INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, IT & MANAGEMENT

IJRCM

IJRCM

A Monthly Double-Blind Peer Reviewed (Refereed/Juried) Open Access International e-Journal - Included in the International Serial Directories

Indexed & Listed at:

Ulrich's Periodicals Directory ©, ProQuest, U.S.A., Cabell's Directories of Publishing Opportunities, U.S.A., Google Scholar,
Indian Citation Index (ICI), J-Gage, India [link of the same is duly available at Inflibnet of University Grants Commission (U.G.C.)],
Index Copernicus Publishers Panel, Poland with IC Value of 5.09 (2012) & number of libraries all around the world.
Circulated all over the world & Google has verified that scholars of more than **7835 Cities** in **197 countries/territories** are visiting our journal on regular basis.

Ground Floor, Building No. 1041-C-1, Devi Bhawan Bazar, JAGADHRI – 135 003, Yamunanagar, Haryana, INDIA

http://ijrcm.org.in/

CONTENTS

CALL FOR MANUSCRIPTS

We invite unpublished novel, original, empirical and high quality research work pertaining to the recent developments & practices in the areas of Computer Science & Applications; Commerce; Business; Finance; Marketing; Human Resource Management; General Management; Banking; Economics; Tourism Administration & Management; Education; Law; Library & Information Science; Defence & Strategic Studies; Electronic Science; Corporate Governance; Industrial Relations; and emerging paradigms in allied subjects like Accounting; Accounting Information Systems; Accounting Theory & Practice; Auditing; Behavioral Accounting; Behavioral Economics; Corporate Finance; Cost Accounting; Econometrics; Economic Development; Economic History; Financial Institutions & Markets; Financial Services; Fiscal Policy; Government & Non Profit Accounting; Industrial Organization; International Economics & Trade; International Finance; Macro Economics; Micro Economics; Rural Economics; Co-operation; Demography: Development Planning; Development Studies; Applied Economics; Development Economics; Business Economics; Monetary Policy; Public Policy Economics; Real Estate; Regional Economics; Political Science; Continuing Education; Labour Welfare; Philosophy; Psychology; Sociology; Tax Accounting; Advertising & Promotion Management; Management Information Systems (MIS); Business Law; Public Responsibility & Ethics; Communication; Direct Marketing; E-Commerce; Global Business; Health Care Administration; Labour Relations & Human Resource Management; Marketing Research; Marketing Theory & Applications; Non-Profit Organizations; Office Administration/Management; Operations Research/Statistics; Organizational Behavior & Theory; Organizational Development; Production/Operations; International Relations; Human Rights & Duties; Public Administration; Population Studies; Purchasing/Materials Management; Retailing; Sales/Selling; Services; Small Business Entrepreneurship; Strategic Management Policy; Technology/Innovation; Tourism & Hospitality; Transportation Distribution; Algorithms; Artificial Intelligence; Compilers & Translation; Computer Aided Design (CAD); Computer Aided Manufacturing; Computer Graphics; Computer Organization & Architecture; Database Structures & Systems; Discrete Structures; Internet; Management Information Systems; Modeling & Simulation; Neural Systems/Neural Networks; Numerical Analysis/Scientific Computing; Object Oriented Programming; Operating Systems; Programming Languages; Robotics; Symbolic & Formal Logic; Web Design and emerging paradigms in allied subjects.

Anybody can submit the **soft copy** of unpublished novel; original; empirical and high quality **research work/manuscript** ***anytime*** in ***M.S. Word format*** after preparing the same as per our **GUIDELINES FOR SUBMISSION**; at our email address i.e. infoijrcm@gmail.com or online by clicking the link **online submission** as given on our website (***FOR ONLINE SUBMISSION, CLICK HERE***).

GUIDELINES FOR SUBMISSION OF MANUSCRIPT

1. **COVERING LETTER FOR SUBMISSION:**

DATED: _____________

THE EDITOR

IJRCM

Subject: **SUBMISSION OF MANUSCRIPT IN THE AREA OF ______________________________________.**

(e.g. Finance/Mkt./HRM/General Mgt./Engineering/Economics/Computer/IT/ Education/Psychology/Law/Math/other, please specify)

DEAR SIR/MADAM

Please find my submission of manuscript titled '____' for likely publication in one of your journals.

I hereby affirm that the contents of this manuscript are original. Furthermore, it has neither been published anywhere in any language fully or partly, nor it is under review for publication elsewhere.

I affirm that all the co-authors of this manuscript have seen the submitted version of the manuscript and have agreed to inclusion of their names as co-authors.

Also, if my/our manuscript is accepted, I agree to comply with the formalities as given on the website of the journal. The Journal has discretion to publish our contribution in any of its journals.

NAME OF CORRESPONDING AUTHOR	:
Designation/Post*	:
Institution/College/University with full address & Pin Code	:
Residential address with Pin Code	:
Mobile Number (s) with country ISD code	:
Is WhatsApp or Viber active on your above noted Mobile Number (Yes/No)	:
Landline Number (s) with country ISD code	:
E-mail Address	:
Alternate E-mail Address	:
Nationality	:

* i.e. Alumnus (Male Alumni), Alumna (Female Alumni), Student, Research Scholar (M. Phil), Research Scholar (Ph. D.), JRF, Research Assistant, Assistant Lecturer, Lecturer, Senior Lecturer, Junior Assistant Professor, Assistant Professor, Senior Assistant Professor, Co-ordinator, Reader, Associate Professor, Professor, Head, Vice-Principal, Dy. Director, Principal, Director, Dean, President, Vice Chancellor, Industry Designation **etc**. ***The qualification of author is not acceptable for the purpose***.

