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Implementation of Garbage Litter Detection using Image Processing with Novel Perspective of Software Development

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Abstract: ***The rising issue with garbage disposal has made people realize the importance of waste management. The challenge is to make people aware of how harmful the household or a general waste can be if not disposed of properly. Garbage can be harmful to our health as well as our social well-being. We must adhere to keeping our surroundings clean, even in the rising times of the coronavirus pandemic for our personal as well as social hygiene. This lack of awareness has become the bottleneck for the solution of waste management. People's well-being is also supported by waste disposal units, which aid in their disease-free status. This review paper will throw light on our proposed system which we have designed and developed to monitor anyone who throws the trash outside the allotted area, using image processing, facial recognition, and object detection techniques. All the techniques are integrated in such a way that the offender will get penalized and will not commit the same again due to the fine amount. We have also incorporated e-challan generation for the offender to pay a nominal fee for the offense if caught under surveillance. This project aims at the cleanliness and sanitation of the nation to accelerate the efforts to achieve universal sanitation. The surveillance of communal dustbins by our system will increase sanity and prevent the trash from exposing in public areas.***

Keywords: Image Preprocessing, Face Recognition, Image Processing, Object Detection, Garbage Tracking, E-Challan prosecution, Feature Extraction, Garbage litter detection

I. INTRODUCTION

A healthier workforce is more productive and happier. Throwing waste all over the place would make our air filthy and pollute the atmosphere making it very unhygienic. Litter is any type of trash that is thrown in small amounts, particularly in places where it does not belong. Correlation between the presence of litter in a given region and the deliberate throwing of litter in that same area. Currently, many cities have adopted different strategies and made great strides to improve their cleanliness. For example, New York City used a Scorecard inspection program to assess the cleanliness of the city. To ensure proper management of this garbage we came with the idea of Garbage Litter Detector which will be in function in and around society and at respective public places where risk is high.

Face detection has been a hot subject in the field of computer vision in recent years. Face recognition is commonly used in a wide range of applications, including social media, law enforcement, secure online payments, offender tracking, precise biometrics, and many others[12].

Face detection and recognition has been a common subject in biometrics for many decades because it is the best method of identifying individuals because it does not require human cooperation. This is referred to as a landmark moment because many techniques for identification and recognition have been established. Face recognition from photos or videos is a hot topic in biometrics research.

Surveillance cameras for video recording are common in public places, and these cameras have significant security value. Face-based authentication has two distinct advantages over other biometrics: uniqueness and acceptance. Face detection is a difficult problem in computer vision because the human face is a complex entity with a high degree of variability in appearance. Face recognition has gotten a lot of attention in recent years from both the scientific community and the industry.

Face detection algorithms and drugs have been extensively developed over the last few decades. Several well-known algorithms are discussed. The efficiency of the camera, the distance between the person and the camera, lighting conditions, and whether or not the person looks at the camera, among other factors, determine the quality of an image. Pre-processing the captured image can improve recognition results in these cases[18].

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Various image processing techniques can be used to improve the captured image and thus increase the ecognition rate. Image normalization, de-nosing, filtering, histogram equalization, image resizing and cropping, and accurate face detection are some techniques for improving image quality and recognition rates. An image must be pre-processed before it can be used to extract features. The chances of correct recognition are determined by the quality of the image captured[18].

Face recognition involves extracting a face from a large image and pre-processing it to satisfy the requirements of the feature extraction technique being used. Several feature extraction methods have been employed, with the majority of them concentrating on structural or geometric features[12].

The process of identifying a single object from a complex image with multiple lines and shapes is known as object detection. Object detection is used in face recognition, object tracking, image retrieval, and automatic parking systems. Thrown object detection is primarily of interest in video monitoring and sports video research[2].

