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CONTENTS

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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

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- Bowersox, Donald J., Closs, David J., (1996), "Logistical Management." Tata McGraw, Hill, New Delhi.
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- 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

RURAL CONSUMERS' SATISFACTION TOWARDS ONLINE SHOPPING WITH SPECIAL REFERENCE TO BELAGAVI

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ABSTRACT

Online shopping has gained significant importance in rural areas for several reasons. It has bridged the geographical gap, providing access to a wide range of products and services that may not be readily available in remote rural regions. The objective of this paper was to identify the factors that influence rural consumers for online shopping and also to analyse the satisfaction level of rural consumers towards online shopping in the rural areas of Belagavi. The data was collected from both primary and secondary sources. The simple random sampling technique was applied to collect data from the 50 respondents. Descriptive statistics and tabulation techniques were used to draw the conclusions. It is found that Online shopping companies and the government should take some steps to reach online shopping and e-commerce facilities in the rural area of Belagavi to improve the standard of living of the people as well as the GDP of the country.

KEYWORDS

online shopping, rural consumer, factors influencing, consumer satisfaction.

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1. INTRODUCTION

Online shopping has gained significant importance in rural areas for several reasons. It has bridged the geographical gap, providing access to a wide range of products and services that may not be readily available in remote rural regions. This brings convenience and flexibility to rural consumers, eliminating the need for long journeys to urban areas to purchase products and services. It has had an insightful impact on the rural economy. It has created opportunities for local artisans, farmers, and small businesses to reach a broader customer base, thereby expanding their market horizon. This enables rural entrepreneurs to showcase their products and services to generate income and in turn, contribute to economic growth and sustainability within rural communities.

Online shopping plays a crucial role in education and awareness. Rural areas often have limited access to information and technology resources. Online shopping platforms provide access to educational materials, books, and digital courses, empowering rural residents with opportunities for learning and personal development. It also enables them to stay informed about current events, government schemes, and various aspects of life that can lead to overall progress. In addition, the convenience of online shopping enhances the quality of life in rural areas. It saves time and effort by delivering essential goods and services directly to residents' homes. This is particularly significant in regions with bad weather conditions, limited transportation options, or for individuals with limited mobility, such as the elderly and disabled. Furthermore, the growth of online shopping has encouraged the development of digital skills in rural communities. As people adapt to using technology for making purchases, they become more digitally literate, which can open doors to employment opportunities and participation in the digital economy. This digital empowerment has far-reaching implications for the socioeconomic development of rural areas.

2. REVIEW OF LITERATURE

Adrita Goswami et al. (2013) study explicitly indicates that in this competitive era, online marketers should concentrate on customer satisfaction to retain existing customers and have to offer new schemes day by day to attract new customers. **Malika Sharma (2020)** found that in spite of so many issues and challenges, e-commerce tries to capture the rural areas that need further development. **Dutta and Dasgupta (2010)** reveal that the availability of information, family income, the experience of using the internet and online security are the important factors influencing Indian customers' attitude toward online shipping. **P. A. Deshmukh and S. Chourasia (2019)** revealed that urban customers have a favorable attitude towards online shopping as compared to rural customers. **P. Madhavi & Chandra Shaker (2014)** revealed that e-commerce in rural areas is facing many issues. It can be explored by providing infrastructural facilities in villages. **Sonnet Debbarma (2014)** found that e-commerce is facing various issues, among security and privacy concerns are the major issues of e-commerce. **Ghosh, A. (2011)** found that to eradicate the digital divide, online shopping requires adequate financial and government support, industry and community participation and massive campaigns on e-commerce involving rural people.

3. RESEARCH GAP

After reviewing the various works of literature, it is found that the majority of the research on online shopping and e-commerce has been conducted in different parts of the country and abroad, but very little study has been found on the rural consumer's satisfaction towards online shopping at Belagavi. Hence, the researcher has undertaken this study in the rural areas of Belagavi district.

4. STATEMENT OF THE PROBLEM

Online shopping plays a crucial role in rural areas for several reasons. It offers a diverse array of products that might not be readily accessible in the local market. This accessibility empowers rural residents to meet their needs by eliminating the necessity of physically visiting stores, saving valuable time and effort. Furthermore, online shopping can serve as a solution to the limited transportation options in rural regions. It provides a platform for local artisans and businesses to exhibit and sell their goods, thereby fostering economic growth within these communities. There exists a significant gap in our understanding of rural consumers' satisfaction with their online shopping experiences. This research aims to thoroughly investigate and analyze the factors that influence rural consumers' satisfaction with online shopping. Key factors under study include issues pertaining to Payment Security, product price, customer care, product comparison, product quality, trust, and easy return policy. Keeping the above points in mind, the researcher made an attempt to study the topic entitled **"Rural consumers' satisfaction towards online shopping with special reference Belagavi"**

5. RESEARCH METHODOLOGY

The present study is empirical and descriptive in nature. To accomplish the objectives of the research both primary and secondary data were used. The primary data was collected through the structured questionnaire administered to rural consumers of the study area. Secondary data was collected from various research articles, journals, magazines, books and suitable official websites. The simple random sampling technique was applied to collect the data from 50 respondents. The five-point Likert scale was used in the questionnaire. Descriptive statistics and tabulation techniques were used to draw the conclusions.

PROFILE OF THE STUDY AREA

Belagavi is called the 'Foundry Hub of North Karnataka' and also the 'Sugar Bowl of Karnataka State'. It is located in the northern part of Karnataka along the Western Ghats. According to the 2011 census, the Belgaum district consists of 1270 villages with a total area spread across 13,454 sq. km. The population of the district is 47.78 lakh among 74.66% population of Belgaum districts lives in rural areas of villages. The literacy rate is 73.94% and the gender ratio is 969 females per 1000 males.