NOTES:

a) The whole manuscript has to be in ***ONE MS WORD FILE*** only, which will start from the covering letter, inside the manuscript. ***pdf. version** is liable to be rejected without any consideration*.

b) The sender is required to mention the following in the **SUBJECT COLUMN of the mail**:

New Manuscript for Review in the area of (e.g. Finance/Marketing/HRM/General Mgt./Engineering/Economics/Computer/IT/ Education/Psychology/Law/Math/other, please specify)

c) There is no need to give any text in the body of the mail, except the cases where the author wishes to give any **specific message** w.r.t. to the manuscript.

d) The total size of the file containing the manuscript is expected to be below **1000 KB**.

e) Only the **Abstract will not be considered for review** and the author is required to submit the **complete manuscript** in the first instance.

f) ***The journal gives acknowledgement w.r.t. the receipt of every email within twenty-four hours*** and in case of non-receipt of acknowledgment from the journal, w.r.t. the submission of the manuscript, within two days of its submission, the corresponding author is required to demand for the same by sending a separate mail to the journal.

g) The author (s) name or details should not appear anywhere on the body of the manuscript, except on the covering letter and the cover page of the manuscript, in the manner as mentioned in the guidelines.

2. **MANUSCRIPT TITLE:** The title of the paper should be typed in **bold letters**, **centered** and **fully capitalised**.

3. **AUTHOR NAME (S) & AFFILIATIONS:** Author (s) **name**, **designation**, **affiliation** (s), **address**, **mobile/landline number** (s), and **email/alternate email address** should be given underneath the title.

4. **ACKNOWLEDGMENTS:** Acknowledgements can be given to reviewers, guides, funding institutions, etc., if any.

5. **ABSTRACT:** Abstract should be in **fully Italic printing**, ranging between **150** to **300 words**. The abstract must be informative and elucidating the background, aims, methods, results & conclusion in a **SINGLE PARA**. ***Abbreviations must be mentioned in full***.

6. **KEYWORDS:** Abstract must be followed by a list of keywords, subject to the maximum of **five**. These should be arranged in alphabetic order separated by commas and full stop at the end. All words of the keywords, including the first one should be in small letters, except special words e.g. name of the Countries, abbreviations etc.

7. **JEL CODE:** Provide the appropriate Journal of Economic Literature Classification System code (s). JEL codes are available at www.aeaweb.org/econlit/jelCodes.php. However, mentioning of JEL Code is not mandatory.

8. **MANUSCRIPT:** Manuscript must be in ***BRITISH ENGLISH*** prepared on a standard A4 size ***PORTRAIT SETTING PAPER***. *It should be free from any errors i.e.* ***grammatical, spelling*** *or* ***punctuation.*** *It must be thoroughly edited at your end*.

9. **HEADINGS:** All the headings must be bold-faced, aligned left and fully capitalised. Leave a blank line before each heading.

10. **SUB-HEADINGS:** All the sub-headings must be bold-faced, aligned left and fully capitalised.

11. **MAIN TEXT:**

THE MAIN TEXT SHOULD FOLLOW THE FOLLOWING SEQUENCE:

INTRODUCTION
REVIEW OF LITERATURE
NEED/IMPORTANCE OF THE STUDY
STATEMENT OF THE PROBLEM
OBJECTIVES
HYPOTHESIS (ES)
RESEARCH METHODOLOGY
RESULTS & DISCUSSION
FINDINGS
RECOMMENDATIONS/SUGGESTIONS
CONCLUSIONS
LIMITATIONS
SCOPE FOR FURTHER RESEARCH
REFERENCES
APPENDIX/ANNEXURE

The manuscript should preferably be in ***2000 to 5000 WORDS***, But the limits can vary depending on the nature of the manuscript.

12. **FIGURES & TABLES:** These should be simple, crystal **CLEAR**, **centered**, **separately numbered** & self-explained, and the **titles must be above the table/figure**. **Sources of data should be mentioned below the table/figure**. *It should be ensured that the tables/figures are referred to from the main text*.
13. **EQUATIONS/FORMULAE:** These should be consecutively numbered in parenthesis, left aligned with equation/formulae number placed at the right. The equation editor provided with standard versions of Microsoft Word may be utilised. If any other equation editor is utilised, author must confirm that these equations may be viewed and edited in versions of Microsoft Office that does not have the editor.
14. **ACRONYMS:** These should not be used in the abstract. The use of acronyms is elsewhere is acceptable. Acronyms should be defined on its first use in each section e.g. Reserve Bank of India (RBI). Acronyms should be redefined on first use in subsequent sections.
15. **REFERENCES:** The list of all references should be alphabetically arranged. ***The author (s) should mention only the actually utilised references in the preparation of manuscript*** and they may follow Harvard Style of Referencing. **Also check to ensure that everything that you are including in the reference section is duly cited in the paper**. The author (s) are supposed to follow the references as per the following:

- All works cited in the text (including sources for tables and figures) should be listed alphabetically.
- Use (**ed.**) for one editor, and (**ed.s)** for multiple editors.
- When listing two or more works by one author, use --- (20xx), such as after Kohl (1997), use --- (2001), etc., in chronologically ascending order.
- Indicate (opening and closing) page numbers for articles in journals and for chapters in books.
- The title of books and journals should be in italic printing. Double quotation marks are used for titles of journal articles, book chapters, dissertations, reports, working papers, unpublished material, etc.
- For titles in a language other than English, provide an English translation in parenthesis.
- ***Headers, footers, endnotes*** *and* ***footnotes*** *should* ***not be used*** *in the document****.*** However, **you can mention short notes to elucidate some specific point**, which may be placed in number orders before the references.