Throwing trash near the trash can is very common in many areas. To deal with litter throwers and take appropriate action against them. The challan will be sent to the violator via SMS, and the challan will then be available for payment on the consumer side of the site. When the challan is issued, it is sent via mail with a descriptive paragraph, which is a time-consuming process that takes a long time from issue to delivery[13].

II. LITERATURE SURVEY

There are concretes previously identified with the picture processing philosophies, the path for picture acquisition, its stockpiling, and recovery. Other than this, there are numerous cases where individuals have produced E-challans based on utilizing Artificial Intelligence(A)I. Numerous individuals accompanied thoughts of discovery of pictures and consolidating them all and utilizing the best of them this task is proposed. In picture preprocessing the info, the shading picture is changed over into a dim picture. Utilizing reasonable editing (face recognition) conspires, the picture is trimmed and afterward resized to meet the prerequisite. The picture is then standardized to have a uniform power/dim level. The picture is then sifted utilizing a low pass channel. Object detection is normally completed by inspecting each aspect of a photograph to isolate parts whose photometric or mathematical properties match those of the objective item in the preparation information base. Applications for object discovery got a ton of notoriety and still a ton to cover in this field, because of its immense examination reach. Correlation of different item discovery calculations, for example, Faster R-CNN, SSD, and YOLOv3[11] with key attributes, for example, speed, time, and precision. Item recognition utilizing convolutional profound neural organization and provincial-based convolution organization. This strategy expands the precision and diminishes the time needed to finish the program. The dataset utilized is PASCAL VOC[2] which contains 20 marks. Convolutional Neural Networks are utilized to distinguish objects in nature. Two cutting-edge models are analyzed article location, Single Shot Multibox Detector with MobileNetVI and a quicker district-based convolutional neural organization. Article following in video observation is a significant part of PC vision and example acknowledgment. The regular design of characterization comprises three primary advances: Motion division, object following, and order. In complex situations, some of the time just one sort of highlight may not give adequate data of the picture information, which brings about at least two highlights to be extricated. The greater part of the shading object following calculations uses the HSI shade of The article and is powerful to lightning varieties.

YOLO (You Only Look Once) ongoing object detection algorithm is one of the best object detection algorithms that envelops a considerable lot of the most creative thoughts emerging from the PC vision research network helping for object recognition which is one of the old style issues in PC vision where you work to perceive what and where — explicitly what objects are inside a given picture and where they are in the picture.

YOLO accomplishes high exactness while likewise having the option to run continuous applications. Crossover of Darknet-19 and novel lingering network is utilized in YOLOv3[14] for include extraction which is referred to as Darknet-53 as it comprises 53 convolutional layers.

Object detection is a key feature of advanced driver assistance systems (ADAS), which enable vehicles to recognise driving paths and perform person-on-foot discovery to improve street safety. Object detection is useful in applications as well, for example, video observation or picture recovery frameworks. SURF is the most well-known and broadly utilized component based calculation for object discovery and following. SURF utilizes Hessian-framework estimation for intrigue point discovery which performs well as far as precision[8]. SURF recognizes mass like structure at areas with the most extreme estimation of determinant. For decreasing the computational intricacy indispensable pictures are utilized. The computational time for SURF is free of the size of the picture. SURF calculation functions admirably in various lighting conditions, static and moving articles, turn, scaling, impediment and intersection.