6. OBJECTIVES OF THE STUDY

1. To identify the factors that influence rural consumers for online shopping in the rural areas of Belagavi.
2. To analyse the satisfaction level of rural consumers towards online shopping in the rural areas of Belagavi.

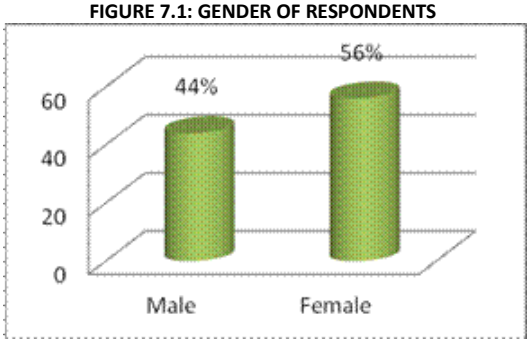
7. DATA ANALYSIS AND INTERPRETATION

TABLE 7.1: GENDER OF RESPONDENTS

Particulars	Frequency	Percentage
Male	22	44
Female	28	56
Total	50	100

Source: Field survey

FIGURE 7.1: GENDER OF RESPONDENTS



The above table and figure 7.1 show the gender profile of the respondents. Out of the total 50 respondents, 44% of the respondents were male and the remaining 56% were female. This shows that "Female" dominates the rating for "Gender of respondents".

TABLE 7.2: AGE GROUP OF RESPONDENTS

Particulars	Frequency	Percentage
Below 30 years	09	18
30 - 45 years	25	50
45 - 60 years	12	24
Above 60 years	04	08
Total	50	100

Source: Field survey

FIGURE 7.2: AGE GROUP OF RESPONDENTS

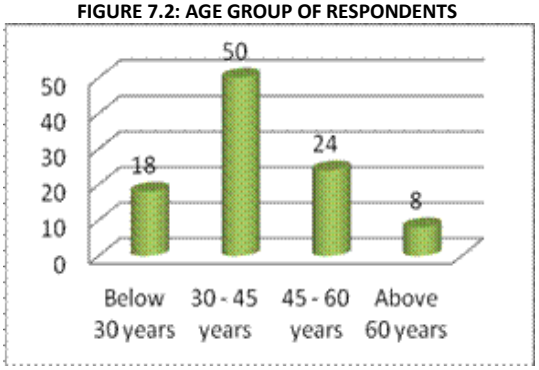


Table and figure 7.2 show the age group of the respondents. Out of the total 50 respondents, 50% were in the age group of 30-45 years, followed by 24% in the age group of 45-60 years, whereas 18% were in the age group of below 30 years. The remaining 8% were in the age group of above 30 years. This highlights that the "30- 45 years" dominates the rating for the "Age group of respondents".

TABLE 7.3: QUALIFICATION OF RESPONDENTS

Particulars	Frequency	Percentage
SSLC	22	44
PUC	15	30
Degree	10	20
Illiterate	03	06
Total	50	100

Source: Field survey

FIGURE 7.3: QUALIFICATION OF RESPONDENTS

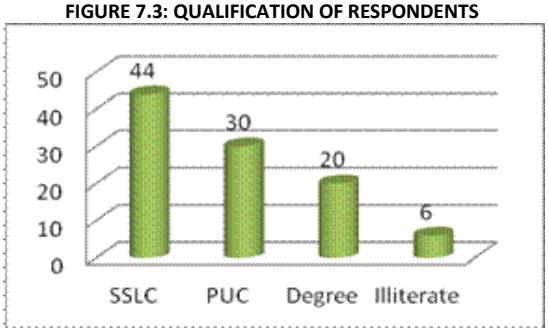


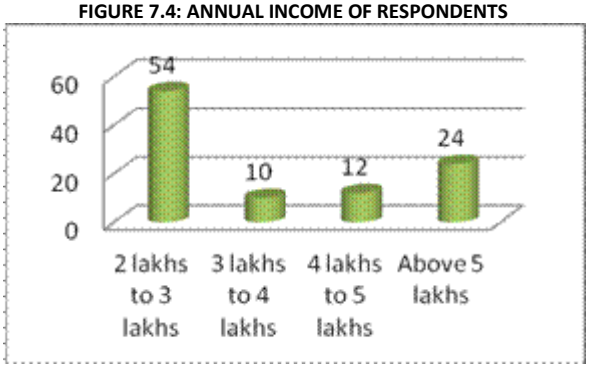
Table and figure 7.3 show the education level of the respondents. Out of the 50 respondents, 44% of the respondents qualified for the SSLC, 30% of the respondents cleared the PUC, 20% completed degrees and the remaining 6% were found to be illiterate. The above analysis shows that "SSLC" dominates the rating for "Qualification of respondents".

TABLE 7.4: ANNUAL INCOME OF RESPONDENTS

Particulars	Frequency	Percentage
Below 2 lakhs	27	54
2 lakhs to 3 lakhs	05	10
3 lakhs to 4 lakhs	06	12
Above 4 lakhs	12	24
Total	50	100

Source: Field survey

FIGURE 7.4: ANNUAL INCOME OF RESPONDENTS



The above table and figure 7.4 show the annual incomes of the respondents. 24% of the respondents were earning a yearly income of more than 4 lakhs, 12% were earning an annual income between 3 lakhs to 4 lakhs, 10% were earning between 2 lakhs to 3 lakhs and the remaining were earning an annual income below 2 lakhs. It indicates that "Below 2 lakhs" dominates the rating for "Annual income of the respondents"

TABLE 7.5: FACTORS INFLUENCING THE RURAL CONSUMERS FOR ONLINE SHOPPING

Statements	SDA	DA	N	A	SA
Online shopping helps to find information of new products/services	02 (04%)	03 (06%)	18 (36%)	17 (34%)	10 (20%)
Advertisements and user reviews on online shopping have an influence on trying new brands	01 (02%)	03 (06%)	20 (40%)	16 (32%)	10 (20%)
Promotions and discounts on online shopping influence consumer behaviour	00 (00%)	05 (10%)	15 (30%)	17 (34%)	13 (26%)
Information available on online shopping sites is used in case of uncertainties regarding a purchase	02 (04%)	06 (12%)	27 (54%)	8 (16%)	07 (14%)
Online shopping sites provide an effective platform for gaining consumer's attention	01 (02%)	04 (08%)	21 (42%)	19 (38%)	05 (10%)
Online shopping provides the facility to shop 24/7	00 (00%)	02 (04%)	8 (16%)	22 (44%)	18 (36%)

Source: Field survey

Note: SDA - Strongly Disagreed, **DA** - Disagreed, **N**-Neutral, **A** – Agreed, **SA** – Strongly Agreed.

