

Modified Artificial Bee Colony Algorithm with Multilevel Threshold Segmentation and Boundaries Evaluation for Shadow Detection

Madhu Shandilya, Rakesh Kumar Das



Abstract- The appearance of shadows typically causes severe problems in pc vision. There are various methods have already put forward but scope in this field is open. In this article Shadow Detection and Removal Using Modified artificial bee colony (MABC) Algorithm with Multilevel Threshold segmentation is proposed. The proposed method uses three threshold and corresponding boundaries, associated curvature, edge response, gradient, and MABC algorithm. First data pre-processing is applied to find the correlation between the pixels then three threshold and corresponding boundaries evaluated to accurately differentiate pixels as foreground. The edge response, curvature, gradient are applied to find the boundaries. Finally, MABC has been applied for detecting the shadow. The results show improvement in comparison with other existing methods.

Index Terms -shadow detection, artificial bee colony, curvature, gradient, edge response, boundary value.

I. INTRODUCTION

Shadow free image is required in many situations. In the current scenario, Shadow detection from the image is a challenging assignment and removal of shadow from the image is the latest trend in the PC vision applications like object recognition, image segmentation, and scene interpretation. The published works in this area reflect the large impact [1–4]. Identifying shadow and object tracking are the major shortcoming in the detection method [5–6]. Therefore, there is the need of effective techniques which should take care of boundary values so that exterior and interior regions should be classified. Most shadow detection and removal strategies are supported many assumptions like : (i) shadow area are dark as compare to the background; (ii) shadow always occurs neighbouring to the moving objects (iii) illumination direction of the source and strength must be known. Various color-based [7], edge-based [8], change in texture-based [9], and other methodology have successfully brought the desired objectives. In 2016, Su et al [10] discussed the shadow detection in case of satellite images. They have considered bimodal histogram which depends on the pixel density of shadow. They have used the mean value of the two peaks for thresholding in the histogram function. In 2017, Mostafa et al [11] discussed SDI (shadow detector index) to find a shadow in remote sensing images.

They have considered RGB color band to identify the shadow pixel intensity then automatic threshold applied in the histogram. In 2017, He et al [12] describe a methodology that used 3D surface modeling. They suggested that the surface intensity of the shadow region may be obtained by considering the same texture in the area of non-shadow region. They have used technology that is image decomposition in which edge-preserving filter is registered to extract the details of the texture in the shadow region. In 2018, Tomas F. Yago et al [13] discussed the leave one-out error. They have used eight kernel values, the kernel weights (w_L, w_a, w_b, w_t) and the scaling factors ($\sigma_L, \sigma_a, \sigma_b, \sigma_t$). They have defined eight grids and each grid has a close similarity to a kernel value. The distinct values for σ_t make a set of mean distance. They have proposed the least square support vector machine LS-SVM to find the shadow probability in the image region. In 2018, Xudong Kang et al [14] discussed a method based on the collection of training sample to get a detection map. They have integrated the shadow pixels and correlations among adjacent pixels. They have also proposed a high resolution shadow detection methodology based on random walker approach. They have used Otsu for the threshold value detection and support vector machine as the classifier for the pixel classification. Then random walker model has been used for the refinement in the initial classification map to improve shadow detection accuracy in satellite images. In 2019, Das and shandilya [15] discussed the efficient artificial bee colony (ABC) with boundary value segmentation. In this method, the hybridization of association rules, Otsu approach, gradient segmentation, and ABC algorithm are used. First the data pre-processing has been applied for adjoin and adjacent matrix. Then association rules have been applied for adjoin and associated pixels and joint correlations have been formed. The Otsu's approach and gradient segmentation have been applied. It is beneficial in threshold value estimation in case of intra class variations also. Finally, the ABC algorithm has been applied for the final object detection and tracking.

II. METHODS

Our approach uses three thresholds to distinguish pixels as foreground after getting three thresholds we calculate corresponding boundaries and MABC algorithm is used for final shadow detection as the classifier. The approach is divided into four categories: 1) Image pre-processing 2) thresholds selection and corresponding boundaries 3)

Manuscript published on 30 September 2019.