Face recognition includes recognizing a face from a picture utilizing total (picture based methodology) or by identifying at least one highlight from the picture (Feature based methodology, for example, nose, eyes, lips and so forth. Face recognition should likewise be possible dependent on dynamic shape models, for example, finding head limits. Contributions to manufacture a choice tree are the highlights acquired from the element extraction strategies, entropy[15], mean and standard deviation of pixel force estimations of information pictures alongside marks of relating pictures. Face recognition includes restriction of face from an enormous picture followed by preprocessing it to suit the necessities of the component extraction strategy to be utilized[12]. Different component extraction approaches have been utilized the vast majority of which center around auxiliary or mathematical highlights. Face-based ID's real advantages over other biometrics are its uniqueness and recognition. Because the human face is a powerful article with a significant amount of changeability in its appearance, face discovery is a difficult problem in PC vision. Public places as a rule do have reconnaissance cameras previously introduced in a large portion of the spots. PCA and LDA classifiers think about worldwide highlights though LBP and Gagor classifier consider neighborhood highlights Factor Analysis created the best outcomes with all the classifiers tried against. 100% exactness was accomplished with Neural Network, Support Vector Machine and Naive Bayes. Decision Tree delivered a practically ideal outcome with 99.17%[12] exactness. This shows Factor Analysis all alone is the best technique appropriate for ordering facial pictures. Thus, Factor Analysis is the most reasonable dimensionality decrease procedure which most intently speaks to Human face. Factor Analysis has the best exhibition as far as exactness, it is the slowest among different procedures utilized aside from Neural Network. Be that as it may, the distinction being minuscule doesn't influence the general powerful presentation.

An observational assessment of a picture stockpiling framework utilizing Caffe profound learning frameworks to prepare different neural organization models utilizing distinctive datasets. Close to this is recovery of the information by stacking it in LevelDB, log organized capacity instrument utilizing combined tree and LMDB[16]which is key worth stockpiling utilizing clusters and is B+trees. The key-esteem stockpiling is multiple times quicker than the capacity components utilizing N number of datasets in it. Adaptable in nature and peruse and compose is much quicker than the customary segment line stockpiling framework. Since, it represents no invalid worth choice so exact moment size pictures could likewise be put away without any problem.

For multiple times quicker read tasks of colossal squares of pictures or any item caught we utilize the direct octave joined with the LMDB stockpiling perspective. It changes over the 3D picture into 2D structure[5] for profound screening of internal and external focuses. This is considered as a choice tree framework. Choice trees require less exertion for information arrangement during preprocessing. Alongside it, doesn't need information scaling. On the off chance that any qualities get missed, there is no issue in handling the information. When the offense has been watched, the facial acknowledgment framework will check the right certainty score from the highlights information base and concentrate the mail id and different subtleties of the waste litter and charge fine. This proposed framework can undoubtedly be actualized and efficient to keep up.

III.BACKGROUND

Millions of metric tons of garbage is generated each day at a global scale which results in a very high amount of solid waste exposed in the open areas followed by highly unprocessed open solid waste causing severe pollution to the environment and nations. The cleanliness of urban streets has a significant effect on the environment and public health of the community. Conventional methods of street cleaning include street sweepers going to several spots and manually checking if the street needs to be swept. This technique however, involves numerous manual operations to detect and evaluate the cleanliness of the street, contributing to a high cost for cities.

A. The Major Reasons Of Exposed Garbage On Public Area Are As Follows

1) Residents of the city dump waste or trash anywhere depending on their convenience.
2) The debris from hotels, buildings, industries and societies dump the trash on streets.
3) Stray animals spill the garbage from the dustbin on streets.

B. Causes of Exposed Trash to the Environment

1) Pathogens Thrive from the Garbage

a) Domestic organic waste poses an existential threat because it ferments, providing ideal conditions for microbial pathogen survival and development.
b) Direct interaction with solid waste can cause a number of infectious and chronic diseases, including garbage workers and waste collectors being especially vulnerable.

2) Respiratory Diseases Caused By Air Pollution Due To Overflowing Garbage

a) Food poisoning is caused by the release of household garbage into the atmosphere, which may cause illness by direct exposure.

b) Contaminants are absorbed from the lungs into other areas of the body, causing negative health effects. Carbon dioxide, nitrous oxide, and methane are among the hazardous compounds present in waste-contaminated air.

c) Bad odours, which are commonly caused by decomposing and liquid waste products, pollute the air.

