A Novel Data Compression and Suppression Method based on DCT and Overlapping for the Wireless Sensor Networks(WSN)

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Abstract – This paper presents a robust and optimized data compression and suppression based on DCT and Image overlapping methods to transfer panorama images through the Wireless Sensor Networks (WSN). First, we will receive the input images in a fixed interval of times and then we apply two compression algorithms to achieve a compressed and transferable panorama images taken from eight different directions. Our Proposed Algorithm can compress the size of original panorama images up to thirty percent while the vital color information as well as the quality of the original images can be preserved .The panorama image quality and the size of compressed image are two main issues that need to be considered during the process of the panorama image compression. Our DCT-Overlapped Panorama Image compressing Algorithm consists of two major compressing levels of image compression and Overlapping using DCT and our new Overlapping techniques.

Keywords:DCT, lossyCompression, image diffusion, panorama, WSN

I. INTRODUCTION

There are two classes of data compression techniques. The first one is lossy compression and second one is lossless compression. In lossy we will lose some details of image information but still preserved the vital information of the image and the quality of image is in acceptable range. The main goal of lossy compression is to remove redundancy and some details that are not vital to the image and reduce the amount of data storage while preserving the quality of the image. The data compression techniques often are applied on the sound and images that have some redundancy that can be removed to reduce the size of audio and video information before transmission on any networks. A good example of lossy image compression is JPEG [1]. In the second class of compression, lossless compression, the detail of information is important and we would like to preserve all details and vital information while reducing the size of image or sound files for the storage reduction. This type of data compression is more suitable for text and file compression [3]. There are many applications that use lossy data compression techniques to reduce the data redundancy and improve their efficiency by reducing data storage and processing time, such as air and water quality monitoring, Natural disaster prevention, industrial and agriculture monitoring. [2]In this paper, we have presented a robust algorithm based on the DCT and overlap compression for panorama images, in which every image that is received from a WSN has a phase shift of 45 degree respect to the previous image. Then, DCT compression is applied on all images and overlap compression also is applied on the compressed images to reduce the size of panorama images based on the received images. Thus, we are able to reduce the size of panorama image about 70 percent of its original size while preserving the quality of original panorama image. In this process every images is taken with an offset of 45 degree to have a 360 degree panorama image for the monitoring of environment activities.

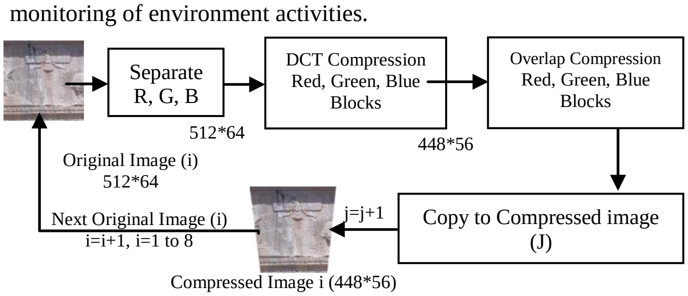

Figure1: Block diagram of panorama compression

We use our algorithm to reduce the size of panorama image before transmission through WSN node to enhance the energy consumption and prolong the life time of sensors.

Figure 1 shows the block diagram compression process. In this figure we can see two levels of compression which are DCT and overlap compressions. In the first level of compression we retrieved the original image by a *MATLAB* command called imread and then changed it into RGB Color spaces with three different matrixes (Red, Green and Blue). Each matrix is broken down into a set of 8 × 8 blocks, and then the Discrete Cosine Transform (DCT) is applied on each block. The DCT will transfer the original image from the spatial domain into the frequency domain in which the vital information is moved to the low frequency area, Low-Low LL, and less important information, or details, will be moved into Low-High, LH, High-Low HL, and High-High, HH, frequency areas. Once the DCT is applied and the original image is transferred into DCT coefficient matrix of block size 8 x 8, then the last row and last column of the each 8*8 blocks are deleted to obtain a good compression rate while the vital information is preserved and the quality of compressed image is guaranteed.

The result of above DCT compression will reduce the size 8 x 8 sub-blocks into 7x7 sub-blocks, and 15 elements of the 8 x 8 blocks are deleted to reduce the size of each block from 8 x 8 into 7 x 7.We will continue this operation until all sub-blocks of 8 x 8 are reduced into sub-blocks of size 7 X 7. This operation will be applied for the sub-blocks of Read, Green, and Blue matrices. Figure 3 shows the block diagram of the DCT Compression Processes.

