The effectiveness of the Hermite wavelet discrete filter technique in modify a convolutional neural network for person identification

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ABSTRACT

Classification is of great importance in the field of image processing, and convolutional neural networks (CNNs) have achieved great success in this field. Although CNN has proven to be a powerful technology for image recognition problems, it has failed in complex situations involving many real-world applications (for example, visual monitoring and automated driver assistance). Where it is difficult to detect a human in a series of images for various reasons. One of these reasons is the difference in the size of the human body, the height of the platform to which the camera is attached during the task of capturing accurate images, and the short training time in using the cameras, all of which are important factors to consider for the robustness and effectiveness of the human classification system. In this paper, a new deep CNN-based learning model is designed based on a new discrete waveform transformation (DWT) derived from discrete Hermit wavelet transform (DHWT) instead of modular wavelet, and the second stage is to train the convolutional neural network Hermit wavelets (HWCNN) is the most accurate and efficient deep learning.

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1. INTRODUCTION

Wavelets have a great role in image processing through computer vision [1]-[4], such as compression [5]-[8], noise reduction, and image retrieval without losing the original image qualities [9]-[12]. This helped to identify faces and engineering and scientific applications because they are characterized by very important features which are the frequencies and time-dependent [13]-[15]. The mathematical aspect and the flexibility that characterizes the wavelets that help simplify dealing with them [16]. The mother function that builds the mother wavelet is one of the basic wavelets that have been used in many fields and applications, including Haar, Meyer, and Morletetc [6], which is able to analyze data with high accuracy, better than sine and sine functions because of its dependence on frequency and time and not only on frequency [17].

Feeder neural networks can be replaced by new wavelets to mitigate the weaknesses generated by wavelet analysis with neural networks without losing the advantages of the proposed method [18]. It is considered that the wave networks are the ones that combine the sigmoidal neural networks [19]. Wavelet networks in the recent period have received great attention and achieved success in scientific applications such as engineering, security, finance, signal processing through compression and noise lift [20]. There are non-linear dynamic applications that are not underestimated [21]-[24].

One of the important reasons for using wavelet transformations are the influences responsible for the contraction and expansion have given by the ripple characteristic that are able to compress and calculate the local scale of the function at one point responsible for the small coefficients that make up the lattice wavelets [25], [26].

In this work, new wavelets derived from the Hermit polynomial are applied, which are being worked on in the discrete wavelet neural modeling and the convolutional neural network in person detection. Four samples were used to conduct the experiment to get better results than if the selection was without new wavelets. Examples and results show the role of the new wavelet algorithm The proposed construction of wavelets and their use in identifying people has proven its efficiency in obtaining the best results with the use of the MATLAB program in programming the proposed algorithm The Figure 1 represents the samples that were used to implement the proposed algorithm in this work, in which the wavelets of the convolutional neural network (CNN) were used and compared with the ordinary CNN, and it was called in this work the modify Hermit wavelets convolutional neural network (HWCNN).

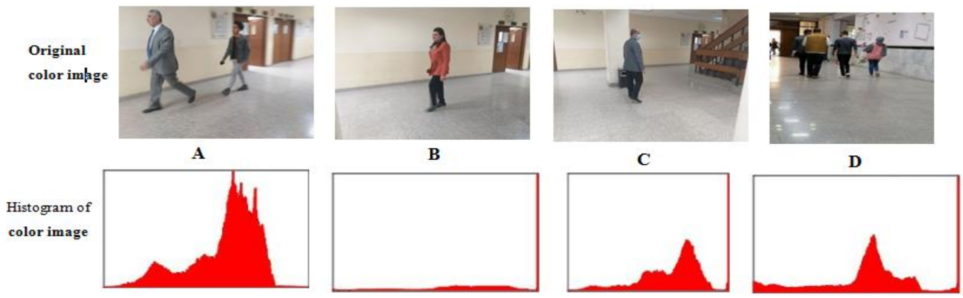

Figure 1. Represents the samples that were used to implement the proposed algorithm

2. METHOD

In this work, the details of the discrete wavelet generation (DHWT) of the image are analyzed to approximate the coefficients and the detailed coefficients, then the image is divided into four parts LL, LH, HL and HH, and the LL part is selected after compression and noise removal and inserted into the reflected wave convolutional neural network (RWCNN) directly through the results that were reached by adopting the samples that were dealt with. Figure 2 shows the application of the theory, the proposed method, and the stages that will occur in this work. In the proposed methodology, preprocessing was used to improve the image quality as well as remove noise from the images. In the third stage, the new network is used to classify the images and compare the results between the normal convolutional neural network and the developed convolutional neural network.

