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Targeted Billboard Advertisements

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Abstract

Billboards are the source of advertisement from last few years and used to promote newly items available for sale. Traditionally, an advertisement from the pool of ads is randomly selected and displayed on the billboard without the intention of who is in the surrounding. If we could sense information from the surrounding and predict the type of visitors (i.e. men or women, young or old) present in the surrounding, we can display the ads relevant to them and improve the sales remarkably. But this is not possible to select an ad every time with man power, luckily with the advancement in artificial intelligence and machine learning it is possible to build a system which can identify character standing in front of it. Computers can be train to identify and classify a specific person. Cameras can record video; from this video persons will be identified. Once the person is identified, we can classify him/her as male or female by providing his face to computer. By further processing person's age will be predicted and all information will be sent to the server. From this point onwards regular procedure will be followed but instead of random our provided information will be used to select appropriate ad. As a result, sales will rise exponentially because every time an ad will be according to the person's characteristics. Also, the software will give far more financial benefits comparative to its development cost because a well-developed software will require only one person to handle all operations.

Chapter 1: Introduction

Targeted Billboards Advertisements System executes an innovative idea of displaying advertisements on billboards by gathering information from its surroundings and displaying advertisements accordingly. This system takes images from the front of the billboard and classifies the subject standing in front of it as male or female. After recognizing the gender of the subject, the system computes the age of the subject. Based on these two factors, the system displays the advertisement most suited to that pair of gender and age.

1.1 Goals and Objectives

To develop a prototype that will facilitate both the company who is advertising and visitors by detecting and identifying the gender and age group with digital image taken by cameras located and different locations in shopping mall.

- The system should be able to detect visitor's gender with 90%-95% accuracy.
- The system should be able to classify the visitor as child, young or old.
- Develop a system, which show ads according to age and gender.
- Build a system that will be user friendly with a GUI that will serve as an access to the functionalities of the system.
- Utilize machine and deep learning techniques to predict genders and age groups with the help of some conventional computer vision techniques.

1.2 Scope of the Project

- **System Requirements**

The system will be able to perform the following main functions:

  - Upload advertisements in local database
  - Label advertisements with age and gender
  - Set priority of each advertisement
  - Request an advertisement to be displayed at billboard
  - Detect the face of human in a given image frame
  - Classify the face image as male or female based on the facial features
  - Compute the age of human based on the facial features

- **Process Requirements**

The advertisements will be stored in a local database with labels of age and gender. A server will be connected with all the billboards installed at let's say, malls. The cameras installed at the billboards will capture images, age and gender classification will be performed by the hardware (Raspberry Pi) placed at each billboard. The information of age and gender will be sent to the server. The server will reply with an appropriate advertisement according to information of age and gender it received.

- **Limitations**

This system will not be able to classify the advertisements suitable for specific gender and age group. This system assumes that all the advertisements are pre labeled with age group and gender.

Chapter 2: Literature Survey / Related Work

2.1 Gender Classification

Over the period of time, gender classification has become an active area of research with the huge development in Artificial Intelligence and Machine Learning. Gender classification is part of face recognition that has found its applications in many fields such as; monitoring, surveillance, commercial profiling and targeted advertisements. Because of its high demand application, many researchers have put effort in gender recognition field however, there are still vast gaps in gender recognition.

2.1.1 A comparative analysis of gender classification techniques

Gender classification usually follows three basic steps: pre-processing, feature extraction and classification. Pre-processing involves, illumination and face detection. Feature extraction comes after pre-processing where geometric based features and appearance based features are extracted. And finally the image is classified as Male or Female. Ali et al. [1] has done a comparative analysis of gender classification techniques. Geometric based feature extraction is a technique in which facial features such as; eyes, nose, cheeks etc. are extracted. These features are passed to the classifier to determine the gender. Appearance-Based Feature Extraction extracts the whole face part instead of facial points. Gait-Based Gender Classification classifies gender on the basis of human walking, running etc.

2.1.2 Analysis of Multi-modal Biometrics System for Gender Classification Using Face, Iris and Fingerprint Images

Grouping through mixture plan of iris, face and specific mark is proposed [2]. The proposed strategy intertwined MB-LBP and BSIF with SVM classifier. The proposed strategy yielded precision of 99.8% as seemed in Figure 1.

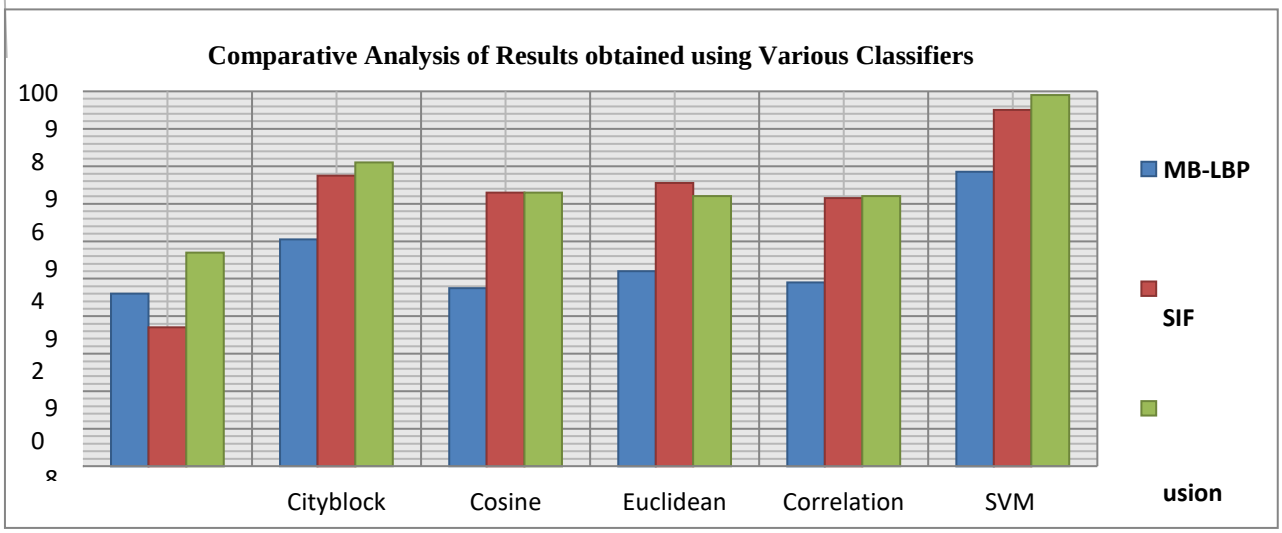

Figure 1: Comparative Analysis of Results Obtained Using Various Classifiers

The figure clearly shows the results with 99.8% accuracy with fusion of MB-LBP and BSIF with SVM classifier [2]

2.1.3 Age and Gender Classification through Face Segmentation

Framework for gender classification through face segmentation is implemented [3]. CRFs was trained based totally division model via bodily named face pictures. The CRFs model turned into utilized to fragment face into six classes in particular; hair, eyes, nose, mouth, pores and skin and back.

Afterwards, the PCS was used and probability maps were created for all six classes. The procedure uses face segmentation followed by gender classification. To estimate the various parts segmentation CRFs was used. The image was segmented in super-pixels. And each pixel was assigned probability of segment class.

After face segmentation, gender classification is performed using proposed GC- CRFs- as shown in Figure 2.

Algorithm 1 Proposed GC-CRFs algorithm

Input: training data: $\boldsymbol{I}_{train} = \{(P_n, Q_n)\}_{n=1}^{m}$, $\boldsymbol{I}_{test}$.

where the model $\mathfrak{A}$ is trained through $\boldsymbol{I}_{train}$ and evaluated through $\boldsymbol{I}_{test}$. The symbol P represents the input training image and $Q(i,j) \in \{1,2,3,4,5,6\}$ the ground truth manually annotated image.

a: Face segmentation model $\mathfrak{A}$:

Step a.1: Training a CRFs based model $\mathfrak{A}$ through training data.

Step a.2: Dividing each testing image intro super-pixels and finding the center of each super-pixel. Creating a bounding box/patch around the central pixel and passing the patch to the model $\mathfrak{A}$

Step a.3: Using the PBS and generating probability maps for all six classes, represented as:

Pb_{skin}, Pb_{mouth}, Pb_{eyes}, Pb_{nose}, Pb_{hair}, and Pb_{back}.

b. Gender classification part:

Creating a feature vector from each face image such that:

$$f = \mathrm{Pb}_{skin} + \mathrm{Pb}_{eyes} + \mathrm{Pb}_{nose} + \mathrm{Pb}_{hair}.$$

c. Training an RDF classifier for gender classification

Output: Predicted gender

Figure 2: Proposed GC-CRFs algorithm

GC-CRF takes training data as input. The algorithm segments face image into six classes, namely: hair, skin, mouth, eyes and nose [3]

CRFs based model was initial step. This model sections a face image into the most possible category (hair, eyes, nose, moth, skin and back) for every super-pixel. Each super-pixel comprised of some pixels that done an analogous magnificence mark from the ready version. PCS became applied and likelihood maps are created for every category in an exceedingly face pic. We tend to visit these chance maps as Pbnose, Pbback, Pbeyes, Pbskin, Pbmouth, and Pbhair. Some pix from the FEI dataset and its division outcomes with probability maps as regarded.

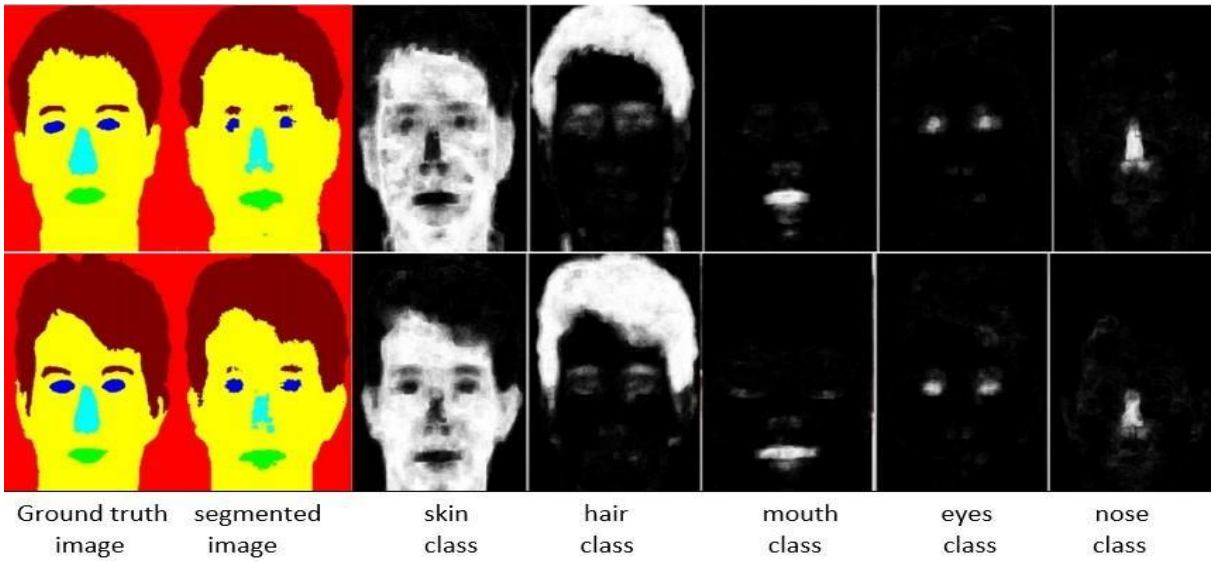

Figure 3 Images segmented with the proposed MSFS-CRFs
The figure shows the faces segmented using MSFS-CRFs into six classes. The eyes, mouth, nose, hair and skin are segmented. These segmented classes are color coded. [3]

Geometric Based Feature Extraction approach is affected by complex background. All the techniques mentioned fail in real time data [1]. These techniques cannot yield Better results in classification phase when brightness is week or hue concentration is low. These techniques showed less accuracy rate for recognition. However, Gender classification using face images attain more importance. Other than six classes of face segments [2]; the model provided very useful information for various natural hidden variables in a face image for gender classification. These variables could potentially provide information towards more complicated facial analysis other than recognizing gender such as; facial expression, ethnicity region etc. This information could provide a detailed knowledge about the subject that could help in narrowing down ads. Moreover, the performance could be increased by using Convolutional Neural Networks.

