Human Face Detection and Image Restoration by Upscaling from Blur Image

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering [Font-14]

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APPROVAL

This Project titled "**Human Face Detection and Image Restoration by Upscaling from Blur Image"**, submitted by Zahura Zaman, ID: 171-15-1381, Sabiha Jannat, ID: 171-15-1376, Sujon Ahmed, ID: 171-15-1369 and Mohammad Nazmul Hoshen Nayeem, ID: 171-15-1467 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 05th December, 2020.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Amit Chakraborty Chhoton, Lecturer, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

Image represents the external form of an object in the form of art. In digital technology depended world, image processing is a vast research area. Image processing is one of the most essential part of Computer Vision. Face Recognition and detection is another beneficial part of this area. Lately, reference-based face restoration techniques rose up highly and on great talk among world-wide researchers because of its immense potential in resolving high density details over low resolution images. Nonetheless, most of these approaches have limitations in requirements which is they need high standard trained image of similar identity. Besides, many analysts have presented methods and algorithms to solve misfocus, motion blur. But most of them performed over the whole picture pixel and so can't detect the main goal of the image mostly. To address the issue of restoring face from blur surrounding, in this study we applied the accurate reference-based deep face dictionary (DFDNet) algorithm. In this algorithm, four steps are performed to reach the expected output of restored image along with face detection. Here, in this method, upscaling of picture is done to repair each and every pixel inside an image in details. This method works by feature matching of input image to pre-coached high quality images reference dataset and at the very end, a good output is established. This algorithm works both over synthetic and real time pictures but don't need any personal information from the image. Side by side, we compared other techniques and algorithms with our applied algorithm where it is effectively found that this algorithm can reach promising outcomes on debased low resolution images.

Keywords:- Face restoration, Face detection, upscaling, landmark, deep face dictionary, reference-based, Image processing.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The whole world is digitalizing so the value of clicking amazing digital photos with digital cameras is increasing [2]. Image processing has been on top research and concentration of the researchers for many decades. Digital image processing has succeeded rapidly in its platform today. Still, towards more contribution, novel aspect is to explore the area as much as possible for its completeness. Some image processing techniques are image pre-processing, image enhancement, image segmentation, image restoration. Image analysis mainly focuses about information inside an image. To process an image, image analysis is performed. When an image is processed, sometimes blurriness or noise inside the image is recognized. Due to lack of knowledge sometimes the pictures are of low quality. A blur is an area which our eyes or camera's lens cannot see clearly because it is out of the focus area and has no distinct outline. Some sort of blurriness is termed as motion blur, gaussian blur, atmospheric blur, uniform blur. In digital image processing, blurring is used to make an image smooth in the edges. Blurring effect is used to average out rapid changes in pixel density. It removes outlier pixels in an image [1]. Considering that, various kinds of noise like Gaussian noise, Poisson noise, Speckle noise, Salt and Pepper noise (Impulse noise), Multiplicative noise also exist [1].

Human viewpoint has around 10 8:1 absolute span from entirely regulated dull vision to entirely regulated lighting conditions at twelve on the orbit [14]. But the camera lens may cause deformity while snapping and recording which the lens can't regulate through. These discolorations are caused by allied focus camera movement, contingent baroscopic turmoil, sources of noise and wrong focusing by able or wide lens [1].

Now many methods have been reported for restoring or detecting the actual image from these imperfections under blur image detection operation.

The reason for image restoring is to gauge the primary picture from the corrupted information. It is worried about separating the noticed picture to limit the impact of corruptions. Adequacy of picture restoring relies upon the degree and exactness of the

information on the corruption cycle even as on channel plan. Image restoring is not quite the identical as image improvement. Therein the last is intended to underline highlights of the image that make the picture all the more satisfying to the spectator, yet not really to deliver practical information from a logical perspective. The fact says to improve a degraded image, Image restoration is the ultimate need.

The Objectives of the proposed work are, to discover a reasonable exceptionally precise reclamation algorithm to filter and eliminate the corruption on a picture. To locate a reasonable algorithm with elite efficiency of filtering and working superbly of reestablishing the picture and to create a gauge of the first picture preceding the degradation [1].

In last few decennium, different works on face detection from blur picture has been done using different techniques and algorithms as of POCS (Projection onto convex sets) method [4], EM algorithm [5], Harr Wavelet transform direct method [3], Space adaptive equalization method [13], 3-way blur identification method [6], etc. Each of these methods have its advantages and disadvantages. Still, many of the techniques haven't worked completely as expected. Besides, some reference methods [14, 15] have been practiced earlier to get a good solution to this. Among these reference procedures, GFRNet [15] and GWAINet [14] approve a frontal high quality image as relevance advisor to the renewal of debased information [13]. Nonetheless, these two techniques suffer from two imperfections.

i. They need to get a frontal high quality reference which is from the synonymous identity with low quality image.
ii. The dissimilarities of posture and expressions between the relevance and debased input will influence the reconstruction efficiency.

These two drawbacks limit their considerable capacity.

To triumph over these deficiencies of preceding processes, in this research paper, we applied DFDnet algorithm by recreating deep face terminologies to overcome the prior obstructions. At the very Beginning, in this algorithm, there pre-trained Vggface has been set to evulse multiple features of images with high resolution by building them as a reference to train debased images. Following that, RoIAlign technique has been uploaded where pixel of an image is cropped according to row wise alignment based on facial

landmarking components pixel location. K-means process is then performed to bring about K-cluster for each of those components. Through this procedure, at last the face inside the image is restored. Since we used multiple featured dictionaries to guide the whole restoration method, so it shows a handful efficient performance than other above-mentioned algorithms.

1.2 Motivation of the research

Computer vision has developed so rapidly still sometimes to find any criminal or a missing person it takes a lot of hassle and time. Safety and rights become a question then. It seems to solve these bigger issues we focused on detecting the goal image i.e. the face after also deblurring the whole image.

1.3 Rationale of the Study

Researchers have directly used particular algorithms or techniques to deblur image or restore image. But our main objective is to apply a technique which performs in four steps to cropping and aligning face, landmarking for face detection, upscaling and restoring the face, inputting restored face in original image and get the output at the end. This will completely recreate the face in an image which is the most necessity.