In the second level of compression process the overlapped part of all images will be deled to reduce the size of the underline panorama images combined from all captured images during the 360 camera rotation as shown in Figure 2. In a 360 degree panorama image we have captured 8 images, one at each 45^{O} rotation. Among these eight images four of them have an overlap cross section of about 23.7^{O}. In order to have a compressed panorama image we should remove these sections.

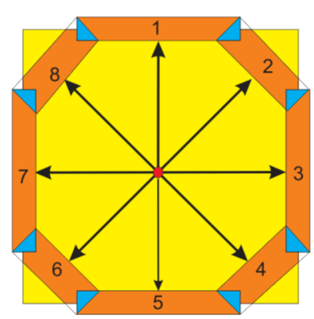

Figure 2: Panorama image with central position for 360 degree image

Our image overlapping algorithm consists of two steps. In the first step of compression the first image, No. 1, is taken by the camera located at the fix position, then the second one, No. 2, is obtain after a 45^{O} camera rotation, and all other images, No. 3-8, are taken by 45^{O} camera rotation. Once all images are captured by the camera rotation the DCT is applied on all eight images but the overlapping compression algorithm is applied only on four images, No. 1,3,5,7. In the DCT compression level each image will be divided into blocks of size 8 x 8 and DCT algorithm is applied on each block and then 15 elements of high-frequencies area are removed. Thus the algorithm enables us to transfer panorama images among Wireless Sensor Networks or other communication facilities. Our proposed model created a high rate image compression with a high quality captured images in which the received panorama image is almost the same as the original panorama image.

We have selected one R, G, and B color image of size 512 x 64 as the panorama images and then divided the image into three matrices (Red, Green and Blue) each 512 x 64. Then, each matrix is divided into blocks of size 8 x 8 for the future operations. We used MAT Lab to perform the following operations: 1-Read the Image file and change it into the color space of Red, Green, and Blue matrices 2-Divide each matrix into several segments, sub-matrices of size 8 x 8 blocks 3- Calculate the DCT of all segments of Red, Green, and Blue matrices 4-remove the 15 high frequency coefficients from the high frequency area of DCT matrix so we have DCT coefficients matrix which is 7x7 5-apply IDCT function on the compress DCT matrix and save them into the appropriate location of main compressed image 6- Repeat the steps 1-5 to compress all block of DCT. 7-Repeat the steps 1-6 for all other Green and Blue matrices8-Copy the compressed, 7 x 7 IDCT blocks into corresponding Red, Green, and Blue matrices to get compressed matrices and then forms the each of eight panorama elements Images.

This paper is organized into the following sections. Section 1 is introduction. Section 2 is an overview of the related works. Section 3 explained the detail of proposed DCT compression Method used for the compress the first level of panorama compression and in section 4 we explain the overlap compression method in details. Performance analysis and experimental results is discussed in section 5. Conclusion and future directions introduced in section 6.

II. Related Works

There are so many different articles, Journal papers, books, and magazine about image compression using DCT but none of them are related to the panorama image compression and instead they use overlapping compression. We have proposed a hybrid compression by using DCT and Overlapping in which first DCT is applied on the panorama images and then the overlapping portion two panorama image is removed to to reduce the size of panorama images. *Er. Ramandeep Kaur Grewal M.Tech* and *Navneet randhawa* used a hybrid technique for Image compression using DCT and DWT [5]. In the JPEG compression, the target image is partitioned into the 8*8 Blocks, and then DCT is applied to each block to reduce the size of image close to an acceptable range. In addition, a quantization table is used to normalize the DCT values where the quantized coefficients are arranged into a zigzag order for the easy compression. N*ikolay Ponomarenko* and *Vladimir Lukin*[6] used the Huffman coding to compress the target into the JPEG format then applied the DCT compression on each image sub-blocks of size 32 x 32 to obtain the high compression rate for the image. They also used an effective method of bit plane coding for the Quantized DCT Coefficients [7]. *Dr. Mohammad V. Malakooti* and *Mehrzad khederzadeh* [4] applied DCT on the target image to embed the scrambled credit card numbers into the mid frequency range of the DCT coefficients. They presented a Robust Lossless Information Embedding Algorithm in which the vital information can be embedded into the cover image while preserving the quality of cover image and maintaining the security of the information to be embedded. The cover image quality and embedded information security are two main issues that need to be considered during the process of the information embedding. The SDEM-DCT (Scramble Data Embedding in Mid-frequency range of DCT) Algorithm consists of three major security levels that can be used to hide Credit Card Numbers of many customers inside the bank LOGO. In order to have more security levels we used the Malakooti Scramble Algorithm on the credit card numbers and then applied the XOR operation on the scrambled data and the secret keys generated by the Malakooti-khederzadeh randomize key generator. On the third level of security Malakooti Orthogonal Transform (MOT) is applied for the higher security. Once three algorithm is applied on the credit card numbers and the scrambled and processed data are obtained, then DCT is applied to embed these information into the mid frequency area of the DCT coefficients[4]. DCT has many applications in the areas of data and image compression, encryption, watermarking, and embedding and can be combined with other algorithms to provide the compressed multimedia compression before the transmission over the internet or wireless networks. Our proposed model of DCT compression and Overlapping suppression has provided a good compression rate for the panorama image used in the wireless Sensor Network when the node energy in concerned.

