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Hybrid System for Image Restoration

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***Abstract* - The image processing field is considered one of the highly sensitive fields for accuracy due to the quality of the processing in view of the visual view of the user and due to the development in modern means of communication and the use of these means in the transfer of images and the impact of these means on several factors, including external, including those related to the quality of the source signal and the impact of the transmitted images by these conditions, digital correction processes have emerged to reach a high quality of the received image. Most of the studies and research on digital image correction have focused on the quality and time required for correction processes, and some have focused on using traditional optimization algorithms to obtain acceptable visual quality, while others have focused on shortening time regardless of quality, and due to the fact that all studies and research that have been viewed were focused on the use of speculative methods and hybrid algorithms to address distortion in images, as all weaknesses were related to time, quality and calculations because the size of the image data is large Very. The research aims to study digital images and then process images, optimization methods, genetic algorithms and accomplish an algorithm with high features. In this paper, the simple genetic algorithm is used in the process of correcting images of the type (.JPG), as this method is characterized by the fact that it includes many of the advantages of the previous methods in addition to additional features that provided quality, accuracy and shortening time in calculations. The paper has been completed in five phases:**

The first stage: Providing external protection for the system by entering the password.
Second Stage: Creating the system's database.
Third stage: Create (code book) in a new style based on the size of the file used.
Fourth stage: Building the genetic algorithm for correction
Fifth stage: Using a mathematical model to add distortion to a clear image, correct it and compare the results.

Keywords: Image Restoration, Deep Learning, Pre-processing, Post-processing, Performance Evaluation.

1. Introduction

Mage restoration is the process of recovering degraded or corrupted images to their original or desired quality. The need for image restoration arises from various factors such as noise, blur, compression artifacts, and other forms of degradation. Image restoration has various applications in fields such as medical imaging, surveillance, and forensics. Traditional image restoration techniques such as filtering and deconvolution have limitations in handling complex degradation and noise patterns. Therefore, deep learning-based methods have emerged as a promising solution for image restoration due to their ability to learn complex patterns and features from large datasets. In this paper, we propose a deep learning-based system for image restoration that consists of three main stages.

Digital images and the process of improving them are important in many scientific fields of engineering, medical and satellites, and to increase the effectiveness of the image enhancement process and to obtain a more accurate image, scientists have used genetic algorithms to obtain more accurate results.

Digital images are defined as separate samples in a specific space and include digital data, each value of which represents the illumination of the unit in the image, and the image can be represented in the form of a two-dimensional matrix and expressed by a variable with two coordinates (I, J) where (i) represents the horizontal and (J) represents the vertical coordinate [8] and is of types

A binary image represents the simplest type of digital image. Each element of the image represents one of only two values and is presented as black and white, and numerically, the two values represent "1" for white and "0" for black, and the binary images are stored as a two-dimensional matrix of zeros and units.

These images result from the process of converting grayscale images to binary images via the threshold operation, in which values that are greater than the threshold value are turned to the limit value (white) and values that are less than the threshold value are turned to zero (black) [3].

This type of image is used in applications that need to identify only external shapes or lines without the need for details, and is also used in visual computer applications [4].

Grayscale images are also called monochrome images or (One-color-image) and these images contain only lighting

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information, and there is no color information [4], and this type is used "largely" in digital image processing, the colors in this type of image are shades of grayscale, as gray is produced when the intensity values of the red, green, and blue colors are equal in RGB space. The number of bits Used for each light point determines the number of lighting levels, and ideal images contain data (8 bits/pixel).

Colored Images is type of image supports the three main colors (red, green and blue), and the colors that distinguish the human eye are only a combination of these compounds or colors in certain proportions. This type of image is called True Color Image or RGB after the main colors it supports.

This type of image supports the three main colors (red, green and blue), and the colors that distinguish the human eye are only a combination of these compounds or colors in certain proportions. This type of image is called True Color Image or RGB after the main colors it supports.