1.4 Research Questions

- How to escalate picture standard by upscaling pixel quality or image intensity?
- Which are some the most trended techniques to restore blur image?
- What are the shortcomings of those aforementioned methods?
- How can we use different technique to efficiently restore face in an image from a blur one?

1.5 Expected Output

We applied Deep Face Dictionary Network (DFDNet) algorithm to restore debased images caused by motion blur or noisy blur. Foremost, cropping the original image and aligning the face comparing it to the pre-coached pictures set by default as raw inside algorithm. Then taking on account, human face has four components (e.g: left/right eye, nose and mouth) similar among most of the population. We import face detection dictionaries to create a landmark of the input face. After landmarking, the image is segmented to that particular pixel where the target goal face is available. While the face locating and detecting becomes complete, then the face is restored by upscaling low quality portrait into a high quality one comparing to the pre-trained images. After restoring the face, the output picture is put on the original out of focus image and re-established. That is, to attain a re-established and detected face from a blur picture is the expected output.

1.6 Report Layout

This paper is organized as follows, In chapter one the thesis title is elaborated and explained in Introduction part. This section includes Introduction of research in 1.1, Motivation of research in 1.2, Rationale of study in 1.3, questions before staring the research in 1.4, Expected output in 1.5 and report layout in 1.6. Chapter two is Background, where previous related works is deliberated. This section embodies, Terminologies in 2.1, preceding research activity or related works in 2.2, comparative analysis and short summary in 2.3, scope of the problem in 2.4 and at the last of the section, challenges in 2.5. Chapter three justifies Research Methodology. This chapter has elaborated Research subject and instrumentation or tools used in 3.1, Data set utilized developing the project in 3.2, statistical analysis of the process in 3.3, A proposed processing model in 3.4 and implementation requirements in 3.5 at the end is delivered. The most important part is Experimental result and discussion part found in chapter 4. Here result output, analysis and discussion is abbreviated in 4.1, 4.2 and 4.3. Chapter 5 reports Impact on Society, Environment and Sustainability Plan in 5.1, 5.2 and 5.3. At the last section, in chapter 6 which includes summary, Conclusion and future work in 5.1,5.2,5.3 followed by the relevant references.

CHAPTER 2
BACKGROUND

2.1 Terminologies

In this paper, terms as blur image (motion blur, noisy blur), face detection and restoration, image landmarking are mostly concentrated on. Face visualization and restoration has been done in four steps in our project where image segmentation and face cropping is done comparing to pre-trained images set by default, pixel wise landmarking, upscaling low resolution image to high quality picture and finally image restoration is done inputting the output upgraded face in the original image. Previously, many researchers applied techniques over the whole image to get the restored image which tended to make the complete picture deblur but couldn't restore the main target of the picture which is the face. But here the technique which we applied in this paper, successfully performs over all the pixels in a picture and deblurs the main targeted pixel and then aim at goal target face to restore and sharpen it. This technique shows its probability over real life appliances.

2.2 Related Works

Table 2.1. Literature Review

Author (year)[ref]	Title	Description	Achievement Claimed
D. A. Fish, A. M. Brinicombe, E. R. Pike and J.G. Walker (1995) [17]	Blind deconvolution by means of the Richardson–Lucy algorithm.	In this paper, point-spread-function (PSF) is completely unknown. This is a continual process. In every iteration, one receives evaluation of mass and PSF by inverse filtering. This way, clarity of blind image is found.	This algorithm achieved a peak accuracy level at 74% of average overall.

A.K. Katsaggelos and K.T. Lay (1991) [16]	Maximum Likelihood Blur Identification and Image Restoration Using the EM Algorithm.	In this paper, they proposed an iterative algorithm which achieves maximum likelihood counts of the anonymous parameters with the use of EM algorithm. In this way picture is restored to some extent using EM iterations.	The proposed algorithm obtained a 65.67% overall classification accuracy.
Hyukzae Lee and Changick Kim (2014) [6]	Blurred Image Region Detection and Segmentation.	In this paper a 3-way blur identification method has been suggested which dissect a picture into non-blur, defocus blur and motion blur. Based on three-elegance blur model, it has been shown here how the gradient data can be successfully exploited to predict different form of blur with decrease computation.	The proposed method remarkably outperforms a rate of 86% with appreciate to each accuracy and computational fee.
Zou Mou-yan and Rolf Unbehauen (2002) [10]	An Iterative Method Of Blur Identification And Image Restoration.	In this paper the philosophy of an increment iterative blind deconvolution (IIBD) algorithm within the frequency domain has been used. In the IIBD algorithm, they didn't impose a statistic presumption on the unknown picture. Alternatively, a priori know-how is utilized in the initialization and inside the new release technique of the algorithm in order that an accurate solution can be reached.	Owing to its simplicity and its computational performance, the algorithm reached accuracy rate of 70% overall.
Berk Dogan, Shuhang Gu, Radu Timofte (2019) [14]	Exemplar Guided Face Image Super-Resolution without Facial Landmarks.	In this paper, they addressed CNN located result, namely GWAInet. This procedure uses High Resolution image instead of facial landmarks and helps in regaining super quality restored images.	Since, this procedure could regain images with good efficiency, so it attained an average accuracy of 75%.

Tu-Li You and M. Kaveh (1994) [13]	A simple algorithm for joint blur identification and image restoration.	In this paper, the proposed a trendy space-adaptive regularization technique for image restoration, prolonged to improve the joint blur and photograph estimation. The ensuing scheme has two regularized phrases, one for the portrayal and the alternative for the blur. The computational overhead for blur identification is much less than the computational load required for regularized photograph restoration while the blur operator is precisely known.	The effectiveness and ease of the proposed method make it viable to be extended to the identification of area-variation blurs with a good performance of 65%.
Xiaoming Li, Ming Liu, Yuting Ye, Wangmeng Zuo, Liang Lin and Ruigang Yang (2018) [15]	Learning Warped Guidance for Blind Face Restoration.	In this paper, they presented a guided face restoration model (GFRNet) along with subnetwork WarpNet to landmark and line up guided image. In this way they re-establish a devalued picture into a good quality one.	The technique is well applied and gives outperforming result with an accuracy of 85%.
A. M. Tekalp, M. K. Ozkan and M. I. Sezan (1992) [4]	High-resolution image reconstruction from lower-resolution image sequences and space-varying image restoration.	Researchers combines two before used techniques (frequency domain and technique based on projections onto convex sets i.e POCS) in this paper to identify noise in a figure and translate that into a good intent image.	This method reached an accuracy of 60% on average.