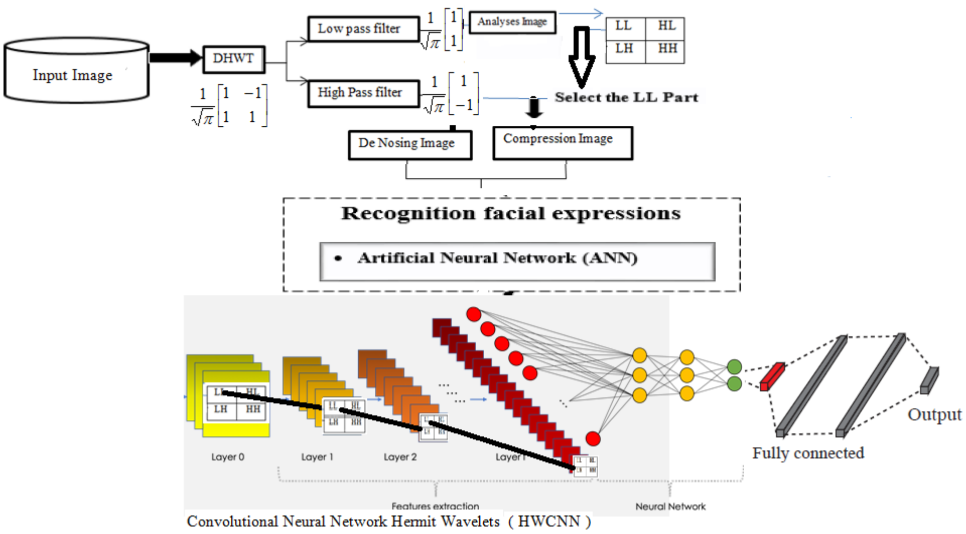

Figure 2. The stages that will take place in this work

2.1. New discrete wavelet transform (NDWT)

Building the new wavelets on the basis of the mother wavelets in which the two influencers (e, f) have a significant impact on the wavelet movement in terms of contraction and extension responsible for the analysis process in (1).

$$\Psi_{e,f}(x) = e^{\frac{-1}{2}} \Psi\left[\frac{x-f}{e}\right] \; e, f \in R, e \neq 0 \quad (1)$$

$$\Psi(t) = [\,\Psi_0(t),\, \Psi_1(t) \ldots \Psi_{M-1}(t)]^T$$

The factors in the above vector are called orthogonal base functions of the period $[0,1]$.

Let dilation by parameter $= 2^{-k}$, translation by parameter $f = \big(e(2s-1)\big)$ and transform $x = e(2e^{-1}t)$, in (2) a, b are parameters by rotation and transformation into the variable x, in (1). DHWT $\Psi_{n,m}(t) = \Psi(k, s, r, t)$ include four parameters, $s = 1,2, \ldots, 2^k$ here the degree of Hermite polynomials are denoted by the symbol m, k any positive constant, the independent variable t is time in $[0,1]$.

$$\Psi_{s,r}(t) = \begin{cases} 2^{\frac{k}{2}} \Psi_r^*(2^{k+1}t - 2s + 1) & t \in \left[\frac{s-1}{2^k}, \frac{s}{2^k}\right] \\ 0 & otherwise \end{cases} \quad (2)$$

where $\Psi_r^* = \frac{1}{2^r r! \sqrt{\pi}} \Psi_r$ (3)

$$r = 0,1,2, \ldots, M-1 \; s = 0,1,2, \ldots, 2^k$$

The new filter resulting from these new wavelets, which led to facilitating the task of these wavelets in the field of color image processing. The filter produced by the new wavelets after performing operations multi-resolution analyses (MRA) with approximate coefficients and details coefficients and in processing a color image of compression and de noising it.