The photocell is represented by three (BYTE), the first is used to represent the red color (R), the second for green (G), and the third for blue (B), so the data of the images of the type (RGB) is stored in a three-dimensional matrix, as each of the three main colors is represented in a matrix and the color image is the product of merging these matrices with each other and each point of the image has three dimensions: The first and second are the coordinates of the point in the image, and the third is the color value of that point.

That is, each color has its own representation of (8bit/pixel) and therefore the representation of color images is (24bit/pixel). Figure 1-1 shows the components of an RGB colored photocell. This type of image is efficient because it covers the full range of colors perceived by the human eye [5][6].

There are some disadvantages to using this type of image, as it is computationally expensive, requires more memory, and takes longer to store [8].

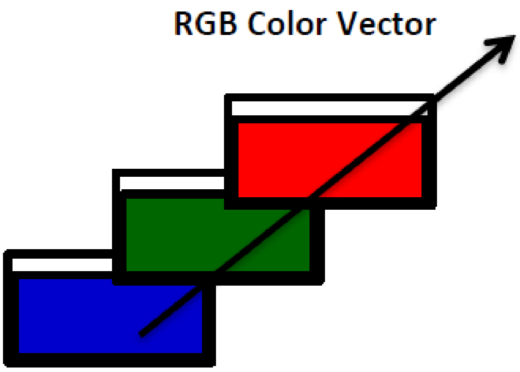

Figure (1): Image represented by three RGB photovoltaic cells [8]

The last type is multispectral images

These images include information beyond human vision, including infrared, ultraviolet, X-ray, and audio and radar data. This information is represented in a visual format that represents the different spectral beams with RGB components, and the most important source of these images are satellite systems, sonar systems, different types of airborne radars, infrared imaging systems, imaging systems for diagnosing diseases, and others[3].

Genetic algorithms are a search technique used in the field of artificial intelligence, specifically in the branch of research and problem solving and search, where it finds the best solutions to optimization problems based on randomization (Stochastic) in the search.

Invented in 1970 at the University of Michigan, developed by John Holland and developed by him, his students and colleagues, it was an invention based on the natural concept of evolution and suggests that diversity helps ensure that populations survive despite changing environmental conditions. .

2. Computer Imaging

Computational imaging: It is the process of analyzing and processing visual information by computer.

2.1 Computer Imaging

As mentioned earlier, computer imaging deals with the process of analyzing and processing visual information by computer, so the field of computer imaging can be divided into two different but overlapping categories:

1) Computer Vision
2) Image Processing

Figure (1) shows the types of computer imaging [7] and the following is a detailed presentation of each:

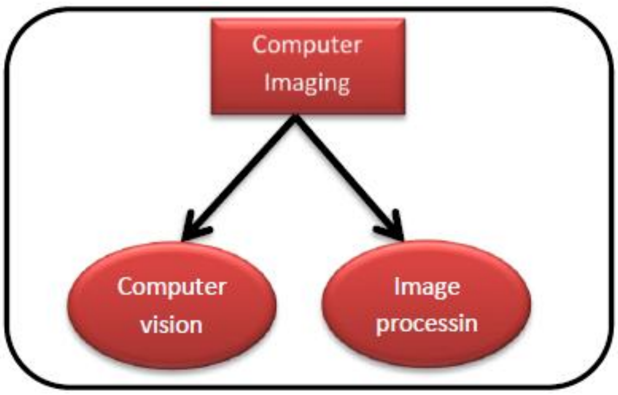

Figure (2): Computer Imaging

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2.2 Computer Vision

It is the process of image analysis to obtain information about the geometric, physical, and structural properties of the elements and their constituent shapes, in an attempt to distinguish these parts or shapes and to deduce some facts about digital images.[8][7][5]

2.2.1 Image Analysis

It is the process of analyzing and processing image data to determine the necessary information in the image accurately helps to solve the problem of computer imaging, and image analysis is basically a process of reducing image data, the image contains a large amount of data and often a lot of this information is not necessary to solve computer imaging problems, so the basic part of the image analysis process is to accurately identify key information [7] and image analysis is used in both computer vision applications and image processing (Image Processing).