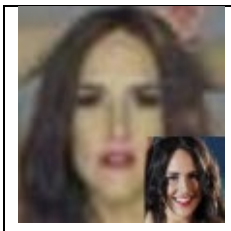
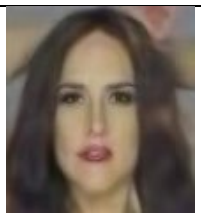
Ebrahimi Moghaddam, Mohsen. (2008) [9]	Out of focus blur estimation using genetic algorithm.	In this paper, a unique and sturdy technique is presented to estimate the out of central point blur function. This technique estimates defocus variables with usage of a genetic algorithm outlined base on gauging of the picture density feedback. The genetic algorithm analyzes sign to noise ration and debasement limit.	With some future plan to analyze parameters more correctly, this algorithm obtained an accuracy of 67%.

"Table 2.1" exemplifies literature review which is the other research works done using different techniques and algorithms to reshape and recreate an image from noisy blur, motion blur environment eradicating different types of blurs and noises.

2.3 Comparative Analysis

Table 2.2. Comparison with other works

Input Image	Output Image	Reference Number	Description
		16	In this paper, they proposed an iterative EM algorithm. Picture is using EM iterations. Obtained a 65.67% accuracy.
		1	A comparative study has been done in this research where Richardson-Lucy algorithm stands best which is an iterative methodology with inverse filtering working process. This approach reached 74% certainty.

		15	In this paper, GFRNet along with subnetwork WarpNet to landmark and line up guided image. Picture is restored managing with guided images and have an accuracy of 85%.
		14	This method GWAInet approve a high resulotion image instead of landmarks as reference to the development of degraded information and reaches 75% correctness.
		This Paper	In this research, image is fixed with a Deep Face Dictionary Network Algorithm which performs in three different steps namely (Crop and Align, Landmarking, facte detection and restoration). With a brilliant efficiency, this compared method reached 88% of accuracy above all.

"Table 2.2" compares among other different techniques and algorithm along with ours to find the best efficient one to restore blur image and detect or visualize degraded face completely.

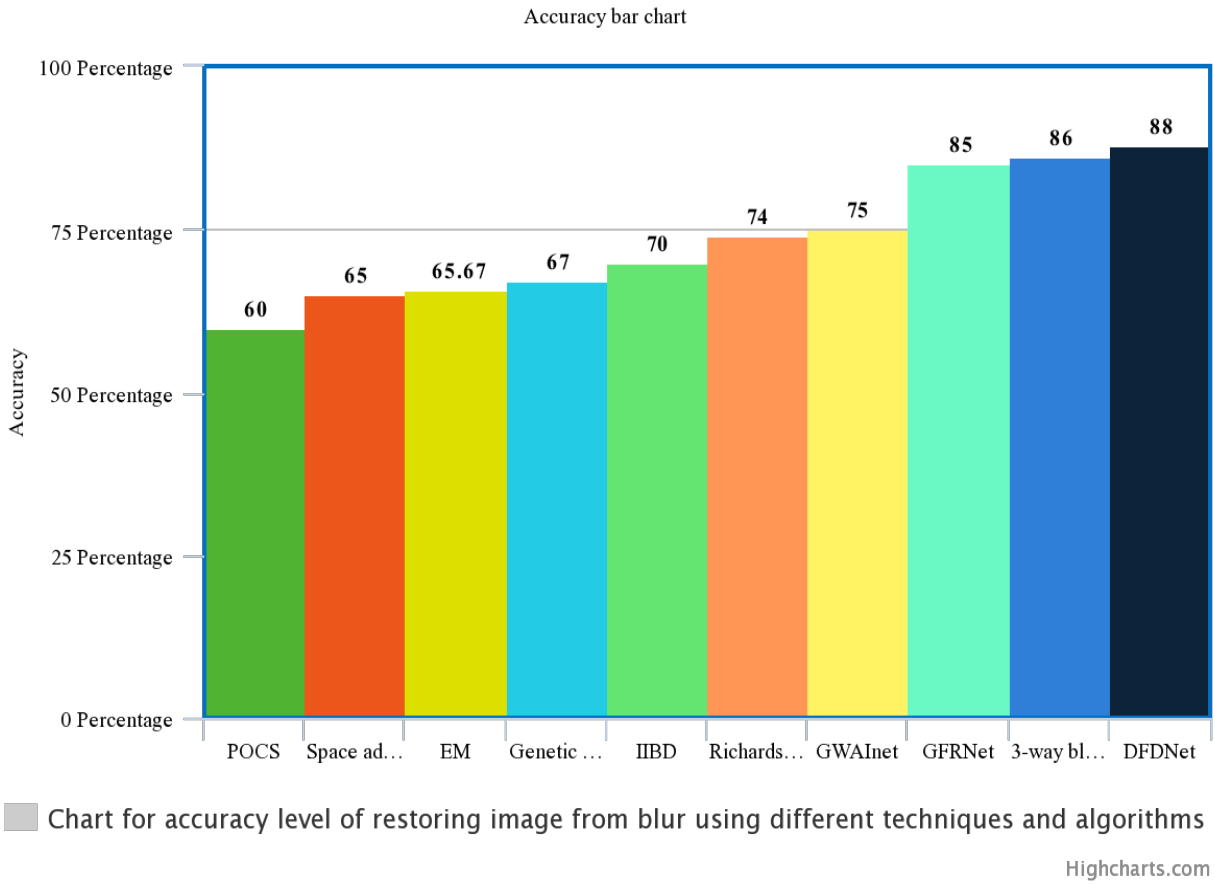


Fig. 2.1. Comparative analysis with accuracy rate

In "*Fig. 2.1"* bar chart is formed by using *"Table 2.1"* and *Table 2.2"* with the values of blur image restoration. Various techniques, algorithms and ours has been compared in this chart for analyzing the prediction of accuracy or effectiveness level.