In the first statement, the majority of respondents fall into the "Neutral," "Agree," and "Strongly Agree" categories, with a total of 90% of respondents agreeing in some way. Only a small percentage strongly disagreed, indicating that a minority might not find online shopping platforms helpful in this regard.

The second statement explores that around 92% of respondents fall into the "Neutral," "Agree," and "Strongly Agree" categories, highlighting that online shopping platforms play a pivotal role in shaping consumer preferences and choices through such content.

The third statement examines the influence of promotions and discounts on online shopping behavior. 60% of respondents fall into the "Agree" and "Strongly Agree" categories, indicating that promotion and discounts are generally effective strategies to influence consumer behavior and attract them to online shopping.

In the fourth statement, 30% of respondents fall into the "Agree" or "Strongly Agree" categories, suggesting that consumers often rely on the information provided on online shopping platforms when there are uncertainties with respect to purchasing.

In the fifth statement, the majority of respondents fall into the "Neutral," "Agree," and "Strongly Agree" categories, with a total of 90% of respondents agreeing that online shopping sites provide an effective platform to gain consumer's attention.

The final statement highlights the 24/7 availability and convenience of online shopping. The data indicates that a substantial 80% of respondents, including 44% who strongly agree, consider online shopping as a convenient, flexible and accessible option to shop 24/7.

TABLE 7.6: SATISFACTION LEVEL OF RURAL CONSUMERS TOWARDS ONLINE SHOPPING

Statements	HDS	DS	N	S	HS
Payment Security	02 (04%)	05 (10%)	18 (36%)	15 (30%)	10 (20%)
Product Price	01 (02%)	02 (04%)	20 (40%)	15 (30%)	12 (24%)
Customer care	01 (02%)	04 (08%)	12 (24%)	18 (36%)	15 (30%)
Product comparison	02 (04%)	04 (08%)	25 (50%)	10 (20%)	09 (18%)
Quality product	02 (04%)	04 (08%)	16 (32%)	22 (44%)	06 (12%)
Trust	03 (06%)	05 (10%)	20 (40%)	14 (28%)	8 (16%)
Easy Return Policy	02 (04%)	03 (06%)	10 (20%)	20 (40%)	15 (30%)

Source: Field survey

Note: **HDS** - Strongly Dissatisfied, **DS** - Dissatisfied, **N**-Neutral, **S** – Satisfied, H**S** – Highly Satisfied.

Payment security receives a balanced response from the respondents, while the majority falls into the "Neutral" and "Satisfied" categories (66%). There is a significant number who express concern in the "Dissatisfied" and "Highly Dissatisfied" categories (14%). This suggests that improving and reassuring payment security is crucial in online shopping platforms.

The price of products appears to have a more favorable response from the majority of the respondents, with 54% expressing satisfaction (30%) or high satisfaction (24%). However, it's important to note that a substantial number are in the "Neutral" category (40%), indicating space for improvement in perceptions regarding pricing.

Customer care receives a mix of responses, with a significant portion of respondents in the "Satisfied" (36%) and "Highly Satisfied" (30%) categories. However, there is also a notable number in the "Neutral" category (24%), indicating that there may be space for improvement in customer support services.

Product comparison appears to leave a significant number of respondents in the "Neutral" category (50%). However, a notable percentage is also in the "Satisfied" (20%) and "Highly Satisfied" (18%) categories, indicating that product comparison features are supported by many online purchasers.

Quality of products seems to have a relatively positive response, with a significant portion of respondents expressing satisfaction (44%) and a high degree of satisfaction (12%). Nevertheless, the "Neutral" category (32%) suggests that some respondents may have mixed feelings regarding product quality.

The aspect of trust appears to be satisfied with a considerable number of respondents expressing "Neutral" feelings (40%). While a significant portion falls into the "Satisfied" (28%) and "Highly Satisfied" (16%) categories, there are also a notable percentage of respondents who express some level of distrust or dissatisfaction (16%).

The ease of return policy is relatively well-received, with a substantial number of respondents expressing satisfaction (40%) and high satisfaction (30%). However, it's worth noting that a significant number are in the "Neutral" category (20%), suggesting there may be room for improvement in making return policies more user-friendly.

SUGGESTIONS AND RECOMMENDATIONS

TO IMPROVE THE FACTORS THAT INFLUENCES THE ONLINE SHOPPING OF RURAL CONSUMERS

To build on the positive sentiment expressed in the first statement, online shopping platforms should continue to focus on making product discovery easier. This includes improving search algorithms, providing detailed product descriptions, and enhancing the visibility of new products or services.

Given the strong influence of advertisements and user reviews, e-commerce platforms should continue to invest in effective marketing strategies. They can encourage customers to leave reviews and improve the visibility of these reviews to help consumers make informed decisions.

Since promotions and discounts have a significant impact on consumer behavior, online retailers should continue to offer enticing deals and tailor promotions to individual customer preferences. Personalized discounts and flash sales can be effective strategies to attract and retain customers.