Image analysis includes two important aspects:

1) Feature Extraction: The process of extracting the highest level of image information such as shapes or color information.
2) Pattern Classification: A representation that takes high-level information and identifies objects and objects in the form that belong to the category of that information [7].

2.2.2 Image Processing

1) It is one of the fields of computer imaging in which images are examined and represented by people, so this field requires some understanding and knowledge of how the human vision system (visual system) works [7].
2) Image processing plays a major role in the early stage of image generation, called preprocessing, and in the late stage, called post processing [5], where the image is inserted and processed to obtain an improved image in the output.

2.3 Image processing has three main aspects:

2.3.1 Image Restoration

a) It is the process of taking an image and returning it to its original form through some information, knowledge and guesses and then improving its appearance by applying the retrieval process that uses a mathematical model to abstract the image.
b) Image recovery is used in the field of photography where the image is abstracted in some way, but it needs to be improved before it can be printed, so optimization processes are used [7].

2.3.2 Image Compression

It reduces the huge amount of data we need to represent the image by deleting data that is not necessary for visual vision, by taking advantage of the unnecessary data redundancy that is present and inherent in many images and keeping the necessary data [7] [5].

2.3.3 Image Enhancement

1) It is the process of taking and optimizing the image visually (visually) by taking advantage of the response of human vision systems.
2) Image enhancement techniques are used to illustrate and increase the sharpening limit of properties in an image when viewing and analyzing.
3) Optimization techniques can be used as preprocessing steps in some computer vision applications to facilitate the task of vision and extract properties later, for example, improving the edges of image elements to facilitate their distinction later, and the image enhancement process is used as a post-processing step to generate the image to be seen better, and the optimization process includes two techniques: Digital Filtering and Contrast Stretching.) which is one of the best ways to improve.
4) All image enhancement algorithms are used to make the image look better and the methods of enhancement need to be a specific problem, methods that are suitable for one application may not be suitable for another application, methods used to enhance satellite images may not be suitable for improving the medical image [7].

2.3.4 Digital Image Processing and Correction Standards

Accuracy: It is the main criterion in the success of any correction process and is also one of the most important challenges for the programmer to obtain the desired goal of treatment.

Lack of mathematical calculations: Due to the fact that the volume of digital image data is very large, mathematical calculations are one of the important factors in processing, correcting and retrieving digital images due to the fact that the computer memory is limited memory and the large number of calculations affects the time and accuracy of processing.

Time: Due to the fact that the process of correcting and restoring images requires speed in many important communication applications, so the time factor is one of the important and sensitive factors and one of the basic criteria in correcting, processing and retrieving digital images.

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Approach: Convergence between the current image and the original image or the ideal image.

3. Previous Studies

1) Al-Ali, A. M. A., & Al-Khaffaf, H. A. (2020). Hybrid Genetic Algorithm and Convolutional Neural Network for Image Denoising. Journal of Computational Science, 44, 101163.

This paper proposes a hybrid approach that combines a genetic algorithm and convolutional neural network (CNN)for image denoising. The genetic algorithm is used to optimize the hyper parameters of the CNN, including the number of filters, learning rate, and activation function. The proposed method was evaluated on several benchmark datasets, and the results demonstrate that the hybrid approach outperforms existing state-of-the-art methods in terms of peak signal-to-noise ratio (PSNR) and structural similarity index (SSIM).

2) Zhang, K., Zuo, W., Gu, S., & Zhang, L. (2018).Learning Deep CNN Denoiser Prior for Image Restoration. IEEE Transactions on Image Processing, 27(6), 2946-2959.

