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A Study on Improvement Extraction Stability of Active Net Using All-Image BL-DCDAM Introduced BL-DCDAM

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Abstract: In this paper, we have described the new All-Image DCDAM that introduces BL-DCDAM into conventional All-Image DCDAM that we have proposed before. BL-DCDAM adopts the algorithm independent on the order of presenting the input vectors. To our research, BL-DCDAM is effective because we used all pixels of the input image as the input vectors. New All-Image BL-DCDAM has obtained a correct result even in the case that conventional one has failed from the experiment.

1. Introduction

In recent years, image recognition and understanding are applied to various fields such as individual attestation which used face recognition[1], hospital round robot[2] in order to decrease the working load of the doctor and the nursing staff and automatic recognition of road sign for Intelligent Transport Systems(ITS) [3]. Achieving the highly developed society by such image recognition and understanding the target is extracted with some features of the character, the person, and the land mark, etc. in the image. It is indispensable that the machine automatically judges the situation and acts. As techniques mentioned above, contour line extraction of the target is picked up. Various researches are actively done[4]. In this paper, as the target sample of research the road sign is taken up which everyone has a chance to attract one's notice.

For this purpose, it is necessary to extract the area where the object exists. And, there is an Active Net[5] that enhances Active Contour Model[6] to the dynamic net model with two dimensions as the method of an contour line extraction. Active Contour Model or Active Net has an advantage that the contour line can be extracted while restoring them even the case that the edge which appears originally, is cut off or lost. So, various ideas to improve are proposed in the field of Active Contour Model or Active Net[4].

Active Net can try to extract the target from image area over all, but it is sometimes difficult to extract the target at the edge on the image area. To solve the problem, the improved method paid attention to the structure[7], but failing to extract the special target with a shape or a size was reported. And another Active Net model was proposed with two-steps alignment method of Active Net paid attention also to velocity of lattice points[8], referring between the outmost lattice point and one-inside. So it happens that two or more positional presumption differs from the desirable result in a case that two or more radiation lines with different velocities are involved in one object. Conventionally, our proposed DCDAM[10] extracts an contour line by Self-Organizing Map[9], which is a kind of the neural net work.

We have proposed the technique for applying DCDAM as the initial position of Active Net so far[11]. There is rarely failure example though Active Net succeeded in the great improvement of the capture ability. Then, we have adopted and examined BL-DCDAM that introduced Batch-Learning SOM algorithm into DCDAM.

2. Active Net

Active Net is a lattice network model based on the theory minimizing energy in order to extract the region of a target from the land images for example. The Active Net extracts a domain as repeating transformation by oneself so that the net energy defined becomes an infinitesimal state.

Energy on Active Net is explained as below. In this algorithm, there are two kinds of energy, those are, internal strain energy E_{int} and conformity characteristics energy E_{image} in the net model. The total net energy E_{net} is defined as a linear combination of the both energy functions shown as (1).

$$E_{net} = \int_0^1 \int_0^1 \{E_{int}(\mathbf{v}(p,q)) + E_{image}(\mathbf{v}(p,q))\} dpdq \quad (1)$$

3. BL-DCDAM (Batch-Learning Direct Color Distribution Applying Method)

A. Self-Organizing Map

Self-Organizing Map (SOM) model is based on the unsupervised learning and the neighborhood learning. SOM consists of two layers (those are the competitive layer and the input layer).

B. Batch-Learning SOM Algorithm

First of all, Batch-Learning SOM algorithm defines (2) as the radius $NR_c(t)$ of the neighborhood area. Where, $NR_c(0)$ is an initial neighborhood area size, and T is total learning iteration. It defined (3) as the $N_c(t)$ of units included in the neighborhood area.

Where, function d_M is the distance function between units on a competitive layer, and m_c shows the unit with the update object at time t. Next, the input vectors that fulfilled (4) are corrected on the competitive layer units included in set $N_c(t)$.

$$NR_c(t) = NR_c(0)\left(1 - \frac{t}{T}\right) \quad (2)$$

$$N_c(t) = \{ m_i \mid d_M(m_c, m_i) \le NR_c(t) \} \quad (3)$$

$$x_l = \arg\min_{1 \le k \le n} \| x_k - m_j \|, m_j \in N_c(t) \tag{4}$$

And, the unit to be updated is renewed as (5) by the mean vector of the input vector collected according to (4).

$$m_c(t+1) = \frac{1}{|N_c(t)|} \sum_{x_k \in N_c(t)} x_k \tag{5}$$

Thus, on the process neighborhood learning, by learning not only the unit to be updated but also the neighborhood unit representing Voronoi region, SOM a unit to be updated and the surrounding unit are renewed to the reference vector with the same tendency at the same time.