To address uncertainties, e-commerce websites should maintain and enhance customer support services. Offering live chat, clear return policies and comprehensive FAQs can help customers make more confident purchasing decisions.

Given the agreement that online shopping platforms are effective in gaining consumer attention, businesses should continue to invest in creating engaging user experiences. Personalized recommendations, interactive content, and attractive visuals can help keep consumers engaged and returning for more.

To maintain the convenience of 24/7 shopping, online retailers should prioritize website and system reliability. Regular maintenance and robust customer support throughout the day and night can further enhance the accessibility and reliability of online shopping platforms.

Security should remain a top priority for online shopping platforms. Regularly update and communicate robust payment security measures to assure customers of the safety of their transactions. Transparency in data handling and privacy policies can also help build trust.

Online retailers can create educational materials or tutorials to help customers make the most of online shopping platforms. This can be especially useful for those who may not be as familiar with the process.

Maintain a user-friendly and intuitive design for the online shopping platform. User-centered design principles can simplify the shopping process and reduce any potential frustrations that users might encounter.

TO IMPROVE THE SATISFACTION LEVEL OF RURAL CONSUMERS TOWARDS ONLINE SHOPPING

While a significant portion of respondents express satisfaction with payment security, it's crucial to continue investing in robust security measures. To address the concerns of the 14% who are not satisfied, online retailers should provide clear information about their security protocols and offer multiple secure payment options. Building trust in this area is essential.

Given the relatively high percentage in the "Neutral" category regarding product prices, online shopping platforms can focus on providing clear and transparent pricing information. To appeal to the 6% who are not satisfied, they can consider offering competitive pricing, price-match guarantees, or loyalty programs to make customers feel they are getting value for their money.

To address the concerns of the 10% who are dissatisfied with customer care, e-commerce platforms should invest in improving their customer support services. This includes responsive live chat support, clear and easy-to-find contact information, and well-structured FAQs. Enhancing customer care can lead to higher satisfaction levels.

To serve the 38% of respondents who agree that online shopping helps in comparing products, e-commerce websites should continue to refine and expand their product comparison tools. This may include side-by-side product comparisons, detailed feature listings, and user-generated comparisons, making it easier for customers to make informed choices.

Since 32% of respondents are in the "Neutral" category regarding product quality, online retailers can improve customer confidence by providing detailed product descriptions, high-quality images, and customer reviews. Offering a robust return policy for quality-related concerns can also boost satisfaction levels.

Building trust is essential for online shopping platforms. For the 16% who express dissatisfaction, businesses should emphasize transparent policies, secure transactions, and clear terms and conditions. Additionally, actively seeking and responding to customer feedback can help improve trust levels.

To cater to the 10% of respondents who are not satisfied with the return policy, online shopping platforms should maintain and improve their return processes. This includes making return instructions clear and hassle-free, offering free returns when possible, and ensuring prompt refunds.

LIMITATIONS OF THE STUDY

a) This study has considered the only rural people of the Belgaum district.
b) The outcomes are purely based on the opinion of the respondents.
c) The researcher has selected a sample size of only 50 respondents. Therefore, the findings cannot be generalized.

CONCLUSION

E-commerce and online shopping have become pivotal drivers of comprehensive growth in India, poised for even more transformative changes in the years to come. These digital platforms have made significant contributions to the nation's economy, fueled by the rapid advancements in information technology. With the ever-expanding internet user base, accessing competitive markets for better product deals has become more accessible and convenient. However, alongside the evident progress and evolution in the e-commerce landscape, concerns surrounding security and privacy among customers persist. Notably, despite the remarkable strides in this sector, online shopping has yet to penetrate rural and remote areas of India, primarily due to a host of challenges and issues. It is imperative for online shopping companies and the government to proactively address these hurdles and take affirmative steps to extend the reach of online shopping and e-commerce services to the countryside. By doing so, they can enhance the quality of life for rural residents and, concurrently, contribute to the growth of the nation's Gross Domestic Product (GDP).

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A GENETIC ALGORITHM BASED IMAGE AUTHENTICATION TECHNIQUE FOR DIGITAL IMAGE USING PIXEL VALUE DIFFERENCING (GASTPVD)

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ABSTRACT

In this paper Genetic Algorithm based steganographic technique for digital image using pixel value differencing (GASTPVD) has been proposed. This is a spatial domain-based image authentication technique where correlation between the neighboring pixels determines the number of secret bits to be embedded. The difference between consecutive two pixels in the edge area is larger than the difference between the consecutive two pixels in smooth areas. So, more number of secret bits can be embedded in edge area than smooth area. In this proposed technique variable number of secret bits can be embedded based on the difference(d) between consecutive two pixels. The difference between consecutive two pixels has been categorized into four area as follows: very smooth, smooth, medium smooth and edge area. If d <= 31, then difference fall into very smooth area. If 31<d<= 63, then difference fall into smooth area. If 63<d<= 127, then it falls into medium smooth area. If d>127, then it falls into edge area. Three, four, five and six secret bits are embedded in the very smooth, smooth, medium smooth and edge area difference respectively. Genetic Algorithm has been applied to generate optimized stego image. The proposed technique has been compared with two existing pixel value differencing based steganographic techniques. It shows that the proposed technique performs better than existing approach.

KEYWORDS

genetic algorithm (GA), image fidelity (IF), peak signal to noise ratio (PSNR), pixel value difference (PVD), mean square error (MSE).