2.3.1 Summary Analysis

In *"Table 2.2"* comparison can be seen among some techniques and algorithms. If we consider all inputs we can be assured that analysts worked over detecting blur extent and repairing images from blur environment. Most of the papers have good detecting and restoring rate. But still there are some drawbacks where we can find that while restoring the image, some of them are deteriorating the contrast, saturation of the picture. Also some are taking more techniques combining together to get an output while this is ruining more time to process. In the reference papers, we see that the restored picture is somehow mostly good but the face detected in the methods are not fully perfect while reaching them to an accuracy of maximum 86%. But in our study, we applied a deep face dictionary algorithm to repair and completely detect the face by upscaling. We take very low resolution to medium low resolution images as our dataset where we can find that except for the very far away image and edited blur, this algorithm can efficiently perform upto 88% accuracy rate by restoring the goal human face well.

2.4 Scope of the Problem

In previous works, researchers only deblurred the full image in where the main target point that is, the face sometimes remain hazy or some part of the face remain blur and can't be recognized fully. Whereas, in this research work we focus on the main targeted face and deblur it with also repairing by upscaling. So, in different sectors like crime branch, legal works, privacy control; this technique will outrun.

2.5 Challenges

Sometimes we capture images during motion which causes motion blur or also due to some presence of noise blur may occur. Then again, in CCTV footage images can't be captured or seen well due to haziness or blur by noise. At times, deblurring is done over such images

using different software enrolled with different algorithm or methodologies. But this causes only the image to remove blur to some extent over some pixels. Only using those particular algorithm, full clear image while detecting face can't be found. To recognize and re-establish exact face, this technique needed to be done.

CHAPTER 3
RESEARCH METHODLOGY

3.1 Research Subject

Our research topic is now a vital experimental part of the Computer Vision area. Recognizing face and re-establishing the picture by subtracting blur is a bigger question in the modern world. So, any add-ons to that area is a good contribution for the society and world. Our research subject is based on this that how a face can be fully restored and detected from a blurry environment. To find the most efficient algorithm by comparing to devote in this sector is what we focused on.

3.1.1 Research Instrumentation

Hardware Components:

- Computer having 1080ti GPU
- Minimum 16gb RAM

Software Components:

- Anaconda Prompt
- DFDNet ready Environment
- Visual Studio
- Cmake

3.2 Dataset Utilized

To implement this algorithm, we have exploited almost 50 images. From them, we took 22 images as our dataset because of variations of blur extent present in them. Among those images, in *"Table 3.1"*, we took 9 pictures as sample data in the dataset here. These data vary in total number of pixels and sizes for different images.

Table 3.1. Sample Dataset

Image number	Total number of pixels (height * width) in original image	Size of original image (KB)
1	900 * 601	22.1
2	375 * 398	23.4
3	225 * 225	5.84
4	361 * 649	27.3
5	2401 * 3013	464
6	677 * 871	61.3
7	766 * 766	117
8	528 * 1152	103
9	512 * 768	34.2

"Table 3.1" is represented total number of pixels in height and width, along with size of input/original image (Blur image). It represents total number of data the image contains. In this research, face is detected and restored inside an image by increasing pixel of a blur image and upscaling it. In this way, the picture resolution is increased and image is repaired. We run the program on the sample input images of the dataset and collects the

3.2.1 Output Dataset

"Table 3.1" represents number of pixels in height and width axis and also their size. *"Table 3.2"* constitutes the result of pixels in every stage of reaching the output images, face restore. *"Table 3.3"* result according to size of output images is presented. From Dataset, easily recognize that in each step, the image resolution of pixels increases gradually more than previous stage and increased size too. First, original image cropped and pixel value is changed from the input one. Similarly, in second, cropped image is restored to bring it to such a position that it can be landmarked. In this way, outcome is found. The face is rebuilt. But important thing to mention is that edited blur (an image which is made blur after

editing), can't be removed properly. Still in such degraded image, it can detect the face to some extent and bring bit of accuracy on that kind of image as well which many other algorithm or techniques can't even work on.

Table 3.2. Changes in pixels of Height and Width in each and every step

Image Number	Pixel of Input Image	Pixel after cropping	Pixel after restoring cropped face	Pixel of Output Image	Image Restored?	Face Detection Quality
1	900 * 601	512 * 512	512 * 512	3600 * 2404	Yes	Good
2	375 * 398	512 * 512	512 * 512	1500 * 1592	Yes	Good
3	225 * 225	512 * 512	512 * 512	900 * 900	Yes	Good
4	361 * 649	512 * 512	512 * 512	1444 * 256	Yes	Good
5	2401 * 3013	512 * 512	512 * 512	9604 * 12052	Yes	Good
6	677 * 871	512 * 512	512 * 512	2708 * 3484	Yes	Good
7	766 * 766	512 * 512	512 * 512	3064 * 3064	Yes	Medium
8	528 * 1152	512 * 512	512 * 512	2112 * 4100	Yes	Good
9	512 * 768	512 * 512	512 * 512	2048 * 3072	No	Bad

Table 3.3. Changes in size after upscaling in each and every step

Image Number	Size of Input Image (KB)	Size after cropping (KB)	Size after aligning (KB)	Size of Output Image (KB)
1	22.1	16.6	22.3	231
2	23.4	16.4	20.8	111
3	5.84	18.8	23.4	52.1
4	27.3	16.8	20.8	166
5	464	13.6	22.0	2210
6	61.3	13.6	22.1	256
7	117	19.8	30.0	399
8	103	20.3	31.7	369
9	34.2	13.4	18.7	234

"Table 3.2" and *"Table 3.3"* briefs variations in pixel values and sizes of the image in different steps and shows the quotient if the image is restored after applying these stages of the algorithm and quality of face detection. It is found that every image changes in pixel values throughout all treads where also the size of each picture is upscaled and face is detected and restored at last.

Since, this project fully shows that image is restored on basis of pixel and size upgrading; so we took these data as our sample datasets and get our expected analyzed result.