PLEASE USE THE FOLLOWING FOR STYLE AND PUNCTUATION IN REFERENCES:

BOOKS

- Bowersox, Donald J., Closs, David J., (1996), "Logistical Management." Tata McGraw, Hill, New Delhi.
- Hunker, H.L. and A.J. Wright (1963), "Factors of Industrial Location in Ohio" Ohio State University, Nigeria.

CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

JOURNAL AND OTHER ARTICLES

- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–23

UNPUBLISHED DISSERTATIONS

- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, Kurukshetra University, Kurukshetra.

ONLINE RESOURCES

- Always indicate the date that the source was accessed, as online resources are frequently updated or removed.

WEBSITES

- Garg, Bhavet (2011): Towards a New Gas Policy, Political Weekly, Viewed on January 01, 2012 http://epw.in/user/viewabstract.jsp

A GENETIC ALGORITHM BASED IMAGE AUTHENTICATION TECHNIQUE IN FREQUENCY DOMAIN USING HAAR WAVELET TRANSFORM (AGAIAFDHWT)

Dr. AMRITA KHAMRUI
ASST. PROFESSOR
DEPARTMENT OF COMPUTER SCIENCE
VIVEKANANDA COLLEGE
MADHYAMGRAM

ABSTRACT

In this study A Genetic Algorithm based image authentication technique in frequency domain using Haar Wavelet Transform has been proposed. This is frequency domain-based image authentication technique where Haar Wavelet Transform is applied to generate transformed domain coefficients. A 2 × 2 mask is taken from the source image in row major order. Haar Wavelet Transform is applied on it. It generates four frequency coefficients. Three bits of the authenticating image is embedded onto each coefficient of the mask. Embedded mask is processed through reverse Haar Wavelet Transform to generate spatial domain coefficients. Stego sub intermediate image is obtained by applying this process for the whole cover image. Stego sub intermediate image is processed through Genetic Algorithm to generate optimized stego image. New Generation followed by Crossover and Mutation are performed as part of Genetic Algorithm. Genetic Algorithm is applied as optimization process to generate optimized stego image. The proposed technique has been compared with existing approaches. It has been shown that the proposed technique obtains better result as compared to the existing approaches.

KEYWORDS

haar wavelet transform (HWT), image fidelity (IF), mean square error (MSE), peak signal to noise ratio (PSNR), structural similarity index measure (SSIM).

JEL CODE

O31

1. INTRODUCTION

In today's scenario image authentication is achieved through Steganography. Image Steganography is a way of sending messages through digital image such that apart from sender and receiver no one realize that there is some hidden information. Image authentication can be achieved in two ways, using spatial domain steganography[11], [12] and using frequency domain steganography [10]. To detect unauthorized access information security and image authentication are widely used. The secret information is embedded inside the source image by keeping its visibility intact. The widely used methods to achieved this is to use the least-significant bit (LSB) replacement [7] by masking [17], [8], filtering and transformations [9] on the source image. Usually, the cover image for steganography can be picture [11], video, sound file etc. A message may be hidden invisibly by using some steganographic algorithms [13] to ensure the security [14] which is main concern today for trafficking across the network. Security may be achieved by hiding information into images. Hiding information in the image without changing its visibility is an important task for image authentication. Ownership verification [15] is very crucial for military people, research institute and scientists. Security of information and authentication of images is very important for the digital image document to prevent them for unauthorized access. Data hiding refers to the nearly invisible embedding of information within a host data set as message, image or video. The data hiding is a process of creating hypermedia document or image, which is very less convenient to manipulate. Steganography is a process of hiding the message/image in the source image by some algorithm and cryptography is a process to hide the message content. The process is to hide a message inside an image by keeping the visibility intact. The most common method of steganography is least-significant bit (LSB) substitution developed through masking, filtering and transformations on the source image. In the proposed technique a frequency domain-based image authentication technique using Haar Wavelet Transform has been proposed.

Present proposal is an algorithm which would facilitate secure message transmission through block base data hiding. Most of the works used minimum bits of the hidden image for embedding in transform domain, but the proposed algorithm embeds large amount of information in transformed domain with a minimum distortion of visual property.

Rest of the paper is organized as follows: section 2 deals with review of literature. Importance of the study has been discussed in section 3. Section 4 deals with the statement of the problem. Section 5 discuss the objective of the proposed technique. Section 6 discuss the hypothesis. The research methodology has been discussed in section 7. Results and discussion are discussed in section 8. Some findings are mentioned in section 9. Recommendations are given in section 10. Conclusion, limitation and scope for future research are presented in section 11, 12 and 13. References are drawn at end.

