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CNN Based Criminal Identification

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Abstract: *Considering abnormal increase in crime rate and number of criminals, there is a need of more effective Criminal Identification Technique. Biometric technique like thumb print identification is faded out today as criminals of these days obtaining cleverer to not leave their fingerprints on the scene. Human Face is the most important attribute to recognize any individual. It is a dynamic object having high degree of variability in its appearance which makes it a better identification technique among the other biometric techniques.But there are many challenges in Face Identification system too. Our project aims to overcome such challenges and evaluates various faces using Convolutional Neural Network (CNN) to provide a complete solution for Image based Face Detection with an accuracy of 76.19 for Criminal Identification.*

Keywords: CNN, Face Detection, Criminal Identification, ml5.js

I. INTRODUCTION

Convolutional Neural Network are designed to figure with grid-structured inputs, which have strong spatial dependencies in local regions of the grid. the foremost obvious example of grid-structured data may be a 2-dimensional image. the basic difference between fully connected and convolutional neural network is that the pattern of connection between consecutive layers. In fully connected case, each unit is connected to any or all of the units within the previous layer. in an exceedingly convolutional layer of a neural network, on the opposite hand, each unit is connected to a (typically small) number of nearby units within the previous layer. Furthermore, all units are connected to the previous layer within the same way, with the precise same weights and structure.

The overwhelming majority of applications of CNN specialize in Image data. Object Detection, Optical Character Recognition, Image Classification, Face Recognition, etc. are some real time samples of CNN. Our project aims to use Face Recognition Technique for Criminal Face Identification.

Criminal record contains personal information about a particular person together with photograph. To spot any criminal, we'd like identification regarding that person, which are given by the eyewitness. Biometric Techniques like Fingerprint, DNA, Iris etc. are effective modes of Identification. But Face Identification Technique is kind of simpler than them as Face is primary focus of attention in social intercourse. Also, data required to create Face Identification model may be available easily through criminal records, video footages and lots of more.

Face Identification has applications in various other fields too. Today, payment companies like MasterCard, Alipay have developed a system within which User will pay by taking selfies. Almost all told smartphones, there's a feature of Face lock. Face Detection is currently used at Picasa, Photo Bucket, and Facebook.

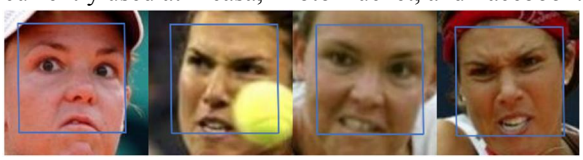

Figure 1: Face Detection Alignment

Proposed Face Recognition system uses a database of both Criminals and non-criminals and compares another image to seek out a match whether an individual is criminal or not. The full operation is categorized into three significant steps. First part is to form a good database. Second step is to spot & prepare recognized faces within the

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database and the last step is to test Face Recognition to work out the face that is has been trained. After completing the whole process, the system is giving overall accuracy of 76.19%.

II. Related Work

The early motivation for convolutional neural networks was derived from experiments by Hubel and Wiesel on a cat's visual cortex [1]. The visual area has small regions of cells that are sensitive to specific regions within the field of vision. In other words, if specific areas of the visual field are excited, then those cells in the visual area are activated moreover. Furthermore, the excited cells also depend upon the form and orientation of the objects within the field of regard.

Based on these biological inspirations, the earliest neural model was the neocognitron[1]. However, there have been several differences between this model and therefore the modern convolutional neural network. The foremost prominent of those differences was that the notion of weight sharing was not used. Supported this architecture, one of the primaries fully convolutional architectures, remarked as LeNet-5 [1], was developed. This network was utilized by banks to spot hand-written numbers on checks. Since then, the convolutional neural network has not evolved much; the main difference is in terms of using more layers and stable activation functions just like the ReLU. Furthermore, numerous training tricks and powerful hardware options are available to achieve better success in training when working with deep networks and huge data sets. CNN has been successfully employed in face recognition, object detection, semantic segmentation, image captioning, and sophisticated & complicated models like R-CNN, Fast R-CNN, and Faster R-CNN [5] are created for many object detection models deployed in autonomous vehicles, facial detection, and more [2].