3.3 Statistical Analysis

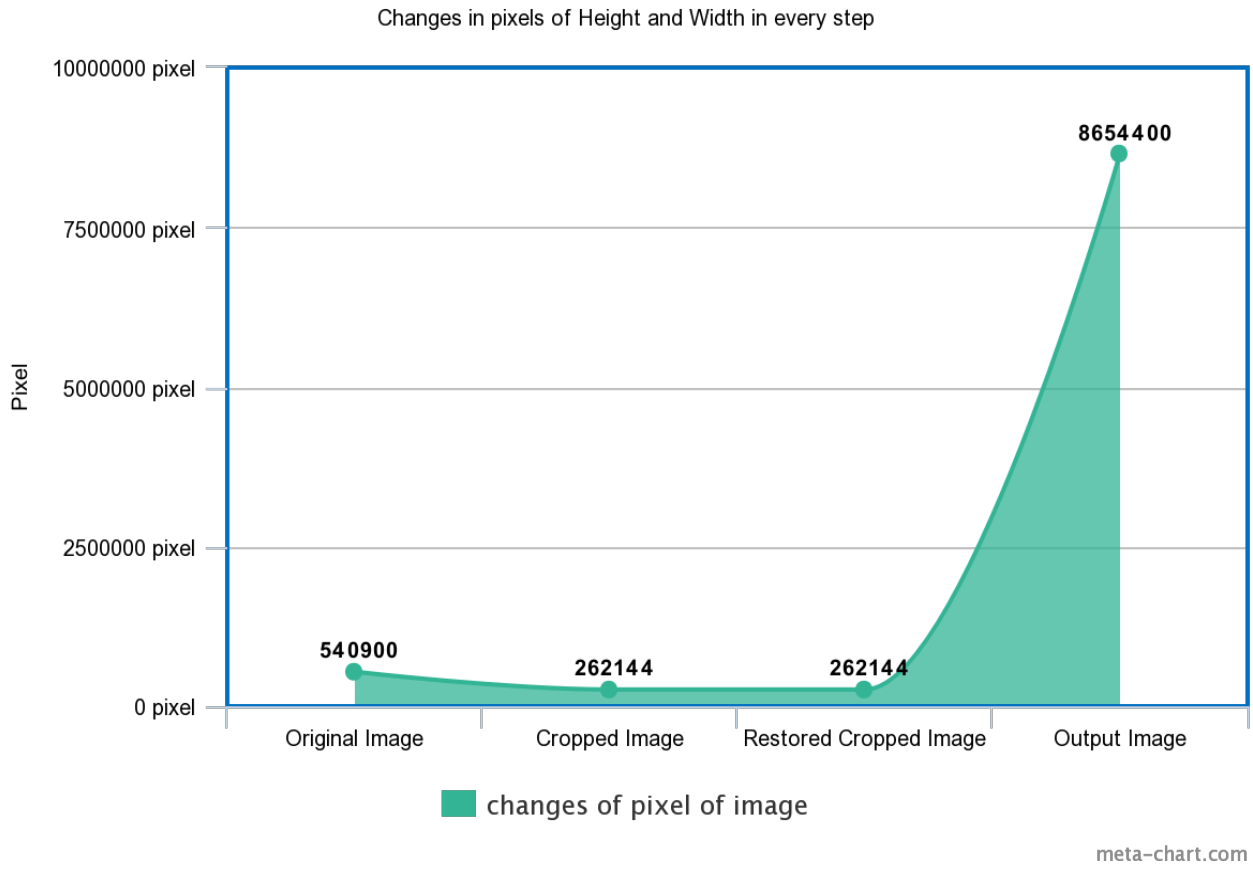


Fig. 3.1. Changes in pixels of height and width in each and every step

"Fig. 3.1" represents an area chart where changes in pixels of height * width in every step is plotted in. In this study, the applied algorithm (DFDNet) works in four steps. Original Image to copped picture, cropped to landmarking, landmark to restoring cropped portrayal, inputting restored face in original one to get output. Here, in these 4 steps we determined the increment of pixel or index for accession of color combination value or brightness quality which leads to convert low resolution image to a high quality one.

In this chart, it can be seen that how pixels increased from original image where it is 540900 pixel to output image's 8654400. Here, a graph considering the 1st image is given since each image which can be executed gives same outcome mostly.