3) Contamination of Natural Water Sources

a) Garbage and liquid waste that end up in bodies of water have a detrimental effect on the water's chemical composition.

b) It has an effect on all marine species, including fish and other animals that drink contaminated water. Batteries, electronic devices, and leftover paints are among the most hazardous household waste materials for surface waters.

4) Overflowing Wasted Exposed to Health Risk

a) Infections, chronic illnesses, and injuries are all threats that waste collection employees face when cleaning up and treating overflowing garbage.

b) Regular engagement with waste can lead to skin and immune disorders from contaminated wounds, as well as a variety of illnesses from the bites of animals consuming the waste and abdominal infections from flies eating the waste.

5) Futile Solid Waste Management By Municipal

a) Inefficiently run incineration plants pollute the environment and poorly maintained and built landfill sites produce a number of disease-carrying insects and pests.

b) A stinky city with poor sanitation and litter all over does not attract visitors or investments. Cities continue to lose money, as well as the income and jobs that come from proper waste management and recycling.

The development and application of sanitary measures for the sake of cleanliness, protecting health which would reduce the severity and impact of malnutrition; promoting dignity and boosting safety.

IV. DESIGN

There could be many designs that could be made for the project, but the most efficient design which has approximately the most accurate results and in the most correct way is as follows:-

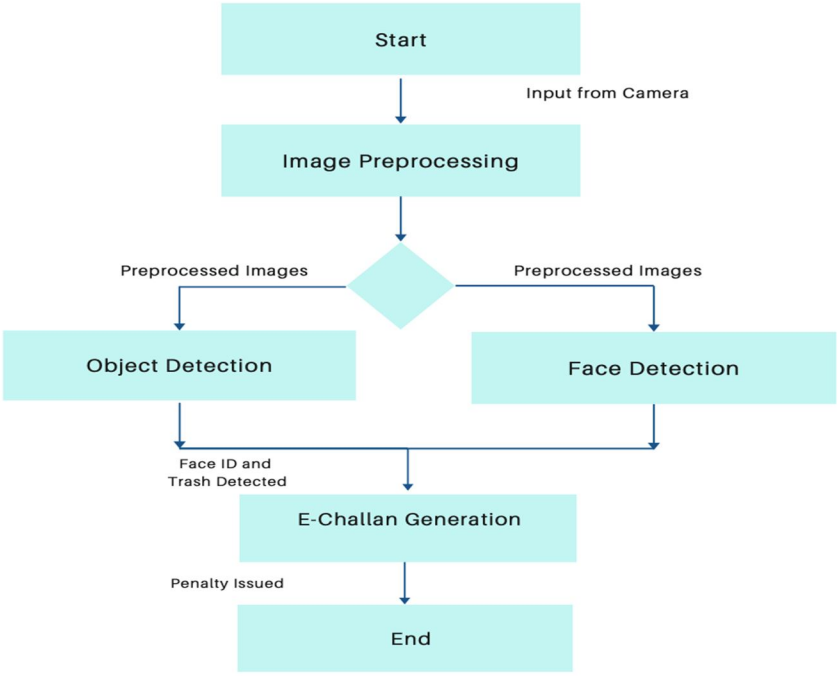

FIG.1: Flowchart of the Entire System

The design phase of the project begins with the image preprocessing portion, which converts the input colour image to a grayscale image. Using appropriate cropping schemes, the image is cropped and resized to meet the specifications. After that, the image is normalised to have a consistent intensity/gray level. The image is then passed through a low pass filter.

Now the filtered image or preprocessed image is passed through the object detection and face detection component. For face detection, we use the Deep Dense Face Detector, which employs a single model based on a deep convolutional network. In the Local Environment, There Are Binary Patterns, The histograms method, precision, recall, and F-measure are the parameters used to evaluate the algorithm's performance.

Face recognition involves identifying the face from a large image accompanied by pre-processing it according to the specifications of the technique of extraction of the feature to be used. Different feature extraction techniques have been used mainly focusing on structural or geometric features[12].