2.2 Face Detection

2.2.1 S3FD: Single Shot Scale-invariant Face Detector:

This paper gives an ordinary face discoverer, which plays superiorly on top notch sizes of faces with a single significant neural framework, especially for little faces. The makers endeavor to take care of the essential trouble that stay basically based discoverers rot impressively in light of the fact that the things develop to be smaller. They work on the going with 3 points:

- Proposing a scale-impartial face notoriety structure to manage splendid sizes of faces well. The remaining parts are tiled on an immense extent of layers to verify that all sizes of faces have adequate proposed indistinguishable charge stretch norm.
- Improving the remember cost of little faces with the manual of a scale repayment hook organizing system.
- Reducing the counterfeit top notch pace of little faces through a greatest out premise mark. Thus, our methodology achieves marvelous at school region execution on all the conventional face recognizable proof benchmarks, which envelop the AFW, PASCAL face, FDDB and WIDER FACE datasets, and might run at 36 FPS.

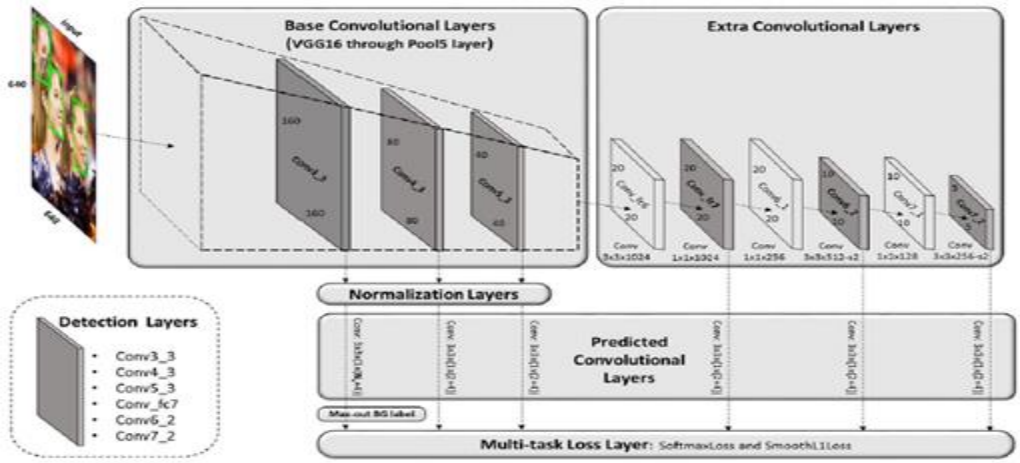

Figure 4: Architecture of single shot scale invariant face detector

The algorithm begins with a large convolutional layer and gradually decreases in size while the number of channels increase. The Predicted Convolutional Layers play a role in computing loss for optimization. [4]

Table 1: the comparative and ablative results of the model on wider face validation subset

S3FD's accuracy as compared to other older versions of S3FD's algorithms and state-of-the-art algorithms. [4]

mAP(%) Subsets / Methods	Easy	Medium	Hard
RPN-face	91.0	88.2	73.7
SSD-face	92.1	89.5	71.6
$S^3FD(F)$	92.6	91.6	82.3
$S^3FD(F+S)$	93.5	92.0	84.5
$S^3FD(F+S+M)$	**93.7**	**92.4**	**85.2**

2.2.2 Face-MagNet: Magnifying Feature Maps to Detect Small Faces:

In this paper, the authors introduce the Face scientific instrument Network (Face-MageNet), a face detector based mostly completely at the Faster-RCNN framework that allows the accompany the flow of discriminative facts of tiny scale faces to the classifier with none skip or residual connections.

The paper proposes to create larger the detail maps of the additional profound layers in an exceedingly discriminative means with the intention that the issue AP dreams before the RPN, classifier, and also the regressor increments. consequently, the RPN covers a denser matrix on the first image that permits in presenting littler bouncing boxes. to boot, the RoI pooling layer catches additional data for littler boxes. within the primary structure, conv − five of VGG16 encompasses a step of sixteen as AN example each location on the issue AP compares to sixteen pixels inside the primary image. A ConvTranspose layer is ready, otherwise called deconvolution, before RoI pooling with piece size of eight and step of 4. on these lines, each place can relate to four pixels of the data image.

Likewise, the creators to boot configuration, train, and assess 3 alternative substantially tuned fashions that talk to the normal answers for the scale issue: putting pooling, skip associations, and scale allocation. each this kind of three systems accomplishes much identical outcomes to slicing edge face indicators. The visible portrayal of the layout is regarded in Figure 5 below.

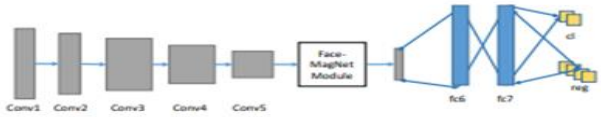

Figure 5 the architecture of the Face-MagNet network
The architecture has 5 Convolutional layers which are fed into the Face-MagNet module. The output, in return is fed into a fully convolutional layer and another one after that. The results are one regression result and the other a classification one. [6]

Table 2: Average Precision on hard partition
Face-MagNet's accuracy as compared to other state-of-the-art algorithms.

Size	600	800	1000	1200	1500	Pyramid	Runtime	FDDB-Runtime
Base-VGG16	0.5002	0.6191	0.7094	0.7501	0.7629	0.7368	0.21s	0.10s
SkipFace-NC	0.7173	0.7657	0.7751	0.7734	0.773	0.7854	0.77s	0.12s
SizeSplit-NC	0.6479	0.7209	0.7577	0.7624	0.7624	0.7779	0.69s	0.21s
Face-MagNet-NC	0.6443	0.7353	0.7833	0.8003	0.7913	0.8170	0.77s	0.10s
Context	0.5983	0.7063	0.7658	0.786	0.794	0.7887	0.25s	0.10s
SkipFace	0.7453	0.7913	0.805	0.8064	0.806	0.8101	1.07s	0.22s
SizeSplit	0.6675	0.7367	0.768	0.7735	0.7733	0.8106	0.88s	0.27s
Face-MagNet	0.7006	0.7791	0.8156	0.82	0.8195	0.847	0.98s	0.11s
CMS-RCNN [27]	0.643	-	-	-	-	-	-	-
HR-VGG16 [7]	-	-	-	-	-	0.745	-	-
HR-ResNet101 [7]	-	-	-	-	-	0.806	-	-
SSH [2] [17]	0.686	0.784	-	0.814	0.810	0.845	-	-

2.2.3 RetinaFace: Single-stage Dense Face Localisation in the Wild:

Summary:

This paper offers a hearty unmarried-degree face indicator, named RetinaFace, that performs pixel-wise face localisation on totally different sizes of appearances by taking favorable circumstances of joint more and more administered and self-regulated multi-task learning. specifically, commitments square measure created within the related to five angles:

- The creators physically clarify five facial milestones at the broader FACE dataset and watch Brobdingnagian improvement in extreme face discovery with the help of this additional outstanding oversight signal.
- The creators more transfer a self-regulated work decoder workplace for foreseeing a pixel-reasonable 3D structure face records in corresponding with the predominant managed branches.
- On the broader FACE extreme check set, RetinaFace beats the country of the work of art traditional accuracy (AP) by ways for 1:1% (coming to AP same to 91:4%).
- On the IJB-C check set, RetinaFace grants realm of the acquirement techniques (ArcFace) to enhance their outcomes in face confirmation (TAR=89:59% for FAR=1e-6).
- By utilizing light-weight spine systems, RetinaFace will run continuous on a solitary electronic equipment center for a VGA-goals image.

The authors use the Multi-task loss function:

$$L = L_{cls}(p_i, p_i^*) + \lambda_1 p_i^* L_{box}(t_i, t_i^*) + \lambda_2 p_i^* L_{pts}(l_i, l_i^*) + \lambda_3 p_i^* L_{pixel}. \quad (1)$$

Where L(cls) is the face classification loss, L(box) is the face box regression loss, L(pts) is the facial landmark regression loss, and the L(pixel) is the dense regression loss

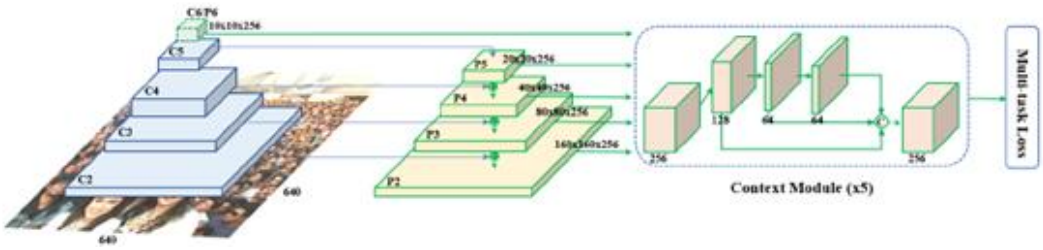

Figure 6 Single stage dense face localization

The architecture has 4 convolutional layers connected respectively with 4 other convolutional layers. The 5th conv. Layer is fed into, along with the 2nd column's 4 conv. Layers into a context module which processes for computing Multi-task loss.[5]

Table 3: Ablation experiments of the proposed methods on WIDER FACE

The algorithm's accuracy as compared to other state-of-the-art detection algorithms.