2. REVIEW OF LITERATURE

Some existing methodologies have been discussed in this section. In 2022, Tevaramani Saleem S et al. [1] proposed image steganography performance analysis using discrete wavelet transform and alpha blending for secure communication. In this technique, alpha is called a scaling parameter. Source image and authenticating images are of different types and dimensions, images from a webcam, and other predefined images of different formats have been normalized and preprocessed. A Haar Discrete Wavelet Transformation (DWT) is applied to both the source image and authenticating images. Stego image is generated by encrypting the authenticating image and embedded in the source image. In 2021 Varuikhina Vladmir et al. [2] proposed continuous Wavelet Transform applications in steganography. This paper focused on successful hiding of information with the help of Wavelet Transformation without any visible changes in the source image. This technique used single level 2D Discrete Wavelet Transformation such as Daubeshi, Haar and coiflet transformation and compare the result generated by each transformation with one another. In 2020 Govindasamy V et al.[3] proposed coverless image steganography using Haar Integer Wavelet Transform. Coverless image steganography is recent technique of steganography. It does not modify the source image that is carrying the secret information. This approach used Haar Integer Wavelet Transform to hide more secret information using coverless image steganography. Here the image has been divided into sub matrices. Then Integer Wavelet Transformation is used to generate coefficients of the submatrix. Then the sub-matrices are reshaped to form arrays. The coefficients are converted into binary bits. At last, the secret message has been fragmented into 8 bits to match it with the block and starting location in the array. The location map has been used to obtain the secret information by the receiver. In 2016 Houssein Essam H. et al. [4] proposed an image steganography algorithm using Haar Discrete Wavelet transform with advanced encryption system. In this paper Advanced Encryption System (AES) is used to encrypt data and Haar Discreet Wavelet Transform (HDWT) is used for embedding. HDWT decreases the complexity in image steganography and ensures less image distortion and lesser detect-ability. In 2010 Hui-Yu Huang et al proposed a lossless data hiding technique which is based on [5] discrete Haar wavelet transform. In 2016 Tushara M et al [6] proposed a review of image Steganography using discrete wavelet transform which presents a review on steganography techniques that use discrete wavelet transform.

3. IMPORTANCE OF THE STUDY

The existing techniques used different steganographic techniques with less embedding capacity. This paper presents an algorithm that would facilitate secure message transmission using frequency domain based data hiding procedure that uses Haar Wavelet Transformation. This method embeds large amount of secret information as compared to the existing works [3],[5],[6],[8] by keeping visual property intact.

4. STATEMENT OF THE PROBLEM

The detailed study of the Review of Literature reveals the following facts:
The proposed technique is frequency domain based image authentication approach which uses Genetic Algorithm for optimization. Most of the previous techniques having less capacity of hiding secret information but the proposed technique can embed huge amount of secret information. The proposed technique uses Genetic Algorithm as optimization technique but very few existing techniques used optimization.

5. OBJECTIVE

The objective of this research is to develop a new Genetic Algorithm based frequency domain based image authentication technique and can hide large message by keeping quality stego image.

6. HYPOTHESIS

The proposed technique uses some benchmark images taken from the USC-SIPI Image Database: Version 5, Original release: October 1997, Signal and Image Processing Institute, University of Southern California, Department of Electrical Engineering [20]. Source and authenticating images are considered as color images.

7. RESEARCH METHODOLOGY

In this section the technique (AGAIAFDHWT) is illustrated with an example in detail. A mask of size 2 × 2 from source color image is taken in row major order. The mask is processed through haar wavelet transformation to generate frequency domain coefficients. Three bits of the authenticating image is embedded onto each transformed image coefficient sub mask. The image sub mask is transformed from frequency domain to spatial domain using inverse haar wavelet transform. The dimension of the hidden image is embedded first. Resulting stego image is processed through Genetic Algorithm to generate optimized stego image. As part of GA, New Generation followed by Crossover and Mutation are applied on it. In New Generation eight random chromosomes are taken as initial population. Roulette wheel selection has been applied to generate two fittest chromosomes using hash function. Two fittest chromosomes are processed through crossover and two new off springs has been generated in this process. Off springs are then processed through Mutation. In elitism most fitted offspring is chosen for next iteration. This process is repeated until the optimum value has been received. The Haar functions can be defined as follows:

$$\mathrm{har}(0,\theta) = 1, 0 \leqslant \theta \leqslant 1,$$

$$\mathrm{har}(1,\theta) = \begin{cases} 1, & 0 \leqslant \theta < 1/2, \\ -1, & 1/2 \leqslant \theta < 1, \end{cases}$$

$$\mathrm{har}(2,\theta) = \begin{cases} \sqrt{2}, & 0 \leqslant \theta < 1/4, \\ -\sqrt{2}, & 1/4 \leqslant \theta < 1/2, \\ 0, & 1/2 \leqslant \theta \leqslant 1. \end{cases}$$

$$\mathrm{har}(3,\theta) = \begin{cases} 0, & 0 \leqslant \theta < 1/2, \\ \sqrt{2}, & 1/2 \leqslant \theta < 3/4, \\ -\sqrt{2}, & 3/4 \leqslant \theta \leqslant 1, \end{cases}$$

$$\vdots$$

$$\mathrm{har}(2^p+n,\theta) = \begin{cases} \sqrt{2^p}, & n/2^p \leqslant \theta < (n+1/2)/2^p, \\ -\sqrt{2^p}, & (n+1/2)/2^p \leqslant \theta < (n+1)2^p, \\ 0, & 0 < \theta < \frac{n}{2^p} \text{ and } \frac{(n+1)}{2^p} < \theta < 1, \end{cases}$$

$$p = 1, \ldots; \quad n = 0, \ldots, 2^p - 1.$$

The original Haar defined as follows

$$\mathrm{har}(k,0) = \lim_{\theta \to 0, \theta > 0} \mathrm{har}(k,\theta),$$

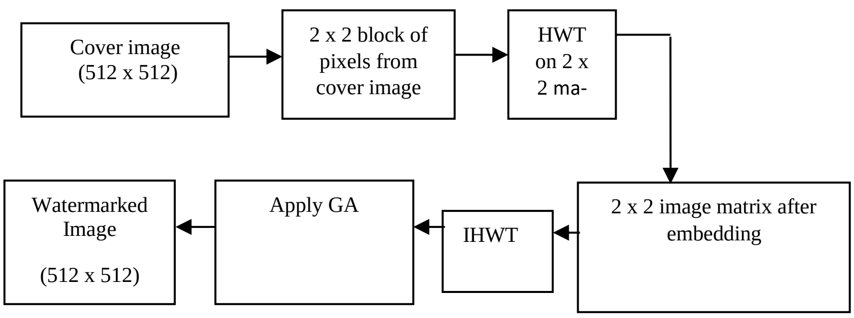
$$\mathrm{har}(k,1) = \lim_{\theta \to 1, \theta < 0} \mathrm{har}(k,\theta),$$