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1. INTRODUCTION

Steganography is the concealment of digital information in the form of image/ video/ text within computer files/images. The covering image is also named as source image. The information that is hidden in the cover image [18],[23] is referred to as secret information. The cover image with secret information hidden on it is referred to as stego image [6]. Steganography [4] means embedding of digital information within computer files/images. In General, secret information in steganography can be anything, it may be video, image [9],[10], sound file even the radio communication also. To ensure security, a message may be secretly embedded by using some algorithms [5] which is invisible to the intruder and also reversible [8] as the message can be extracted from the receiver end. Security [13], [15] may be achieved by hiding message/ image within an image either in spatial domain [14] or in frequency domain. Image authentication can be achieved through data hiding technique [11], [12]. Ownership verification is an important task of military people. Authentication [16], [17] is the major task for research institute and scientist. Ownership verification and image authentication [22] has become very important to secure the document from unauthorized access. Steganography means secret communication within a host image and the secret communication can be message, image, and video. A popular example of steganography is that of a prisoner secretly communicating with outside under the supervision of a prison warden. Steganography is useful method to the construction of a hypermedia document or image, which is very less convenient to manipulate. The objective of steganography or data hiding is to hide the message/image in the source image by some key techniques and cryptography [19] hides the message content. In case of steganography, a message is hidden inside a cover image without changing its visible properties [7] and the content of source image can be changed. A popular method of steganography is least-significant bit (LSB) substitution developed by [7] masking, filtering and transformations on the source image. All the experiments have been performed on the image taken from the image database [20].

Rest of the paper is organized as follows. Section 2 deals with review of literature. Section 3 deals with importance of the study. 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 has been discussed in this section. In 2021, Fadhel S A et al.[1] proposed an improved “pixel-value differencing” steganographic method that uses AES method to encrypt and hide the important text data. This method builds a map to embed in non-sequential way by using hyperchaotic system that increases the security level. In this technique data embedding is done one of the three levels of the colour image that is Red or Green or Blue. This increases the efficiency of this technique. In 2020, Kim P H et al.[3] proposed another dual image based pixel-value differencing technique which is reversible in nature. This technique can hide more number of secret information based on neighbouring pixel difference. In this technique non-overlapping mask is taken from the source image and the difference between the neighbouring pixels are calculated. The highest difference is chosen for embedding. A hash function is taken for determining the number of secret bits. In 2020 Majumder J et al.[2] proposed a steganography technique based on Pixel Value Difference and some cryptographic method such as AES and SHA-2. It combines cryptography with steganography. Here a message is encrypted using AES algorithm using SHA-2 as hash function. Pixel value differencing technique has been used by adding a key to the hash function. Another pixel value differencing steganography technique proposed by Majumder J [4] in 2020 based on neighbouring pixel matching. It is a reversible data hiding scheme which considers two, three and four neighbouring pixels. It embeds a greater number of bits in edge areas than smooth areas as the edge area can tolerate more changes than smooth areas. In 2017 Al Dhamari A K et al. [5] proposed pixel value differencing-based steganography technique which uses new structure of blocks to hide secret information. It also uses modulus function as a hash function. In 2016 Jana B et al. [7] proposed reversible data hiding technique for dual-image. It is a pixel value differencing technique where secret information is divided into two sub-streams. First hides n-1 bits secret data using pixel value differencing technique, next hide 1 bit using difference expansion for n bit secret data. It uses two neighbourhood pixels for calculating the difference. Another technique proposed by Jana B et al. [6] is dual image-based steganography using pixel value differencing and exploiting modification direction. The secret information is embedded using two ways, some bits are embedded using pixel value differencing technique and some are embedded using exploiting modification direction in pair of pixels. The modified pixel pairs are distributed among the dual images. This method obtained two modified pairs of pixels which contain 7 bits secret message and distributed these pixel pairs among dual stego images depending on a shared secret key (K). The recipient successfully obtains secret message and retrieve original image using same shared secret key.

3. IMPORTANCE OF THE STUDY

The existing techniques used different steganographic techniques but the amount of secret information is not so much. This paper presents an algorithm that would facilitate secure message transmission using mask-based data hiding procedure depends on pixel value differencing technique. This method embeds large amount of secret information as compared to the existing works [4],[5],[6],[21] with minimum distortion of visual property as it embeds more bits in the edge area compared to the smooth area. The proposed method GASTPVD is compared with other existing techniques and find out good results with respective to payload as the edge areas can tolerate more changes than the smooth areas.

4. STATEMENT OF THE PROBLEM

The detailed study of the Review of Literature reveals the following facts:
Most of the previous techniques are LSB substitution techniques but in the proposed technique variable amount of information are embedded based on the difference. Few techniques used Genetic Algorithm as the optimization process to generate optimized stego image but in this technique, GA is used as optimization technique. Most of the earlier works used less embedding capacity but the proposed techniques conform large embedding capacity with least distortion in the stego image.

5. OBJECTIVE

The objective of this research is to develop a new Genetic Algorithm based image authentication technique that 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 GASTPVD, a mask of size 2×2 from the source image [20] is taken in row major order. Another image is taken as the authenticating image from the image database [20]. First four mask is used for embedding dimension of the authenticating image. Authenticating image dimension is extracted from the header part of the image and is embedded in the first four mask of the source image with a bit per byte (bpb) of 3. The dimension is embedded in the rightmost three LSB position. Authenticating image pixels are embedded through pixel value differencing technique using 2-neighbour pixel. The difference value (d) has been calculated by the difference between the two neighbour pixels. According to the difference value (d) four areas are determined. Those are very smooth area, smooth area, medium smooth area and edge area. If the difference value(d) is less than or equal to 31, then it falls into very smooth area and three bits from the authenticating image are embedded in the difference value. If the difference value(d) falls between 31 and 63, then it falls into smooth area and four bits from the authenticating image are embedded in the difference. If the difference value(d) falls between 63 and 127, then it falls into medium smooth area and five bits are embedded in the difference. If the difference value(d) is higher than 127, then it falls into edge areas and six bits are embedded in the difference. The pixel value differencing method is a reversible steganographic technique that embed more number of bits in the edge area compared to the number of bits in the smooth area using the high correlation among the pixels. If the pair of adjacent pixels are X_1 and X_2, the difference value d is calculated by the **equation (1)** and mean value m is calculated through **equation (2)**. The inverse transform is given by **equation (3)** and **equation** (4).

