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A Study on Block Based Vs Object-Based Stereo Image Compression

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Abstract: The first stereo image compression algorithm was to code the sum and difference of the two images. However, the performance of this technique decreases with increased disparity values. A modification to this method is to shift one of the images horizontally to the point where the cross correlation between the imagesof stereo pair reaches its maximum value The shifted image is then subtracted from its partner image and the difference is encoded. This method, assumes that objects in the scene have similar disparity values and thus is not particularly efficient. Another approach is to translate the row blocks instead of the whole image. stereoscopic sequences can be compressed much more efficiently than the independent compression of its two image streams by exploiting, in addition to the spatial and temporal correlations that are exploited by sequence compression schemes, the high cross-stream correlations present between the streams. A disparity-based segmentation and the subsequent transmission of these segment disparities encode one image of a stereoscopic image pair at a very low coding overhead given the other image. In this paper I focused the advantage of object based stereo image compression over blocl based stereo image compression.

Keywords: Stereo images, block based stereo image compression ,object based stereo image compression.

I. Introduction : stereo images

Stereovision could be simulated by acquiring two views of a 3D scene and by presenting them separately to the left and right eyes. Stereo capture equipment play an important role in the first step of this process. Many technical and operational variations are present between the practical designs of capture equipment. A pair of stereo images is very similar to each other as they are the images of a stationary object taken from two different angles. This is why compressing both images independently is an in-efficient way of compressing stereo images. An efficient way to compress a pair of stereoscopic images is to calculate the difference between the two images; also known as disparity estimation and then compress one image independently.

Fig 1. Stereo images

This image is known as the reference image and can be either the right image or the left image. The reference image and the disparity vectors are then used to reconstruct the second image. A stereo image is produced by taking two cameras, separated by a distance of 6.5 centimeters which is approximately the distance between the human eyes and recording the perspectives of the right eye and the left eye using different lenses . The left image is seen through the left lens and the right image is seen through the right lens. The brain then merges the two images into one and also perceives the depth of the object. Stereo images can be produced cheaply using inexpensive digital cameras and are used widely in clinical applications, mining, metallurgy, environmental science and entertainment.

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II. Block based stereo image compression

The left image is taken as the reference image and the disparity vectors between the two images are estimated using the Exhaustive Block Matching Algorithm (EBMA). The reference image is transformed using two-dimensional discrete cosine transform (DCT-II) and quantized using the JPEG quantization matrix. The resulting matrix is compressed into a bit stream using arithmetic coding. The left image is taken as the reference image and is transformed using two dimensional forward discrete cosine transform (DCT-II). The resulting image matrix is quantized using the JPEG quantization matrix in (3) and then compressed using Arithmetic coding. The second part of the encoder involves compressing the right image. Since the two images are very similar to each other, disparity vectors between the two images are estimated. The resulting disparity vectors are compressed into a bit stream using arithmetic encoding. When decode the image, all the steps in encoding were performed in reverse order.