Method	Easy	Medium	Hard	mAP [33]
FPN+Context	95.532	95.134	90.714	50.842
+DCN	96.349	95.833	91.286	51.522
$+L_{pts}$	96.467	96.075	91.694	52.297
$+L_{pixel}$	96.413	95.864	91.276	51.492
$+L_{pts} + L_{pixel}$	**96.942**	**96.175**	**91.857**	**52.318**

2.3 Age Classification

2.3.1 Age Group Classification of Facial Images Using Rank Based Edge Texture Unit (RETU) and Fuzzy Texture

The classification model used involve seven steps. [7]

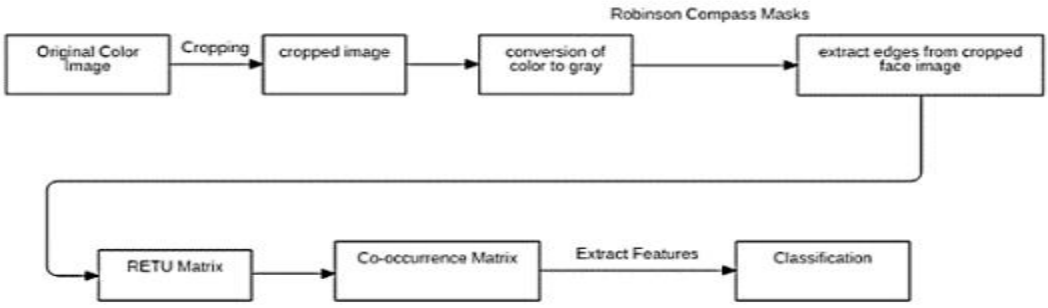

Figure 7: Block diagram of RETU-CM for age classification system

Image shows seven steps which are include in age classification using RETU and fuzzy texture [7]

Initially they convert RGB to HSV (Hue Saturation Value) model and extract the 'h' values of the facial image and the task is to process this 'hue' value to obtain the results. The range of Hue is in the range [0=255]. The process of conversion is as follows,

$$V = \max(R, G, B) \quad (2)$$

$$S = V - \min(R, \mathrm{G}, \mathrm{B})\ V \quad (3)$$

$$H = [G-B]\ 6S\ if\ V = R \quad (4)$$

$$H = 1\ 3 + [B-R]\ 6S\ if\ V = G \quad (5)$$

$$(4)\ H = 1\ 3 + [R-G]\ 6S\ if\ V = B\ (5) \quad (6)$$

Edge Detection uses local edge features as preprocessing step. This method gets information about cropped facial image by using Robinson Compass edge operator and 3*3 matrix is converted into 2*2.

Table 4: A sub image of 3x3 matrix and 2x2 edge matrix

3x3 matrix of image is transformed into 2x2 matrix [7]

P_1	P_2	P_3
P_4	P_5	P_6
P_7	P_8	P_9

$E_0(r_0)$	$E_1(r_1)$
$E_2(r_2)$	$E_3(r_3)$

2×2 edge picture is deteriorated into set of little units is Texture Unit (TU). Arranging the every component in 2×2 edge grid. Sort the components in 2×2 edge lattice (E0(r0) ,E1(r1) ,E2(r2) ,E3(r3)) and dole out position esteems (0, 1, 2 or 3) to arranged components . On the off chance that ,the incentive in 2×2 lattice is same at that point dole out a similar position esteem .After appointing the rank qualities to arranged components we will get the components of TU (R1, R2 ,R3 ,R4).

$$\mathrm{TU} = \sum power\ (4, (k-1)/2) * xi\ 3\ k{=}0\ (\mathrm{i}{=}1, 2, 3, 4) \quad (7)$$

A lot of RETU - CM highlights are removed on picture characterized by Haralick .This technique depicts both factual and auxiliary data of pictures. The highlights utilized in this technique are vitality, entropy, latency, nearby homogeneity, connection and group conceal .They are represented from conditions 7 to 12.

$$\mathrm{Entropy} = \sum -\ln(Pij),\ Pij\ N{-}1\ i, {=}0 \quad (8)$$

$$\mathrm{Energy} = \sum -\ln(Pij)\ N{-}1\ i, j{=}0\ 2 \quad (9)$$

$$\mathrm{Inertia} = \sum Pij\ N{-}1\ i = 0\ (\mathrm{i\text{-}j})\ 2 \quad (10)$$

$$\mathrm{Local\ Homogeneity} = \sum Pij\ 1{+}\ (i{-}j)\ 2\ N{-}1\ i{=}0 \quad (11)$$

$$\mathrm{Correlation} = \sum Pij\ N{-}1\ i{=}\ 0\ (i{-}\mu)(j{-}\mu)\ \sigma\ 2 \quad (12)$$

$$\mathrm{Cluster\ Shade\ (cs)} = \sum (i - Mx + j - My)\ 3 * Pij \quad (13)$$

Fuzzy Texton Algorithm Fuzzy c-means (fcm) is a strategy for bunching which enables one bit of information to have a place with at least two groups. This technique is often utilized in design acknowledgment.

Important: The uniqueness of this method is that it divides the age group into 7 classes i.e. the age groups are 1-10, 11-20, 21-30,31-0,41-50,51-60,>60. With this method, the results cope up to 97.16%

2.3.2 Improving Accuracy in Human Age Classification Using Ensemble Learning Techniques

The systems projected were to look at age victimization countenance [8]. options area unit expelled from four giant areas of appearances and wrinkles on these zones can foresee age. periodic Forest and material classifier area unit outfit along to boost the viability. Pre-getting ready and request the usage of these classifiers autonomously offers a lot of less accuracy once appeared in in a different way in regard to give strategy

2.3.2.1 Random Forest

The discretional forest classifier could be a Meta understudy classifier that features over one person understudy. The understudies (trees) incorporate to outline fitful backwoods that alternatives on a particular outcome. every pick out discretional woodland computation is given equal weight. The portrayal is performed dependent on the foremost extraordinary votes created.

2.3.2.2 Bagging

In company system we have a tendency to apply bootstrap aggregation unremarkably noted with the help of sacking, during which we have a tendency to build fashions. The brought models use a comparative rely with scattered sub trial of the dataset made of the hidden dataset with inspecting strategy. during this sort of reviewing some one in each of a kind half regards ar accessible bigger than as before long as and a few might not be accessible within the model. It depends upon upon the dataset tests needed that's loved n times. within the attendant level we have a tendency to entire the created models via throwing a polling type and averaging frameworks used for the proportional.

2.3.2.3 Feature Extraction

Info snap shots are reduce after normalize in the predefined region of interest. Obvious regions are Forehead, Corner proper final touch of eye, Corner left of entirety of eye and Lower facial structure. The close by twofold version overseer is an govt which delineates the pixel condition by making a bit code from a pixel's same subordinates. The executive is usually used for dull snap shots and strength subordinates. The LBP executive works with eight pals of a pixel, inside pixel regard is taken as edge. The neighbor pixels are differentiated and the estimation of this middle pixel, in case it has a better diminish really worth or same really worth, via then one is given out to that pixel, for the maximum component zero.

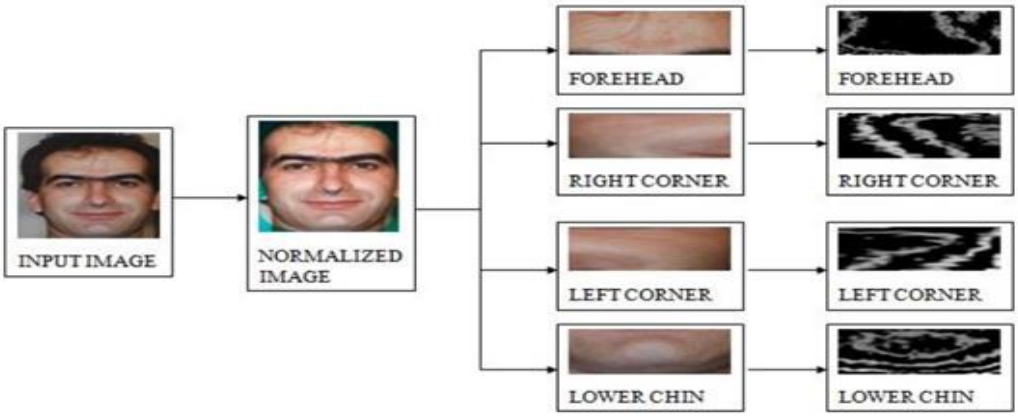

Figure 8: Methodology applied for feature extraction
Figure shows focused part for features extraction [8]

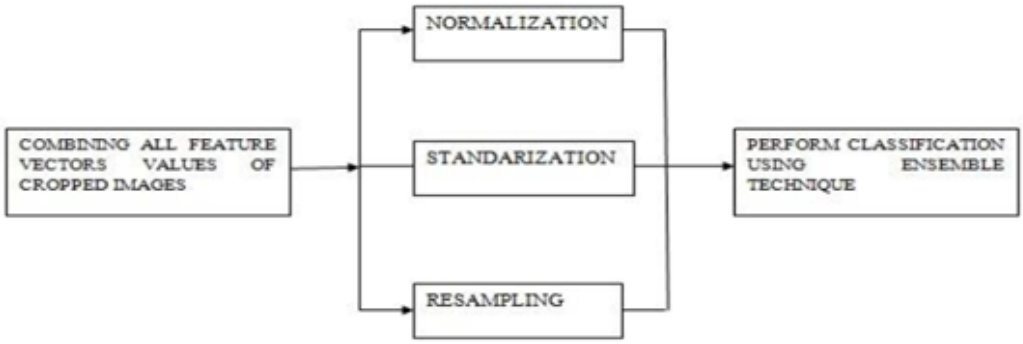

Figure 9: Application of ensemble technique to the feature set values
Steps that are performed before classification [8]

2.3.2.4 Ensemble Technique

It is AI approach during which various base fashions ar joined to accomplish excellent outcomes. The outcome indicates cloth (Random Forest) displays the pleasant altogether presentation measures as contrasted and accuracy of eighty nine.13% for J48 classifier to our technique that offers a preciseness of ninety five you curious about mistreatment applying outfit approach utilizing packing for Random solid ground classifier. The expectation accuracy as a protracted manner as evident electric charge is higher once contrasted with extraordinary specialists.

2.4 Literature Review Summary Table

Table 5: Methods for face detection, gender and age classification
The summary of various methods used for face detection, gender and age classification.in different papers

No.	Name, reference	Study Description	Purpose	Result
1.	A comparative analysis of gender classification techniques, [1]	This paper compares the different techniques used in gender classification	To analyze and compare different methods in gender recognition .	The techniques mentioned cannot yield better results in classification phase when brightness is week or hue concentration is low. However, Gender classification using face images attain more importance
2	Examination of Multi-modular Biometrics System for Gender Classification utilising Face, Iris and Fingerprint Images [2]	feature level fusion is considered to obtain robustness in gender determinatio n	To infer the gender by combining different biometric traits like face, iris, and fingerprints	The combination of MB-LBP and BSIF indicated that this methodology can accomplish better execution to lead sexual orientation order dependent on multimodal biometric framework

3	Automatic Gender Classification through Face Segmentation [3]	Structure is proposed wherein it first quantities a face photograph into face parts, and later on performs programmed sexual orientation order	To predict the gender information based on the six face segments; hair, eyes, nose, mouth, skin and back	The division model offers extraordinarily valuable records to completely different "function hid factors" in a face image. it's contended that this knowledge might deliver a path towards a lot of and a lot of raddled face investigation issues, as an example, sophisticated outward look, quality acknowledgment, and so on.
4	Single shot scale-invariant face detector [4]	Proposes a scale-equitable face detection framework to handle different scales of faces well.	Detect varying scales of faces using a single deep neural network with superior accuracy.	Average accuracy around 90.43 %. Easily rivals state-of-the-art algorithms. Takes time to train and run.
5	RetinaFace [5]	Perform pixel-brilliant face restriction on different	Detect varying scales of faces	The algorithm used in pixel-wise face localization showed 99.8% accuracy

		sizes of appearances through taking endowments of joint extra directed and self-administered multi-task learning		
6	Face-MagNet [6]	Magnify the feature maps of the deeper layers in a discriminative way so that the feature AP resolution before the RPN, classifier, and the regressor increases.	Detect small scale faces without use of any residual or skip connections.	The smaller objects were able to be magnified under mentioned algorithms With 99.6 % accuracy.
7	Age Group Classification of Facial Images Using Rank Based	This paper proposed seven step technique to predict the	To predict the age of the person.	The proposed model produces efficiency of about 97% and classify the age of the person in one out of seven classes.