A discrete Haar function is given in equation

$$r_n(t) = \sum_{k=0}^{2^n-1} \psi_{n,k}(t), \quad t \in [0,1], \; n \geq 0. \quad (1)$$

This is an orthogonal function. The process of AGAIAFDHWT is shown in Figure 1. Process of embedding is explained in section 7.1 process of extraction is explained in section 7.2. An example of AGAIAFDHWT is given in section 7.3.

FIGURE 1: SCHEMATIC DIAGRAM OF AGAIAFDHWT



7.1 ALGORITHM FOR INSERTION

In this technique color image of size p×q is taken as source image. Color image of m×n is taken as authenticating image. Authenticating image bits are embedded in the transformed coefficients mask of source image.
Input: Source image of size p×q, authenticating image of size m×n.

Output: Optimized stego image of size p×q.
Method: Insertion of authenticating image bits into the source color image followed by GA
Step 1: Extract the dimension of the authenticating image from the header part of the authenticating image
Step 2: For each hidden message/image, read color source image mask of size 2×2 in row major order. Apply Discrete Haar wavelet transform to obtain transformed coefficients.
Step 3: The Dimension is embedded first followed by authenticating image pixel onto three LSBs of each coefficient. First sixteen embedding positions are reserved for width and next sixteen are reserved for height.
Step 4: Apply inverse haar Transform to back the mask into spatial domain.
Step 5: The process is repeated for the whole cover image to generate stego image.
Step 6: Stego image pixel is processes through GA. Eight random chromosomes are generated as initial population.
Step 7: The hidden information's are fabricated on last three LSB positions. Roulett Wheel selection is applied on it using a hash function to select two fittest chromosomes among eight initial populations. f(n) = 1/(mod(s(x,y) – c(x,y))+1)
f(n) is the fitness function, s(x,y) is intensity value of stego image pixel for the coordinate (x, y). c(x, y) is intensity value of Host image/ source image for the same coordinate (x, y). Best fittest value is one.
Step 8: Uniform crossover process is followed where first bit is from first parent and second bit is from second parent which will be started from fourth bit.
Step 9: Mutation is applied on the crossovered chromosome by flipping a bit from one to zero or from zero to one which will be started from fourth bit.
Step 10: Elitism forwards the best chromosome in the next iteration by eliminating the weak chromosome. In elitism the average between the consecutive two pixels of the mutated image should be same as the average between the consecutive two pixels in the source image for the odd positions of the image and difference between the average and the odd position coefficient should be same as the previous one to ensure proper decoding.
Step 11: Step 7 to Step 10 is repeated for the whole stego image to generate optimized stego image.

7.2 ALGORITHM FOR EXTRACTION

The optimized stego image is received in spatial domain. The optimized stego image is taken as the input and the hidden message/ image size, content is extracted from it.
Input: optimized stego image of size p×q.
Output: Source image of size p×q, authenticating image of size m×n.
Method: Extract bits of authenticating image from embedded image
Step 1: Apply Discrete Haar wavelet transform onto the stego image mask to regenerate four frequency components
Step 2: Extract the authenticating image bits from three LSBs of each coefficient. Replace authenticating message/ image bit position in the block by '1'. For each eight extracted bits construct one image pixel of authenticating image. First sixteen bit extraction form the width of the authenticating image and next sixteen bit extraction form the height of the authenticating image.
Step 3: Repeat step 1 and 2 to regenerate authenticating image as per size of the authenticating image.
Step 4: Stop

7.3 EXAMPLE

FIGURE 2

226 137 91 209 2.i Source image mask	165 7 15 51 2.ii Transformed mask	161 3 11 51 2.iii Embedded mask	220 124 96 204 2.iv Embedded mask in spatial domain
230 140 2.v New Generated chromosome	230 140 2.vi Cross overed offspring	246 156 2.vii Mutated offspring	220 124 2.viii Resultant mask

Figure 2.i shows a 2 × 2 block of the source image. Haar wavelet transformation has been applied on it to generate four frequency components. Figure 2.ii Shows the transformed coefficients of the source image. Figure 2.iii shows the embedded image block. Three bits of the authenticating image is embedded onto each transformed coefficients of the source image, in three LSB positions. Figure 2.iv shows the embedded image block in spatial domain after applying reverse Haar Wavelet transformation. Embedded image is processed through Genetic Algorithm to generate optimized stego image. Each byte is processed through New Generation. Eight random chromosomes are generated for initial population as 3 LSB positions have been taken for embedding. Roulette Wheel selection has been applied to generate new generated image. Figure 2.v shows the new Generated chromosome. Two consecutive pixels are taken for Crossover. Uniform Crossover has been applied on two consecutive pixels after fourth bit position. Figure 2.vi shows the crossover offspring. Figure 2.vii shows the mutated offspring. Figure 2.viii shows the result of elitism.

