Moving Object Segmentation using Weighted Coefficients Ratio Based on Discrete Wavelet Transform

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Abstract: In this paper, it is proposed that edge detection using weighted coefficients ratio (WCR) video object segmentation algorithm based on discrete wavelet transform (DWT). The proposed method is applied DWT to two successive frames. Also, we utilize detection method with different thresholds in four wavelet sub-bands and make the map of boundary using Prewitt edge operator in wavelet domain. As mixing the difference and division operation, our algorithm improved the performance test that is able to find more accurate monving objects. on DWT. After the inverse discrete wavelet transform (IDWT), the robust edge map can be obtained. Through combination with the current frame's moving edges and previous can be detected and tracked. It is then used to extract video object planes (VOPs) by a simple filling technique. The proposed algorithm is robust to the entire motion object detection and can obtain fruther shape information, more accurate extraction of moving object. The experimental results are proved the effectiveness of our algorithm.

1. Introduction

The traditional video-coding standards, such as MPEG-1/MPEG-2 and H.261/H.263, lack high-level interpretation of video contents. The MPEG-4[1] video standard introduces the concept of a video object layer (VOL) to support content-based functionality. Its primary objective is to support the coding of video sequences which are pre-segmented based on video contents and to allow separate and flexible reconstruction and manipulation of contents at the decoder. Thus, a prior decomposition of sequences into video object planes (VOPs) becomes an important issue[2].

The MPEG-4 standard provides a content-based framework to achieve the goals of fast transmission, efficient storage, flexible manipulation and re-use of visual content. For video, it lets users transmit, retrieve, download, store and re-use arbitrarily shaped VOPs efficiently, and it also interacts with media sources. However, MPEG-4 does not provide concrete techniques for VOP extraction. Nonetheless, it is an indispensable process for many digital video applications. Unfortunately, it is very difficult to extract VOPs, therefore the preprocessing used to decompose sequences into VOPs becomes an issue[3],[4].

Video object segmentation which aims at the exact separation of moving objects from background is principal technique of MPEG-4 content-based functionalities. An intrinsic problem of video object segmentation is that objects of interest are not homogeneous with respect to low level features such as color, intensity, texture, or optical flow. Instead, it involves higher level semantic concepts. Hence, conventional low-level segmentation algorithms will fail to obtain meaningful partitions[5].

Our paper presents robust video object segmentation in kaleidoscope video sequences. So, we show to stand comparison with robust changeable intensity based WCR algorithm comparing conventional method. The precedence of this paper is organized as follows. Section 2 addresses proposed video object segmentation algorithm. Section 3 presents the experimental results and evaluation. The conclusion follows in Section 4.

2. Proposed Object Segmentation algorithm

2. 1 Detection in wavelet domain

Wavelet transform is multi-resolution analysis. It converts an image into four sub-bands, commonly. They are each called: *LL* contains the lower-frequency information; *HL* contains the high-frequency vertical information; *LH* contains the high-frequency horizontal information; and *HH* contains the high-frequency information about each axis direction. We use two-dimensional wavelet, so the transform can be represented by four sub-band. These four divisible filters are as followed:

$$\begin{aligned} LL(n_x, n_y) &= l(n_x)l(n_y) \\ HL(n_x, n_y) &= h(n_x)l(n_y) \\ LH(n_x, n_y) &= l(n_x)h(n_y) \\ HH(n_x, n_y) &= h(n_x)h(n_y) \end{aligned} \tag{1}$$

The two-dimensional wavelet is represented by four divisible filters which composed by low pass filter $l(n)$ and high pass filter $h(n)$, as the equation (1).

Fig. 1 is presented the original image and result of 1-level DWT.

(a) *(b)*

Fig. 1 *Image of reference named Akiyo:*
(a) Orginal image
(b) Result of DWT

After DWT for the current frame and precious frame, we make the change detection mask (CDM) in the wavelet domin using the difference and division operation. Suppose $W_n(i, j)$ and $W_{n-1}(i, j)$ are the wavelet domain images of the current frame and previous frame. $W_{d,n}(i, j)$, as CDM can be calculated in by:

$$\begin{cases} W_{CDM}(i, j) = 1, & if \left| W_n(i, j) - W_{n-1}(i, j) \right| > V_{thr} \\ W_{CDM}(i, j) = 0, & otherwise, \forall i, j \end{cases} \quad (2)$$

$$\begin{cases} W_{CDM}(i, j) = 1, & if \left| W_n(i, j) / W_{n-1}(i, j) \right| > V_{thr} \\ W_{CDM}(i, j) = 0, & otherwise, \forall i, j \end{cases} \quad (3)$$

Eq.(2) is expressed difference calculations and also, (3) is performed the division. We are used different experimental threshold value in the each sub-band domain. The V_{thr} threshold values are determined by significant test.

