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Selection of Feature Regions Set for Digital Image Using Optimization Algorithm

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Abstract- A feature based "Selection of feature region set for digital image using Optimization Algorithm" is proposed here. The work is based on simulated attacking and optimization solving procedure. Image transformation techniques are used to extract local features. Simulated attacking procedure is performed to evaluate the robustness of every candidate feature region. According to the evaluation results, a track-with-pruning procedure I adopted to search a minimal primary feature set which may resists the most predefined attacks. In order to enhance its resistance capability against undefined attacks, primary feature set is then extended by adding some auxiliary feature regions in it. This work is formulated as a multidimensional knapsack problem and solved by optimization algorithms such as Genetic Algorithm, Particle Swarm Optimization and Simulated Annealing.

Keywords - Feature, optimization, robust, simulated attacks

I. INTRODUCTION

With the rapid development of internet, manipulation of data becomes easier. Application uses digital data including electronic advertising, real-time video and audio delivery, digital repositories and libraries, and Web publishing. This ease of access to digital data brings with itself the problem of copyright protection. It has been recognized that current copyright laws are not enough for dealing with digital data. This has led to an interest towards developing new copy prevention and protection mechanisms. Thus, increasing interest is based on robust regions set, using such robust regions one could keep their information secure. The existing methods do not imply higher robustness and may degrade the quality of the digital image against unknown attacks as characteristics of unknown attacks vary with known attacks. Thus, the difficulty is to obtain or select most robust feature region set for information hiding. The effectiveness of a digital image is indicated by the robustness of regions against various attacks. The robust regions are mainly used to sign copyright information of the digital work as robust regions can resist information after various kinds of attacks such as signal processing or geometric distortions.

Thus it is necessary to work on following issues,

- Finding the most robust region set of a digital image against various kinds of attacks for hiding information,
- developing a faster robustness measurement
- improving image quality

So feature region set selection method based on optimization approaches, by which selection of the most robust regions without violating the image quality is proposed here.

II. SYSTEM ARCHITECTURE

The system architecture is as in "Figure 1". There are two operational stages as Primary feature set searching stage and feature set extension stage respectively.

2.1 Primary Stage (Searching Stage)

The aim is to obtain primary feature region set.

a. Extract features

To extract local features, feature detectors are used. Feature detectors perform specific transformations on digital images to extract their local features, ranging from a point to an object, and have been adopted in many applications such as object recognition, database retrieval, and motion tracking. Most features of an image can be preserved after it suffers a distortion such as scaling, rotation, or illumination changes. Therefore, several feature-based methods have been developed by exploiting the robustness of feature regions against various attacks.

Normally, feature selection according to a single criterion like corner response or the number of neighbouring feature points to obtain regions. Various corner detectors can be used to detect corners. Here, Harris – Laplace corner detector is used to obtain regions. "Figure 2" shows the regions detected by Harris – Laplace corner detector.

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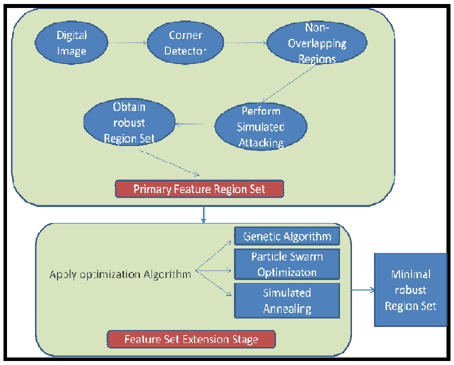