$$(2 \times 2)F = \frac{1}{\sqrt{\pi}} \begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix}$$

For example, sample A was taken and after analyzing this sample it was found that it contains noise which leads to not getting good results but after processing and raising the noise using the new filter in Figure 3 as well as the same for image compression, which will lead to very significant improvement in results in the following sections. The new discrete Hermit wavelet transform (NDHWT) analyzes the image that was used in compression and the quality of the resulting image has been tested by obtaining quality standards they are mean square error (MSE), peak signal for noise ratio (PSNR), bit per pixel (BPP) and compression ratio (CR).

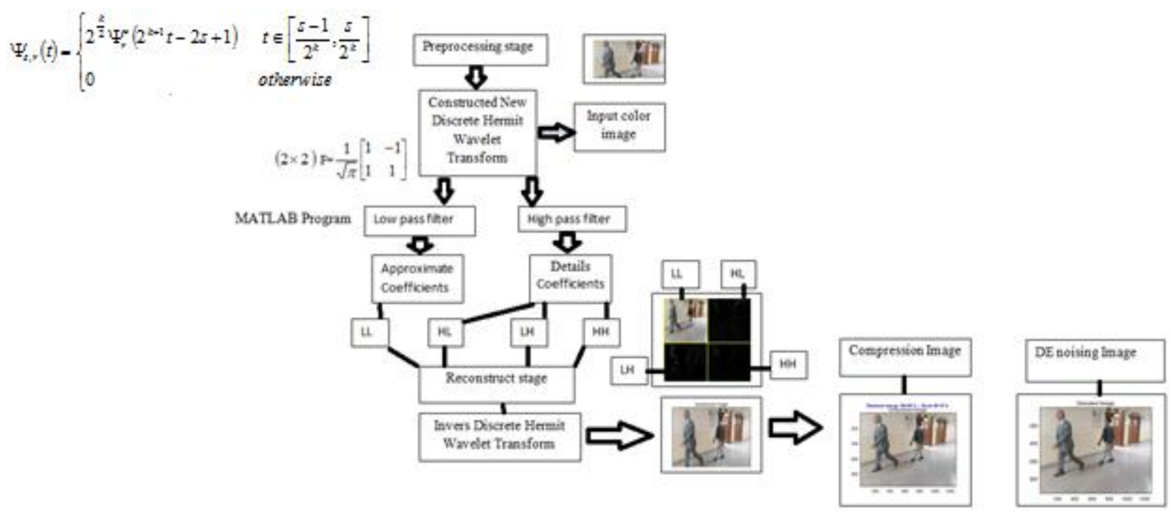

Figure 3. demonstrates the effectiveness of the new filter derived from the new wavelet, so that the image is analyzed within a phase MRA

MSE is a standard for the quality of the resulting image, which It is the amount of changes and differences between the original image and the image obtained [10].

$$MSE = \frac{1}{XY}\sum_{r=1}^{X}\sum_{s=1}^{Y}\left(M_{ij} - N_{ji}\right)^2$$

The PSNR is the perceptual quality of the resulting image over the noise value [11], [13]:

$$PSNS = 10log_{10}\left(\frac{255^2}{MSE}\right)$$

1- Compression ratio (CR) is:

$$CR = \left(1 - \frac{Y}{X}\right) \times 100$$

Y: Represents the number of pixels in the new image after pressing
X: Represents the number of pixels of the image before the compression process
Bit per pixel (B.P.P) which shows the number of bits per stored pixel of the image BPP is 8 bits [10]-[13].

$$BPP = \frac{\text{Compressed image size in bits}}{\text{Total number of pixels in the image}}$$

After designing a new learning model based on the CNN based on the new discrete wavelet transform (DWT) derived from the DHWT instead of the standard wavelet, the second stage is to train the HWCNN is the most accurate, efficient and reliable deep learning algorithm instead of fully connected neural network (FCNN). In the proposed methodology, pre-processing has been used to improve image quality as well as remove noise from images, The new image was obtained after removing the noise and compressing the image using the new waves, so that the trained DCHWT network was equipped to recognize people using the HWCNN. Table 1 shows the most important readings for the quality of standards that have been approved using DHWT.