2. 2 IDWT and Composite

In the 'merge four sub-bands and upscale' step of the box which is in Fig. 2, the algorithm is unioned four binary images that hold the low-frequenc, horizontal, vertical and diagonal edge information. Then we upscale these to the size of the original image to obtain the significant edge pixels. As ecsuing, it is found the all moving edge information by mean of arithmetical OR operator obtained two DWT images.

We reattempted the supplementary different method using difference and division operators in this processing comparing conventional method. As fusing that, we detect more accuracy edge point in the sequences using these operartors.

2. 3 Extraction of edge map

Current frame's edge map is applied by simple edge masks on current frame and it can be detected for extracting moving object's boundary.

$$G_x = \{ f(-1, 1) + f(0, 1) + f(1, 1) \} - \{ f(-1, -1) + f(0, -1) + f(1, -1) \} \quad (4)$$

$$G_y = \{ f(1, 1) + f(1, 0) + f(1, 1) \} - \{ f(-1, -1) + f(-1, 0) + f(-1, 1) \} \quad (5)$$

G_x and G_y are detected all edge points by the edge mask operators which are about horiztal and vertical directions in current frame *n*.

Equation of Static Index (S_n) and Background Index (B_n) of frame *t* are defined as:

$$\begin{cases} S_n(x, y) = count\ 1, & if\ S_{n-1}(x, y) = stationary \\ S_n(x, y) = 0, & changing \end{cases} \quad (6)$$

$$B_n(x, y) = E_n(x, y) \quad if\ S_n(x, y) \geq S_{th} \quad (7)$$

$E_n(x, y)$ is the edge of frame n, S_{th} is static threshold. Static index can be decided according to the sequence, because find it is not a key and sensible parameter.2. 4 Overall proposed algorithm
Fig. 2 is presented the block diagram which is proposed algorithm. As follow Fig. 2:
Step1: Perform wavelet transform for current and previous image.
Step2: Calculate to use difference and division operator.
Step3: Search optimal CDM for operating threshold.
Step4: Merge each sub-band.
Step5: Fuse each result using arithmetical OR operator.
Step6: Detect moving object edge of current frame from referenced current edge information.
Step7: Perform the routine in the whole video sequences.

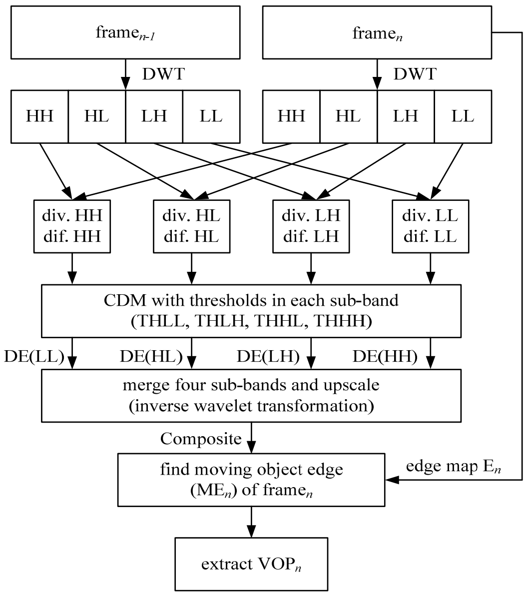

Fig. 2 *Overall block diagram of proposed moving object segmentation algorithm*

3. Experiment Results

Fig. 3 shows the moving object edge (step4) for three methods. *(a)* and *(b)* are frame 100 and 101 of the 'akiyo' video sequences; *(c)* is just deffenence image from frame 100 and frame 101 merged all sub-band. *(d)* and *(e)* which are calculated to difference and division are the result of applying union threshold values each sub-band. *(f)* is the result of the proposed method which composite prior results with IDWT. The edge points number finded comventional method is about 7000 and proposed things are 3500 and 9000, approximately. For more accracy detection point, AND operator is more profitable and OR operator is attached great importanec to real-time image processing system, one after another, fig. 4 is each outcome to perform proposed method which left row and right are carry out the operation, as each AND and OR.