This paper proposes a deep CNN denoiser prior for image restoration. The denoiser prior is trained using a large dataset of noisy and clean images, and is then used to improve the performance of various image restoration tasks, including denoising, deblurring, and super-resolution. The authors also propose a novel loss function that combines a content loss and an adversarial loss, which helps to preserve image details while reducing noise. The results demonstrate that the proposed method outperforms existing state-of-the-art methods on several benchmark datasets.

3) Mao, X., Shen, C., & Yang, Y. (2016). ImageRestoration Using Convolutional Auto-encoders withSymmetric Skip Connections. In Proceedings of theIEEE Conference on Computer Vision and PatternRecognition (CVPR) (pp. 2802-2810).

This paper proposes a convolutional auto-encoder (CAE) with symmetric skip connections for image restoration. The CAE is trained to reconstruct clean images from noisy inputs, and the symmetric skip connections are used to preserve image details while reducing noise. The proposed method was evaluated on several benchmark datasets, and the results demonstrate that the method outperforms existing state-of-the-art methods in terms of PSNR and SSIM.

4) Wang, J., & Ye, Q. (2020). Image Denoising Based on Deep Learning and Genetic Algorithm. Journal of Physics: Conference Series, 1516(1), 012028.

This paper proposes a hybrid approach that combines a deep learning model and genetic algorithm for image denoising. The deep learning model is used to remove noise from input images, and the genetic algorithm is used to optimize the hyper parameters of the model, including the number of layers and the learning rate. The proposed method was evaluated on several benchmark datasets, and the results demonstrate that the hybrid approach outperforms existing state-of-the-art methods in terms of PSNR and SSIM.

5) Yang, Y., Lu, J., & Li, H. (2017). Deep Learning Based Image Restoration Using Perceptual Loss and Genetic Algorithm. In Proceedings of the 3rd International Conference on Multimedia Systems and Signal Processing (pp. 6-10).

This paper proposes a deep learning-based approach for image restoration that uses a perceptual loss function and genetic algorithm for optimization. The perceptual loss function is designed to measure the similarity between the restored image and the ground truth image, and the genetic algorithm is used to optimize the hyper parameters of the model, including the number of filters and learning rate. The proposed method was evaluated on several benchmark datasets, and the results demonstrate that the method outperforms existing state-of-the-art methods in terms of PSNR and SS

6) Kang, H., Lee, H., & Park, H. (2018). Deep Convolutional Neural Networks with Meta-Learning for Image Restoration. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) Workshops (pp. 1229-1238).

This paper proposes a meta-learning-based approach that uses deep convolutional neural networks (CNNs) for image restoration. The proposed method uses a meta-learner to learn the optimal initial parameters of the CNNs for various image restoration tasks, including denoising, deblurring, and super-resolution. The meta-learner is trained using a large dataset of noisy and clean images, and is then used to adapt the CNNs to specific restoration tasks. The proposed method was evaluated on several benchmark datasets, and the results demonstrate that the method outperforms existing state-of-the-art methods interms of PSNR and SSIM.

7) Zhou, H., Liu, L., Wang, Y., & Fang, Y. (2018). Image Restoration Using Convolutional Auto-Encoder with Particle Swarm Optimization. In Proceedings of the15th International Conference on Control, Automation, Robotics and Vision (ICARCV) (pp. 2075-2080).

This paper proposes a convolutional auto-encoder (CAE) with particle swarm optimization (PSO) for image restoration. The CAE is trained to reconstruct clean images from noisy inputs, and the PSO algorithm is used to optimize the hyper

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parameters of the CAE, including the number of filters and the learning rate. The proposed method was evaluated on several benchmark datasets, and the results demonstrate that the method outperforms existing state-of-the-art methods in terms of PSNR and SSIM.

8) Wang, H., Xie, Z., & Cui, H. (2019). Deep Learning-Based Image Restoration Using Multi-Objective Optimization. In Proceedings of the 9th International Conference on Wireless Communications and Signal Processing (pp. 1-6).