8. RESULTS AND DISCUSSION

The proposed technique AGAIAFDHWT has been applied to some benchmark images taken from the USC-SIPI Image Database: Version 5, Original release: October 1997, Signal and Image Processing Institute, University of Southern California, Department of Electrical Engineering [16]. The machine specification is Intel Core 2 Duo CPU, 3.00 GB RAM and 2.00 GHz speed for experiment. The experiment had been performed in Linux platform with GCC compiler. Source images are of dimension 512 × 512, authenticating image is of size 256 × 256 and resultant image is of dimension 512 × 512. This section discusses the results of visual interpretation and performance of the algorithm based on some statistical parameters such as PSNR, MSE, IF and SSIM. Figure 3.i to 3.v shows the source images Lenna, Baboon, Pepper, Tahoe, Toucan. Figure 3.vi shows the authenticating image jet. Embedded images are shown from Figure 3.vii to 3.xi on embedding jet image using AGAIAFDHWT. It is clear from Figure 3 that there are no such changes visible in the embedded image. Table 1 show the PSNR, MSE, IF and SSIM [17] value for each of the embedded image against the source image. From Table 1, the maximum value of the PSNR shown is 39.954643 and that of minimum value of the PSNR is 36.987556. PSNR means peak signal to noise ratio and high value of PSNR in Table 1 indicates that the optimized stego image have better quality. MSE means mean square error. Low value of MSE indicates low error. IF is image fidelity and is used to compare between two images. IF is closer to 1 means two images are almost same. SSIM refers to structural similarity index measurement is obtained by comparing the pixel intensities. It is another metric for comparing the image degradation due to information hiding. If two images are same it will be 1. The formula for PSNR, MSE, IF and SSIM is given in equation (2), (3), (4) and (5) respectively, where the formula for μx and μy is given in equation (6) and σ_x^2 and σ_y^2 are given in equation (7) and (8). The formula for σ_{xy} is given in equation (9) and the constants C1, C2, K1, and K2 are given in equation (10). Table 2 compare with existing [2] and [5]. It has been shown that the proposed technique obtains better result compared to the existing [2] and [5]. The following formula is used to calculate PSNR, MSE and IF (image fidelity) and SSIM.

$$PSNR = 10\ \log\left(max\left(I_{m,n}{}^2\right)/MSE\right) \quad (2)$$

$$MSE = \frac{1}{MN} * \sum_{m,n} (I_1 m,n - I_2 m,n)^2 \quad (3)$$

$$IF = 1 - \sum_{m,n} (I_{1_{m,n}} - I_{2_{m,n}})^2 / \sum_{m,n} I_{2_{m,n}}^2 \quad (4)$$

$$SSIM = 2(\mu_x\mu_y + C_1)(2\sigma_{xy}+C_2)/((\mu_x * \mu_x + \mu_y * \mu_y + C_1) * (\sigma_x * \sigma_x + \sigma_y * \sigma_y + C_2) \quad (5)$$

$$\mu_x = 1/N \sum_{i=1}^{N} X_i,\ \mu_y = 1/N \sum_{i=1}^{N} Y_i \quad (6)$$

$$\sigma_x * \sigma_x = 1/N\text{-}1 \sum_{i=1}^{N} (X_i - \mu_x)^2 \quad (7)$$

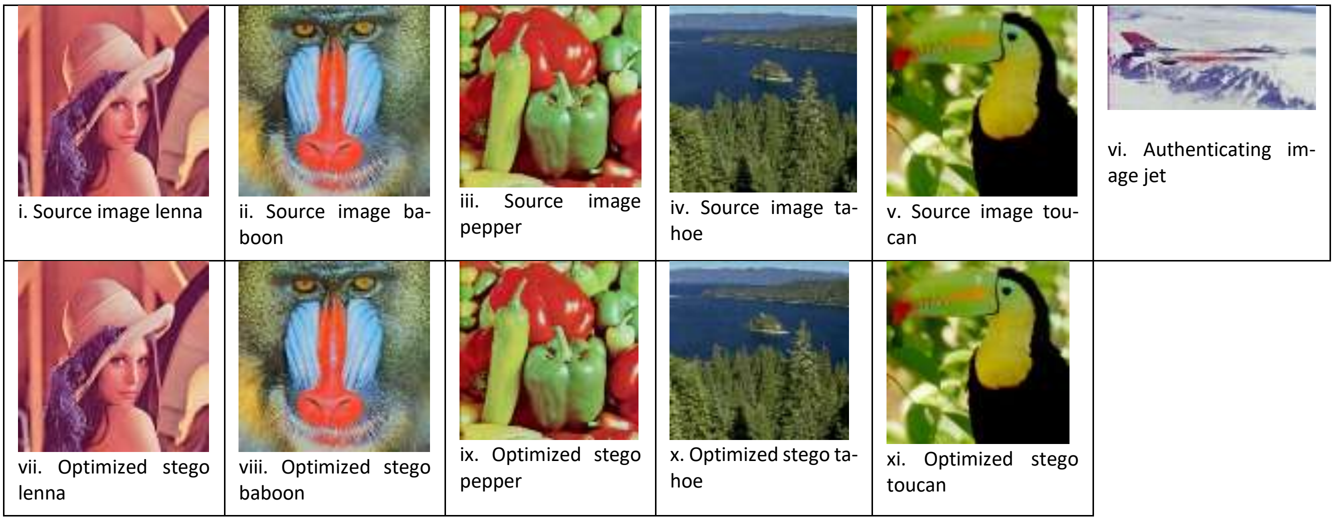
$$\sigma_y * \sigma_y = 1/N\text{-}1 \sum_{i=1}^{N} (Y_i - \mu_y)^2 \quad (8)$$

$$\sigma_{xy} = 1/N\text{-}1 \sum_{i=1}^{N} (X_i - \mu_x)(Y_i - \mu_y) \quad (9)$$