$$d = X_1 - X_2, \quad (1)$$

$$m = \text{floor}((X_1 + X_2)/2 \quad (2)$$

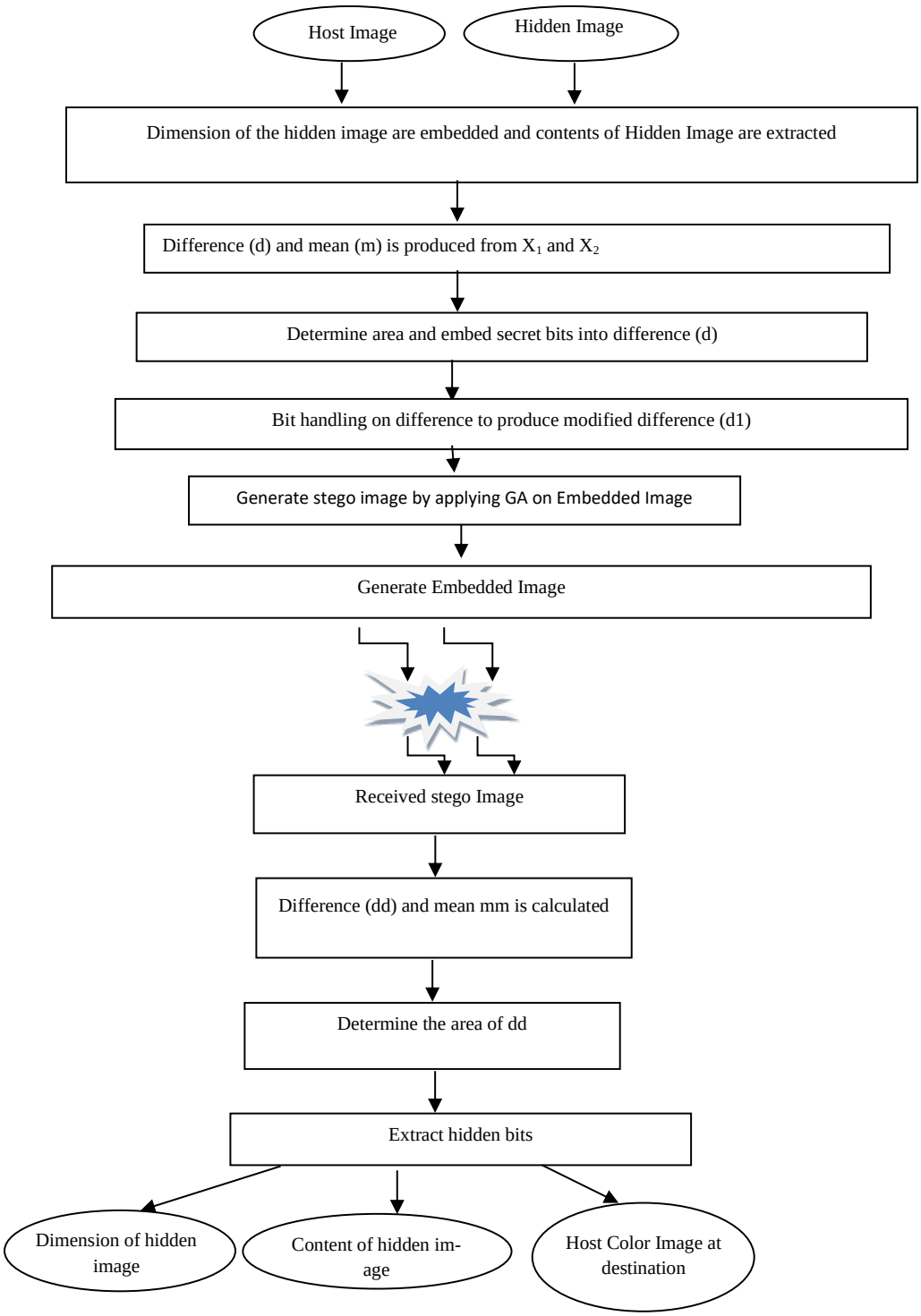
$$X_1 = m + \text{floor}((d+1)/2) \quad (3)$$

$$X_2 = m - \text{floor}(d/2) \quad (4)$$

The difference value (d) determines the number of authenticating image bits to be embedded on it. The induced distortion in the embedded image pixels is generated through the embedding of secret information on the difference value(d). A bit handling procedure has been introduced to keep the embedded difference value in the same area (very smooth/ smooth/ medium smooth/ edge area) to ensure the reversibility. The modified pixel values (X_{11} and X_{22}) are generated through the equation (3) and (4). Embedded stego image is processed through Genetic Algorithm to generate optimized stego image. The optimized stego image is transmitted through network. At the receiver end optimized stego image is received. The authenticating image bits are extracted using extraction algorithm. The algorithm of insertion is discussed in section 7.1 and the algorithm for extraction is discussed in section 7.2.

Schematic diagram of the technique discussed above is shown Figure 1.

FIGURE 1: SCHEMATIC DIAGRAM OF GASTPVD



7.1 ALGORITHM FOR INSERTION

Input: Source image is of dimension 512×512, secret authenticating image is of dimension 256 × 256.
Output: embedded image having dimension 512×512.
Steps:

1. Source image mask of 2×2 is taken.
2. The dimension of the authenticating image is extracted.
3. Calculate the difference (d) between the two neighbours.
4. Find out the area in which the difference (d) belongs and embed secret information on the difference (d). If the area changes, then use bit handling method to make the difference in the same area to keep reversibility.
5. Use the equation (3) and (4) to generate the embedded pixel value.
6. Apply GA to generate the optimized stego image. The process of GA has been discussed in section 7.1.1.