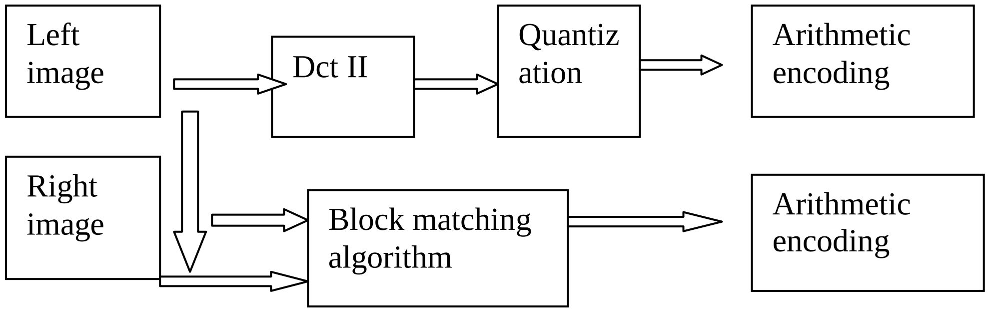

Fig 2. Block based stereo Image encoding process

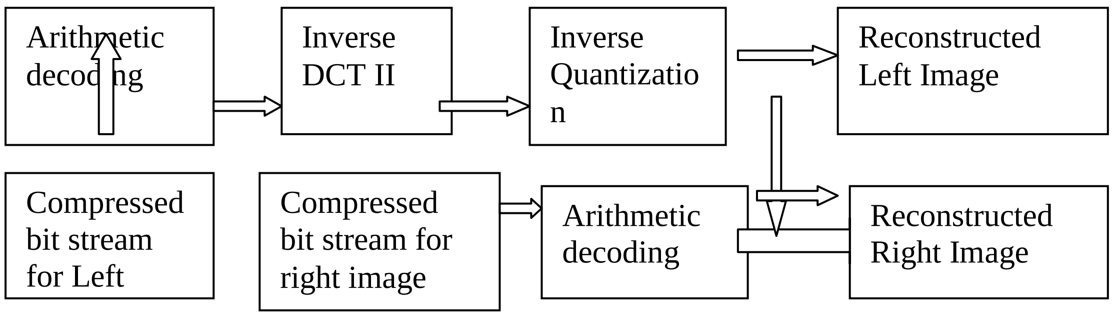

Fig 3. Block based stereo image Decoding process

The fundamental issue is that when 3D-stereoscopy is implemented on a single display each eye gets in some sense only half the display. A user contemplating using 3D-stereoscopy must thus acquire a display (and the underlying system to support it) with twice the pixel-per-second capability of the minimal display needed for the flat application; the alternatives require choosing between a flickering image or a reduced spatial resolution image. The lower level capacities of the system's components must also be doubled. In particular, all the information captured by two cameras must be stored or transmitted or both. Doubling these capacities may be more difficult than doubling the capability of the display, inasmuch as the capability of the display can be increased by simply paying more.

The most difficult system component to increase is probably the bandwidth of the transmission system, which is often subject to powerful regulatory as well as technical constraints. Nevertheless, the bandwidth must apparently be doubled to transmit 3D-stereoscopic image streams at the same spatial resolution and temporal update frequency as either flat image stream. In fact, because the two views comprising a 3D-stereoscopic image pair are nearly identical, i.e., the information content of both together is only a little more than the information content of one alone, it is possible to find representations of image pairs and streams that take up little more storage space and transmission bandwidth than the space or bandwidth that is required by either alone.

III. Object based stereo image compression

To reflect the true disparity between left and right frames, free-form object based matching would be more efficient than block-based techniques. This has been proved in video compression, such as MPEG-4. However, the price to pay is to encode the arbitrary shape of those objects and the complexity level will also be increased accordingly. To make a better balance, we proposed a hybrid scheme with features of both block-based and object-based coding techniques to achieve data compression for stereo image pairs. The algorithm comprises the following operations are, extract objects by contour analysis for both frames, and the objects are then matched to find those areas, which are similar in terms of their shapes; then enclose the matching object pairs by object bounding rectangles, in a similar spirit of MPEG-4. A parity based contour filling algorithm is further used to identify the interior and exterior pixels of the object, in which the shapes of the objects are identified by binary object planes. These planes are only used as an aid in the coding process rather than being encoded finally ,encode the objects in terms of three groups like objects that are enclosed by closed contours, objects enclosed by contours that terminate at the image frame boundaries; and unidentified areas that are treated as the background.

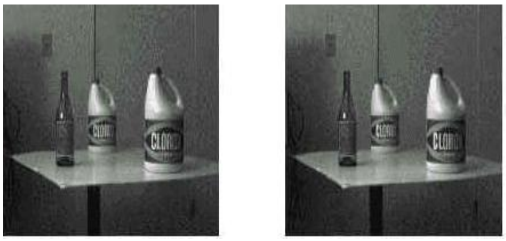

Fig 3. Stereo image pairs- ‘cans’

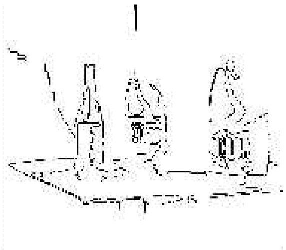

Fig 4. Contour plots for ‘cans’

a)Contour extraction

The contour is extracted by a two-step process. Firstly, the image is convolved (LoG*Image) with a Laplacian-of-Gaussian (LoG) operator, defined by:

$$LoG(x,y) = \left(\frac{r^2-\sigma^2}{\sigma^4}\right)\exp\left(-\frac{r^2}{2\sigma^2}\right) \quad (1)$$

where $r^2 = x^2 + y^2$ and σ is the standard deviation. To facilitate its application, equation (1) can be discretized in various ways. Secondly, edges are detected at the zero-crossing points (e.g., patterns such as "++--" and "--++" along both vertical and horizontal directions). In this step, the slopes of the LoG of the image along both x and y directions, denoted by Sx and Sy, are used to compute the edge strength at each zero-crossing point. An edge strength at a point (x,y) is defined as follows:

$$S(x,y) = \begin{cases} \sqrt{S_x^2 + S_y^2} \\ 0 \end{cases} \quad (2)$$

The contour points are chosen using a hysteresis thresholding technique , that is the edge strength at each point along the contour is greater than Tl and at least one point on the contour has an edge strength greater than Tu , where Tl and Tu are pre-set thresholds and Tl < Tu . Generally, Tl is set sufficiently low to preserve the whole contour around the region boundary and Tu is chosen large enough to avoid spurious edges. Contour search is initiated whenever one point with a value greater than Tu is scanned. The search is conducted in both directions of the contour and the neighbouring pixels, with values greater than Tl being accepted as contour points. The search is terminated when no neighbouring pixels are found to satisfy this condition. Then all edge strength values along the detected contour are set to zethat these points will not be visited again.