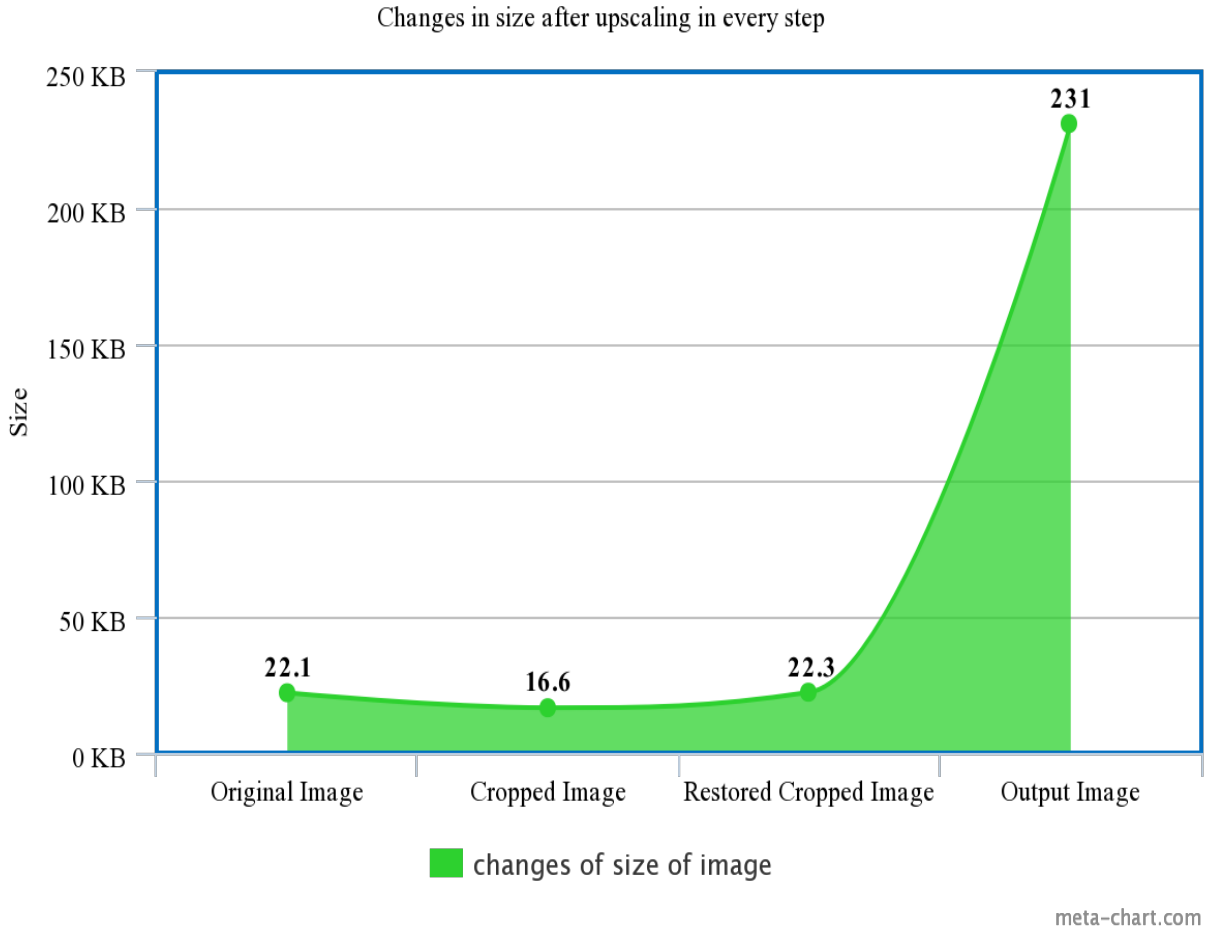


Fig. 3.2. Changes in size after upscaling in each and every step

"Fig. 3.2" represents an area chart where changes in size of image in every step is plotted in. The applied algorithm (DFDNet) upscale an image while restoring. By upscaling this algorithm segments the more detailed parts of the face like the multiscale 4 components (both eyes, nose, mouth) and easily compare and match those to the pre-trained high quality dataset. Then the face is detected and restored by predicting how the face of picture will look in clearer details. Here, in all 4 steps we determined the increment of size from 22.1 KB to 231 KB as shown.

3.4 Proposed Methodology

Face restoring technique from blur image has a vast area of application process or methodology. Considering some, we decided to apply the DFDNet algorithm and compare if it is efficiently better than most others or not.

In this algorithm, first an image is taken as test image from the TestWhole location of DFDNet, where some images are dataset for the method. Run the DFDNet algorithm in the Anaconda prompt of PC joining it to the ready environment to import all models of the algorithm well. Then the image is undergone through some steps.

- Consider 1st step, predict human face as comparison to reference based high quality pre-trained face dictionaries as raw dataset. Then after identifying, crop and align human face from full picture.
- While in 2nd step, recognize face from the image and landmark the multiscale components of face (left and right eyes, mouth, nose) similar in most people by upscaling each component.
- To 3rd step, restoring the face matching features to the reference dictionary.
- In 4th and last step, inputting restored image in the initial test image by pasting and get the final visible restored face as output.

This process helps in recovering degraded image to a high extent which is a good contribution to technology depended civilization.

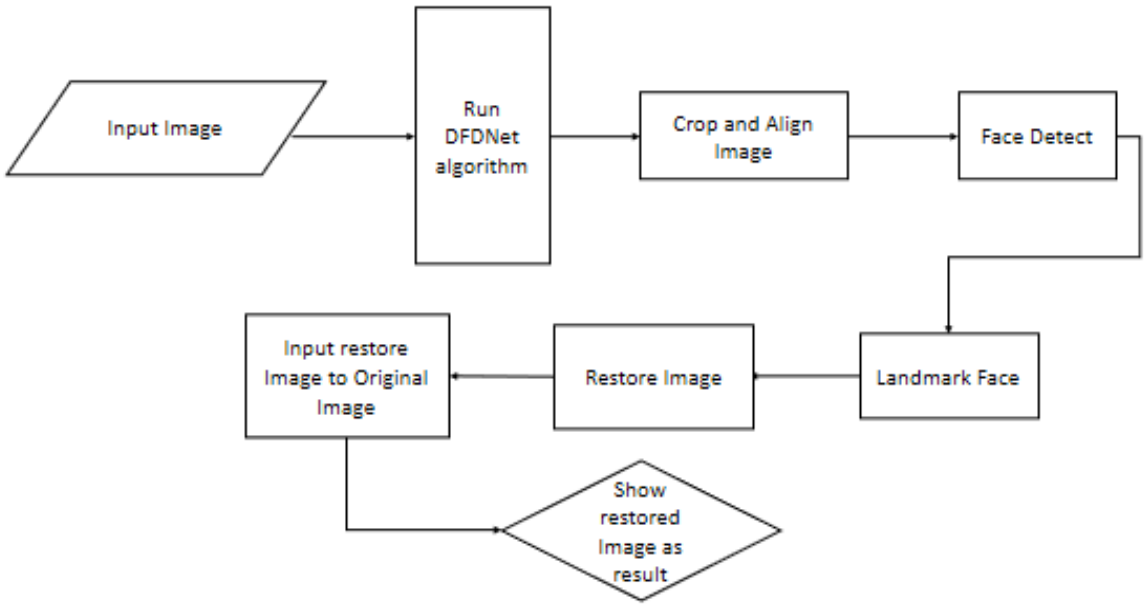


Fig. 3.3. Proposed Process Model

"Fig 3.3" shows the steps of processing of the algorithm to restore final output image from the input blur and degraded image.

3.4.1 Pseudocode: Image Restoration from Blur Environment using DFDNet

1: import all library

2: import checkpoints file

3: import face dictionary DictionaryCenter512

4: import all models in DFDNet algorithm

5: TestWhole ⟶ input test image

6: Run DFDNet algorithm

7: testImg[testImg1, testImg2, testImg3, ..]

8: face_detect ⟶ Predict human face by comparing to reference based face dictionary

9: crop_testImg 1,2,3.. ⟶ crop and align

10: ROIAlign_Img ⟶ segment multiscale components row wise to detect in details

11: upscale_Img ⟶ increase size

12: feature_match ⟶multiscale components and reference pre-trained face dictionary

13: testImg 1,2,3..⟶ Landmark face with multiscale components

14: testImg 1,2,3.. ⟶restoreImg

15: input restoreImg to testImg

16: show_result ⟶Face restored

17: end

The above *"Fig 3.3"* and pseudocode displays the applied mechanism of the algorithm.