The insertion algorithm is illustrated with one example in figure 2.

FIGURE 2: INSERTION OF THE AUTHENTICATING IMAGE BITS IN THE SOURCE IMAGE MASK

10110000 01010000 Figure 2a: Authenticating image pixels	226 137 157 219 Figure 2b: Source image Lenna	01011001 00111110 Figure 2c: Difference image block
01001101 00110000 Figure 2d: Embedded difference image block	220 143 212 164 Figure 2e: Embedded image block	220 143 212 164 Figure 2f: Embedded image block after bit handling

In the figure 2a authenticating image pixels are shown in binary form. The source image pixels are shown in Figure 2b. Here Lenna image from image database [20] has been taken as the source image. The difference between the two neighbour is shown in figure 2c. The difference is in medium smooth region. So, 5 bits from the authenticating image are embedded in the difference shown in Figure 2d. Embedded image pixels are shown in Figure 2e with the help of equation 3 and equation 4. As the region is not changed, so the bit handling process results the same as embedded image pixels and is shown in Figure 2f.

7.1.1 PROCESS OF GENETIC ALGORITHM

Input: embedded image is of size 512×512.

Output: optimized stego image is of size 512×512.

Steps:

1. A 2 × 2 mask from the embedded image is taken.
2. Initial population is considered for the two neighbours of the mask (explained in initialization section).
3. The selection process uses Roulett Wheel selection to select the two fittest chromosomes from the initial population.
4. Crossover is performed over the two fittest chromosomes (explained in section crossover). Crossover results two children.
5. Result of Crossover are processed through mutation (explained in mutation section).
6. The process of elitism (explained in elitism section) and process of termination (explained in termination section) are applied at last.
7. Step 1 to 6 is repeated for the entire matrix.
8. Step 1 to 7 is repeated for the entire embedded image.

Initialization

In Initialization random pixel value has been generated which are less than or equal to 255. The maximum number of authenticating image bits can be embedded per byte is three, so 2^3 that is 8 number of random chromosomes are generated for each pixel in the mask.

Selection

In this process fittest chromosomes are selected using Roulett Wheel selection process with the help of the fitness function

$f(n) = 1/(\text{mod}(s(x,y) - c(x,y))+1)$

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).

Crossover

Two fittest chromosomes for each neighbour are selected through selection process passed through crossover. Uniform crossover process is followed where first bit is from first parent and second bit is from second parent. Example shows the crossover for a pixel of the two neighbours.

Parent 1 = 191

1	0	1	1	1	1	1	1

Parent 2 = 223

1	1	0	1	1	1	1	1

Offspring1 = 255

1	1	1	1	1	1	1	1

Offspring2 = 159

1	0	0	1	1	1	1	1

Mutation

Mutation is applied on the cross overed chromosomes for each neighbour by taking a bitwise XOR on the last three bits on three steps and taking the first bit of each step. Mutation process is explained below for one of the two neighbours.

Before Mutation=255

1	1	1	1	1	1	1	1

After Mutation=252

1	1	1	1	1	1	0	0

Elitism

Elitism forwards the best chromosomes in the next iteration by eliminating the weak chromosomes. In this case by calculating the difference value of two neighbours it forward the two best chromosomes in the next iteration. If the difference value of two mutated chromosomes are same as the difference value of two embedded chromosomes then it forward the result to the next iteration otherwise pass the old value to the next iteration.

7.2 EXTRACTION ALGORITHM

Input: Optimized stego image having dimension 512×512.

Output: Secret authenticating image having dimension 256×256.

Steps:

1. An image mask of size 2 × 2 is taken from the optimized stego image.
2. Calculate the difference between the consecutive two neighbours of the mask.
3. Find out the region in which the difference belongs to and extract the authenticating image bits according to the region.
4. 8 bits extraction form a byte of the authenticating image.
5. Repeat step 1 to 4 according to the dimension of the authenticating image.

Decoding Correctness

The proposed technique embeds the authenticating image pixels in the difference of two neighbours, and GA has been applied to generate optimized stego image. So, the difference between the two neighbours should be same after the generation of optimized stego image, otherwise the extraction of authenticating image bits will not be possible. This is ensured in the elitism step of GA. For example, if the difference between the consecutive two pixels after embedding is 232 and 104, after applying GA, if must be accepted if the values are 236 and 108. That means the difference value should be same to keep the decoding properly.

8. RESULTS AND DISCUSSION

The results are generated on Intel Core 2 Duo CPU having 3.00 GB RAM and 2.00GHz speed. Source images are of dimension 512 × 512 and authenticating image is of size 256 × 256. Table 1 shows the experimental results performed on GASTPVD for the following image metrices like PSNR, MSE, IF and SSIM shown in equation (5), (6) (7) and (8). PSNR is peak signal to noise ratio measured in decibels between two images. PSNR is used to find out the quality of the stego image as compared to the source image. Higher value of PSNR ensures better quality of the stego image. MSE is mean square error is used to compare the quality of the stego image as compared to the source image. MSE measures the cumulative squared error between the stego image and the source image. The lower value of MSE ensures the lower error. IF is image fidelity used to discriminate between two images how accurate those are. If the two images are same then IF will be 1. 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 SSIM is given in equation (8), where the formula for μ_x and μ_y is given in equation (9) and σ_x^2 and σ_y^2 are given in equation (10) and (11). The formula for σ_{xy} is given in equation (12) and the constants C_1, C_2, K_1, and K_2 are given in equation (13).