	Edge Texture Unit (RETU) and Fuzzy Texture [7]	age of person.		
8	Improving Accuracy in Human Age Classification Using Ensemble Learning Techniques [8]	This paper compares single model's efficiency and, than the combined efficiency of two models.	To predict the age of the person.	Combined efficiency of Random Forest and bagging improved to 95% while the individual efficiency was 89%. It classify the person's age correctly most of the time.

Chapter 3: Requirements and Design

3.1 Functional Requirements

The only person who is directly interacting with our system is administrator and all the actions on desktop application will be performed by him.

- **Upload Advertisements**

System must be able to provide a way to upload advertisements at database installed locally.

- **Label Advertisements**

System must be able to provide a way to label each advertisement with age group and gender.

- **Set Priority of Advertisements**

System must be able to provide a way to set the priority to each advertisement on a specific scale.

- **Delete Advertisement**

System must be able to provide a way to delete advertisements at database installed locally.

- **Detect Face**

System must be able to detect human face.

- **Gender Classification**

System must be able to classify a person as a male or female.

- **Age prediction**

System must be able to predict the age of humans in particular interval.

- **Choose Relevant Video**

System must be able to choose video based on the information of age and gender provided.

- **Play Advertisement Video**

System must be to play advertisement video.

- **Graphical Chart of playing ads**

System must be able to produce a bar chart or graph for each advertisement played over the specified amount of time.

- **Recover Password**

System must be able to recover lost password.

- **Authentication**

Whenever a system admin will try to upload or delete an advertisement, he/she will have to pass a authentication protocol.

3.2 Non-Functional Requirements

- **Performance**

The time gap between the start of face detection and the display of the relevant advertisement should be no more than 5-6 seconds.

- **Reliability**

The uptime depends mostly on the place in which the system is situated. It can run all the time given the electricity is sufficiently provided. Loss of data will have minimal chances as backup of the system will be saved on the cloud as well.

- **Security**

System will be able to authenticate the request coming from one of the billboards installed at the Mall.

3.3 Hardware and Software Requirements

Here is the list of hardware and software requirements that will be required to develop and deploy the project.

3.4 Hardware Requirements

- Cameras
- LED/LCD Display
- Raspberry pie
- Ethernet Cables
- GPU/CPU
- Server
- Networking Adapter

3.5 Software Requirements

- Windows OS
- Slack
- Visual Studio Code
- Tensorflow/Pytorch
- Python 3.7(Stable)

3.6 System Architecture

The system is composed of camera, raspberry pi and server. Complete flow of image starting from camera and its processing in the raspberry pi and then getting appropriate video for that person is shown in this architecture diagram.

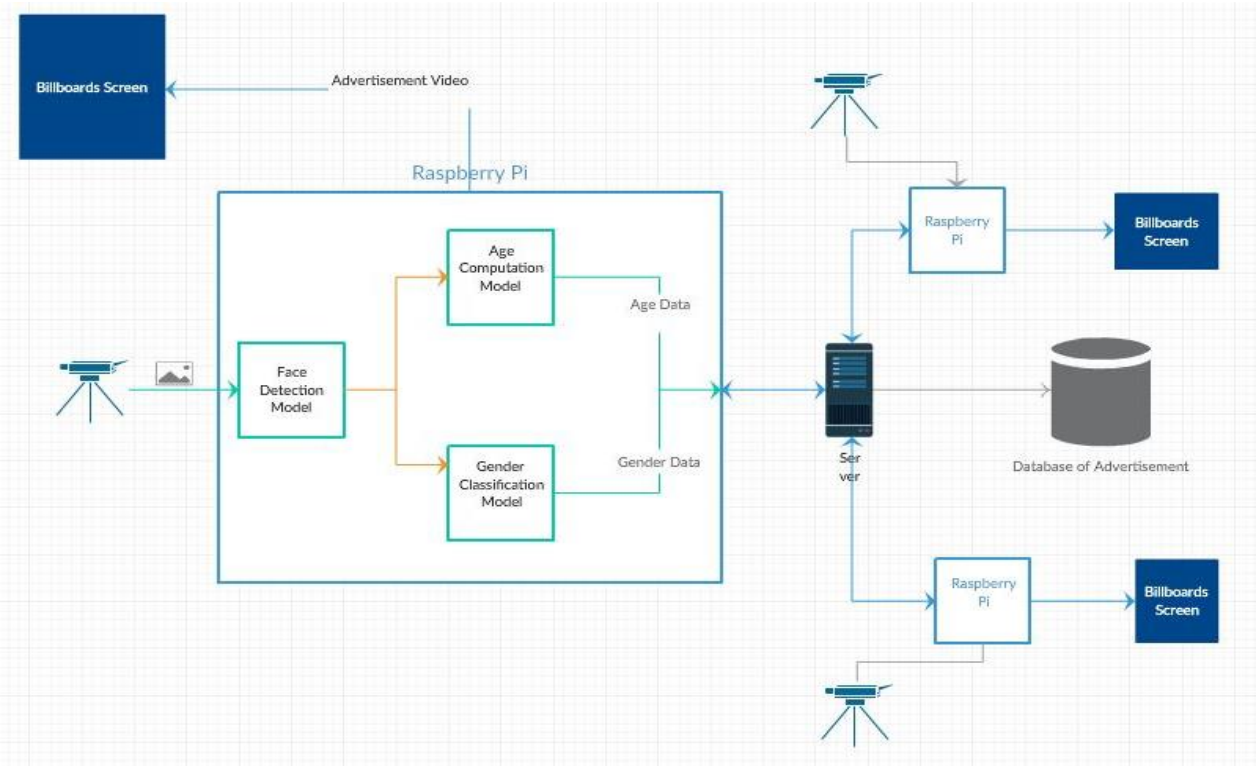

Figure 10: Complete System Architecture

The system architecture shows the integration of different physical modules with each other.

3.7 GUI

Following diagrams explain the interaction of human with the system. Graphical Representation, adding and removing ads and setting ads are shown in the GUI design.

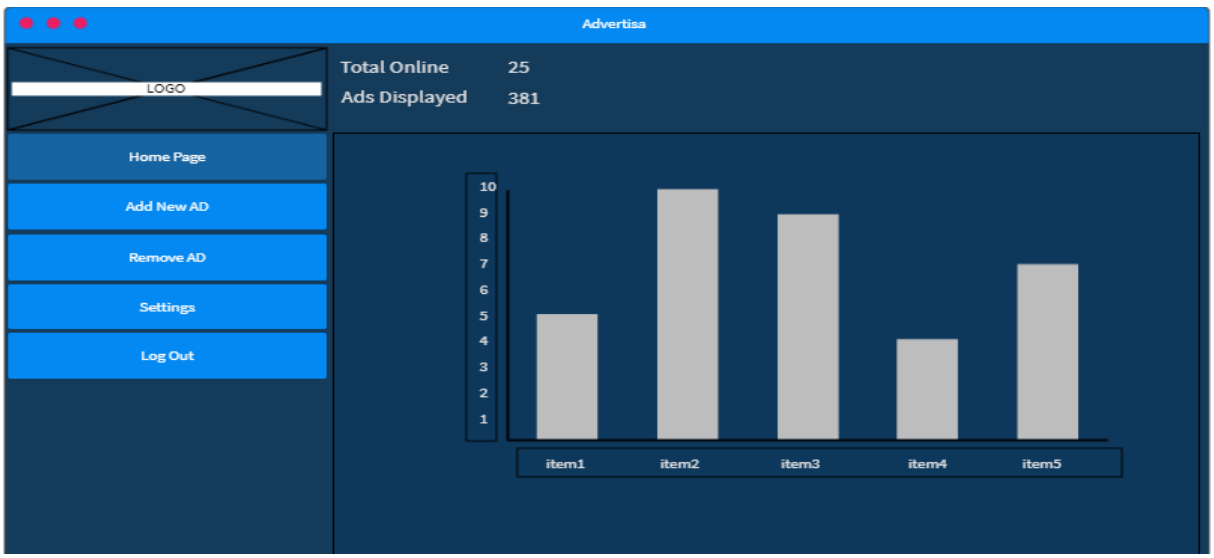

Figure 11: Home Screen of Our System

This screen has basic functionalities to be used by the end user.

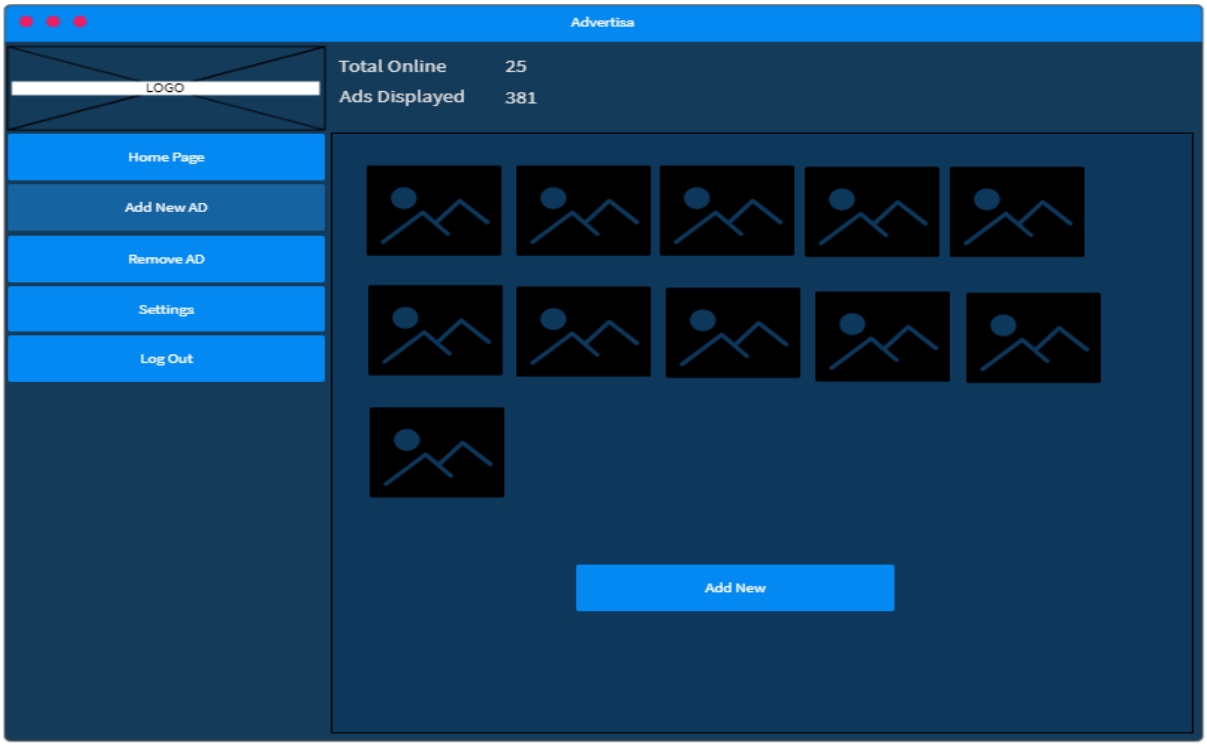

Figure 12: Add new Ad Screen of Our System

This screen shows thumbnails of already uploaded advertisements along with functionality to upload new advertisements.