III. DCT Compression Process

In this step, the first image out of eight images captured by the camera, located at the fixed position but rotated at angle of 45 degree, is retrieved and converted into RGB Color space and separated into three matrices of Red, Green, and Blue. This process is repeated applied for all of 8 images and then the following procedures are applied to reduce the size of the panorama image into acceptable range before the transmission over the wireless networks. The block diagram of the DCT compression has shown clearly in Figure 2.

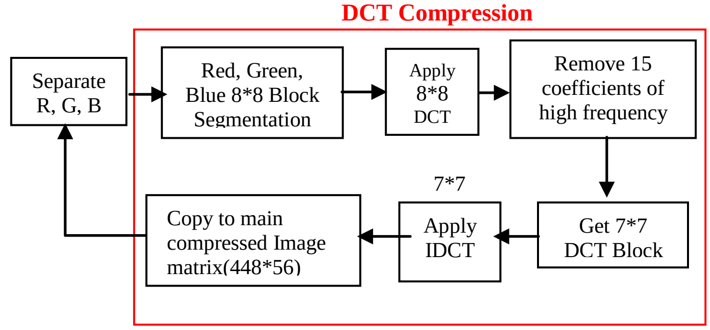

Figure 3: DCT Compression Processes

A. Image Segmentation

We have divided each matrix into the blocks of 8 x 8. The size of all 8 images captured from the camera located at the fixed position, with an angle of rotation 45 degree, are 512 x 64 pixels. Thus we have 512(512= 64 x 8) numbers of 8 x 8 blocks. This can be obtained easily by the following equation (1).

$$sub\_r = \sum_{rw=1}^{Dim/64} \sum_{cl=1}^{Dim/64} R(8rw-7:8rw, 8cl-7:8cl) \quad (1)$$

B. *Apply DCT function*

There are two types of DCT function in *MATLAB* which called one dimensional and two dimensional DCT. For our algorithm we used two dimensional DCT to apply on the sub-blocks of the captured images. The *MATLAB* function is called *dct2*, in which it applied on each sub-block of the image, *sub_r, as shown in equation* (2).

$$DCT\_sub\_r = dct2(sub\_r) \quad (2)$$

C. *Remove DCT coefficents*

In order to reduce the size of image we should remove the coefficients of high frequency area. We need to remove those 15 coefficients of the DCT matrix that have little effect on the image quality and only have the detail information, the last row and last column of 8x 8 matrices. Thus we will obtain a 7 x 7 DCT coefficient matrix with 49 compressed values vs. 64 uncompressed DCT values. The original sub-block and its DCT as well as the row and column to be removed are shown clearly in Figure 4.

14.00	14.00	19.00	18.00	15.00	22.00	25.00	16.00
14.00	14.00	19.00	21.00	18.00	18.00	21.00	22.00
14.00	13.00	14.00	17.00	20.00	19.00	17.00	18.00
18.00	15.00	14.00	15.00	19.00	20.00	17.00	17.00
15.00	13.00	14.00	16.00	14.00	13.00	15.00	20.00
15.00	14.00	16.00	15.00	14.00	13.00	13.00	13.00
14.00	14.00	15.00	14.00	16.00	19.00	16.00	11.00
22.00	22.00	21.00	19.00	20.00	19.00	19.00	21.00

a) Image Sub-block, sub_r

134.00	-6.72	-2.02	1.07	-0.25	2.46	1.65	0.50
3.03	-8.47	-2.13	-1.00	-1.11	3.74	-0.23	0.00
9.75	-0.15	-1.28	-0.86	-5.62	2.86	0.00	0.00
-8.67	0.73	-0.04	-2.21	-3.24	0.00	0.00	0.00
6.25	0.28	4.04	0.37	-0.50	0.31	-0.05	-0.25
-3.96	-0.13	-2.90	0.00	0.00	0.25	0.51	0.11
0.02	2.08	0.00	0.00	0.00	0.00	-0.22	0.45
-3.25	0.00	0.00	0.00	0.00	0.00	0.00	-0.56

b) DCT of _sub_r

Figure 4: The last row and last column of matrix b will be removed for the compression purpose