III. Literature Survey

Title	Author	Journal Name	Journal Year	Conclusion
Web front-end Realtime Face Recognition Based on TFJS	Chenyang Li, Chunfang Li	12th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI)	2019	In this paper, we proposed a web front-end real-time face recognition system. By analyzing different approaches, standard APIs and frameworks, we came up to a design. Then we implemented it and tested it on different scenarios. The result shows that front-end real-time face recognition is possible and user acceptable. In the future, the system shall be integrated to a video/live streaming site, in order to realize face searching or face swapping.
Criminal Face Recognition System	Alireza Chevelwalla , Ajay Gurav, Sachin Desai, Prof. Sumitra Sadhukhan	International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181	2015	This system uses our implementation of a face recognition system using features of a face including colors, features and distances. Using its two degrees of freedom, our system allows two modes of operation, one that results in very few false positives and another which results in few false negatives. We have demonstrated various concerns related to the face recognition process, such as the lighting and background conditions in which the facial images are taken.

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				Our system could be improved in the future through the development of a face detection algorithm which is less prone to incorrectness, failure and performs well regardless of the skin color. A more extensive feature set would also prevent the chance of tricking the system through the alteration of facial features.
Face Detection and Recognition System using Digital Image Processing	Gurlove Singh, Amit Kumar Goel	Proceedings of the Second International Conference on Innovative Mechanisms for Industry Applications (ICIMIA 2020) ISBN: 978-1-7281-4167-1	2020	Since the no. of Eigen faces to be used is restricted in PCA transformation that's why the system did not have an accuracy of more than 90% for both manual and automatic face recognition. A further work that needs to be done is in the field of fully automated frontal view face detection system which when displayed virtually shows a perfect accuracy. The real-world performance of this designed system will be far more precise. In view of attaining a high accuracy rate the designed and developed system was not adequately strong. One of the main reasons behind this flaw is that the sub-system of the face recognition system does not exhibit minute changes in degree of steadiness to scale or rotation of the segmented face image. The performance of this system can be compared with the manual face detection only if we integrate the eye detection system with the developed system.
Facial emotion recognition using deep learning: review and insights	Wafa Mellouka, Wahida Handouzi	The 2nd International Workshop on the Future of Internet of Everything (FIoE) August 9-12, 2020, Leuven, Belgium	2020	This paper presented recent research on FER, allowed us to know the latest developments in this area. We have described different architectures of CNN and CNN-LSTM recently proposed by different researchers, and presented some different database containing spontaneous images collected from the real world and others formed in laboratories (SeeTable.1), in order to have and achieve an accurate detection of human emotions. We also present a discussion that shows the high rate obtained by researchers that is what highlight that machine today will be more capable of interpreting emotions, which implies that the interaction human machine becomes more and more natural.

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IV. PROPOSED SYSTEM

CNN typically has 3 Layers namely, a convolutional layer, pooling layer, and ReLU. Each layer in it is a 3-dimensional grid-structure, which features a height (Lq), width (Bq), and depth (dq). Additionally, a final set of layers is usually fully connected and maps in an application-specific way to a set of output nodes.

4.1 Pooling Layer

The pooling operation works on small grid regions of size Pq × Pq in each layer, and produces another layer with the identical depth. For every square region of size Pq × Pq in each of the dq activation maps, the most of those values is returned [1]. This approach is cited as max-pooling. If a stride of 1 is employed, then this may produce a brand-new layer of size (Lq − Pq + 1) × (Bq − Pq + 1) × dq [1]. However, it is more common to use a stride Sq > 1 in pooling. In such cases, the length of the new layer is going to be (Lq −Pq)/Sq + 1 and also the breadth is (Bq −Pq)/Sq + 1. Therefore, pooling drastically reduces the spatial dimensions of each activation map [1].