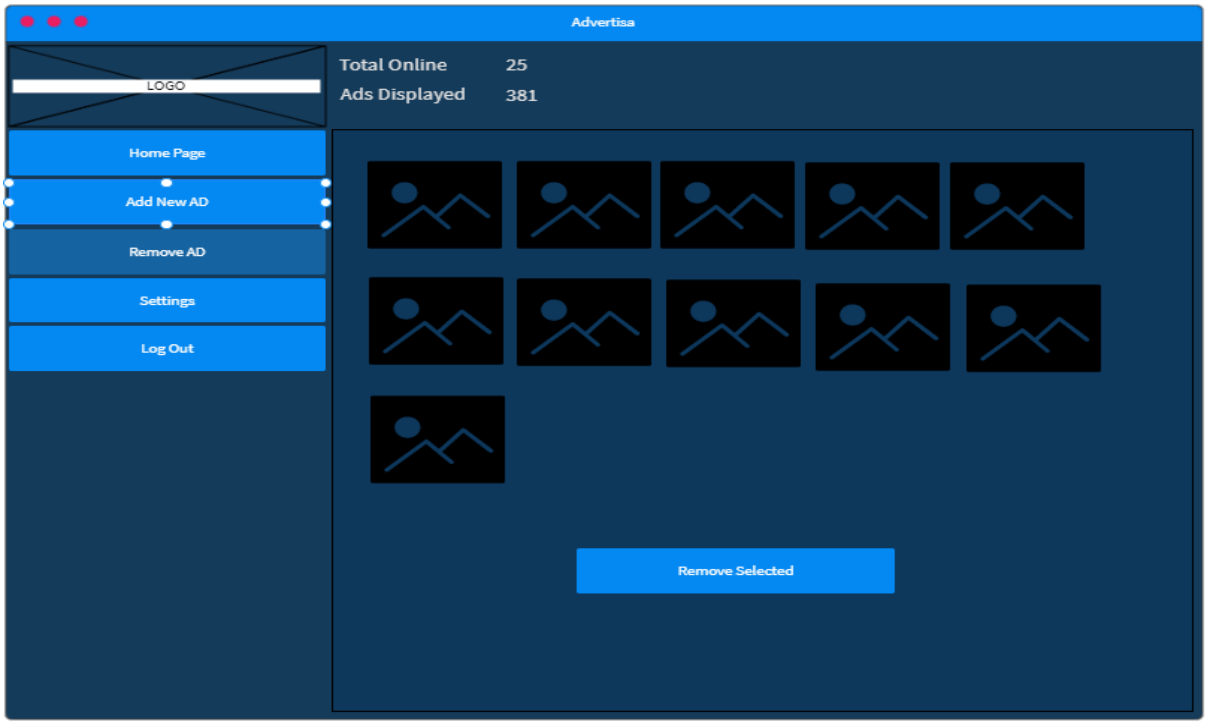

Figure 13: Remove Ad Screen of Our System

This screen offers the functionality to remove advertisement

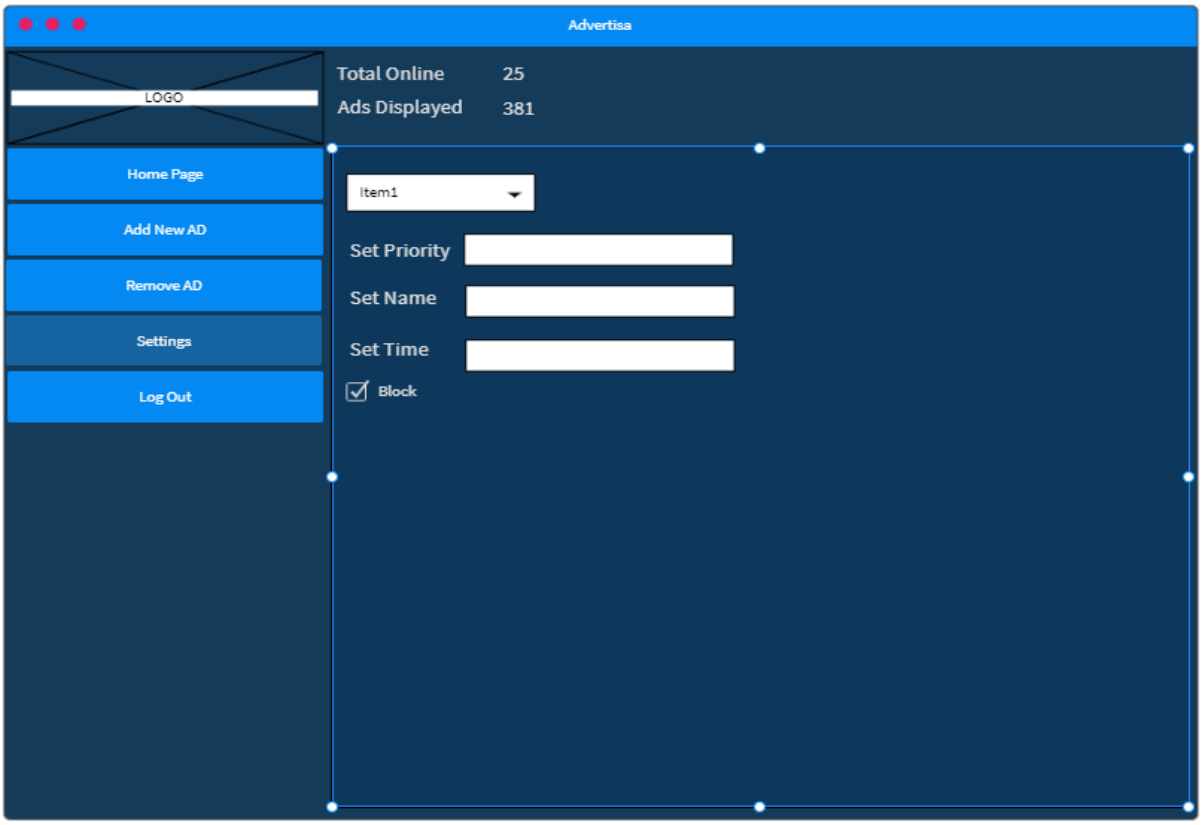

Figure 14: Update Ad Details Screen of Our System

This screen offers the functionality of adding audience.

Chapter 4: Description

The system takes images of the subjects present in front of the billboard. These images undergo a pipeline of trained Machine Learning models. These models detect face in a given image, classifies the gender based on the facial features and finally computes age of the subject based on facial features.

4.1 Model Pipeline

Following are the five stages involved in showing targeted advertisements. In fact, it is a complete flow of our system from start to end.

4.1.1 Capturing data

This is the first stage of our system. In it cameras will be used to record videos, cameras will be installed at some suitable points so that they can capture persons correctly in front of them and provide this data to the respective raspberry pie.

4.1.2 Face Detection

The images taken from the camera are passed through the face detection Machine Learning model. This model detects the facial location in an image (if exists). The detection of face is crucial because the ultimate computation of age and gender is based on facial features. Therefore, the face detection is performed at the beginning.

4.1.3 Gender Classification of the Subject

The facial location detected by the above model, is passed to another model that classifies the gender of the subject. The image along with the location of face is obtained by this gender classification model. This model classifies the gender of the subject based on the facial features.

4.1.4 Age of the Subject

Finally, the image with facial coordinates is passed to Machine Learning Model that computes the age. This model will use regression techniques to compute the age of the subject based on the facial features.

4.1.5 Display Advertisements

The information about the age and gender of the subject obtained from the above models is sent to server running in Local Area Network. The database of advertisements is also present locally. The server takes this information and replies with appropriate advertisement that matches the given information. The server takes the statistics of priority set to each advertisement into account as well. The server will be taking information from all the billboards installed at the mall and sending back the advertisements simultaneously.

4.2 Design

Design of our three models is explained here to get the clear and broader view complete working.

4.2.1 Face Detection

We will be using YOLOv3 algorithm for face detection. The architecture of the algorithm is given below.

	Type	Filters	Size	Output
	Convolutional	32	3 × 3	256 × 256
	Convolutional	64	3 × 3 / 2	128 × 128
1×	Convolutional	32	1 × 1	
	Convolutional	64	3 × 3	
	Residual			128 × 128
	Convolutional	128	3 × 3 / 2	64 × 64
2×	Convolutional	64	1 × 1	
	Convolutional	128	3 × 3	
	Residual			64 × 64
	Convolutional	256	3 × 3 / 2	32 × 32
8×	Convolutional	128	1 × 1	
	Convolutional	256	3 × 3	
	Residual			32 × 32
	Convolutional	512	3 × 3 / 2	16 × 16
8×	Convolutional	256	1 × 1	
	Convolutional	512	3 × 3	
	Residual			16 × 16
	Convolutional	1024	3 × 3 / 2	8 × 8
4×	Convolutional	512	1 × 1	
	Convolutional	1024	3 × 3	
	Residual			8 × 8
	Avgpool		Global	
	Connected		1000	
	Softmax			

Figure 15: YOLO Architecture

Face detection model architecture.

4.2.2 Age Prediction

Age of the detected person will be predicted using Keras and open-cv2. It uses adapt VGG-Face instead of VGG and train the model from scratch.

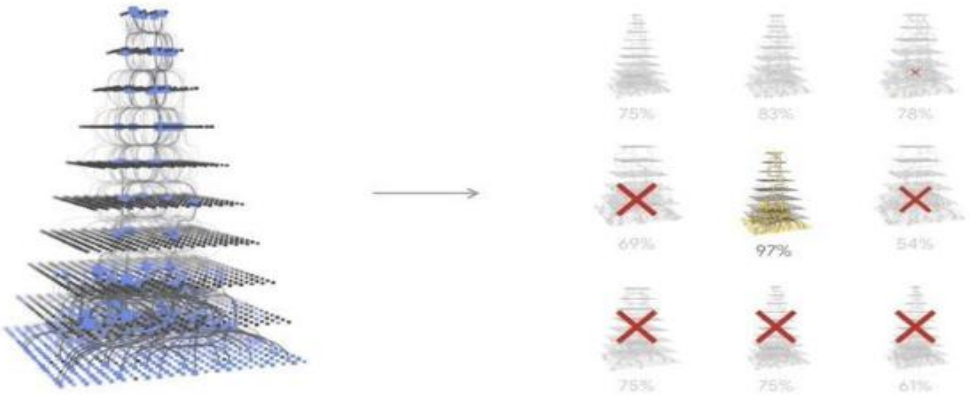

Figure 16: Learning step of model

Age prediction model architecture.