In the object detection component we use Tensorflow as a computer vision technique. It helps us in detecting, locating, and tracing an object from an image or a video. The special attribute about object detection is that it identifies the class of object (i.e, dustbin and trash near to the dustbin) and its location-specific coordinates in the preprocessed image. TThe ability to locate the object inside an image defines the performance of the algorithm used for detection.

After that the automated E-challan generation system works with existing citizens databases by using facial vectors and providing the offenders with sufficient monitoring on the trash box or public dustbins online interface for paying fines. The E-challan system assists offenders in allowing payment by means of the connexion transmitted to their email ID or mobile phone to meet the fine requirements[13].

Detecting and tracking sanitation, hygiene, and cleanliness violations has been a difficult process, despite tremendous automation in the detection and issuance of challans in respect of sanitation, hygiene, and cleanliness violations using facial and garbage detection systems.

V. METHODOLOGY

We studied various concepts and methods in order to find the best suite solution for the problem statement. From defining the camera needed to which database to use to which algorithm for the whole system to run. In any such kind of project it is must that the placement of requirements are as per the need and concept should be fulfilled to achieve the solution. For our project we had different methods crossed from our mind and studied each method in depth. The suitable methodology that we made for the project is:

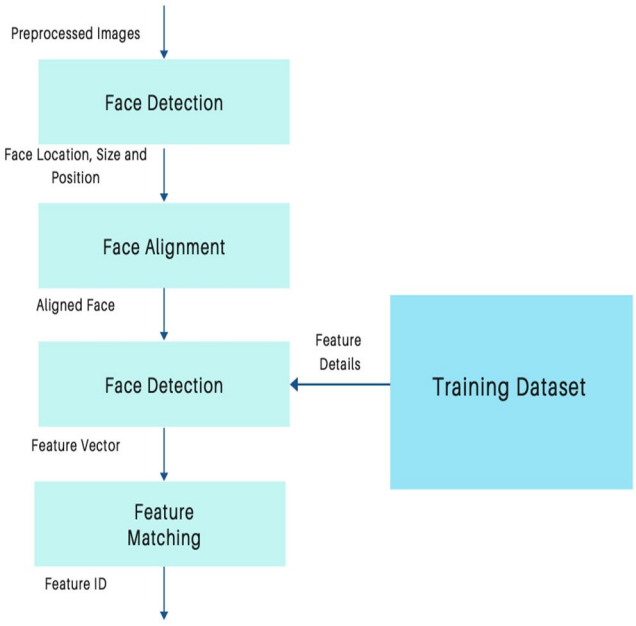

FIG.3: Flowchart of Facial Recognition

FIG.2: Flowchart of Image PreProcessing

A. Image Processing

The basic pre-processing methodology is as follows:

1) Cropping images can be done using a variety of face detection techniques. Face detection can also be done with active shape models, such as locating the head boundary.

2) With the nearest neighbour interpolation method and a specified output size, the image generated by various face detection schemes was resized.

3) The distribution of intensity/grey levels is not uniform. To make these levels equal or nearly equal, we use the histogram equalisation technique.

4) Images often have Gaussian noise by default due to lighting variations. To filter out high-frequency data and keep only low-frequency data, we used a Low Pass Filter (LPF)[18].

B. Face Recognition

The basic facial recognition methodology follows as below:

1) Locating one or more faces in the image with a mark or a bounding box using multi-view face detection using convolutional neural networks.

2) Normalization of the face is done by extracting useful attributes from already trained weights using convolutional neural extractor to check for the consistency with the database such as geometry and photometrics.

3) The convolutional neural network[9] extracts features from the face to use it for recognition and match it against the pretrained database.