4.2 ReLU Layer

The ReLU activation isn't very different from how it is applied in an exceedingly traditional neural network. For every of the Lq × Bq × dq values in a layer, the ReLU activation function is applied to it to form Lq×Bq×dq thresholded values. These values are then passed on to the subsequent layer. Therefore, applying the ReLU does not change the size & dimensions of a layer because it is a straightforward one to one mapping of activation values. In traditional neural networks, the activation function is combined with a linear transformation with a matrix of weights to form the next layer of activations. Similarly, a ReLU typically follows a convolution operation (which is the rough equivalent of the linear transformation in traditional neural networks), and the ReLU layer is often not explicitly shown in pictorial illustrations of the convolution neural network architectures [1].

4.3 Fully Connected Layer

Each feature within the final spatial layer is connected to every hidden state within the first fully connected layer. This layer functions in barely the identical way as a standard feed-forward network. Since the fully connected layers are densely connected, the overwhelming majority of parameters belong the fully connected layers [1].

In this work, we fuse the convolution and subsampling layer and form a simplified version of CNN. We adapt the idea from the work of Y.Simard et al. within which they applied this fusion approach to handwriting recognition problem with 10 classes [6]. Mamalet and Garcia confirmed the viability of this approach in accelerating the processing time. The concept of this fusion approach is tailored to face recognition problem for 100 classes and incorporate partial connection between the primary two layers to confirm different features are learned during the training process. Comparison between the common CNN approach and fusion approach is depicted in Fig. It is often observed that the common approach requires two stages to perform convolution and subsampling whereas the fusion approach requires only one stage. Padding is not required during the convolution process and therefore reduces the size of feature maps at the succeeding layer.

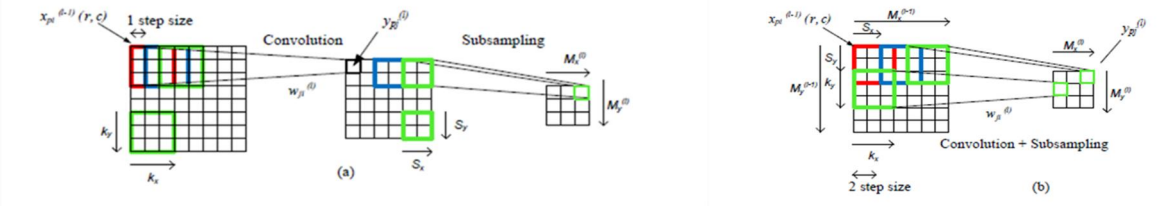

Figure 2: Comparison between (a) Common Convolution & Sampling Method (b) Fusion Approach

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4.4 Workflow Design

To implement CNN based Criminal Identification System, a workflow is designed & described as follows. Fig3 visualizes the whole process.