Contour Matching

The contoured objects are matched in terms of: (i) those that are closed in as illustrated in Fig. 3(a); and (ii) those which are open, and terminated at the image boundaries as shown in Fig. 5

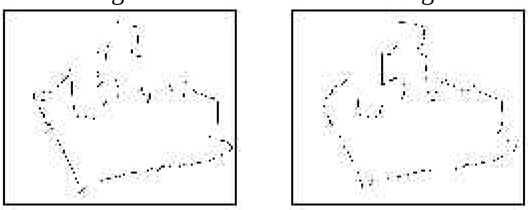

Fig 5. Matched contour pair

Closed contour matching: For every closed-in contour, three shape attributes are computed: (i) the number of pixels representing the perimeter of the contour, n ; (ii) the y co-ordinate of the centroid (x_c, y_c) ; and (iii) the first invariant moment, h . y_c is considered as a good matching attribute as we assume that the vertical stereo disparity between points in the image frames are negligible. This is because that parallel axis geometry [1] is used in obtaining all the test stereo image pairs. If x_i and y_i represent the x and y co-ordinates of the points along the contour, h can be defined as follows:

$$h = \frac{1}{n^2}\sum_{i=1}^{n}\left[(x_i - x_c)^2 + (y_i - y_c)^2\right] \quad (3)$$

Where $x_c = \frac{1}{n}\sum_{i=1}^{n} x_i$ and $y_c = \frac{1}{n}\sum_{i=1}^{n} y_i$. (4)

Every closed-in contour of the right frame is compared with that of the left frame. A contour from the left frame is accepted as an initial candidate match for the right frame contour, if the differences between each of their shape attributes fall below some pre-set thresholds At the end of this procedure, closed-in contours in right frames may have multiple candidate matches and a further step is necessary to find the best match among them. Contour blocking is a process designed to divide the matched objects into blocks in a most efficient way so that different encoding techniques can be applied to compress the stereo image pair. The basic principle is similar to MPEG-4 techniques, which include fitting an object into smallest possible rectangle, padding the reference object and produce disparity compensated predictive errors.

Object Encoding

The stereo image pair is encoded on an object basis by identifying three types of objects within the images. These include: objects that are bounded within closed contours, objects that have open contours and both ends of the open contour terminate at image boundaries, and the rest which fall into the background. Although there exist differences among the three types and their encoding requires individual co-ordination, the major proposed encoding techniques can be described as: (i) padding of left object bounding rectangles; (ii) disparity-based prediction for both arbitrary shaped boundary blocks and internal blocks; (iii) background encoding.

RESULTS OF COMPARISION

MATCHING TYPE	CR	PSNR
BLOCK BASED	39.2	39.5
OBJECT BASED	44.5	38.6

TABLE 1.Block Vs Object based compression

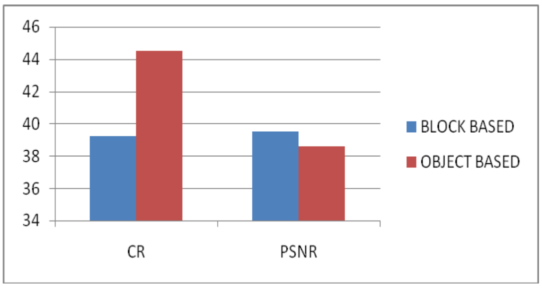

Chart 1. Block Vs Object based compression

IV. Conclusion

In object based stereo image compression , padding of left object bounding rectangles features local gradient inside the object; The disparity values and the prediction errors for each arbitrary shaped boundary block is transmitted on an object by object basis. In this way, the error blocks and disparity values can be properly identified and used to reconstruct the right objects at the decoding end. In the prediction process, the shape of the objects in the left frame are used to produce errors for right objects, and thus no bits are consumed to encode the shape information. Yet correct shape can be reconstructed at the decoding end since the lost information will be picked up by corresponding background block encoding; Internal areas are encoded adaptive to their local texture. An object-based coding scheme was presented for the coding of a channel of a stereo- scopic image sequence using motion and depth information. The segmentation part of the algorithm was interleaved with the estimation part in order to optimize the coding performance. Depth information was transmitted either in the form of dense depth maps or using a wireframe model. Furthermore, techniques were examined for the updating of the depth map and the segmentation information. Study results have shown the performance of the object based stereo image compression to be slightly better than the performance of block-based approaches .

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