4.2.3 Gender Prediction

Gender of the subject will be predicted using Deep Learning using Keras and CVLib. The model uses VGG Network. The deep Neural Network architecture is given below:

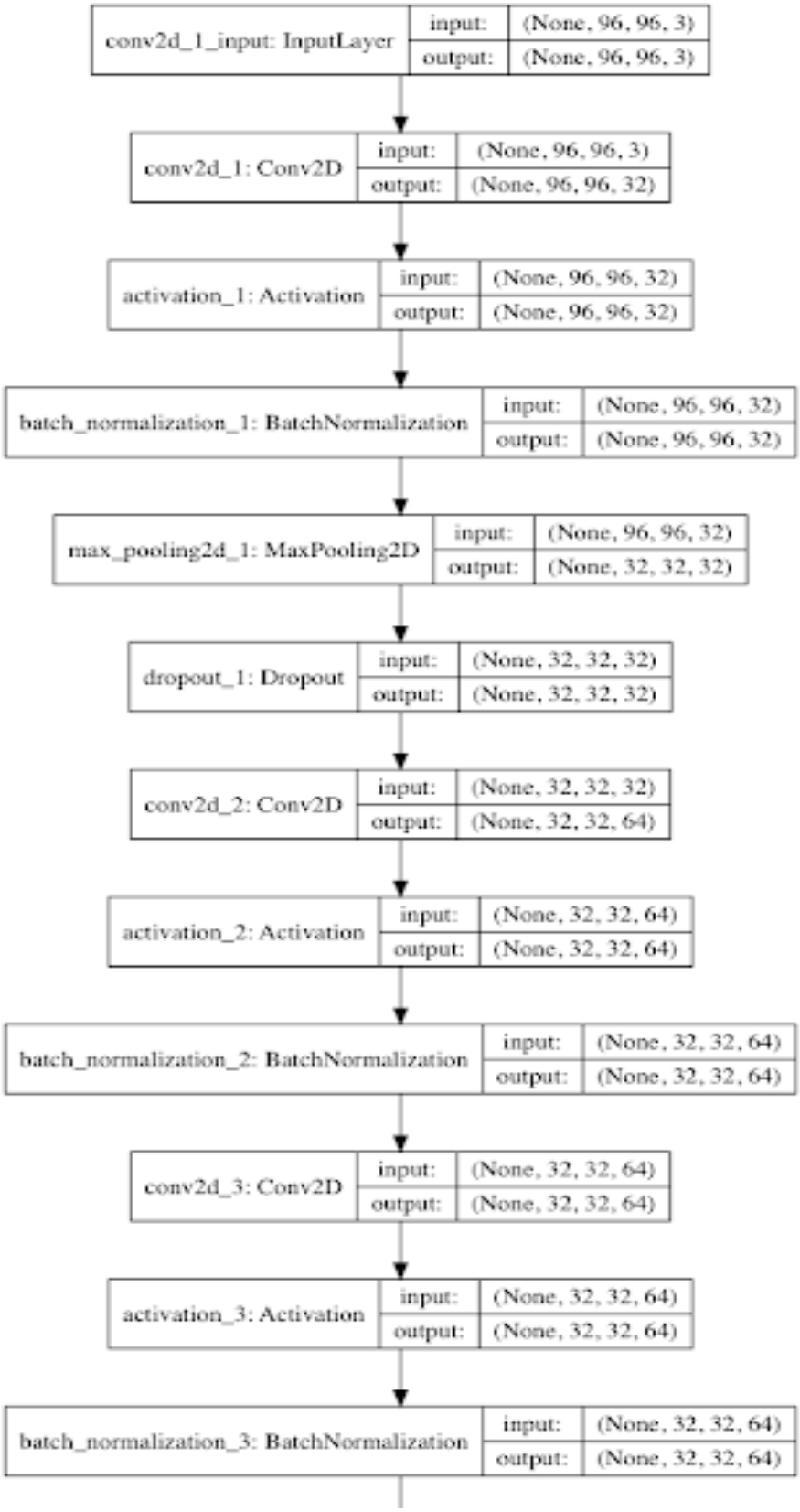

Figure 17: Neural Network Architecture (a)

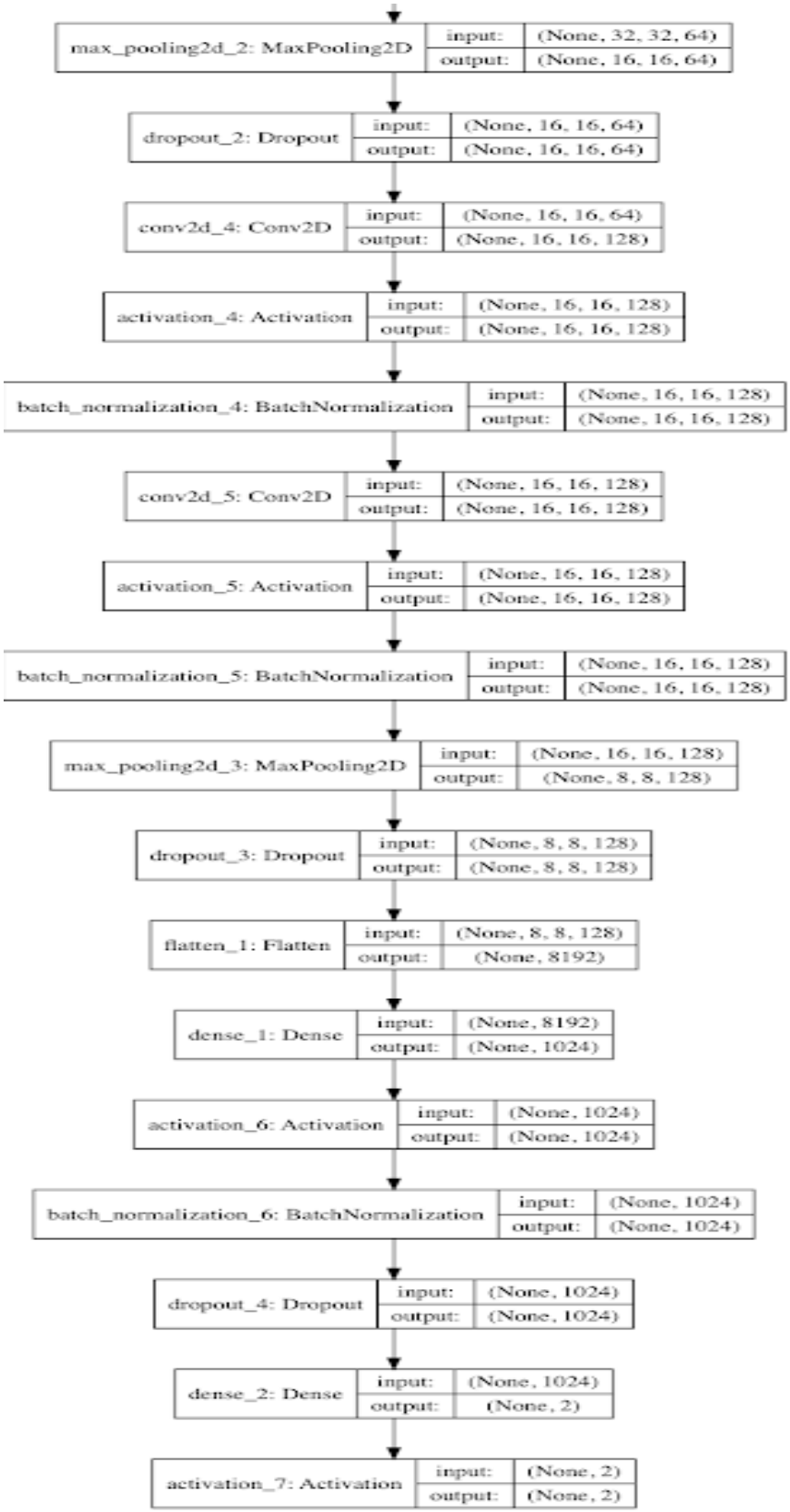

Figure 18: Neural Network Architecture (b)

Deep learning architecture that performs gender classification.

This is a deep learning model consisting of 29 layers. Each layer performs its function such as; Normalization, MaxPooling2D, Activation, Dropout etc.

4.3 Implementation

Following algorithms have been selected and implemented because of their accuracy and efficiency. Initially all these models are being tested with pre-trained models but later in next phase our own data sets will be created/chosen to implement these models again and will try to improve accuracy according to local surroundings.

4.3.1 Face Detection

We will fork a GitHub repository containing the YOLOv3 model. Afterwards, depending on the accuracy of the model, we'll train the model on the WIDERFACE dataset which contains 12K+ images pertaining to faces. If needs be, we'll tweak our model in an experimental manner in order to enhance the accuracy of our model. Afterwards, we'll integrate the model in the pipeline of the system.

4.3.2 Age Prediction

Age prediction algorithm will be accessed from GitHub repository. Algorithm uses Keras, OpenCV and other publicly available libraries. Datasets of Caffe can be used to train the models. Currently working algorithm is currently working for both age and gender which will be transformed for only age and accuracy of atleast 90% will be achieved by altering the algorithm.

4.3.3 Gender Prediction

We will use existing implemented code using Keras and OpenCV which are publicly available. The models that are publicly available have reported ~90% of validation accuracy. This accuracy can be further increased by adjusting the hyper parameters under different conditions. For example, in our situation, the environment where our system will be deployed will have a brighter area. Thus, the parameters can be adjusted not to care about the illuminance. Which could potentially increase its main purpose of gender prediction.

4.4 Test Cases

After rummaging through many object detection models, we decided to go with the YOLOv3 model for face detection as it's not computationally expensive to train and run as its other counterparts such as Faster R-CNN, RetinaNet, SSD etc. The algorithm uses anchor boxes to determine the objects present in an image. Currently, we will be fine-tuning the YOLOv3 model instead of training it from scratch. The reason being that the generic features learned by the model such as detecting edges, corners, shades etc. are invaluable for face detection that relearning them from our data will surely narrow the domain of features and consequently lower the model accuracy.

As for age and gender prediction, we are still in progress as we'll only move on to fine-tuning them once we have fully trained and tested the YOLOv3 model. This is because they can only function effectively if the face detection model is accurately functioning and sending correct crops of images. The algorithms used have been explained in detail in the previous sections. For the gender prediction model, we will use existing implemented code using Keras and OpenCV which are publicly available. The available models have reported ~90% of validation accuracy. This accuracy can be further increased by adjusting the hyper parameters under different conditions.

For computer networking and data transmission, we have resorted to use Node.js as a backend framework. It connects multiple systems (in this case laptops but Raspberry Pi devices in the future) receives data regarding the face, gender and age of a person detected by a camera. It then sends the respective advertisement video to the appropriate device that initiated the request.