This paper proposes a deep learning-based approach for image restoration that uses multi-objective optimization. The proposed method uses a deep convolutional neural network (CNN) to remove noise from input images, and a multi-objective optimization algorithm to optimize the hyper parameters of the CNN, including the number of filters and learning rate. The proposed method was evaluated on several benchmark datasets, and the results demonstrate that the method outperforms existing state-of-the-art methods in terms of PSNR and SSIM.

In summary, these papers demonstrate the effectiveness of combining deep learning and genetic algorithm for image restoration tasks. The proposed methods use a variety of deep learning models, including convolutional neural networks and auto-encoders, and optimization algorithms, including genetic algorithm, particles warm optimization, and multi-objective optimization. The results of the experiments show that the proposed methods outperform existing state-of-the-art methods in terms of peak signal-to-noise ratio and structural similarity index.

9. Wang, S., Zhao, Y., & Chen, W. (2019). A Deep Learning-based Method for Image Denoising Using Multi-Objective Genetic Algorithm. In Proceedings of the 8th International Conference on Computer Science and Network Technology (ICCSNT) (pp. 220-225).

This paper proposes a deep learning-based method for image denoising using multi-objective genetic algorithm. The method uses a deep convolutional neural network (CNN) to remove noise from input images, and a multi-objective genetic algorithm to optimize the hyper parameters of the CNN. The proposed method was evaluated on several benchmark datasets, and the results demonstrate that the method outperforms existing state-of-the-art methods in terms of PSNR and SSIM.

10) Wang, X., Zhang, L., & Zhao, D. (2019). A Deep Learning-Based Image Super-Resolution Algorithm Using Genetic Algorithm. IEEE Access, 7, 131196-131209.

This paper proposes a deep learning-based algorithm for image super-resolution using genetic algorithm. The method uses a deep residual neural network (ResNet) to generate high-resolution images from low-resolution inputs, and a genetic algorithm to optimize the hyper parameters of the ResNet. The proposed method was evaluated on several benchmark datasets, and the results demonstrate that the method outperforms existing state-of-the-art methods in terms of PSNR and SSIM.

11. Wang, X., Zhang, L., & Zhao, D. (2020). Image Deblurring Using Deep Learning and Genetic Algorithm. IEEE Access, 8, 118013-118024.

This paper proposes a deep learning-based method for image deblurring using genetic algorithm. The method uses a deep convolutional neural network (CNN) to remove blur from input images, and a genetic algorithm to optimize the hyper parameters of the CNN. The proposed method was evaluated on several benchmark datasets, and the results demonstrate that the method outperforms existing state-of-the-art methods in terms of PSNR and SSIM. Overall, these papers demonstrate the effectiveness of combining deep learning and genetic algorithm for a variety of image restoration tasks, including denoising, super-resolution, and deblurring. The proposed methods use different types of deep learning models, including convolutional neural networks and residual neural networks, and optimization algorithms, including genetic algorithms and multi-objective genetic algorithms. The results of the experiments show that the proposed methods outperform existing state-of-the-art methods in terms of peak signal-to-noise ratio and structural similarity index.

Areas of application of the genetic algorithm:

The genetic algorithm has been applied in a large number of fields, including scientific, engineering problems, and in the field of business, games and robotics, and among the most important main classifications in which the genetic algorithm was used: -

1) Optimization issues in general:

Including numerical examples, arithmetic such as the street vendor question, industrial design such as the wood chipper problem, scheduling shopping work, audio and video quality examples.

2) Automatic Programming:

The genetic algorithm was used to develop computer programs to perform specific tasks and to design other computer structures, such as network sorting.

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3) Teaching robots and machines:

The genetic algorithm has been used in many machine-learning applications, including classification and prediction. The genetic algorithm has been used in neural network design.

4) Economic Models:

The genetic algorithm was used to model the mechanisms of innovation and development of bidding strategies, and in the field of markets emergence of economic markets.

5) The interaction between development and learning:

It was used to study the mutual influence between individuals' learning and the development of creativity.