CHAPTER 4
EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Experimental Results and Analysis

DFDNet is a reference-based method. Since the performance of reference-based techniques are mostly higher-up than other approaches, so in this research, we mainly apply this source based algorithm to repair low standard image into a high standard picture.

Here, we considered some degraded image as our dataset input and see the change of pixels and sizes of the image in output.

Step1: Input Image1

Step1: Input Image2

Step1: Input Image2

Step 2: Crop and Align

Step 2: Crop and Align

Step 2: Crop and Align

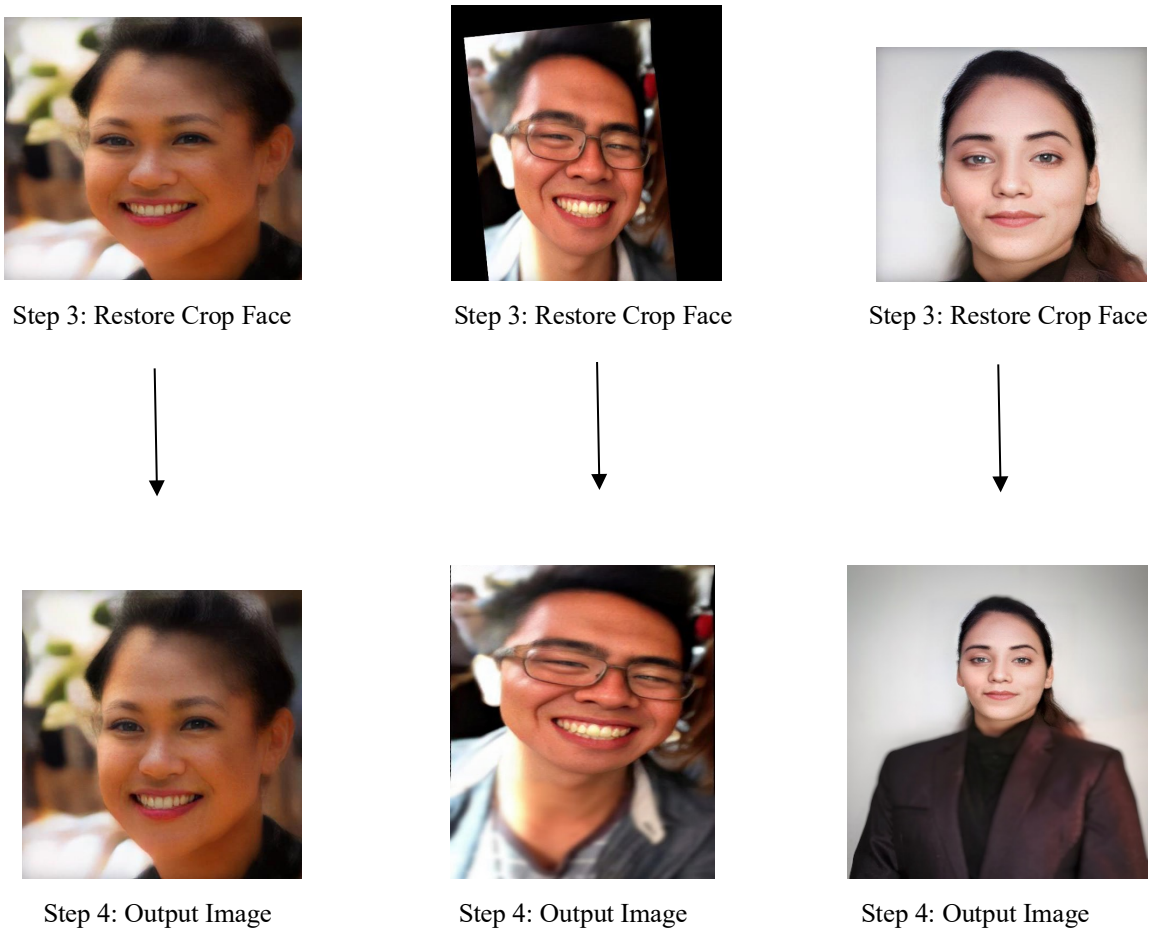


Fig. 4.1. Experimental Results

"Fig. 4.1" shows the output images in each of the four steps the algorithm integrates.

after loading the original input image. It is clearly explainable that here it shows that in 1st step, the input image is placed for reviewing. In the 2nd step, after predicting the face, the figure is cropped and only the face is selected for further processing and also aligned so that if any picture is not facing in the front then it will help aligning the picture in correct position. In the 3rd step, after landmarking the four multiscale featured components of face, the cropped picture of step 2 is restored. In the last and final step 4, the output image is received with face fully restored and deblurred. Here, we have considered 3 images to show the experimental results from the 50 sample datasets.

4.1.1 Result Analysis

"Fig. 4.1" shows that the degraded input image is blur and very low resolution. After that the process continues by cropping and aligning the image where upscaling is done and the size of the image is increased. After increasing the size, multiscale components (both left and right eye, mouth, nose) is landmarked in details so that easily the face can be restored pixel by pixel. Following this, the cropped face is restored where the size is large due to cropping. Finally the restored face is inserted in the input image and the output is find where the resolution is high as well as the size also increased.