Test Case ID	Test Case Name
4.4.1	Upload Advertisement
4.4.2	Upload Advertisement Alternative
4.4.3	Label Advertisement
4.4.4	Label Advertisement Alternative
4.4.5	Set Priority Advertisement
4.4.6	Set Priority Advertisement Alternative
4.4.7	Delete Advertisement
4.4.8	Delete Advertisement Alternative
4.4.9	Detect Face
4.4.10	Detect Face Alternative
4.4.11	Gender Classification
4.4.12	Gender Classification Alternative
4.4.13	Age Prediction
4.4.14	Age Prediction Alternative
4.4.15	Choose Relevant Video
4.4.16	Graphical Charts
4.4.17	Recover Password
4.4.18	Authentication
4.4.19	Authentication Alternative
4.4.20	Performance
4.4.21	Reliability
4.4.22	Security

4.4.1 Upload Advertisement

Test Case ID:	1	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	March 25, 2020		
Objective:	System must allow user to upload the advertisement video		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The advertisement video file should not be of 0 byte size		
Prerequisite:	The desktop application should be running.		
Step No.	**Execution Description**	**Procedure Result**	
1	Click upload button ad. button.	File explorer opens	
2	Select video file to be uploaded.	Video file selected	
3	Click “Upload” button.	File is uploaded to the database.	
Comments:	System works as required		
	Passed **Failed** **Not Executed**		

4.4.2 Upload Advertisement Alternative

Test Case ID:	2	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	March 28, 2020		
Objective:	System state must remain stable.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The advertisement video file should not be of 0 byte size		
Prerequisite:	The desktop application should be running.		
Step No.	**Execution Description**	**Procedure Result**	
1	Click upload button ad. button.	File explorer opens	

2	Select video file to be uploaded.	Video file selected
3	Click “Cancel” button.	System closes the file explorer video
Comments:	System works as required	
	Passed **Failed** **Not Executed**	

4.4.3 Label Advertisement

Test Case ID:	3	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	March 08, 2020		
Objective:	System must allow user to label the advertisement video		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The system must have some video to label.		
Prerequisite:	The desktop application should be running.		
Step No.	**Execution Description**	**Procedure Result**	
1	User selects the video.	Menu opens with a relabel option.	
2	User clicks the option.	Window open with age and gender fields.	
3	User set properties and click OK.	Properties saved into the system.	
Comments:	System works as required		
	Passed **Failed** **Not Executed**		

4.4.4 Label Advertisement Alternative

Test Case ID:	4	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	March 22, 2020		
Objective:	System state must remain stable.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		

Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI	
Assumptions:	The system must have some video to label.	
Prerequisite:	The desktop application should be running.	
Step No.	**Execution Description**	**Procedure Result**
1	User selects the video.	Menu opens with a relabel option.
2	User clicks the option.	Window open with age and gender fields.
3	User clicks Cancel	Properties remained unchanged.
Comments:	System works as required	
	Passed **Failed** **Not Executed**	

4.4.5 Set Priority Advertisement

Test Case ID:	5	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	April 19, 2020		
Objective:	System must allow user to set priority of the advertisement video		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The system must have some video to set priority.		
Prerequisite:	The desktop application should be running.		
Step No.	**Execution Description**	**Procedure Result**	
1	User selects the video.	Menu opens with a Set Priority option.	
2	User clicks the option.	Window opens with selected Priority and priorities to select.	
3	User selects priority and press OK.	Properties set for specific ad.	
Comments:	System works as required		
	Passed **Failed** **Not Executed**		

4.4.6 Set Priority Advertisement Alternative

Test Case ID:	6	**QA Test Engineer:**	Bilal Zumar
Test Case Version:	1	**Reviewed By:**	Zaheer ud Din Faiz
Test Date:	April 19, 2020		
Objective:	System state must remain stable.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The system must have some video to set priority.		
Prerequisite:	The desktop application should be running.		
Step No.	**Execution Description**	**Procedure Result**	
1	User selects the video.	Menu opens with a Set Priority option.	
2	User clicks the option.	Window opens with selected Priority and priorities to select.	
3	User press cancel button.	Priority remains unchanged..	
Comments:	System works as required		
Passed **Failed** **Not Executed**			

4.4.7 Delete Advertisement

Test Case ID:	7	**QA Test Engineer:**	Bilal Zumar
Test Case Version:	1	**Reviewed By:**	Zaheer ud Din Faiz
Test Date:	April 10, 2020		
Objective:	System must allow user to delete the advertisement video		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The system must have some saved videos.		
Prerequisite:	The desktop application should be running.		
Step No.	**Execution Description**	**Procedure Result**	
1	User selects the video.	Menu opens with a Delete option.	
2	User clicks the delete option.	Window opens for confirmation to delete..	

3	User confirms press OK.	Video removed from the system.
Comments:	System works as required	
	Passed ☐ **Failed** ☐ **Not Executed**	

4.4.8 Delete Advertisement Alternative

Test Case ID:	8	**QA Test Engineer:**	Bilal Zumar
Test Case Version:	1	**Reviewed By:**	Zaheer ud Din Faiz
Test Date:	April 10, 2020		
Objective:	System state must remain stable.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The system must have some saved videos.		
Prerequisite:	The desktop application should be running.		
Step No.	**Execution Description**	**Procedure Result**	
1	User selects the video.	Menu opens with a Delete option.	
2	User clicks the delete option.	Window opens for confirmation to delete..	
3	User presses the Cancel button.	Video remains in the system.	
Comments:	System works as required		
	Passed ☐ **Failed** ☐ **Not Executed**		

4.4.9 Detect Face

Test Case ID:	9	**QA Test Engineer:**	Bilal Zumar
Test Case Version:	1	**Reviewed By:**	Zaheer ud Din Faiz
Test Date:	March 01, 2020		
Objective:	System must be able to detect the face of the subject.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		

Assumptions:	System is completely functional.	
Prerequisite:	Cameras are live and the server is working.	
Step No.	**Execution Description**	**Procedure Result**
1	Subject faces towards camera.	Cameras record the picture and send it to the server.
2	Server receives incoming data and passes it to models.	Face detected.
Comments:	System works as required	
	☒ **Passed** ☐ **Failed** ☐ **Not Executed**	

4.4.10 Detect Face Alternative

Test Case ID:	10	**QA Test Engineer:**	Bilal Zumar
Test Case Version:	1	**Reviewed By:**	Zaheer ud Din Faiz
Test Date:	March 04, 2020		
Objective:	System must be able to detect the face of the subject.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	System is completely functional.		
Prerequisite:	Cameras are live and the server is working.		
Step No.	**Execution Description**	**Procedure Result**	
1	Subject faces towards camera.	Cameras don't detect the face.	
2	Server receives no incoming data.	Face is not detected.	
Comments:	System works as required		
	☐ **Passed** ☒ **Failed** ☐ **Not Executed**		

4.4.11 Gender Classification

Test Case ID:	11	**QA Test Engineer:**	Raffey Nasser
Test Case Version:	1	**Reviewed By:**	Noman Shafi
Test Date:	March 01, 2020		

Objective:	System must be able to classify the gender of the subject.	
Environment:	OS: Linux Ubuntu Programming language: JavaScript	
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI	
Assumptions:	The system is functional.	
Prerequisite:	The models have been trained already.	
Step No.	**Execution Description**	**Procedure Result**
1	Face detector passes output to system.	System receives the output.
2	System passes the output to gender classifier.	Gender of the subject is obtained.
Comments:	System works as required	
☒ **Passed** ☐ **Failed** ☐ **Not Executed**		

4.4.12 Gender Classification Alternative

Test Case ID:	12	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	March 15, 2020		
Objective:	System must be able to classify gender of subject.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The system is functional.		
Prerequisite:	The models have been trained already.		
Step No.	**Execution Description**	**Procedure Result**	
1	Face detector passes output to system.	System receives the output.	
2	System passes the output to gender classifier.	Incorrect gender of the subject is obtained.	
Comments:	System works as required		
☐ **Passed** ☒ **Failed** ☐ **Not Executed**			

4.4.13 Age Prediction

Test Case ID:	13	**QA Test Engineer:**	Raffey Nasser
Test Case Version:	1	**Reviewed By:**	Noman Shafi
Test Date:	March 01, 2020		
Objective:	System must be able to predict age group of subject.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The system is functional.		
Prerequisite:	The models have been trained already.		
Step No.	**Execution Description**	**Procedure Result**	
1	Face detector passes output to system.	System receives the output.	
2	System passes the output to age prediction model.	Age group of the subject is obtained.	
Comments:	System works as required		
Passed ☐ **Failed** ☐ **Not Executed**			

4.4.14 Age Prediction Alternative

Test Case ID:	14	**QA Test Engineer:**	Raffey Nasser
Test Case Version:	1	**Reviewed By:**	Noman Shafi
Test Date:	March 08, 2020		
Objective:	System must be able to predict age group of subject.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The system is functional.		
Prerequisite:	The models have been trained already.		
Step No.	**Execution Description**	**Procedure Result**	
1	Face detector passes output to system.	System receives the output.	

2	System passes the output to age prediction model.	Incorrect Age group of the subject is obtained.
Comments:	System works as required	
☐ **Passed** ■ **Failed** ☐ **Not Executed**		

4.4.15 Choose Relevant Video

Test Case ID:	15	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	March 21, 2020		
Objective:	System must be able to choose and play relevant video.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	All models have provided correct output.		
Prerequisite:	The desktop application and server should be functional.		
Step No.	**Execution Description**	**Procedure Result**	
1	Client sends age, gender information to Server.	Server receives information.	
2	Server searches for a video and send.	Video is being played on billboard.	
Comments:	System works as required		
■ **Passed** ☐ **Failed** ☐ **Not Executed**			

4.4.16 Graphical Charts

Test Case ID:	16	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	March 29, 2020		
Objective:	System must be able to show graphical statistics to the administrator.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		

Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI	
Assumptions:	System is completely live.	
Prerequisite:	The system has run for at least one day.	
Step No.	**Execution Description**	**Procedure Result**
1	User selects the menu for statistics.	Graphical charts are represented on the screen.
Comments:	System works as required	
	☐ **Passed** ☐ **Failed** ☐ **Not Executed**	

4.4.17 Recover Password

Test Case ID:	17	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	April 12, 2020		
Objective:	System must allow user to recover password.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	User want to login into the system but forgets password.		
Prerequisite:	User have already signup.		
Step No.	**Execution Description**	**Procedure Result**	
1	User opens app.	App shows login page.	
2	User press forget password.	App shows recovery page.	
3	User enter information and press enter.	User receives email on register email address.	
4	User enter the code and new password.	Password updated.	
Comments:	System works as required		
	☐ **Passed** ☐ **Failed** ☐ **Not Executed**		

4.4.18 Authentication

Test Case ID:	18	**QA Test Engineer:**	Raffey Nasser
Test Case Version:	1	**Reviewed By:**	Noman Shafi
Test Date:	April 12, 2020		
Objective:	System must allow user to securely login.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	User want to login into the system.		
Prerequisite:	System is live and functional.		
Step No.	**Execution Description**	**Procedure Result**	
1	User opens app.	App shows login page.	
2	User adds information and press enter.	App shows home page.	
Comments:	System works as required		
	Passed **Failed** **Not Executed**		

4.4.19 Authentication Alternative

Test Case ID:	19	**QA Test Engineer:**	Noman Shafi
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	April 15, 2020		
Objective:	System must allow user to securely login.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	User want to login into the system.		
Prerequisite:	System is live and functional.		
Step No.	**Execution Description**	**Procedure Result**	
1	User opens app.	App shows login page.	
2	User adds incorrect information and press enter.	App shows error page.	