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Curvature, edge response and gradient analysis 4) MABC algorithm. First the image pre-processing has been performed to find the correlation matrix and the adjacent neighbour matrix. Based on correlation three thresholds are adaptively determined which is used to generate corresponding boundaries. After getting the boundaries value gradient analysis is performed to find in which direction and what rate the value of pixels change. The edge response and curvature evaluation are used for complete mapping and smoothness of the curve. The algorithm 1 shows our approach. Figure 1 shows the proposed architecture.

Algorithm 1: Modified Artificial bee colony with three thresholds and corresponding boundaries

Step 1: Image as input

Step2: Apply triangle methods on histogram function that is a line drawn between peak and largest nonzero value then the distance between the line and histogram is calculated at the right angle, the maximum distance is taken as the threshold,

$$T(j) = \frac{C_1 N_2(j) + C_2 N_1(j)}{N_1(j) + N_2(j)}$$

where $j=L,M,H$ corresponding to low, medium and high threshold. N_1 represent the number of pixels in P_1 and N_2 represents the number of pixels in P_2 . P_1 is the false positive pixels and P_2 is the true positive pixels. C_1 and C_2 is the modes of P_1 and P_2 .

Step 3: Based on thresholds and corresponding boundaries population of the solution is calculated.

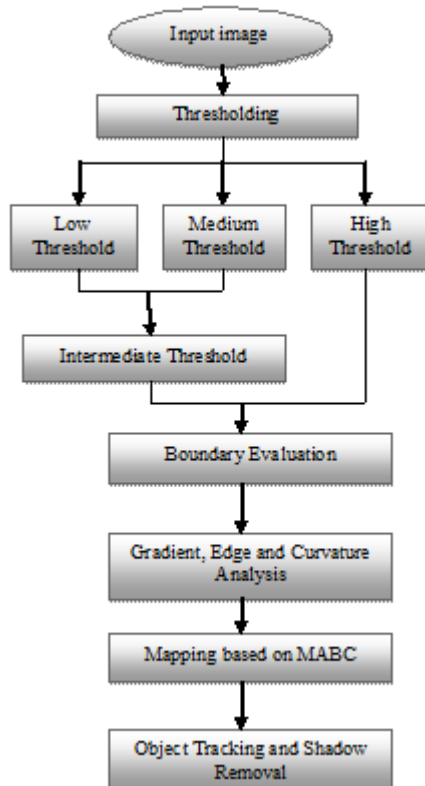


Figure 1: Proposed architecture for shadow detection and removal.

Step 4: For every solution y_i ($i = 1, 2, 3, \dots, m$) is a D-dimensional vector. Where m represents the size of population that is number of the employed bee.

Step 5: Find the probability by onlookers bee P_j

$$P_j = \frac{FV_j}{\sum_{n=1}^m FV_n}$$

Where FV_j represents the fitness gain of the i solution. Step 6 Fitness gain can be calculated by scouts bee that is pixels in our case based on memory and neighborhoods pixels

$$v_{ij} = x_{ij} + (1-\phi)(x_{kj} - x_{ij}) + \phi(\text{best}_j - x_{ij})$$

where $k \in (1, 2, \dots, m)$ and $j \in (1, 2, \dots, D)$, ϕ is a random number between $[0, 1]$. And best_j is the current population which leads to improve the searching performance of ABC.

Step 7: Minimize the problems

Let the fitness gain as F_v and σ_i is objective function then two possibilities occur:

Case 1: $\sigma_i \geq 0$

$$Fv_i = \frac{1}{1 + \sigma_i}$$

Case 2: Otherwise

$$Fv_i = 1 + |\sigma_i|$$

Step 8: Repeat the search process that is step 6 till condition is satisfied.

Step 9: Finally tracking the object for shadow detection.

III. RESULTS AND DISCUSSION

For experiment image of IKONOS is considered. The parameters considered to evaluate the shadow detection performances are overall accuracy (OA), Error Rate (ER) and Balance Error Rate (BER).