The value of C_1, C_2 and C_3 with K_1 and K_2 are from [17] given in equation (10)

$C1 = (K_1 L)^2$, $C2 = (K_2 L)^2$, $K1 = 0.01$, $K2 = 0.03$ (10)

FIGURE 3: VISUAL INTERPRETATION OF VARIOUS SOURCE AND OPTIMIZED STEGO IMAGES ALONG WITH AUTHENTICATING IMAGE



i. Source image lenna; ii. Source image baboon; iii. Source image pepper; iv. Source image tahoe; v. Source image toucan; vi. Authenticating image jet; vii. Optimized stego lenna; viii. Optimized stego baboon; ix. Optimized stego pepper; x. Optimized stego tahoe; xi. Optimized stego toucan

TABLE 1: PSNR, MSE, IF & SSIM VALUES OF VARIOUS OPTIMIZED STEGO IMAGES

Cover image	PSNR	MSE	IF	SSIM
JET	39.954643	6.570766	0.999812	0.999996
BABOON	38.825237	8.522297	0.999555	0.999999
TOUCAN	36.987556	13.011417	0.998222	0.999999
TAHOE	38.796883	8.578120	0.998945	0.999998
BOAT	38.875088	8.425030	0.999576	0.999998
HOUSE	39.052338	8.088099	0.999702	0.999999
LENA	38.588503	8.976978	0.999549	0.999768
SAFARI10	39.063881	8.066632	0.999106	0.993818
PEPPER	38,138615	9.982032	0.999399	0.999561
PEACEFUL	38.472198	9.244015	0.999022	0.995216

TABLE 2: COMPARISON OF PSNR VALUES OBTAINED FOR VARIOUS IMAGES USING AGAIAFDHWT AND EXISTING[2] AND [5]

Host Image	*PSNR values of AGAIAFDHWT*	*Capacity of AGAIAFDHWT*	*PSNR values of existing[5]*	*Capacity of existing[5]*	*PSNR of existing[2]*
Jet	39.954643	54000	28.49	39445	-
Lenna	38.588503	54000	29.68	39706	37.2
Boat	38.875088	54000	28.74	38948	-

9. FINDINGS

It has been observed that the proposed technique obtains consistent PSNR value compared to the capacity. IF value ensures that the source image and the stego images are identical.

10. RECOMMENDATION

The proposed technique can be finding applications in the following areas:

I) IMAGE AUTHENTICATION

This technique (AGAIAFDHWT) can be used for Image authentication. The image/ document that needs to be authenticated is considered as source image. Another small image/message can be taken as authenticating image. Authenticating image is embedded using this approach and send across the network by keeping the visibility of the source image intact. At the receiver end it is extracted by the receiver using extraction algorithm. If the extracted image and the original authenticating images are same, then the image is authentic.

II) TELEMEDICINE

Telemedicine refers to the way of remote medical services via real time both way communication between patient and the doctor using audio or visual electronic means. If the image is communicated over the transmission media, then it should be authenticated. The process of authentication is stated in previous example. So AGAIAFDHWT can be used in image authentication.

III) DOCUMENT AUTHENTICATION

AGAIAFDHWT can be used in document authentication. Consider a legal image. It consists of an image part and a text part. If someone tampers the document it can be recognized through AGAIAFDHWT. From the text part, a digest can be generated using any message digest algorithm and it can be embedded in the image part of the legal document. When it needs to be authenticated the digest is extracted from the image part of the legal document and another digest is generated from the text part of the legal document. If both are same then the legal document is authenticated.

IV) BANK TRANSACTION

Bank can use secure e-payment method through steganography. Now a days there is huge demand of online shopping. This required online transaction. So there is an important task to protect the customers information. AGAIAFDHWT technique can be used in this purpose.

V) SMART CITY APPLICATION

AGAIAFDHWT can be used to hide the health record electronically for smart city application.

VI) SECURE MESSAGE TRANSMISSION

AGAIAFDHWT can be used for secure message transmission. The message that is to be transmitted in secure way should be hidden in the source image and can be transmitted over network. At the receiver end it is extracted from the transmitted image in reverse way.

11. CONCLUSION

The technique AGAIAFDHWT is a frequency domain based color image authentication technique uses Discrete Haar Wavelet Transformation. This technique hides large message with a little distortion by using Discrete Haar Wavelet Transformation and Genetic Algorithm is used to maintain the quality of the optimized stego image. This technique has been compared with some existing Wavelet Transformation-based approaches and the result shows that the technique works better than those approaches.

12. LIMITATION

The proposed technique is a frequency domain approach. The hiding capacity can be increased.

13. SCOPE FOR FUTURE RESEARCH

The proposed technique uses Haar Wavelet Transform. It can be applicable for other transformation also and hence future scope of the research.