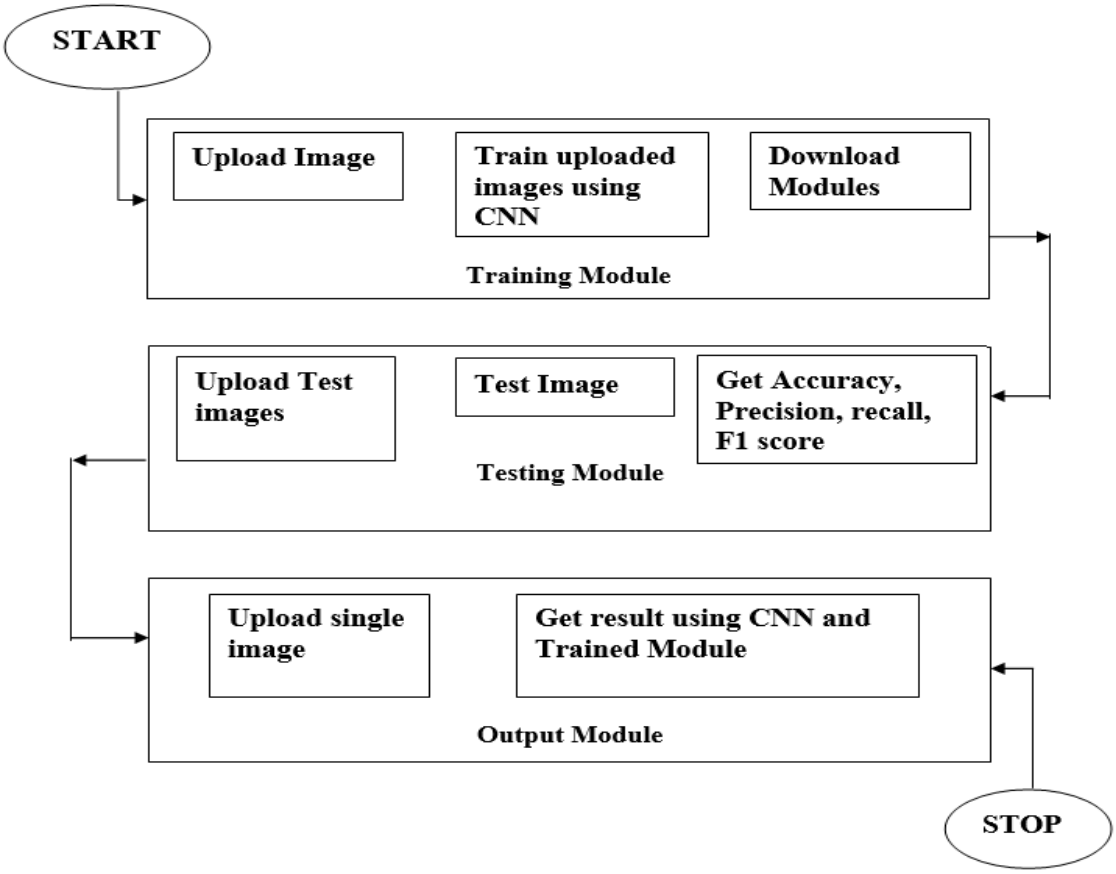

Figure 3: Work Overflow of the Model

Firstly, workflow requires image dataset to upload as an input. For that, we have made a dataset of images of 64*64 pixels with 2 classes of Criminal and Non-criminal. And it will be loaded via a HTML<img> tag.

Once dataset is ready, we start training the model using CNN. The process of training of CNN uses Backpropagation Algorithm. For each layer, there is separate back propagation algorithm.

Internally, input data is organized into 2-dimensional grid structure and values of the individual grid are referred to as pixel. Also, in order to encode the precise color of pixel, CNN uses RCB color scheme. After converting all images into 64*64 and applying RCB color channel, overall number of pixels of each image is 64*64*3.

Here, CNN is implemented using JavaScript's Library ml5.js. It sets & initialize Neural Network, normalize data and train model for Criminal Identification. Once model is trained, it loads pre-trained model, the weights & the metadata and tests on testing dataset.

After testing, we get final accuracy of 76.19%.

4.5 Experiments

We implemented the Workflow by using ml5.js, P5 JavaScript Library and Bootstrap framework. Then we evaluate the prototype system on Windows 10 workstation with Intel i5 processor, 8GB RAM. The obtained results are listed as follows.