C. Color Distribution Function

Color distribution function(CDF)[13] is what defined as a color distribution function by gathering the color distribution of the extracted object as a specimen color beforehand, obtaining the covariance matrix it and furthermore processing statistically. By applying the color distribution function to the input image, we can take out the similarity degree of the pixel compared with color distribution function. As a result, we obtain grayscale image called a color similarity map. The similarity degree of each pixel is defined as (6) by the color distribution function $h(x, y)$.

$$S_m(e_{i,j}) = h\,[x_f(e_{i,j}), y_f(e_{i,j})] \tag{6}$$

where, suffix i and j in the pixel e show X-Y coordinate of input image. $x_f(e_{i,j})$ and $y_f(e_{i,j})$ show the function that converted from X-Y coordinate of pixel $e_{i,j}$ to XYZ color space. In this paper the color distribution function is made and used having a red traffic sign.

D. BL-DCDAM Algorithm

The learning rate coefficient doesn't exist in Batch-Learning SOM algorithm as described by III.B. It is big feature for our previews proposal technique to change the learning rate coefficient adaptively depending on the grayscale value up to now.

Previously described, Batch-Learning SOM algorithm has no learning rate coefficient. So, BL-SOM cannot change the learning rate coefficient depending on the grayscale value.

In order to use in the Batch-Learning SOM algorithm the weight function changed adaptively depending on the grayscale value, we have achieved the BL-DCDAM algorithm in the Batch-Learning algorithm by newly defining (7) and introducing to it.

$$m_c(t+1) = \frac{1}{\sum_{x_k \in N_c(t)} w(x_l)} \sum_{x_k \in N_c(t)} w(x_l)(i_l, j_l) \tag{7}$$

And, we experimented as a weight function $w(x)$ by using Sigmoid function (α=20,θ=0.25) shown in (8).

$$w(x) = \frac{1}{1 + \exp\{-\alpha(x - \theta)\}} \tag{8}$$

4. Improvemnet Target Positon Estimate For Active Net Using by BL-DCDAM

A. All-Image BL-DCDAM Algorithm

At first, Figure 1(a) shows the example of input image. Next, we can get the similarity map by red color distribution function from Figure 1(a) shows in Figure 1(b).

We can get the result Figure 2 by applying BL-DCDAM to Figure 1(b). The point where the lines intersect each other is the unit at Figure 2.

We understand that each unit has been aligned keeping topology between units each other and that the units have been concentrated around the pixels outputted with high similarity.

Next, we apply each studied unit from $u_0 \ldots u_n$ to search region with the circle with radius r. Figure 3 is extended figure in the part of Figure 2, and it shows the search region.