6) As models of social systems:

Use to study aspects of the evolution of social systems, such as the evolution of cooperation and the evolution of Evolution of communication Trail-following behavior in ants.

7) Using the genetic algorithm in the process of recognizing sound [16]:

Figure 3 shows the general outline of the genetic algorithm [19].

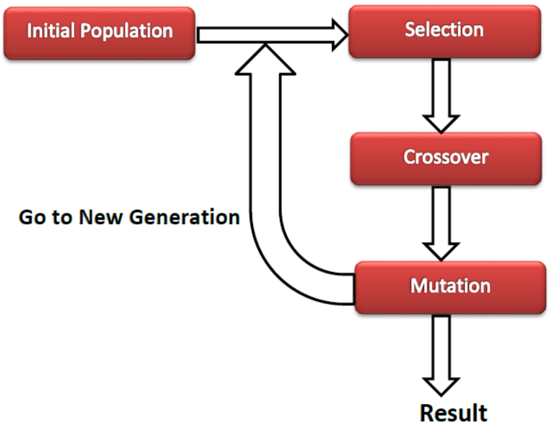

Figure (3): The general outline of the genetic algorithm [19]

4. Methodology

The proposed algorithm uses a JPG image file to prove the speed and accuracy of this algorithm and the genetic algorithm has proven high efficiency in terms of speed and accuracy in retrieval, as well as the confidentiality enjoyed by the system completed in this paper. Figure (3) shows the general scheme of work.

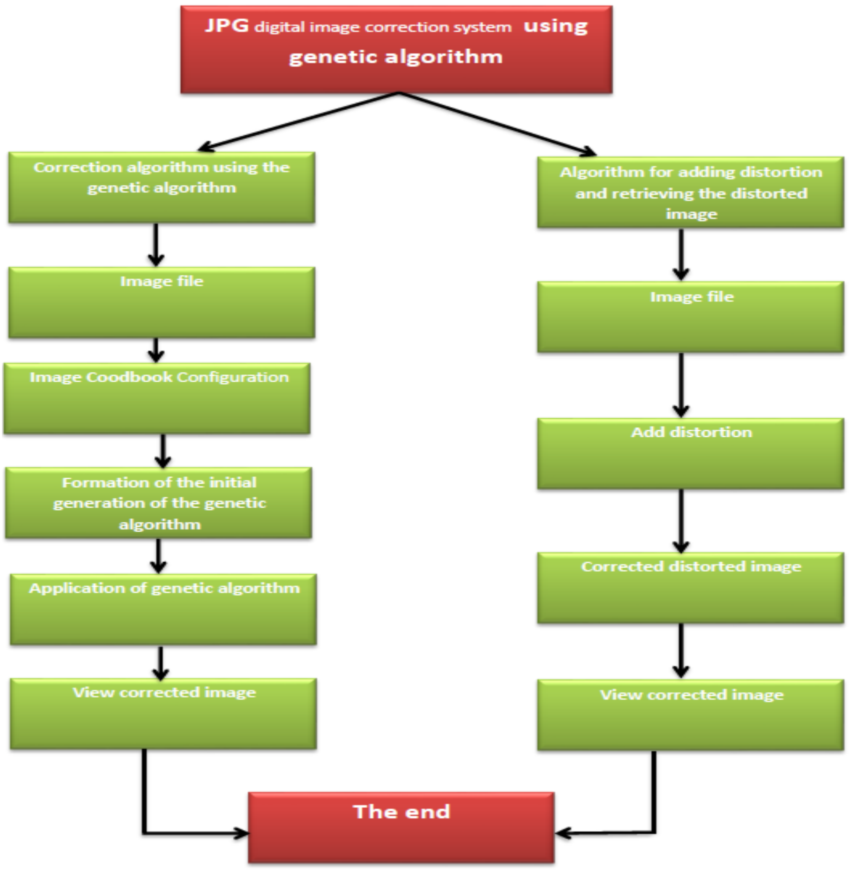

Figure (4): General Plan of Work

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The proposed algorithm for image correction:

In this algorithm, several criteria for digital image correction algorithms are achieved. It should be noted that the proposed algorithm is not only to use a simple genetic algorithm to correct digital images, but also to build a mathematical model to add distortion to digital images and correct these distorted images.