C. Object Detection

Computer vision techniques such as image recognition, object detection, image generation, image super-resolution, and others are among them. Object detection has many uses, including face recognition, vehicle detection, pedestrian counting, online videos, surveillance cameras, and self-driving vehicles. Among the highly accurate object detection algorithms and methods used in this project are R-CNN+MTT together making MRCNN[17] as the major library. Using these deep learning-related methods and algorithms, which are also focused on machine learning, requires a comprehensive understanding of mathematics as well as deep learning systems such as TensorFlow, OpenCV, image-ai etc. Each object in an image can be detected by placing it in one of the highlighted rectangular boxes, identifying it, and assigning it a tag. This includes the accuracy of each object identification method.

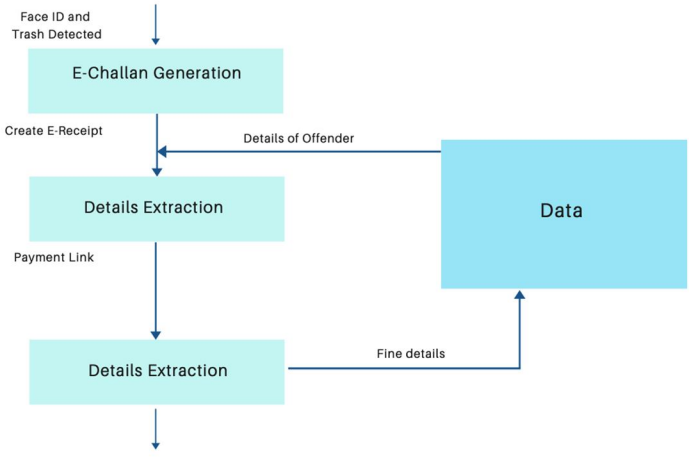

FIG.4: Flowchart of Object Detection

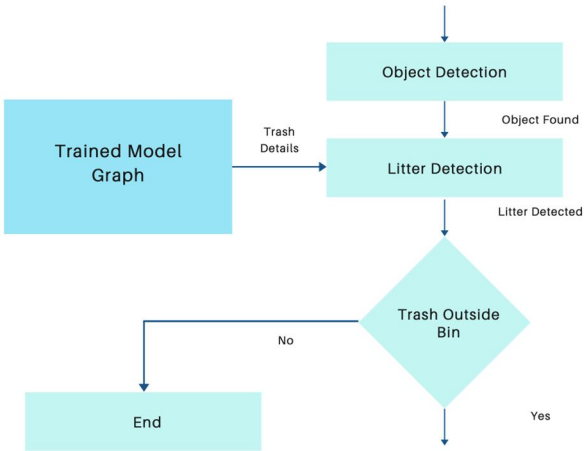

FIG.5: Flowchart of E Challan Generation

D. E-challan Generation

The basic E-challan methodology follows as below:

1) The facial recognition system will check the correct trust score pretrained database, once the offence has been identified.

2) The e-challan generation will be generated at the server's end, a link will be generated using an API[13], this link will then be sent to the offender on their extracted email ID from the pretrained database.

3) The offender will be required to pay the fine online, in order to avoid legal hassles in the future.

VI. IMPLEMENTATION

A. Camera Setup and Motion Detection

The camera will be set up and positioned as shown in the figure. The two cameras will be positioned at a high level, facing the dustbin and its surroundings. When there is a motion change, the camera will activate and capture the frames into a date time folder, which can then be analyzed by the person sitting behind the camera. The person in charge of the camera will locate a clear frame of the action and send it directly to the main system. The frame will be further examined by this system.

B. Face Recognition

After getting the command, the pre-processed image is fed to face detection tracking block, face location, size and position is then calculated and fed to face alignment feature extraction block. The feature details are then examined against the trained model and training image dataset of facial features in order to match the features and then generate the feature ID.