D. *Apply IDCT function*

In order to obtain the compressed image file we should apply the inverse two-dimensional DCT, *idct2* function in *MATLAB.*

$$IDCT\_sub\_r = idct2(DCT\_sub\_r) \quad (3)$$

The retrieved matrices have size of 7 x 7 and considered as the basic elements of the compressed image file. This process was for the Red matrix of color the space and the same process can be applied for the Green and Blue matrices as defined earlier. The result three compressed matrices for the RGB color space will be saved in the main compressed matrices *(COM_MTX_MAIN).*

E. *Compression Ratio*

We can calculate the compression ratio by a simple algorithm.

Step 1: Number of pixels in one image ➔512*64=32768

Step 2: Number of pixels in 8 images ➔32768*8=262144

Step 3: Number of pixels in compressed image➔448*56=25088

Step 4: Number of pixels in 8 compressed images➔200704

Step 5: Compression Ratio:

$$dct\_Com = 100 - \frac{200704 * 100}{262144} = 23.43\% \quad (4)$$

IV. Overlapping compression process

In this paper we proposed a hybrid method based on the DCT compression as well as the overlapping suppression. We have shown that our DCT compression techniques will reduce the size of all 8 images about 23.43%. We also applied the overlapping techniques to remove the overlap of the image number 1,3,5,7 to obtain the higher compression rate for the panorama image. Our proposed method has advantage over the existing digital camera used to remove the image overlapping designed for panorama images because the panorama camera only able to remove the overlapping but our algorithm removes the overlapping as well as applies the DCT compression. As we can see in Figure 2, four of the images out of eight images that are overlapped are image number1, 3, 5 and 7. The details of the image overlapping compression process have shown in Figure 5.

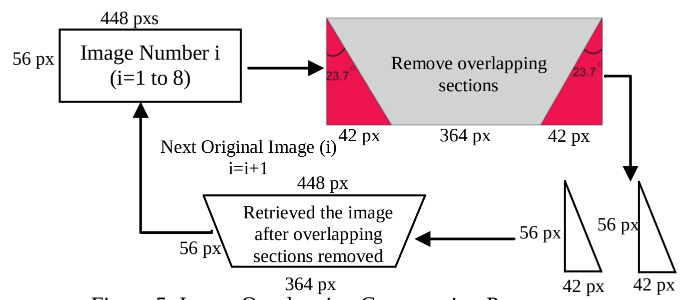

Figure 5: Image Overlapping Compression Process

As we can see in Figure 6 if x=150 m far from the center of the image, and the captured image has the size of 512 x 64 pixels then the size of overlapping sections of two images are calculated as following formula :

$$Area = \frac{56 * 42}{2} = 1176 Pixels \quad (5)$$

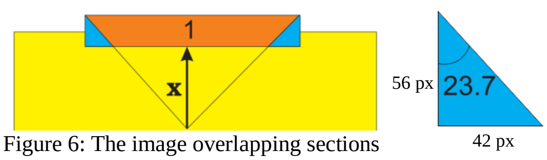

Figure 6: The image overlapping sections

We checked the overlapping sections on the several panorama images and found that the overlapping sections of two images are about 23.7 degree from the left side and right side of the odd images (see Figure 2), but the angle depends upon the distance (x value in figure 6) and the size of images that are captured. The number of overlapping pixels in our method is estimated as following algorithm:

Step 1: The Number of overlapping pixels for one image is calculated as (N1) ➔ Area * 2, Thus we have N1= 1176 *2=2352

Step2: The Number of overlapping pixels for four images is calculated as ➔ N1 * 4, thus we have 4N1=2352 *4=9408

Step3: The Number pixels for all DCT compressed images is calculated as ➔ 448*56*8=200704

Step5: The Compression Ratio can be calculated as following:

$$overlap\_Com = \frac{9408 * 100}{200704} = 4.7\% \quad (6)$$

V. Experimental Results

To prove the efficiency and robustness of our proposed algorithm regarding to the image compression and overlapping suppression as well as the quality of retrieved panorama image, a few examples have been performed based on our algorithm. We applied our algorithm on several images and the results have been tested and displayed to indicate the robustness and high resolution of our algorithm. Our hiding, extracting and restoring algorithms were implemented using ***Matlab*** programming language in a real example (Figure 7) The original panorama image and all panorama image elements with overlapping sections can be seen in Figure 7.