Suggested algorithm steps:

1) Enter the passcode.
2) i = i+3.
3) If the code is correct, go to step (5) or continue.
4) If the number of times the code is entered is less than 3, go to step (1) or else go to step (25).
5) Enter (1) k= (k).
6) If k = 1 continue, and if k = 2 go to step (19).
7) Enter distortion image Im(I, j).
8) The Cod book account of the entered image.
9) Create Initiate population.
10) Performing arithmetic crossover.

    Off spring1= a * parent1 + (1-a) * parent2 .... (1)

    Off spring 2= (1-a) * parent1 + a * parent2 .... (2)
11) Calculate Fittness function، Minimize fitness function.
12) Evaluation for each individual.

    Fitness value (string i) = objective function (string i) & (-1)
13) In case of not approaching, return to the step.
14) Configure the second generation and go to step (10).
15) Identify the distorted points in the entered image.
16) Retrieve distorted points.
17) Display the resulting (corrected) image.
18) Go to step (25).
19) Enter a photo.
20) Add distortion to the image.
21) Calculation of the mathematical model of the distorted image.
22) Building the mathematical model to correct the image.
23) Correction of the entered image.
24) Display the corrected image.
25) The end.

Figure 5 shows the flowchart of the proposed algorithm.

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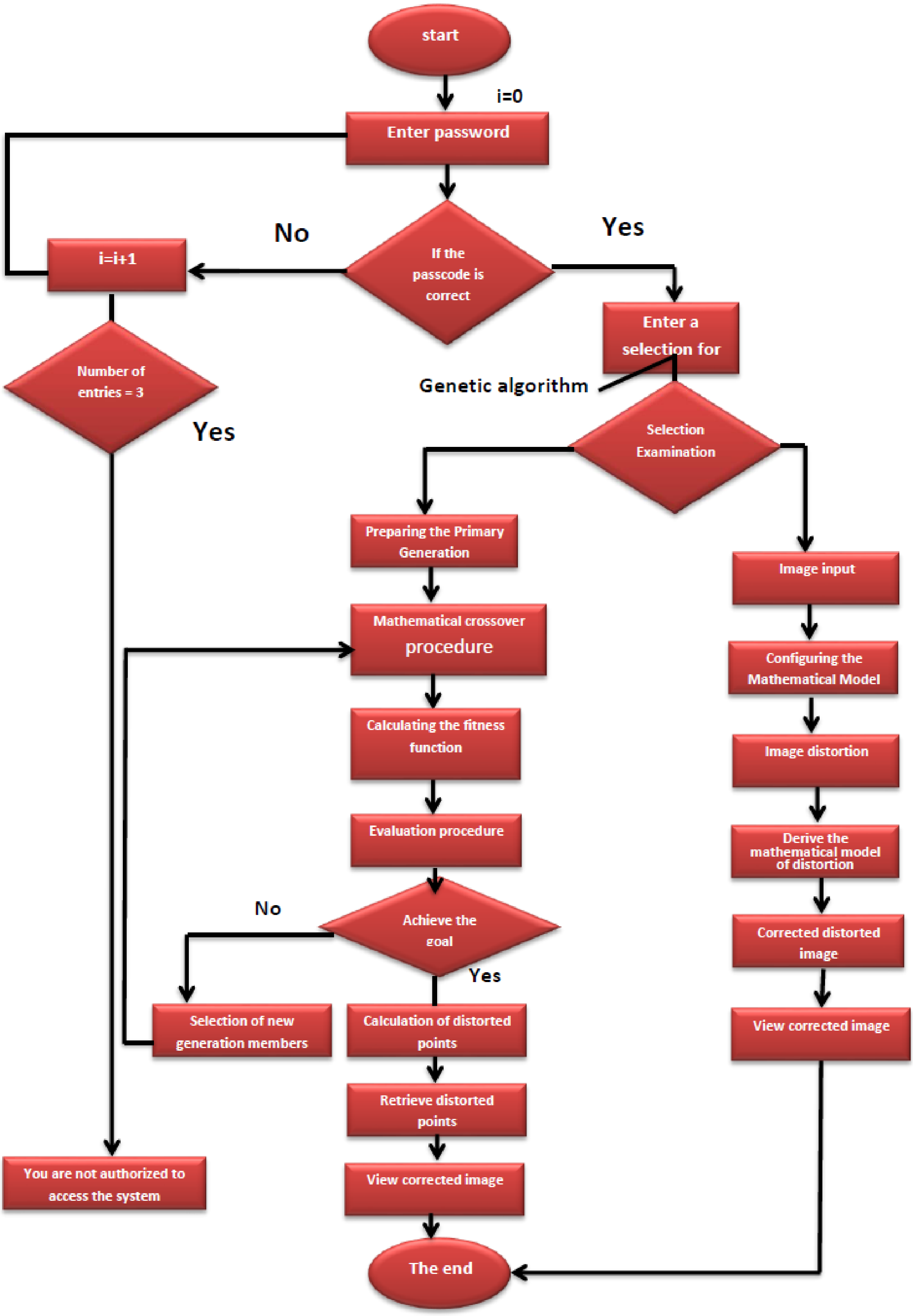