C. Litter Detection

The system takes an input that is captured by the camera setup near to the dustbin. In this scenario the system detects only the dustbin and the trash around it. Loading the graph and using tensor, the image captured will be passed in the graph and according to the dimensions passed, the image will be processed to meet the criteria. The image will then classified into clean and not clean and the prediction score will predict between a scale of "0" and "1"

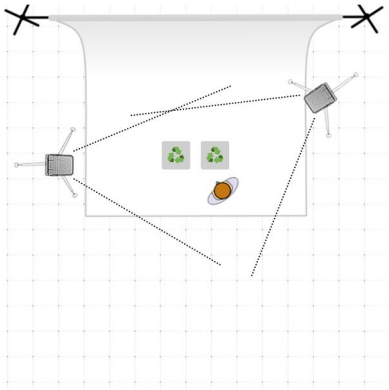

FIG.6: Camera Setup Preview

D. E-Mail Challan

The facial ID and the resulting score from the litter detection system will be the input and the base data that we have created for the E-Challan contains the unique id, name, email address and contact number. The Email and Mobile Number will be used to send a message with payment link for the fine to the offender. A mail will be sent to the offender stating that he/she was suspected with throwing off the litter outside the bin. The offender will be allowed to pay online on the website or UPI.

VII. CONCLUSION AND FUTURE SCOPE

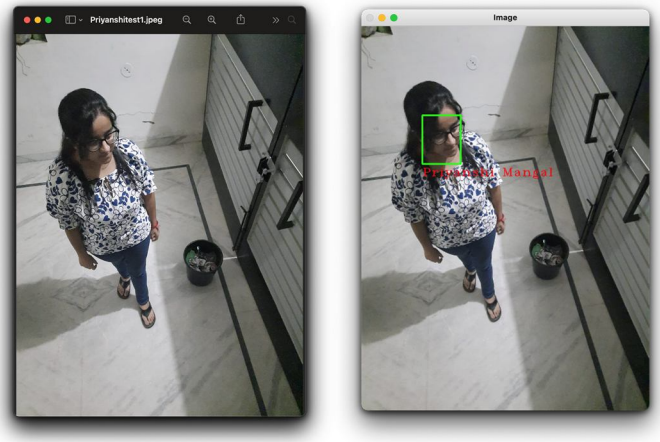

FIG.7: Testing & Facial Analysis of Priyanshi on Integrated System

This paper has proposed an improved way of waste management and disposal to keep the environment clean and to accelerate the efforts of sanitation awareness of the nation. The proposed system monitors the offender using image processing, Facial recognition which has been designed using convolutional neural networks acts as a good feature extractor. Image denoising has been taken care of using deep convolutional neural networks. Our system was incorporates the monitoring of litter detection using cameras, using the remote information by cameras to detect and estimate high calculation motion algorithms for better labelling and monitoring. In order to reduce this problem of trash management we have also taken care of e-challan generation to make the offender pay online, to get the offender acknowledged of the offence. Hence, the accuracy obtained for the object detection system is 68.18% whereas accuracy obtained for the entire system is 74.19%. As future scope, new features will be added to the system before we get it to working condition into small organisations and societies. This system is cost effective and can be accessed from anywhere.

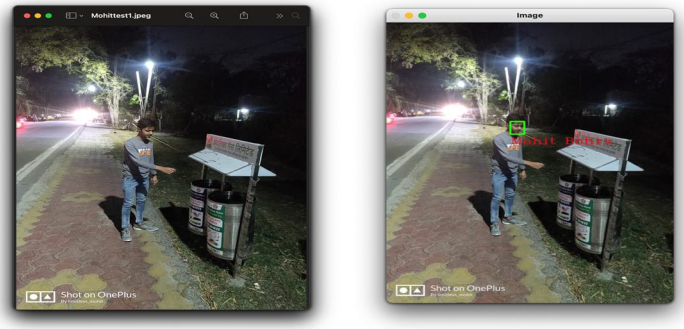

FIG.8: Testing & Facial Result of Mohit on Full System

We want to create an Android app that allows people to quickly locate two things using their phones: the location of the nearest bin and whether it is full or empty. We also hope to put everything on the cloud so that anyone in the world can check on the status of the bins and the constrained area is no longer an issue.