Comments:	System works as required
	Passed ☐ **Failed** ☐ **Not Executed**

4.4.20 Performance

Test Case ID:	20	**QA Test Engineer:**	Noman Shafi
Test Case Version:	1	**Reviewed By:**	Bilal Zumar
Test Date:	April 30, 2020		
Objective:	The time interval between the camera detecting a face and the system showing the ad. is no more than 5 seconds.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript, Python		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	System is working with full capacity.		
Prerequisite:	The desktop application should be running.		
Step No.	**Execution Description**	**Procedure Result**	
1	Camera captures the image and sends it to the server.	An ad. is shown within 5 seconds after detecting a face	
Comments:	System works as required		
	Passed ☐ **Failed** ☐ **Not Executed**		

4.4.21 Reliability

Test Case ID:	21	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Noman Shafi
Test Date:	April 4, 2020		
Objective:	To test the system's uptime and downtime i.e. reliability.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript, Python		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	The system has no possible issues/bugs/errors.		
Prerequisite:	The desktop application should be running.		
Step No.	**Execution Description**	**Procedure Result**	

1	Turn on the system and let it run for about 24 hours.	System runs flawlessly and doesn't incur any downtime.
Comments:	System works as required	
	Passed ☐ **Failed** ☐ **Not Executed**	

4.4.22 Security

Test Case ID:	22	**QA Test Engineer:**	Zaheer ud Din Faiz
Test Case Version:	1	**Reviewed By:**	Raffey Nasser
Test Date:	April 11, 2020		
Objective:	System must allow the user to securely login.		
Environment:	OS: Linux Ubuntu Programming language: JavaScript		
Product/Ver/Module	Targeted Billboard Advertisement System/1/GUI		
Assumptions:	User wants to login into the system.		
Prerequisite:	System is live and functional.		
Step No.	**Execution Description**	**Procedure Result**	
1	User opens app.	App shows login page.	
2	User adds incorrect information and press enter.	App shows an error page.	
Comments:	System works as required		
	Passed ☐ **Failed** ☐ **Not Executed**		

Chapter 5: Experimental Results and Analysis

Best experiments results of models are shown with figures, which shows training graphs and accuracy of each graph.

5.1 Face Detection Model

We obtained the accuracy of about 90% on face model, after performing 204 steps, 30 epochs, and Dropout rate of 0.1

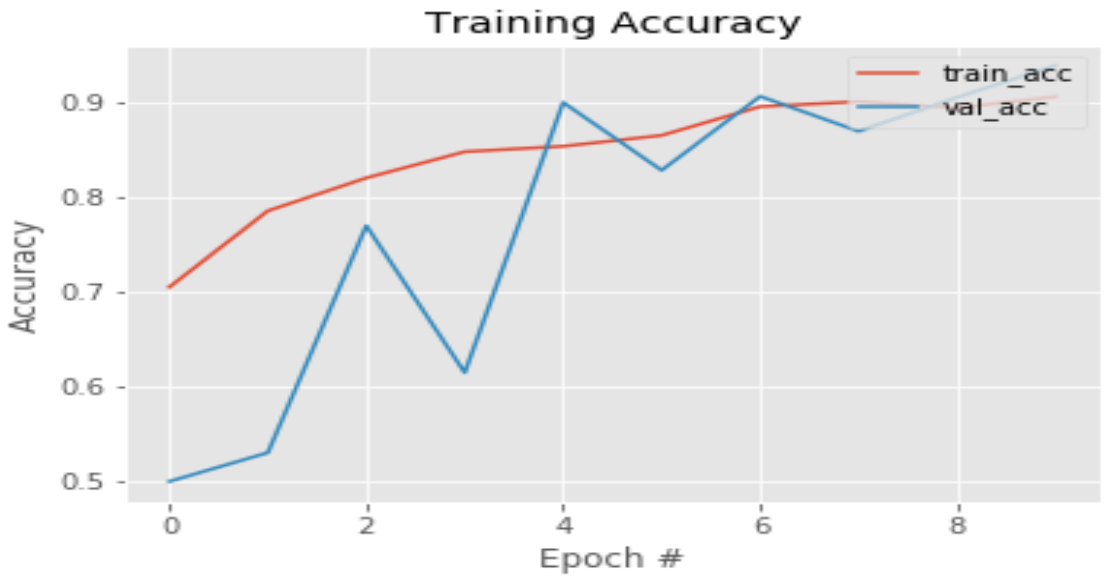

Figure 19: Training and Validation Accuracy

Training and Validation Accuracy of Face Detection Model

5.2 Gender Classification

We obtained 87-88% accuracy with 230steps, 30 epochs and dropout rate was set to 0.3.

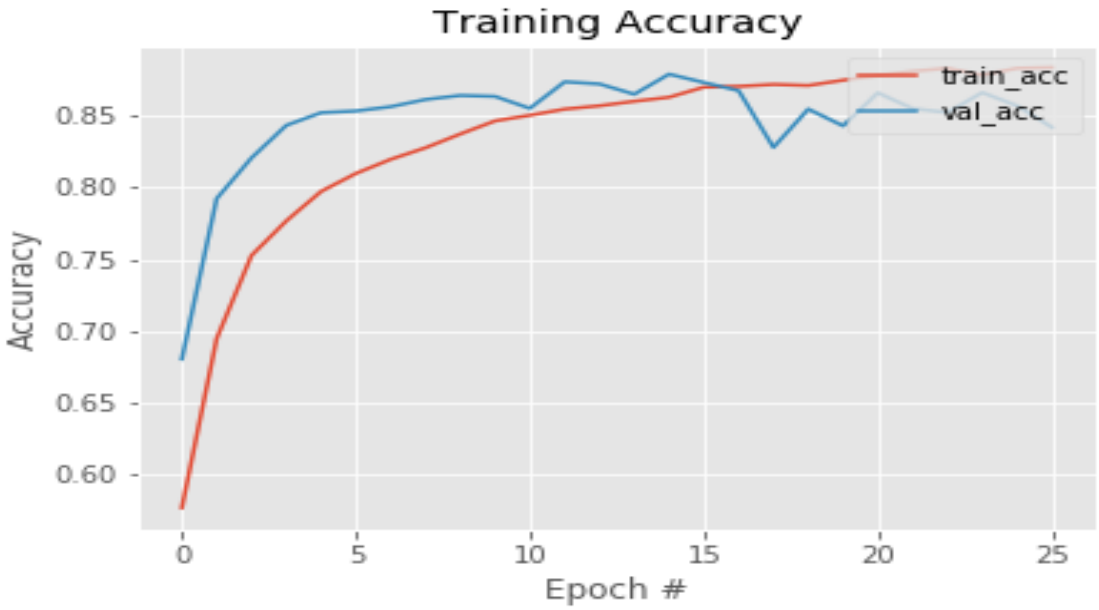

Figure 20: Training and Validation Accuracy

Training and Validation Accuracy of Gender Classification Model

5.3 Age Prediction

Age prediction predicts with the accuracy of 85-86% accuracy when 115 steps were performed, with 20 epochs and dropout rate was 0.2 to 0.3.

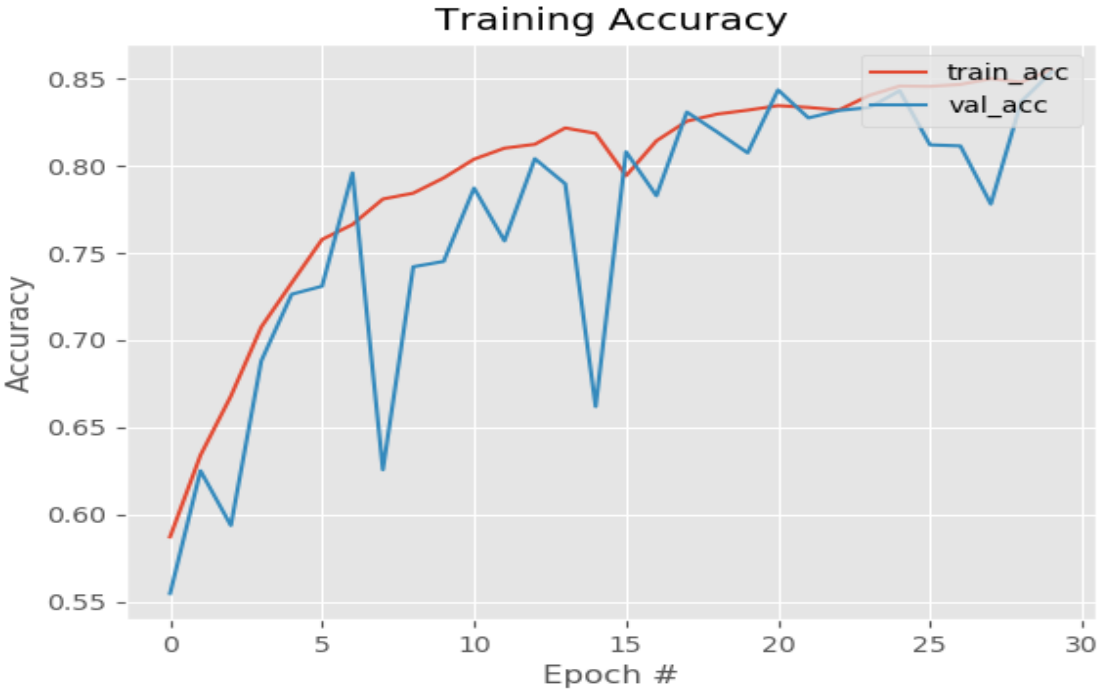

Figure 21: Training and Validation Accuracy
Training and Validation Accuracy of Age Prediction Model

5.4 Analysis

In all of these experiments, it was found that including some amount of dropout was essential to increasing the accuracy of the models. It also helped address the issue of overfitting by not allowing any kind of dictionary like mapping of weights and outputs. The no. of layers was also kept to a moderate amount i.e. somewhere between 4 – 7 to not allow overfitting.

Chapter 6: Conclusion

The project is about targeted billboard advertising that will be developed to show allow a company to showcase their ads in public places and mall(s) and will show people different ads based on their age, gender. The goal is to show ads to all kind of people according to gender and age with an accuracy of about 90+ %. All this will be done by leveraging computer vision and deep learning techniques. The system ‘s scope is as follows: It will be able to upload ads to local database, label ads with age and gender, set priority of each ad etc. The hardware for the software will be a Raspberry Pi which will have the model hosted, a server which will host all the advertisements for display.

The algorithm for Gender classification will be GC-CRF which is a combination of MB-LBP and BSIF with SVM classifier. The algorithm for face detection, after a thorough scrutiny of various algorithms namely: RetinaFace, S3FD, Face Mag-Net and YOLOv3, happened to be YOLOv3 due to its accuracy and lightweight. Subsequently, the algorithm for age prediction is a technique called Rank Based Edge Texture Unit (RETU) and Fuzzy Texture.

The functional requirements for the system include but are definitely not limited to the following: the system should be able to upload, label, set priority of and delete advertisement(s). It should also detect faces foremost, predict age and classify gender(s). As for non-functional requirements, the system should display ad(s) within 5 to 6 seconds after detecting a face. The system should also have a backup in case of electricity shortage(s) and should support the application for both Windows and MacOS.

As for the model pipeline, the process begins from the cameras as they initially capture and record real-time data. They pass this data to the Raspberry Pi device that stores the algorithms that do the processing. First, the data is passed through YOLOv3 in order to detect faces and extract face coordinates. These coordinates are then used by gender and age prediction algorithms to predict age and gender. These predictions are then passed to the server on the local area network that returns the ad that most likely caters to those features.

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