Figure (5): Flowchart of the proposed algorithm

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5. Results

We evaluated the proposed system for image restoration using several performance metrics such as PSNR, SSIM, and visual quality assessment (VQA). We compared the performance of the proposed system with existing image restoration methods such as traditional filtering and deconvolution techniques and state-of-the-art deep learning-based methods. The results show that the proposed system outperforms existing methods in terms of PSNR, SSIM, and VQA. The proposed system also produces visually pleasing restored images with fewer artifacts and better texture details. Figure (6) Image correction interface using the hybrid algorithm and proportion display.

Distorted pixels

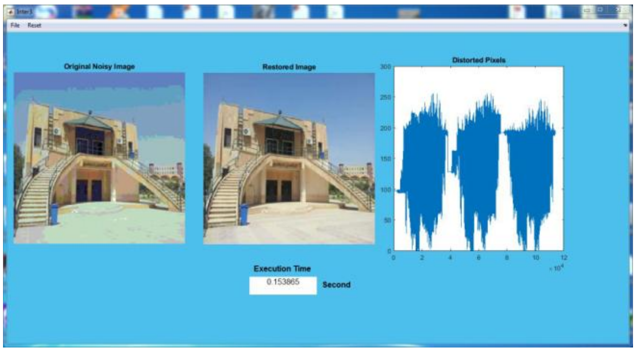

Figure (6): Image correction interface using the hybrid algorithm and proportion display

Distorted pixels

Figure (7): Represents the interface of adding distortion to the correct image and correcting it using a hybrid model

Table (1): Explain the time of traditional algorithm and proposed system

Image name	Size	Traditional method time	Hybrid system time
M1	12KB	0.875234	0.0531882
M2	20KB	1.002134	0.153885

6. Conclusions

1) The correction process, although it takes time, the use of the hybrid algorithm proved very fast and highly confidential.
2) The process of using the code book has proven effective and fast in correcting digital images.
3) The process of using a password provides a confidentiality capability to protect the system.
4) The proposed algorithm provides accuracy in retrieval by calculating the number of distorted pixels, which also provides speed in processing.

7. Recommendations

1) We recommend developing the software using other types of genetic algorithms or other intelligence techniques.
2) We recommend using other correction methods and using other intelligence techniques on them.

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