Table 1. The most important readings for quality standards using DHWT

Compressed samples	Mean squared error (MSE)	PSNR	Bit per pixel (BPP)	Compression ratio (CR)
	0.8282	48.95	8,964	37.35%
	1.582	46.14	5,4338	22.64%
	0.688	49.76	8,739	36.41%
	1.517	46.32	11,0116	45.88%

2.2. Hermit wavelets convolutional neural network (HWCNN)

The neuron is the unit the building block of the artificial neural network that does the work of the human brain. It receives external information, which is called the input. Between every two cells, there is a connection point called the weight that generates the layers. As for the wavelets, as mentioned, they are similar to the neural network of the first layer and then move to the hidden layer to be a number of layers. The wavelets form the neural network in the output stage. When these wavelets are activated to avoid these restrictions, the role of the HWCNN appears to deal with the input image in general and identify people in particular. A new filter has been defined for each pixel that matches the number of channels of the color image derivation of the new filter resulting from the integrals of functions from DHWT in (2) Filter (3×3) is obtained after relying on operators (s,r) in same equation called Hermit filter (HF) with dimension HF= (HF, HF, number of channels) then the color image has three channels the squared filter denoted by HF and the odd dimension denoted.

R the convolution as shown in:

$$C(I,HF)_{x,y} = \sum_{r=1}^{n_H}\sum_{s=1}^{n_W}\sum_{R=1}^{n_C} HF_{s,r-R} I_{x-s-1,y+r-1,R} \quad (4)$$

$$dim\big(C(I,R)\big) = \left(\left[\frac{n_H+2P-FH}{S}\right]+1\right) \quad (5)$$

will be take $S = 1$ in (5) will be (6).

$$(n_H + 2P - FH, n_W + 2P - FH) \quad (6)$$

The floor function is denoted [n] to calculate the output size for n $P = 0$ then $P = (F-1)/2$ for the convolutional neural network if $F = 1$ mean that 1×1 Convolution. Highlight the image by stretching and shrinking to effect ($[m_H, m_W]$) to maintain the number of channels with the new filter with dimensions image (m_H, m_W).

$$dim\big(P(I,K)\big) = \left(\left[\frac{n_H+2P-F}{S}+1\right],\left[\frac{n_W+2P-F}{S}+1\right]\right) \; S > 0; \quad (7)$$

If $S = 1$ as shown in (7) will be (8).

$$(n_H + 2P - F, n_W + 2P - F, n_C) \quad (8)$$

HWCNN has a role in reducing the number of layers in Figure 4.