Figure 1: System Architecture

b. Simulated attacking and selection of non overlapping region set

Since the magnitude of the region gets modified after attacks on region, it is preferred to select nonoverlapping regions to avoid major degradation of image quality.It is hard to accurately identify the robustness of all regions by a single criterion like the corner response. Therefore, this stage is based on simulated attacking. It would be helpful to find out the most robust regions if there is prior knowledge of each region's attack resistance capability.Moreover, a feature region may have different degrees of robustness against different attacks [4], [8]. Regions obtained in "Figure 2" are survived with different predefined attacks. A few representative attacks are applied to the feature regions for evaluating their robustness in the simulated attacking phase. The attack resistance analysis phase is implemented by a two-step procedure. The original feature regions are first checked if they can be re-detected in the attacked image. The redetected region is examines the consistency (bit error) between itself after attacks. Using $d_{r,a}$ to indicate whether the region can resist the predefined attack or not, it is defined as

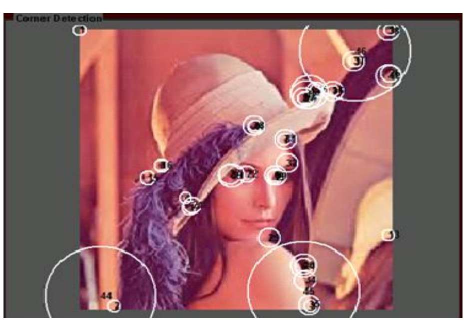

Figure 2: Regions detected by Harris-Laplacian Corner detector

$$d_{r,a} = \begin{cases} 1 & BER(W,Wr) \le T \\ 0 & otherwise \end{cases} \quad \ldots\ldots\ldots\ldots (1)$$

Where,

BER (I, I_a) $\rightarrow$ denotes the bit error between original image I and image I_a after different attacks on it

T $\rightarrow$ a predefined bit error threshold

In the final phase, the most robust and smallest set of nonoverlapping feature regions is selected according to the result of attack resistance analysis. This work is formulated as follows:

$$R_p^* = \arg \max_{Rp} \{\textstyle\sum_{i=1}^{Na} x_{ai}^{Rp} \min Rp; \}$$
$$\forall\ r_k, r_j \in R_p,\ k \neq j \dashrightarrow r_k \cap r_j = \emptyset \qquad \ldots\ldots\ldots(2)$$

Where,

R_p $\rightarrow$ is the set of selected feature regions in which any two regions r_k and r_j are not overlapped, and

The value of for a predefined attack is determined by

$$x_{ai}^{Rp} = \begin{cases} 1, & \exists r \in Rp, dr, ai \neq 0 \\ 0, & otherwise \end{cases} \qquad \ldots\ldots\ldots\ldots (3)$$

Where,

R_p^* $\rightarrow$ the R_p satisfying with the maximum Value of $\sum_{i=1}^{Na} X^{Rp}{}_{ai}$

The selection would be such that, by the involvement of such region's series, all predefined attacks on this series can be resisted As a result, a region set would be better in robustness when its regions can be complementary in attack resistance as many as possible. These results are obtained with the help of track with pruning algorithm.

A track with pruning Algorithm

Step 1: Initialize associated parameters and set the size of inspected feature region sets as NULL.

Step 2: Check if the termination condition is satisfied.

Step 3: while it cannot resist more attacks

The candidate Set is included in the pruned set

by adding more feature regions.

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Step 4: Otherwise

Update the primary feature region set with a candidate feature region set if the latter can resist more attacks than the former.

Step 5: Stop.

In practice, the aggregate attack resistance capability of all selected nonoverlapping regions is more convincing, and it could be regarded as the overall robustness of a digital image.Sometimes this set may fail to resist some non predefined attacks, hence we need to add some auxiliary regions selected from those residual feature regions to enhance the robustness of image against undefined attacks under preserving its visual quality. Since the characteristics of undefined attacks are of wide variety and are difficult to model, we therefore adopt a multi-criteria optimization strategy [15], [16] for the selection of auxiliary feature regions. This phenomena of feature region selection method based on multi-criteria optimization strategy is described in stage 2.