Overall Accuracy (OA)

$$\text{Error Rate (ER)} = \frac{\text{True positive} + \text{True negative}}{\text{True positive} + \text{True negative} + \text{False positive} + \text{False negative}}$$

$$= \frac{\text{False Positive} + \text{False Negative}}{\text{True positive} + \text{False positive} + \text{False negative}} * 100\%$$

Balance Error Rate (BER)

$$1 - \frac{1}{2} \left(\frac{\text{True positive}}{\text{True positive} + \text{False negative}} + \frac{\text{True negative}}{\text{True Negative} + \text{False positive}} \right)$$

Figure 2. Shows the Error rate for Shadow area. Figure 3. Shows the error rate for Non-Shadow area. Figure 4. Shows the Balance error rate. Figure 5 shows the Overall accuracy and Figure 6 shows the computing time of different methods. The results clearly show that our approach has shown significant improvement in case of overall accuracy, error rate, balance error rate and computing time.

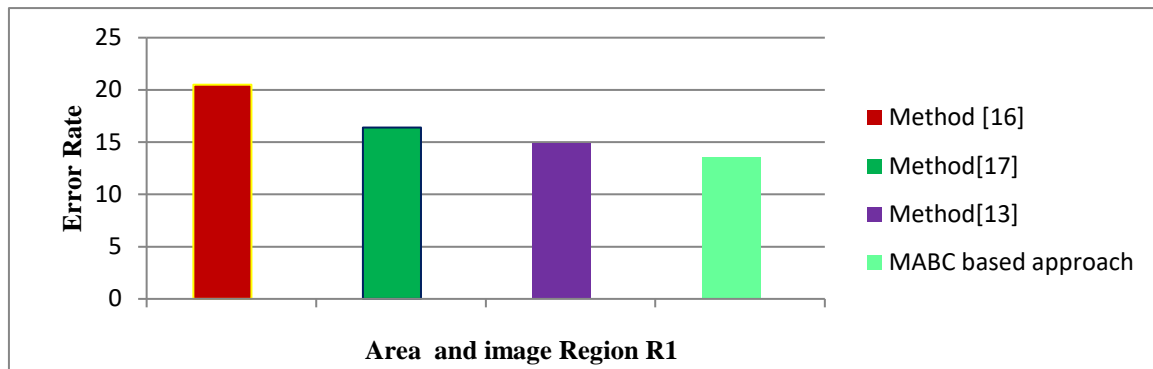