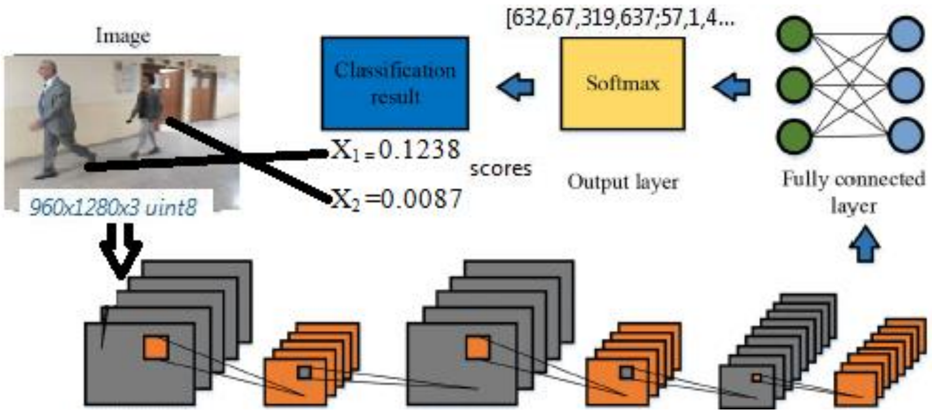

Figure 4. Represents the effectiveness HWCNN on the input image

2.3. Person detection based HWCNN

After improving the quality of the image and removing the noise, the classification is used to train the networks with the wavelets that were used in the initial processing stage and to obtain the new image so that the convolutional neural network is projected through which to identify the people. In this section, the effectiveness of the method proposed in this work is presented and summarized in Algorithm 1. Figure 5 shows the efficiency of the proposed algorithm and the effectiveness of HWCNN with the new Hermite wavelet effect DHWT.