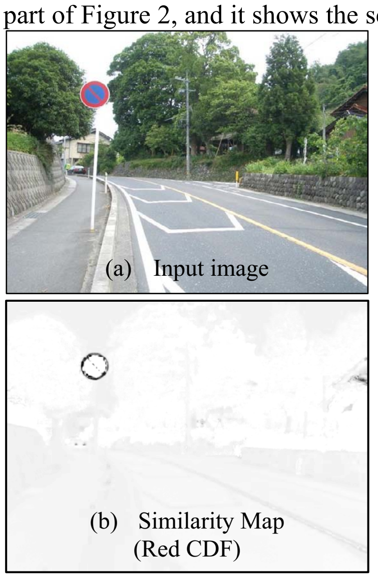

Figure 1. Example of input image

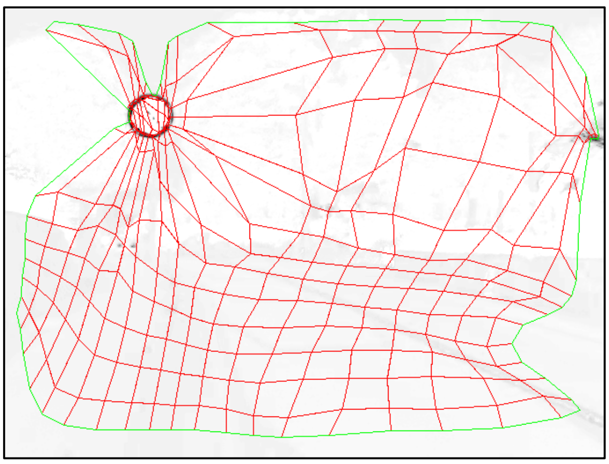

Figure 2. The execution results of applying CDF and DCDAM to Figure 1

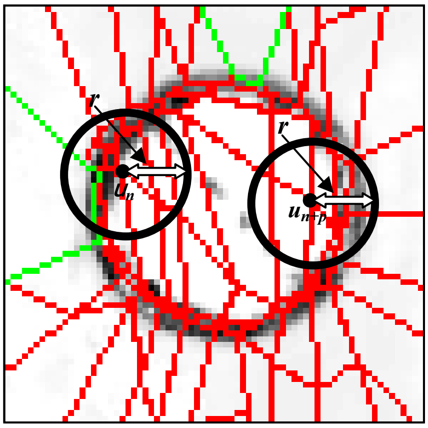

Figure 3. The extended figure in the part of Figure 2 and the search region

At the search region, we will check whether the each unit exceeds a certain threshold t or not. Through the process, it happens for two or more candidate units to be chosen around one vicinity of the target according to the value of the threshold or the size of the search region. Then, we will handle two or more candidate units as a set of one candidate by connecting the units. Figure 4 shows the execution result of connecting to Figure 2. At the connecting process, all units should be candidate on the route from unit u_s to u_t fulfilling the requirements for candidate. The problem that may occur in the technique of reference[8] can be evaded by above mentioned connecting technique.

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As shown in Figure 4, the bold line described as bold on the extended figure shows the selected candidate units by connecting. Then, cover all the search region of the entire sets of units that the labeling is done, the size of Active Net is arranged.

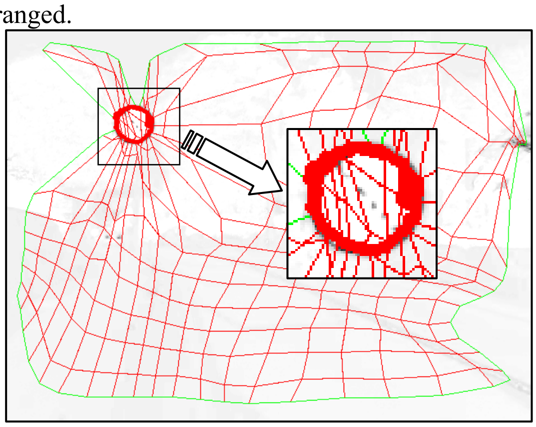

Figure 4. Results of connecting

B. *All-Image DCDAM Algorithm Problrem*

In All-Image DCDAM that we had proposed before, there was case that the learning result was different depending on the order of presenting the input vectors. And, the right candidate unit was seldom chosen as a result.

In order to solve the problem, we introduced Batch-Learning SOM algorithm to DCDAM and we experimented.

5. Experimental Results

In our experiment, we used the image with 640×480 pixels contained the red road sign target on the upper part. Here, we determined parameters as r=15 and t=7 from the preliminary experiment.

And, on the parameter of the SOM, the learning iteration is 75000 in DCDAM and 75 in BL-DCDAM. Both the unit size of the SOM was 25×20, and the initial neighborhood area was 7 units.

Figure 5 shows the experimental result by conventional method and proposed method. It is confirmed that it is possible to arrange Active Net correctly by proposal All-Image BL-DCDAM introduced this time, and to extract it even in the case that the target was not able to be extracted correctly by failing in the arrangement of Active Net in past All-Image DCDAM because of the insufficient selection of the candidate unit, by each input image (a) and (b).

Therefore, we have confirmed that the introduction of BL-DCDAM is effective in this research of extracting contour line.

6. Conclusion

In this paper, we have proposed two-stage method by using All-Image DCDAM in the first step and Active Net in the second step.