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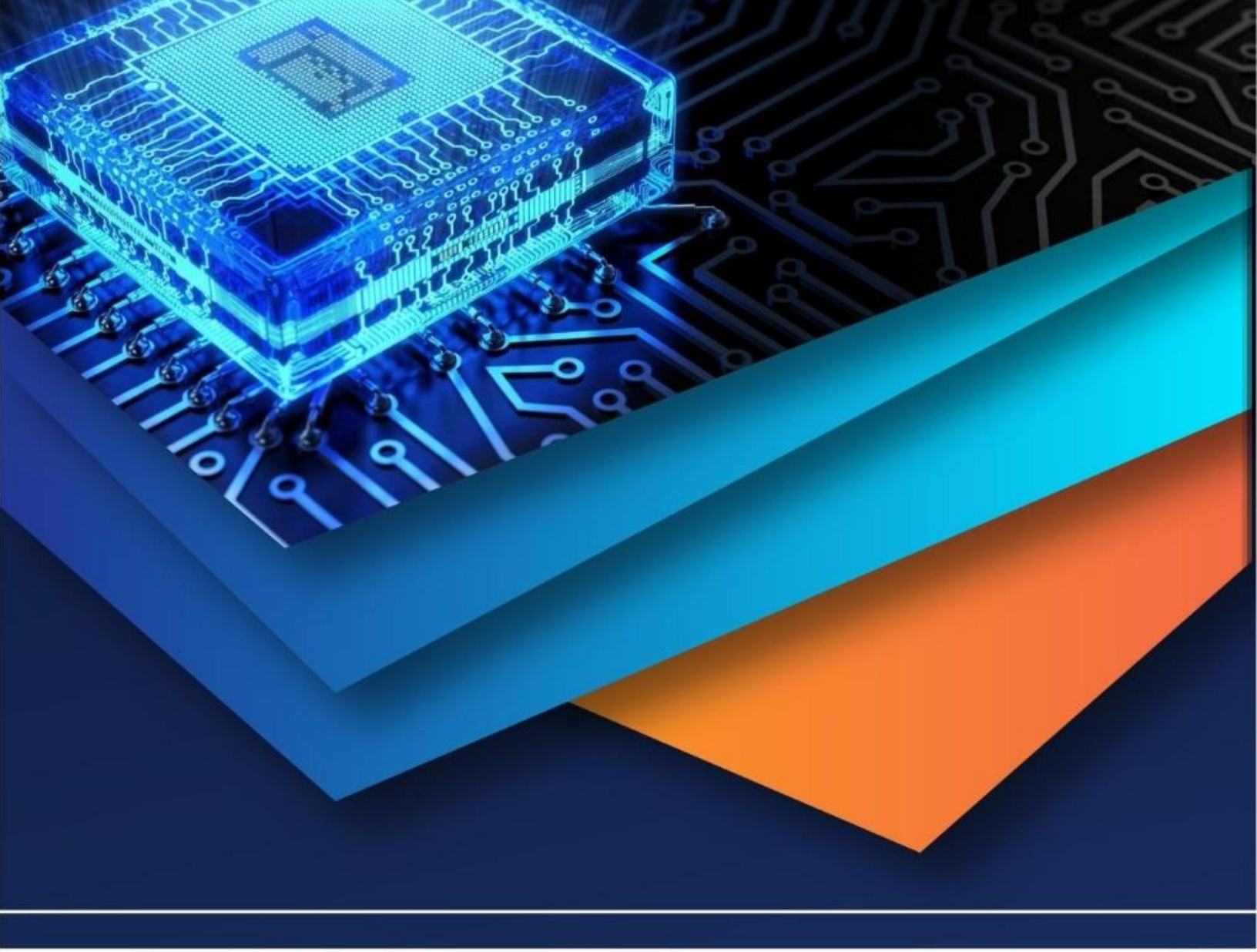

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