Algorithm 1. Person detection with HWCNN

```
Input color Image
Step 1: By using the new wavelet DHWT and passing it on the color image, it will be analyzed
        to the basic channels RGB with the effectiveness of the new filter, the color image
        will be analyzed in MATLAB program
Step 2: Image compression and noise removal the purpose of this is to reduce image data to
        show the role of new wavelets
Step 3: Training a neural network to be convolutional programming in MATLAB and this stage
        is the classification
Step 4: After the classification process, the person and the size of the image matrix are
        determined in order to record the readings and results that the proposed theory has
        proven its efficiency
Output Person Detection
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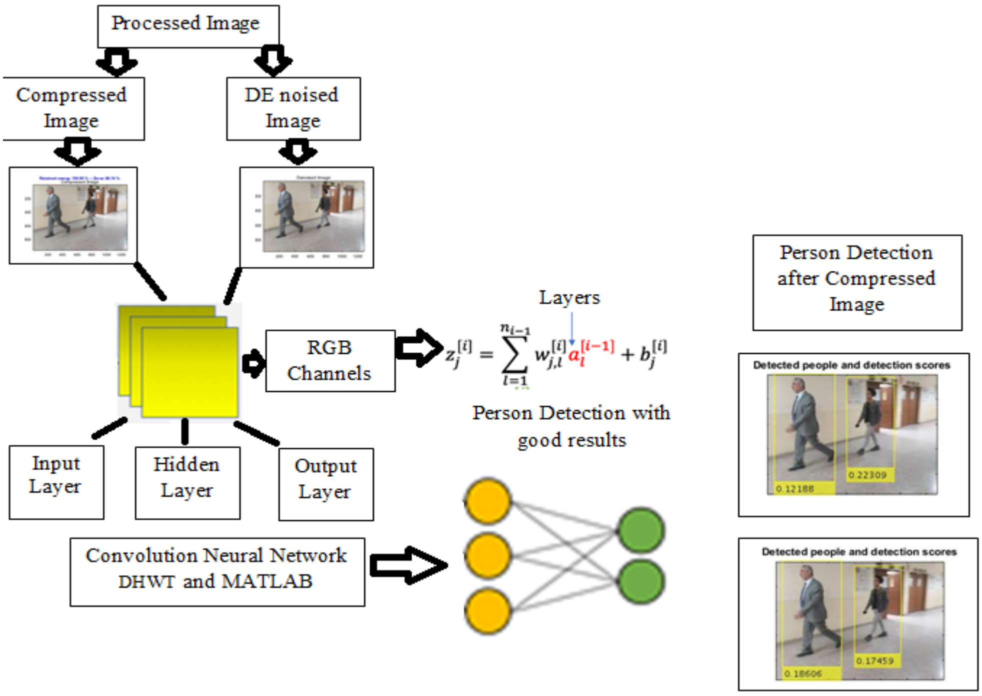

Figure 5. The efficiency and effectiveness HWCNN with the new wavelet effect DHWT

3. RESULTS AND DISCUSSION

In this section, the results that were reached after the development of the method using the new filter, which proved its efficiency, are discussed. This is evidenced by the results shown in Table 2 which shows the scores of the person to be identified before using the new waveform and after using the proposed developed method. Figure 6 and Figure 7 clearly shows these results Figure 8 work space in MATLAB program with sample a befor and after HWCNN and Compute the mean squared reconstruction error in Figure 9.

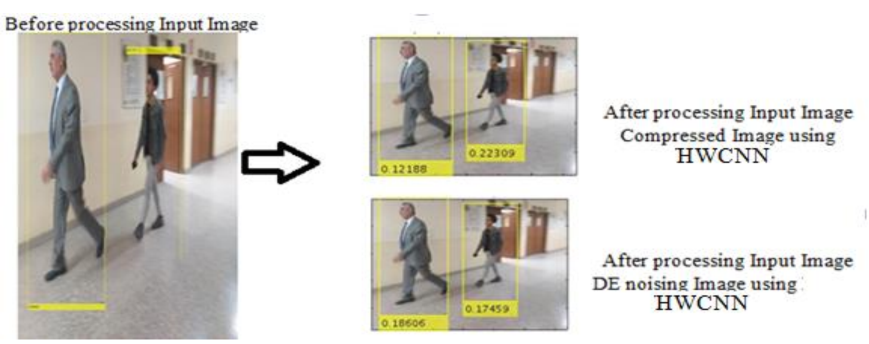

Figure 6. Scores the person to be identified before using the new waveform

Table 2. The results of scores for the samples

Samples	Scores before DHCNN	Scores after HWCNN with compressed	Scores after HWCNN with DE noising