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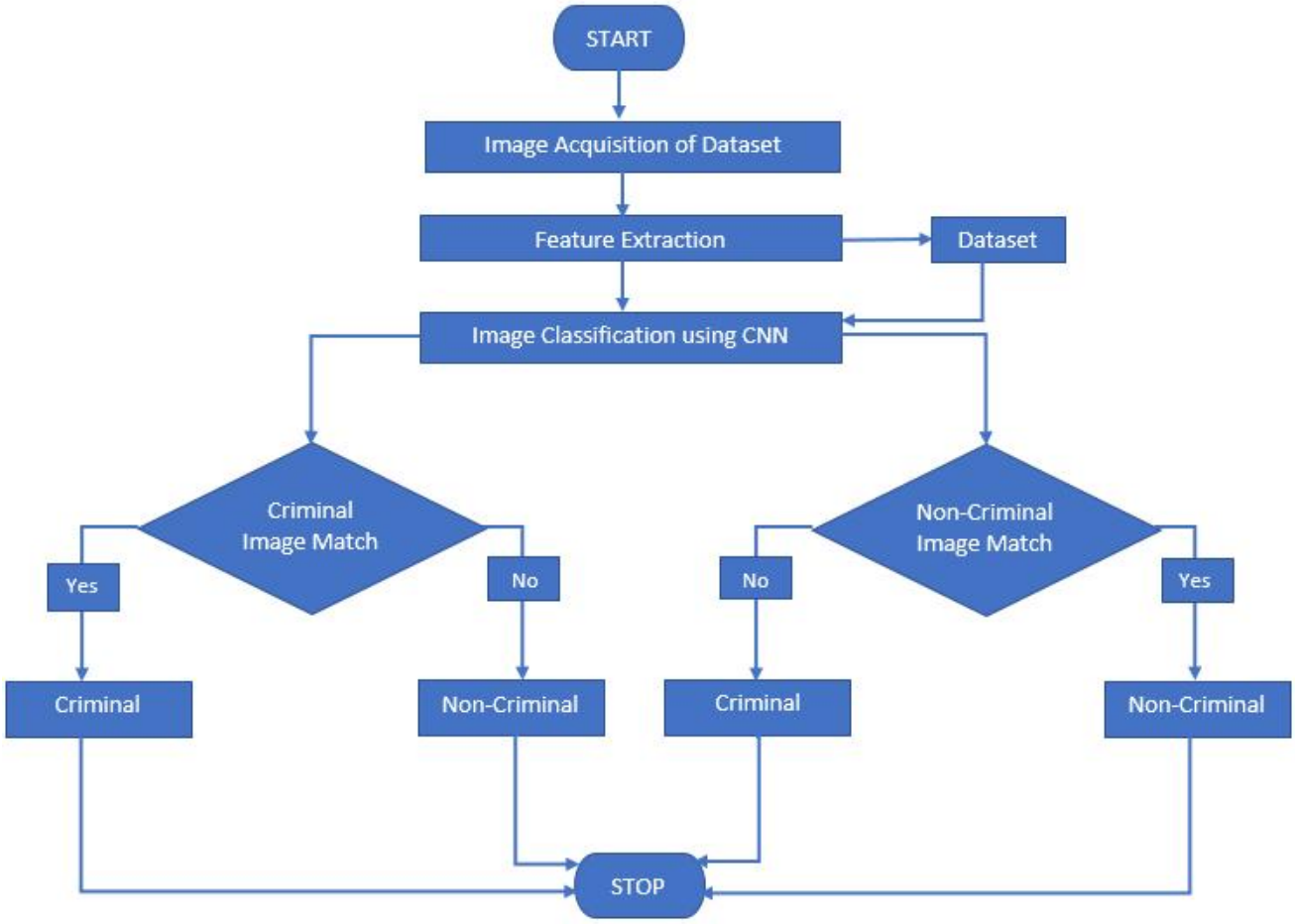

Figure 4: Flowchart of the model

4.6 Output

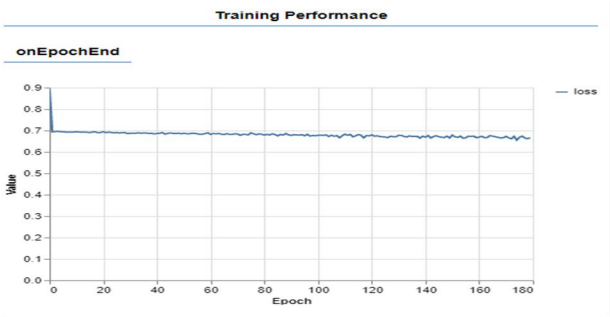

Figure 5: Training Performance with 180 epoch

Model Summary

Layer Name	Output Shape	# Of Params	Trainable
conv2d_Conv2D1	[batch,60,60,8]	808	true
max_pooling2d_MaxPooling2D1	[batch,30,30,8]	0	true
flatten_Flatten1	[batch,7200]	0	true
dense_Dense1	[batch,2]	14,402	true