Figure 2. Error rate in case of shadow

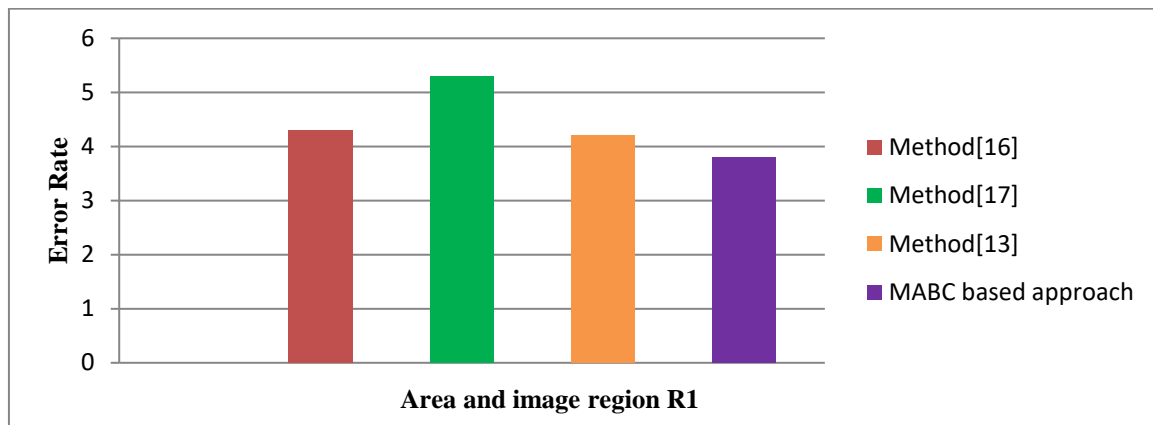


Figure 3. Error rate in case of Non-shadow

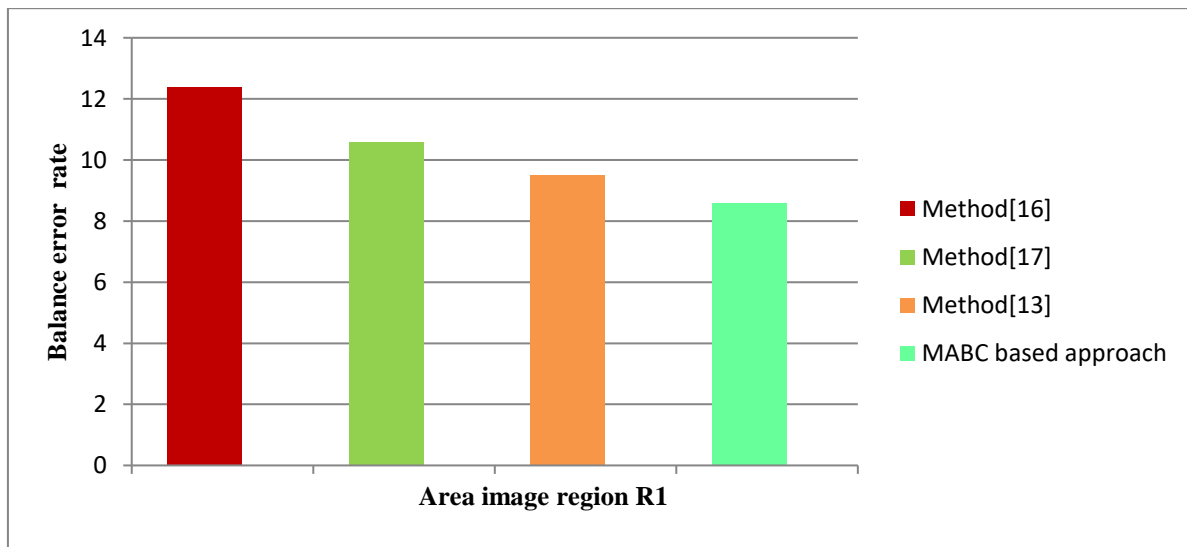


Figure 4. Balance Error rate (BER)



Figure 5.Overall accuracy comparison

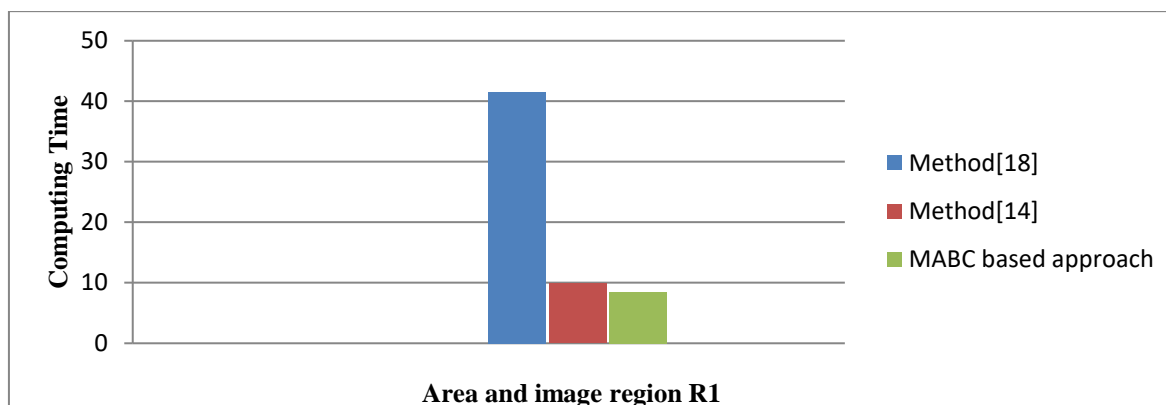


Figure 6.Computing time (in seconds) for processing an image

IV. CONCLUSION

In this paper, we propose a modified artificial bee colony method MABC using three-level of thresholds and boundary evaluation has been proposed, the concept of a gradient, curvature evaluation, and edge response help to enhance the accuracy. MABC is used to optimize the search process and to find the segmented and associated pixels for shadow detection. The accuracy, error rate, balance error rate and computing time compare well with the existing approach the result shows that the proposed method better than the previous one and other existing change detection methods.

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