2.2 Extended Stage (Optimization Stage)

Neither corner response nor the number of its neighbouring feature points, however, can guarantee the selection of nonoverlapping regions with the maximum robustness to various attacks, because higher corner response and a large number of its neighbouring feature points do not always imply higher robustness of itself. Moreover, a feature region may have different degrees of robustness against different attacks [3], [5]. A feature region selection is optimized by optimization to obtain robust regions against unknown attacks occurs, as, a feature region may have different degrees of robustness against different kinds of attacks. To optimize the regions following optimization algorithms are used–

- Genetic Algorithm (GA) [7], [8], [9]
- Particle Swarm Optimization (PSO) [6], [9] and
- Simulated Annealing (SA) [11]

An optimal feature region set is chosen to resist the predefined attacks. But this set may fail to resist some non predefined attacks, we need to add some auxiliary regions selected from those residual feature regions to enhance the robustness of image against undefined attacks under preserving its visual quality. Since the characteristics of undefined attacks are of wide variety and are difficult to model, we therefore adopt a multi-criteria optimization strategy for the selection of auxiliary feature regions. First, the assumption that the feature regions which survive more types of predefined attacks are more likely to resist undefined attacks is applied. The symbol is defined to indicate the overall resistance degree of the region against all predefined attacks, and it is determined by

$$g_r^a = (d_{r1,a1} + d_{r1,a2} + \ldots\ldots + d_{rn,aNa}) = \sum_{i=1}^{Na} X^{Rp} \quad \ldots\ldots\ldots\ldots (4)$$

Where,

$d_{ri,ai} \varepsilon \{0, 1\} \longrightarrow$ indicates if the region can resist the i^{th} predefined attack a_i and

$N_a \longrightarrow$ the total number of predefined attacks.

The resistance of a region against a predefined attack is regarded as a possible characteristic of the region. The symbol g^a_r is the summary representation of N_a characteristics of a region. Other two generic characteristics of feature regions, the corner response and the integration scale are referred, since we cannot exclude the possibility that there are undefined attacks with the characteristics never occurred in the predefined attacks. The parameter which denotes the limitation of quality degradation of an image after being attacked considered as peak signal-to-noise ratio (PSNR) value between a cover image and attacked image. Therefore, the work of the extension stage can be formulated as an optimization problem formulated as Multi Dimensional knapsack problem (MDKP) with multiple constraints as follows,

$$\text{Maximize} \sum_{j=1}^{|Rp^*|} (g_{rj}^{a} + g_{rj}^{c} + g_{rj}^{\sigma})\, S_{rj} \quad \ldots\ldots\ldots\ldots (5)$$

$$\text{Subject to } \sum_{j=1}^{|Rp^*|} q_{rj}^{a} \cdot S_{rj} \leq Q_c$$

$$\sum_{j=1}^{|Rp^*|} (p_{ri,rj} s_{ri} s_{rj} < 1) \qquad i = 1,2,3,\ldots,|Rp^*| \quad \ldots\ldots\ldots (6)$$

Where,

$Rp^* \longrightarrow$ The number of feature regions except those in the primary feature region set as well as the regions overlapped with them and

s_{ri} is defined as,

$$s_{ri} = \begin{cases} 1 & \text{if the reggion ri is selected} \\ 0 & \text{otherwise} \end{cases} \quad \ldots\ldots (7)$$

The value of p_{rirj} indicates whether the two regions are overlapped and is defined as

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$$p_{rirj} = \begin{cases} 1 & ri \cap rj \neq \acute{\emptyset} \\ 0 & \text{otherwise} \end{cases} \quad \dots\dots\dots (8)$$

The optimization problem formulated by 5 and 6 can be formulated as MDKP that is a knapsack problem with a collection of different constraints.

A heuristic search procedure is adopted to solve this MDKP for determining the best choice of auxiliary feature regions.

Hence, to solve this MDKP for determining the best choice of auxiliary feature regions and best choice of optimization algorithm we have used some optimization approaches such as GA, PSO, and SA.