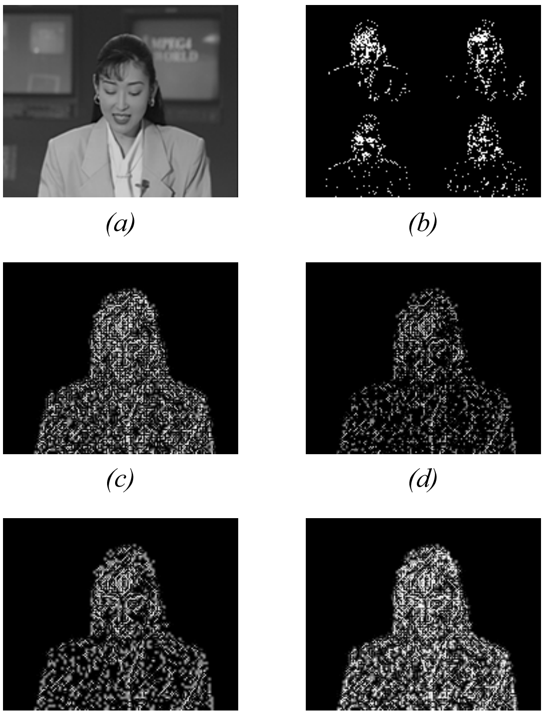

Fig. 3 *Compared with moving object edge detection:*

- *(a) Orginal image (100th frame)*
- *(b) Difference image in DWT*
- *(c) Difference image in IDWT*
- *(d) Division image in IDWT*
- *(e) Fusion with (d) and (e)using AND*
- *(f) Fusion with (d) and (e)using OR*

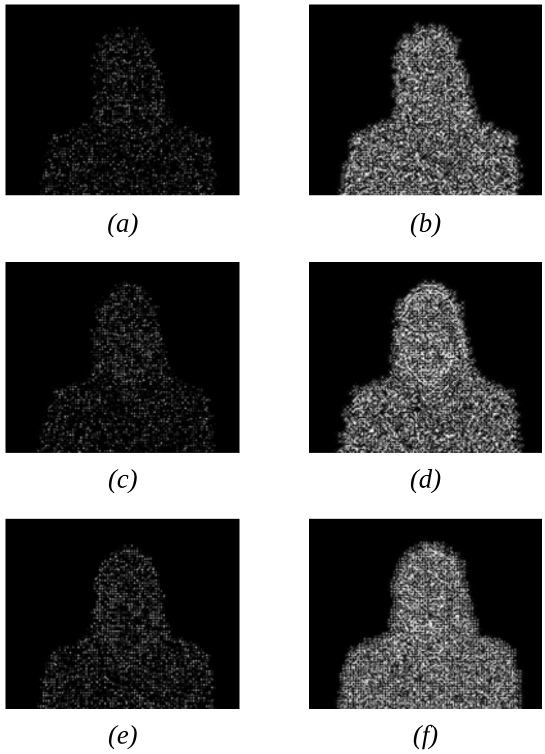

Fig. 4 *Shape of reference image's detected edge points in the whole QCIF sequence until 300 frames on the outline:*

- *(a) After AND operator, between 0th and 1th.*
- *(b) After OR operator, between 0th and 1th.*
- *(c) After AND operator, between 150th and 151th.*
- *(d) After OR operator, between 150th and 151th.*
- *(e) After AND operator, between 298th and 299th.*
- *(f) After OR operator, between 298th and 299th.*

Fig.5 is shown the experimental image's the number of edge points, which, as you can see, using proposed method has been secured better the consequence and obtained stabilized values.

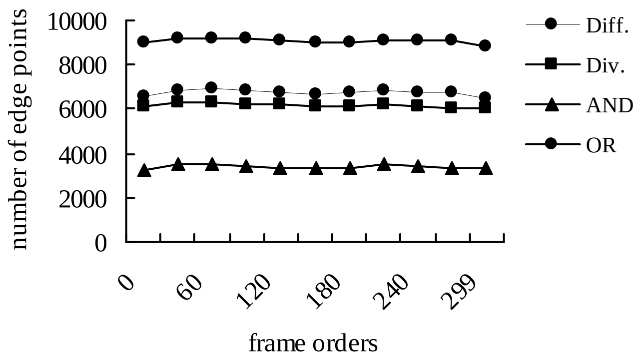

Fig. 5 *The number of edge points reference image : named akiyo (QCIF).*

4. Conclusion

Propose method is a video object segmentation algorithm, the core of which is change detection using difference and diviation operator edge point applied in wavelet domain. As the reason, the wavelet transform has the ability of multi-resolution analysis and weighted coefficients ratio value has feature to detect well moving object in the sequences. we keep more edge information in wavelet domain. Furthermore, proposed change detection using composited two operators in the wavelet domain is more accuracy or more fast, especially. Our method is used enough for real-time image processing system and resemble case or fields. It can be implemented in head-shoulder and surveillance types video.

References

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