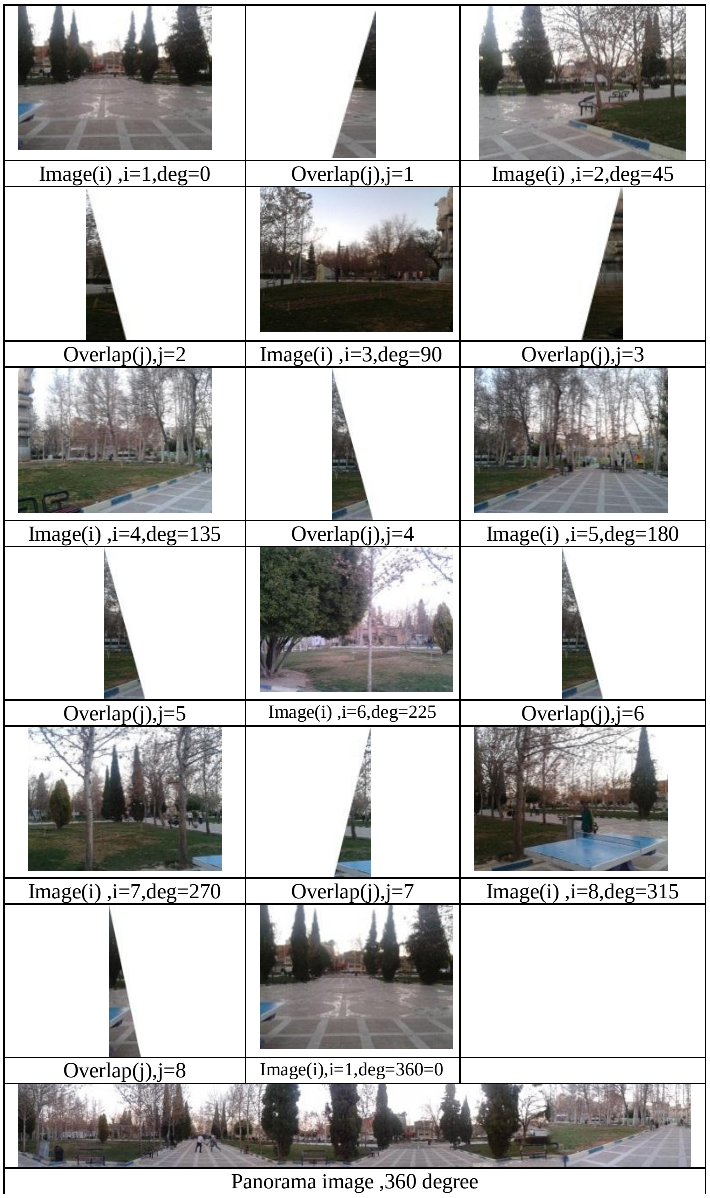

Figure7 : Original panorama images and the overlapping sections

In Figure 8 we tested our algorithm on several images and compared the Compression ratio and PSNR values.

VI. Conclusion And Future Directions

We have proposed new algorithm based on the data compression and overlapping suppression in which images are captured from the camera located at fix position and only has a rotation angel of 45 degree to retrieve 8 images for the 360 camera rotation. We have shown that our algorithm compressed the size of original panorama image in about thirty percent while the vital color information as well as the quality of the panorama image has been preserved. The panorama image quality and the size of compressed image are two main issues that need to be considered during the process of the panorama image compression. To obtain a higher image reduction with a high quality of the retrieved images we will use the combination SVD and DWT instead of DCT. In addition we will improve our overlapping algorithm to remove the exact information that is fully overlapped. Once both parts of algorithm are improved the efficiency and robustness of our future work will be guaranteed.

Original Image	Compression Ratio	PSNR
	28.69%	34
Image size=230 Kb	164 Kb	
	22.72%	25
Image size=8.8 Mb	6.8 Mb	
	26.03%	27
Image size=338 Kb	250 Kb	
	27.71%	25
Image size=83 Kb	60 Kb	
	31.57	19
Image size=76.1 Kb	52 Kb	

Figure 8: Compressed images with the corresponding compression ratio and PSNR

VII. References

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