III. THE ALGORITHMIC FRAMEWORK OF GA, PSO AND SA

i) Genetic Algorithm (GA)

```
Generate initial population
Do
   Calculate the fitness of each member
// simulate another generation
Do
         Select parents from current population
         Perform crossover add offspring to the
         new population
while new population is not full
 Merge new population into the current    population
 Mutate current population while not converged
```

ii) Particle Swarm Optimization (PSO)

```
Randomly generate an initial population
  Repeat
       for i = 1 to population_size
      do
           if f( Xi) < f( Pi) then
                Pi=Xi
                Pg = min (P_neighbours);
            for d =1 to dimensions
                 do
                      velocity_update();
                       position_update();
           end
       end
until termination criterion is met.
```

iii. Simulated Annealing (SA)

Function SIMULATED-ANNEALING(*Problem*, *Schedule*) **returns** a solution state

Current = MAKE- REGION (INITIAL-SOLUTION [*Problem*])

For t = 1 **to** N **do**

T = *Schedule*[t] // Index

If T = 0 **then return** C*urrent*

Next = a randomly selected successor of *Current*

ΛCost = VALUE[*Next*] – VALUE[*Current*]

if ΛCost > 0 **then** *Current* = *Next*

else *Current* = *Next* only with probability exp(-ΛCost /T)

End

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Comparing results of these different optimization techniques on feature region set, it determines the best choice of optimization techniques for selecting most robust region set under the constraint of preserving image quality and extracting feature regions in less amount of time.

IV. EXPERIMENTALRESULTS

System is implemented using Matlab. Results are obtained for test images. The systems implement Harris-Laplacian based robust region set selection. The corner response values are used to remove overlapping feature regions. TABLE 1 illustrates the comparisons, based on the criterion of detection ratio, defined as the ratio of the number successfully detected regions with respect to total number of regions in an image.

TABLE I

Image	Jpeg 50	Jpeg 60	Rotate 15	Rotate 30	Median	Gnoises
LE	4/5	4/5	5/5	4/5	3/5	5/5
BA	3/6	5/6	6/6	4/6	6/6	6/6
FR	2/4	2/4	¾	1/4	1/4	4/4

TABLE II and TABLE III gives results for regions, RN. Where RN → Region Number {3, 5, 6, 7, 8}

TABLE II

RN	JPEG 50	JPEG 60	Rotate 15	Rotate30	Median Filter	Gnoises
3	1	1	1	1	1	1
5	0	0	1	1	0	1
6	1	1	1	0	0	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1

TABLE III

As illustrated in TABLE II and III, this system enhances the robustness of the system of feature based methods against attacks.

.

RN	Corner Response	Attack Resistance Capability
3	49.2244	3
5	36.6759	3
6	38.1657	3
7	45.9059	3
8	44.7766	3

“Figure 3” and “Figure 4” shows results of the proposed system.

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V. Conclusions

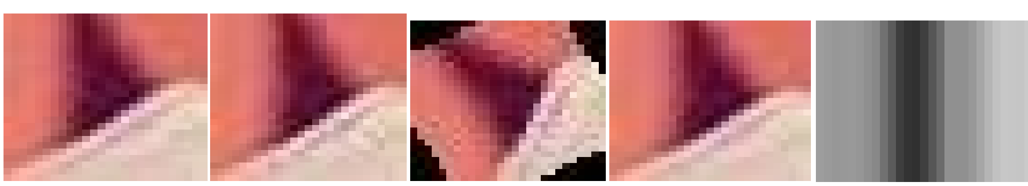
The aim behind "Selection of feature region set for digital image using Optimization Algorithm" is implying higher robustness of the digital image. This system is mainly based on simulated attacking and optimization solving procedure, for obtaining robust region set. It uses integration scale, corner response and attack's resistance capability as performance parameters. Optimization algorithms such as Genetic Algorithm, Particle Swarm Optimization and Simulated Annealing to optimize the regions are used. The results generated after comparing different optimization techniques, determines the best technique for selection of most robust region set under the constraints of preserving image quality and extracting feature region set in less amount of time. Thus, optimization based methods significantly improves the robustness of a digital image. Hence, this system is suitable for applications in which robustness of a digital image is primary key, such as, hiding information or prevention and protection of digital contents.