Figure 6: Model Summary

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		Actual Values: Positive	Actual Values: Negative
Predicted Values	Positive	TP=10	FP=0
	Negative	FN=5	TN=6

Figure 7: Testing Confusion Matrix

- Total number of Test images: 40
- Total Number of Correct Prediction Positive (TP): 10
- Total Number of Correct Prediction Negative (TN): 6
- Total Number of Correct Prediction True Positive and True Negative: 16
- Total Number of Wrong Prediction Positive (FP): 0
- Total Number of Wrong Prediction Negative (FN): 5
- Accuracy: 76.19047619047619
- Recall: 0.6666666666666666
- f1 score: 0.8
- Specificity: 1

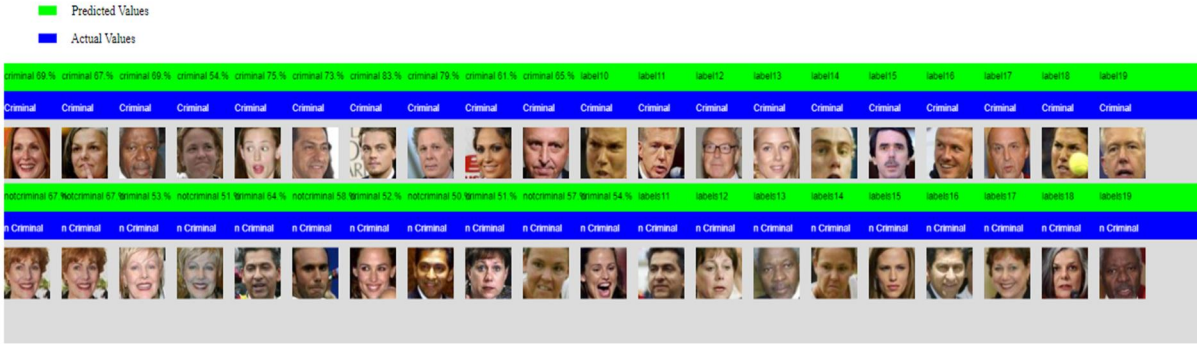

Figure 8: Testing Actual and Predicted images

V. RESULT

So, with the help of above-mentioned procedure, we have completed our project of "CNN Based Criminal Identification" using TensorFlow JS Library & P5 JS Library. We have trained our model using ml5.js and achieved an accuracy of 76.19%.

We have used VS code Editor which is a lightweight but powerful source code editor. It comes with a built-in support for JavaScript which we have used to train CNN for Criminal Face Identification.

The main function of our system is to detect & extract faces from an image and recognize whether the person is Criminal or not. For that, we have created a database of more than 500 images of both Criminals and Non-criminals, each of dimension 64*64. It is further divided in 8:2 ratio for training and testing purpose.

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Our system successfully achieved the result by recognizing Criminal faces, checking from all aspects such as Blur images, face rotation, and addition of other features like glasses, caps, etc. We have improved our model by achieving an accuracy of 76.19% from a previous accuracy of 50%.

VI. CONCLUSION

The implemented model is capable of correctly recognizing faces from images. It can work with variety of pictures and is sensibly strong to change in face appearance or orientation, light conditions, and different variables. The advantage of this model is that it can recognize the side face and blurred image that other conventional models can't recognize. The acquired framework has been widely tried, and distinctive parameter combinations are attempted. Given a picture with an individual in it, it had been capable of following and recognizing them. After passing an image, we get a label whether the image is criminal or not. Finally, we got 76.19 from our project.

FUTURE SCOPE

Our system could be improved in future after taking data from video cameras, CCTV footages and live video streaming.

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