In this paper, we have described the problem in All-Image DCDAM that proposed by the past, and All-Image BL-DCDAM was examined that newly introduced All-Image DCDAM to BL-DCDAM.

From the experimental result, it is confirmed target is extracted correctly even when that is not possible to extract it correctly by a conventional technique, in addition the learning iteration was able to be reduced to about 1/1000.

As future tasks, it is necessary to speed-up of learning, and to examine hardware as like as the reference[14].

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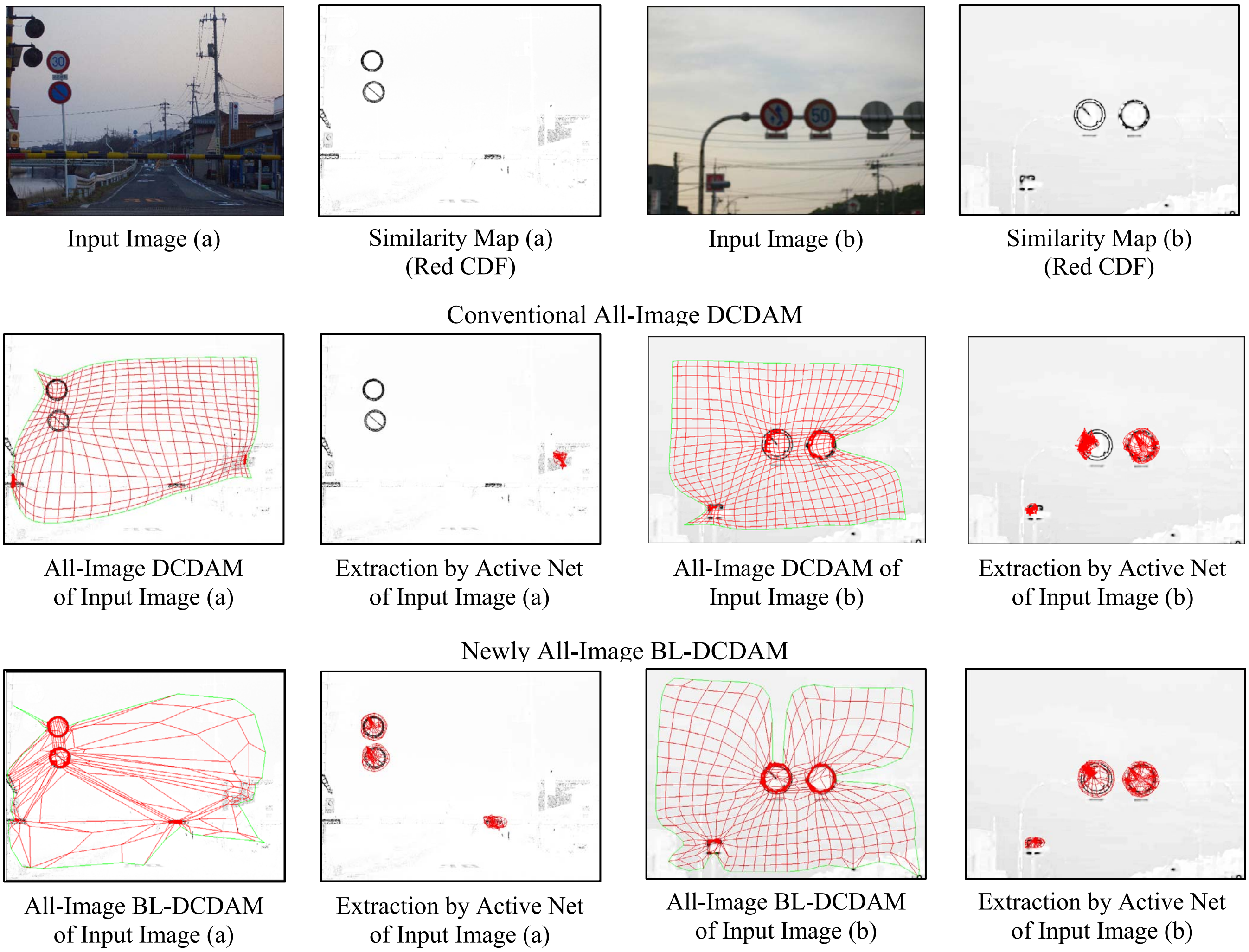

Figure 5. Experimental Result

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