TABLE IV illustrates the comparison of an optimization algorithm to optimized regions

TABLE IV

SN	Terms	GA	PSO	SA
1	**Number of Lines**	More	Few	Few
2	**Memory**	More	Less	Less
3	**Time**	Less	More	More
4	**Tuning of parameters**	Difficult	Easiest	Easiest
5	**Structure**	Complex	Simple	Simple
6	**Implementation**	Difficult	Easy	Easy

Following figure shows regions after attacked on region.



'a' 'b' 'c' 'd' 'e'

Figure 3: Attacked region

Where,
a : original region
b : attacked region after – JPEG Attack
c : attacked region after – ROTATE Attack
d : attacked region after – Gnoises Attack
e : attacked region after – Median Filter Attack

Following images gives results of this system

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Figure 4: Results of "Selection of feature region set for digital image using Optimization Algorithm"

Where,

a: Original Image of Lina
b: Image after applied Harris Laplace Corner
c: Image before applying TWPA algorithm
d: Image after applying TWPA algorithm
e: Image obtained after applying GA
f: Image obtained after applying PSO
g: Image obtained after applying SA Detector

Results:

Number of Regions for optimization {7, 3, 5, 6, 8}

Fig. 'd': Number of Regions obtained after GA {8, 3, 5}

Fig. 'e': Number of Regions obtained after PSO {8, 3, 7}

Fig. 'f': Number of Regions obtained after SA{8, 3}

REFERENCES

[1] Jen-Sheng Tsai, Win-Bin Huang, and Yau-Hwang Kuo , "On the Selection Optimal Feature Region Set for Robust Digital Image Watermarking", in IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 20, NO. 3, MARCH 2011

[2] J. S. Tsai, W. B. Huang, C. L. Chen, and Y. H. Kuo, "A feature-based digital image watermarking for copyright protection and content authentication, "in Proc. IEEE Int. Conf. Image Process., Sep. 200, vol.5, pp. 469–472.

[3] D. G. Lowe, "Distinctive image features from scale-invariant keypoints," *Int. J. Comput. Vis.*, vol. 60, no. 2, pp. 91–110, Nov. 2004.

[4] C. S. Lu, S. K. Huang, C. J. Sze, and H. Y. Mark Liao, "Cocktail watermarking for digital image protection," *IEEE Trans. Multimedia*, vol. 2, no. 4, pp. 209–224, Dec. 2000.

[5] J. S. Seo and C. D. Yoo, "Image watermarking based on invariant regions of scale-space representation,"

[6] *IEEE Trans. Signal Process.*, vol. 54, no. 4, pp. 1037–1049, Apr. 2006.

[7] Konstantinos E. Parsopoulos, Michael N. Vrahatis, " Particle Swarm Optimization for Constrained optimization Algorithms" research centre (UPAIRC), GR -26110, Patras, Greece

[8] Riccardo Poli, William B. Langdon and Nicholas F. McPhee "A Field Guide to Genetic Programming" University of Essex – UK rpoli@essex.ac.uk

[9] Golderberg, David E., *Genetic Algorithms: in Search, Optimization & Machine Learning*, Addison-Wesley Publishing Company, Inc., New York, 1989.

[10] Sadiq M. Sait and Habib Youssef, *Iterative Computer Algorithms with Application to Engineering: Solving Combinatorial Optimization Problems*, IEEE Computer Society, LA, 1999.

[11] George S. Tarasenko, *Stochastic Optimization in the Soviet Union Random Search Algorithms*, Delphic Associates, Inc., VA, 1985.

[12] Duc Truong Pham and Dervis Karaboga, *Intelligent Algorithms, tabu search, simulated annealing and neural networks*, Springer, New York, 1998.