A	X_1 = 0.1238	X_1 = 0.12188	X_1 = 0.18606
	X_2 =0.0087	X_2 =0.22309	X_2 =0.17459
B	X= 0.1325	X=0.18513	X=0.28354
C	X= 0.1061	X= 0.26154	X= 0.32591
D	X_1 = 0.0646	X_1 = 0.2403	X_1 = 0.2418
	X_2 =0.0658	X_2 =0.853	X_2 =0.0957
	X_3 =0.0184	X_3 =0.853	X_3 =0.0957

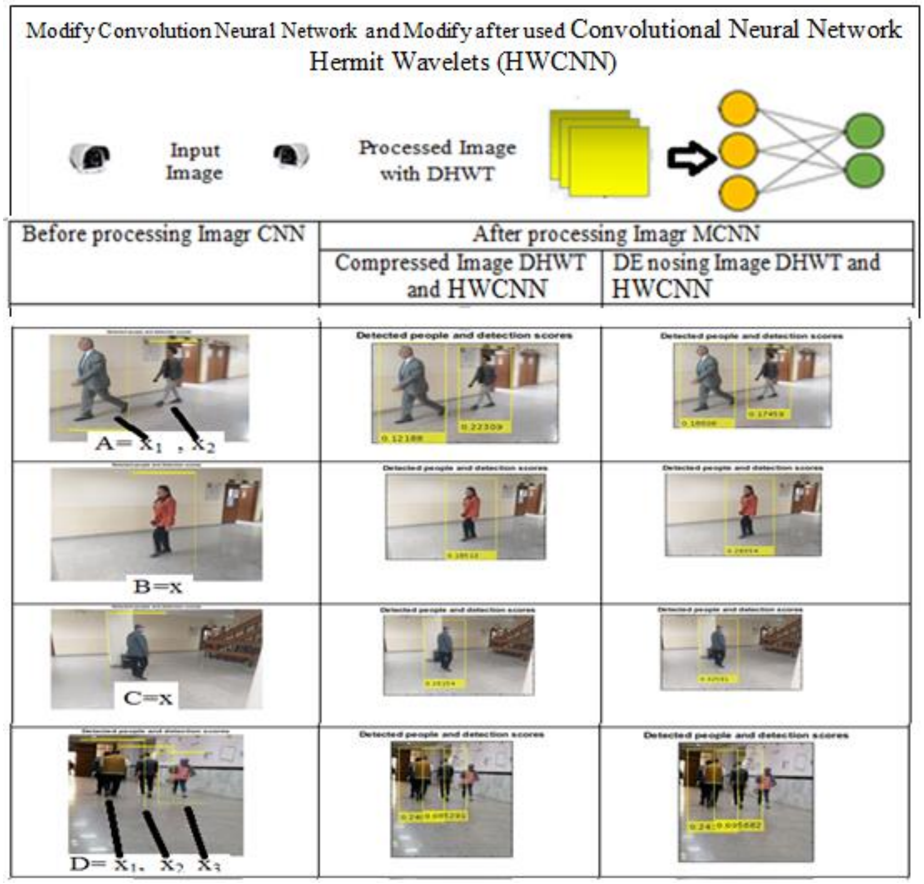

Figure 7. Scores of the person to comparison between the results and the resulting image before and after DHCNN

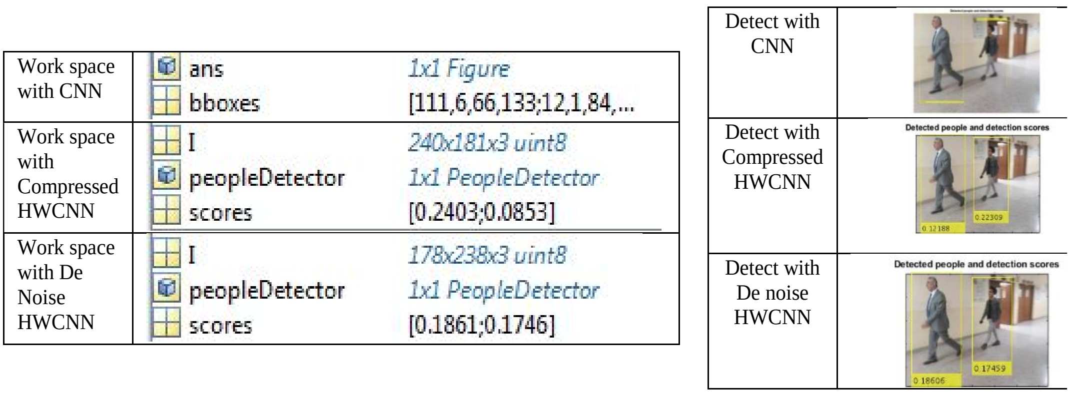

Figure 8. Work space in MATLAB program with sample a befor and after HWCNN

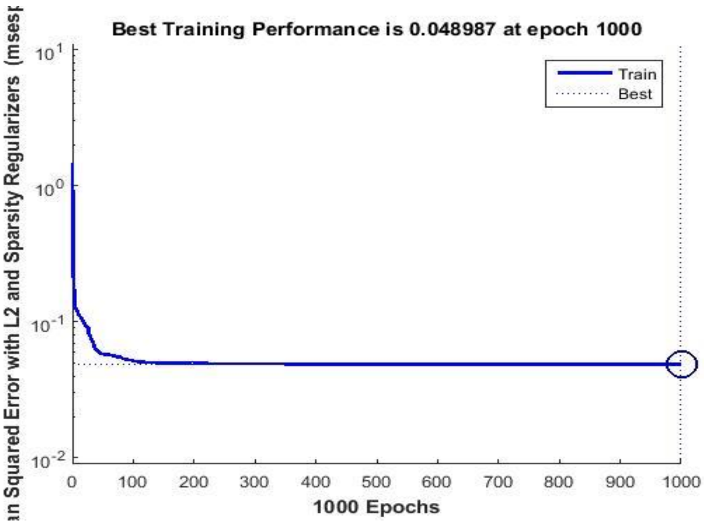

Figure 9. Compute the mean squared reconstruction error in the best training

4. CONCLUSION

Recently, artificial intelligence has played a large role in the field of identifying people using the convolutional neural network algorithm, which is very important in this field, but it is not free from some errors that have been overcome. In this work because of building new wavelets from polynomials new discrete Hermit wavelet transform (NDHWT) and after creating an algorithm of HWCNN where the role of the new wavelets was to raise noise and compress the input image through it, errors were reduced and the values of the input image quality parameters were increased, which led to significantly improving the results with training the convolutional neural network to recognize People with the help of the MATLAB program in artificial intelligence to program the proposed new technology to identify people in public places, airports and security. The above tables clearly demonstrated the difference between the readings before the new technology and after the new technology.

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