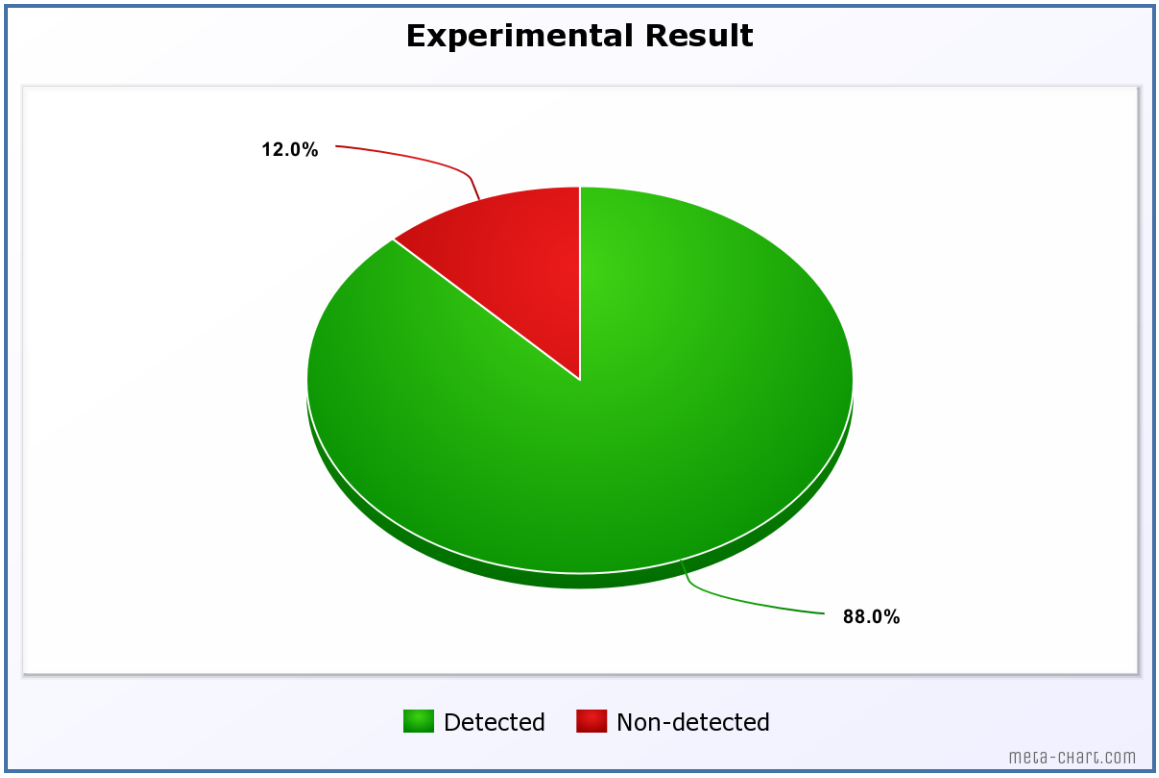


Fig. 4.2. Percentage of detected and non-detected face

"Fig. 4.2" From the pie chart, it can be seen that the number of face Detection rates is 88 percent after applying the algorithm DFDNet. Some of the image cannot be recognized because of after processing the image has still blur extent present in it. The non-detected part is 30 percent.

4.2 Discussion

In “Fig. 4.1” and “Fig. 4.2” it is explained how this algorithm works and the accuracy rate of the algorithm. It is shown that 88% of the face is detected applying the algorithm. Our applied procedure reach good accuracy applying three steps to work. Whereas some other techniques work in the whole blur of the image and can’t restore the main target sometimes due to focusing on other less important indexes; there our applied algorithm works mainly with the face part and so along the face is detected and restored efficiently easily.

CHAPTER 5
IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY

5.1 Impact on Society

Camera misfocus, noise, motion causes different types of blur containing different measurements. This kind of blur causes degradation of pictures and sometimes it become hugely essential to regain those pictures. We applied an algorithm to resolve this issue which has a brighter side in the contribution to society and environment. We expect that our approach will bring a good impact on the society. Now-a-days crimes have rose in our society, country a lot. While looking for those criminals, investigators search through CCTV footage or other camera photos. But is seen that in most cases those pictures are low resolution due to motion blur or far away capture. Then again wile finding any missing person, same things happen. Thus, there are many good contributions to the society. Pointing out the sectors of society where this approach contributes to:

- In legal sectors or criminal investigating branch
- In industrial privacy sector
- In biometrics sector
- Research area
- Development of technology sector
- Social Media algorithms

These are the main important sectors of society where image restoration technique or algorithm contributes to.

5.2 Impact on Environment

We believe our solution sets good impact on environment as well. As our approach helps in detecting criminals and eradicating or lessen up crimes from society, this surely helps in building positive and safe environment for people.

5.3 Ethical Aspects

This algorithm is 100% free of cost and open source which help the general people. It is the main ethics we are following on. Moreover, this solution doesn't take any personal information or identity belonging reference. Just taking the blur image, restores it. So, this approach will confirm the security and safety of all everyone.

5.4 Sustainability Plan

As this algorithm is 100% free, some donation from the government, top business parties or investors to execute the approach in different sectors is expected. If this approach is integrated in economical sectors of country, then a high probability foreseen from this project.

CHAPTER 6
SUMMARY, CONCLUSION, RECOMMENDATION AND IMPLICATION FOR FUTURE RESEARCH

6.1 Summary of the Study

Computer Vision is a vast area where blur image restoration is an essential part. In this paper, an efficient algorithm to detect and restore face from blur surrounding with almost 88% probability has been applied. Comparing with different other tactics, it is assured that to bring back a debased face of an image into real and high quality one, this algorithm performed noticeably with a great output rate. In this study, an algorithm which works in four steps by cropping, detecting, landmarking and then restoring image is applied. While restoring the image, pixel quality is increased and upscaling of size is done to clearly build up the image in details. And it is found that this algorithm focuses on mainly the face which is the target goal to be restored. Overall, this algorithm is a great contribution to research area.

6.2 Conclusions

Restoration cultiminates into enhanced visualization of the image. Blur detection, Image restoration from blurry environment, face detection in blur; all these are big sectors and top searched and worked on research or studies in the world now. So, a small endeavour to this sector can surely be a bigger beneficence to the digital developed world. Thus for this reason, in this paper, we applied a reference based Deep Face Dictionary Network (DFDNet) algorithm which worked more efficiently in four steps to revive image comparing to most other techniques, approaches and algorithms. Our main goal was to detect the face properly by restoring image and here using this algorithm this target is fulfilled. This algorithm mainly works on developing and improving human face from blur image. With bigger concept of development in various sectors, this approach has been applied.Test Images validate the accurateness of DFDNet in restoring both counterfeit and real world low resolution pictures.

6.3 Implications for Further Study

In this study, the algorithm which we applied have some limitations at present.

Limitations:

- It only works over human face because the pre-trained dataset used as reference high quality face dictionaries, includes only huma images.
- It can't work over very much far away low resolution image if the face is not clear since it mainly works aligning, landmarking, rebuilding the face.

Future Scope:

- We will develop a better efficient algorithm with prre-coached dataset of both human and animals.
- We will propose a new enhancement and face detection along with restoration technique which will be more productive in regaining high quality image from a low resolution one and deblur the whole image more clearly.

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