gyroscope sensors.
10. Shared preferences: This plugin is used for reading and writing key-value pairs.
11. Background location: This plugin is used to get location updates in the background.
12. SMS_maintained: SMS library which allows to send, receive, query sms messages, sms delivery and query contacts info.
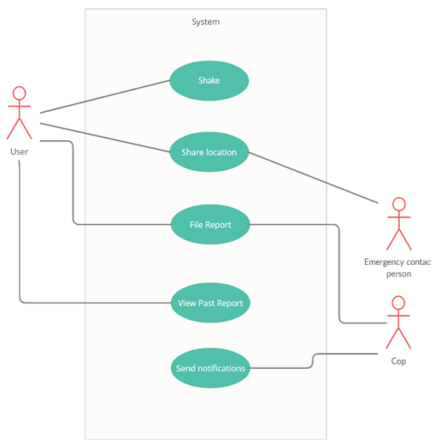
F. Design Modeling and Test Cases

Fig. 7. Use case

G. Estimation

1) Resources required

　Hardware: No hardware required apart from cell phones.
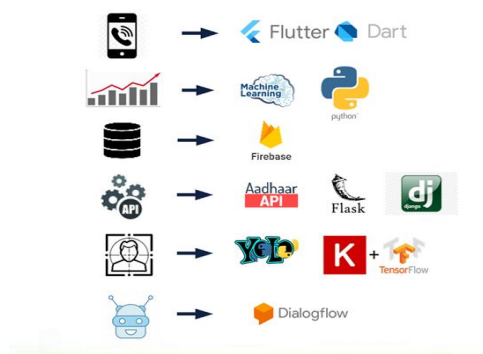
2) Software

Fig. 8. Technologies used

H. Firebase

Firebase is a product designed and developed by Goggle

which helps you build, improve and grow your app. backend components are fully managed and maintained by Google. Client SDKs provided by Firebase interact with these backend services directly, with no need to establish any middleware between your app and the service. Firebase considers as scalable, reliable, fault tolerance etc. It provides many fully managed services like real time-database, FCM, etc.
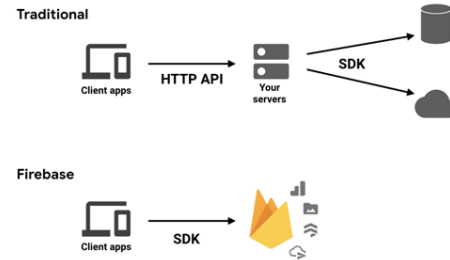

Fig. 8. Traditional approach vs modern approach.

This technology and platform is primarily used to analyze data along with the prediction of crime rate and safe percentage. Free GPU offered by Google colab help us to get a proper train model in less time. Python libraries like pandas, NumPy plays a crucial role in pre-processing stage and processing stage. Skit learn is the leader in the post-processing stage .apart from this many libraries helped in-store data, model etc.

1) API

This is the smooth bridge between python server and flutter client. With the help of Flask technology, we made API which acts as good middleware. Flask is a micro framework for Python developers based on Werkzeug (WSGI toolkit) and Jinja 2 (template engine). Flask is easy to use, simple, fast, minimal setup. Lightweight, extensive documentation, secure cookies etc. Government ADHAAR API is used in the login module of flutter to avoid anonymous user.

2) YOLO (You only look once)

This is used in the detection and recognition module. As it has excellent architecture, YOLO performs far better than other deep learning detection algorithms. We can use pre-trained weights to detect the object (object should present in coco name file).

3) Dialog flow

Dialog flow is designed and developed by Google team to perform NLP task with ease specially designed for a chat bot with many inbuilt services. Basically, it lets you make Digital Programs that interact with end-users through natural languages. Therefore, you could even say that Dialog flow enables the creation of Conversational User Experience Platforms

4) Flutter and Dart

Flutter is Google's open-source UI Software development toolkit, used to develop cross platform applications, and is used to develop applications for Android, iOS, Linux, Mac, Windows from a single codebase. Flutter uses Dart, which is an object-oriented, fast language features like isolates, generics, and optional static types. Another special aspect of Dart is that it can use Just-In-Time compilation.

5) HTML

Hypertext Markup Language (HTML) is the markup language for designing documents to be displayed in a web browser.

6) W3CSS

W3CSS is a modern CSS framework with built-in responsiveness. It supports responsive mobile first design by default, and it is smaller and faster than similar CSS frameworks.

7) JavaScript

JavaScript is a text-based programming language used both on the client-side and server-side that allows you to make web pages interactive. Where HTML and CSS are languages that give structure and style to web pages, JavaScript gives web pages interactive elements that engage a user.

4. Conclusion and Future Scope

In this project we have overcome the problem of communication gap between the user and the police and as well user can instantly report any crime with the picture and we are also using object detection algorithms to detect the object in the image that will help police to categories the crime evidence. We are using Aadhar number for login, so if anyone report any fake crime, police can track him. With our crime prediction API user can check the crime rate of his or her current location based of previous crime and take precautions according to that. With our live tracking feature user can share his or her live location with anyone and the other person can track the location from our application .Our application will give many feature with which user can ensure his or her safety.

A. Future work

1. In future, we can display user how many users have reported crime from their area, so they will be alerted for the crime.
2. We will try to add face extraction algorithm so that cops can have faces from the crime scene. In case if we have more users so we will move our database and all the API to Amazon Web services.
3. This we can further modify prediction algorithm by considering different parameters like population density etc.
4. Further Web platform can be modified into smart web platform which can help to cop in the management, crime hotspot-operation, night-patrolling scheduling, extracting crucial information from surveillance cameras with the help of new technologies like machine learning, computer vision etc.
5. We can add other services to overcome the threat in moving objects like car, bus etc. In the future, we can design smart web portal in such way that portal can monitor the criminal movements (like phone tapping, phone current location etc.).

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