REFERENCES

1. Tevaramani Saleem S et al. “Image steganography performance analysis using discrete wavelet transform and alpha blending for secure communication “, Global Transitions Proceedings Volume 3, Issue 1, June 2022, Pages 208-214.
2. Varuikhina Vladmir et al. “Continuous Wavelet Transform Applications In Steganography”, 14th International Symposium on Intelligent Systems, Procedia Computer Science 186 (2021) 580–587.
3. Govindasamy V et al. “Coverless Image Steganography using Haar Integer Wavelet Transform “, Proceedings of the Fourth International Conference on Computing Methodologies and Communication (ICCMC 2020) IEEE Xplore Part Number:CFP20K25-ART; ISBN:978-1-7281-4889-2
4. Houssein Essam H. et al. “An Image Steganography Algorithm using Haar Discrete Wavelet Transform with Advanced Encryption System”, Proceedings of the Federated Conference on Computer Science and Information Systems pp. 641–644, DOI: 10.15439/2016F521, ACSIS, Vol. 8. ISSN 2300-5963, 978-83-60810-90-3/$25.00 c 2016, IEEE.
5. Hui-Yu Huang et al. “A lossless data hiding based on discrete Haar wavelet transform”, CIT 2010, 978-0-7695-4108-2/10 $26.00 © 2010, IEEE DOI 10.1109/CIT.2010.276
6. Tushara M et al. “Image Steganography using discrete wavelet transform- A Review”, International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, ISSN: 2321-2004, Vol 3, Special Issue 1, February 2016
7. Lifang Yu et al “Improved Adaptive LSB steganography based on Chaos and Genetic Algorithm”, EURASIP Journal on Advances in Signal Processing, volume 2010, Article ID 876946.
8. Khamrui, A et al., “A Genetic Algorithm based Steganography on Color Images (GASCI)" International journal of Signal and Imaging Systems Engineering (IJSISE), 2014 Vol.7 No.1, pp.59 – 63, Inderscience publishers.
9. Khamrui, A et al., “An Image Authentication Technique in Frequency Domain using Genetic Algorithm (IAFDGA)”, International Journal of Software Engineering & Applications (IJSEA), ISSN: 0975-9018 (Online),0976-2221(Print), Indexed on DOAJ,EBSCO,INSPEC,ProQuest etc.,DOI:10.5121/ijsea.2012.3504, Vol. 3, No. 5, pp.39-46, Sept. 2012.(http://airccse.org/journal/ijsea/papers/3512ijsea04.pdf),2012.
10. Khamrui, A. et al. “A Genetic Algorithm based approach in image authentication using Z transform” (GAIAZT), AMSE Journals 2014 series: Advances B, Vol. 57,N^{0}1, pp 20-30.
11. Khamrui A et al., ‘A Data Embedding Technique for Gray Scale Image Using Genetic Algorithm (DEGGA)’, IEEE Sponsored International Conference on Communication, Computing & Security (Proceedings by Excel India Publishers ISBN-978-93-80697-505), NIT Rourkela, pp. 19–22 7–9 January 2010.
12. Khamrui A.et al.,“A Data- Hiding Scheme for Digital Image using Pixel Value Differencing (DHPVD)”, International Symposium on Electronic System Design (ISED),Print ISBN:978-1-4577-1880-9, 19-21 December, Kochi, India, 2011.
13. Hashad A. I. et al “A Robust Steganography Technique using Discrete Cosine Transform Insertion” Information and communication Technology, 2005. Enabling Technologies for the New Knowledge Society: ITI 3rd International Conference.ISBN:0-7803-9270-1.
14. Khamrui A. et. al. “A Novel Genetic Algorithm Based Data Embedding Technique in Frequency Domain Using Z Transform (ANGAFDZT)”, DPPR- 2012, Advances in Intelligent Systems and Computing, 177, ISSN No.: 2194-5357, Springer, pp. 885-893, July 13 -15, Chennai, India (2012).
15. Khamrui A., Mandal, J. K, “A spatial Domain Image Authentication Technique using Genetic algorithm”, International Conference on Computational Intelligence, Communications, and Business Analytics, CICBA 2017, Computational Intelligence, Communications, and Business Analytics pp 577–584, Springer Link.
16. Allan G. Weber, The USC-SIPI Image Database: Version 5, Original release: October 1997, Signal and Image Processing Institute, University of Southern California, Department of Electrical Engineering. http://sipi.usc.edu/database/(Last accessed on 20th January, 2011).
17. Mandal Jyotsna Kumar, “Reversible Steganography and Authentication via Transform Encoding”, Studies in Computational Intelligence 901, Springer Nature.

REQUEST FOR FEEDBACK

Dear Readers

At the very outset, International Journal of Research in Commerce, IT & Management (IJRCM) acknowledges & appreciates your efforts in showing interest in our present issue under your kind perusal.

I would like to request you to supply your critical comments and suggestions about the material published in this issue, as well as on the journal as a whole, on our e-mail **infoijrcm@gmail.com** for further improvements in the interest of research.

If you have any queries, please feel free to contact us on our e-mail **infoijrcm@gmail.com**.

I am sure that your feedback and deliberations would make future issues better – a result of our joint effort.

Looking forward to an appropriate consideration.

With sincere regards

Thanking you profoundly

Academically yours

Sd/-
Co-ordinator

DISCLAIMER

ABOUT THE JOURNAL

In this age of Commerce, Economics, Computer, I.T. & Management and cut throat competition, a group of intellectuals felt the need to have some platform, where young and budding managers and academicians could express their views and discuss the problems among their peers. This journal was conceived with this noble intention in view. This journal has been introduced to give an opportunity for expressing refined and innovative ideas in this field. It is our humble endeavour to provide a springboard to the upcoming specialists and give a chance to know about the latest in the sphere of research and knowledge. We have taken a small step and we hope that with the active co-operation of like-minded scholars, we shall be able to serve the society with our humble efforts.

Our Other Journals