The experimental results for all the sixteen images (Table 1) have been observed that the PSNR value lies between 42 and 49 which results better quality of the stego image. The highest PSNR is 48.209309, lowest PSNR value is 42.121918. IF value lies between 0.999628 and 0.999975. The highest value of IF is 0.999975 and the lowest value of IF is minimum value 0.999628 which results stego image is almost same as source image. MSE value indicated that how close the source image with stego image. Lower value of MSE (ranging from 0.873201 to 3.989226) in the table indicates that the stego image and source image are very close. SSIM value is very closer to 1 which indicates that the optimized stego image is almost same as source image. Figure 3 shows the visual interpretation of various source and optimized stego images. It is seen that there are no such visual changes in the source and optimized stego image. Table 2 shows the comparison of existing technique with the proposed technique. It has been observed that the proposed technique embeds more volume of secret information than the existing methodologies[2] and a better quality of image as compared to the existing methodology[3]. It has also noted that the proposed technique obtains high PSNR value as compared to the existing methods. It means that the quality of the optimized stego image is better than the existing methodologies.

$$PSNR = 10 \log\left(max\left(I_{m,n}{}^2\right)/MSE\right) \quad (5)$$

$$MSE = \frac{1}{MN} * \sum_{m,n} (I_1 m, n - I_2 m, n)^2 \quad (6)$$

$$IF = 1 - \sum_{m,n} (I_{1_{m,n}} - I_{2_{m,n}})^2 / \sum_{m,n} I_{2_{m,n}}^2 \quad (7)$$

$$SSIM = 2(\mu_x\mu_y + C_1)(2\sigma_{xy}+C_2)/((\mu_x * \mu_x + \mu_y * \mu_y + C_1) * (\sigma_x * \sigma_x + \sigma_y * \sigma_y + C_2) \quad (8)$$

$$\mu_x = 1/N \sum_{i=1}^{N} X_i,\ \mu_y = 1/N \sum_{i=1}^{N} Y_i \quad (9)$$

$$\sigma_x * \sigma_x = 1/N\text{-}1 \sum_{i=1}^{N} (X_i - \mu_x)^2 \quad (10)$$

$$\sigma_y * \sigma_y = 1/N\text{-}1 \sum_{i=1}^{N} (Y_i - \mu_y)^2 \quad (11)$$

$$\sigma_{xy} = 1/N\text{-}1 \sum_{i=1}^{N} (X_i - \mu_x)(Y_i - \mu_y) \quad (12)$$

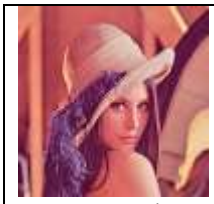
The value of C_1, C_2 and C_3 with K_1 and K_2 are from [23] given in equation (13)

$C1 = (K_1 L)^2$, $C2 = (K_2 L)^2$, $K1 = 0.01$, $K2 = 0.03$ (13)

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

Cover image	*PSNR*	*MSE*	*IF*	*SSIM*
Lenna	43.434471	2.948718	0.999852	0.999996
House	46.716660	1.384888	0.999949	0.999999
Baboon	45.350311	1.896921	0.999901	0.999999
Pelican	46.895218	1.329103	0.999961	0.999998
Pepper	43.178005	3.128094	0.999812	0.999998
Peaceful	46.867504	1.337611	0.999858	0.999999
Avion	48.719662	0.873201	0.999975	0.999768
Toucan	42.977612	3.275814	0.999740	0.993818
Tahoe	44.771507	2.167352	0.999733	0.999561
Sailboat	45.660923	1.765990	0.999911	0.995216
Manhatan	48.209309	0.982086	0.999908	0.999999
Sedona	46.864376	1.338575	0.999871	0.999703
Colomtm	46.542160	1.441664	0.999887	0.999999
Butrfly1	45.932850	1.658806	0.999887	0.999916
Blueeye	45.163162	1.980451	0.999628	0.999999
Blakeyed	42.121918	3.989226	0.999646	0.999999

FIGURE 3: VISUAL INTERPRETATION OF VARIOUS SOURCE AND OPTIMIZED STEGO IMAGES


i. Source image lenna

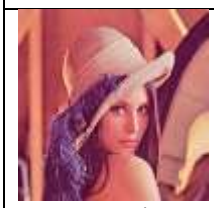

ii. Source image baboon


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

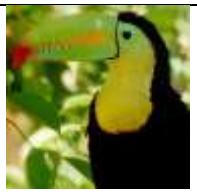

xi. Optimized stego toucan

TABLE 2: COMPARISON OF PSNR VALUES AND THE CAPACITY OF VARIOUS OPTIMIZED STEGO IMAGES WITH EXISTING APPROACH

Source image	PSNR value of existing technique[2]	PSNR value of existing technique[3]	PSNR value of GASTPVD	Capacity (in bytes) of existing technique[2]	Capacity (in bytes) of existing technique[3]	Capacity (in bytes) of proposed technique
Lenna	42.2	41.9185	43.434471	20480	100000	54000
Baboon	40.2	-	45.350311	21440		54000
Pepper	-	41.6474	43.178005		100000	54000

9. FINDINGS

It has been observed that the proposed technique having high PSNR value and IF value nearly equals to 1 which ensures good quality of the stego image and also embed large amount of secret information.

10. RECOMMENDATION

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

This technique (GASTPVD) can be used in Image authentication. The image that needs to be authenticated is considered as source image. Another small image 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.

The proposed technique can be used in 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 GASTPVD can be used in image authentication.

GASTPVD 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 GASTPVD. 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.

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. GASTPVD technique can be used in this purpose.

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

GASTPVD 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 GASTPVD is a spatial domain colour image authentication technique based on pixel value differencing technique. This approach hides large amount of information with a little distortion and by applying Genetic Algorithm the quality of the optimized stego image is maintained. This technique has been compared with some existing pixel value differencing-based approaches and the result shows that the technique works better than those approaches.

12. LIMITATION

The proposed technique is a spatial domain technique. It cannot be applicable in frequency domain.

13. SCOPE FOR FUTURE RESEARCH

The capacity of the secret information can be increased in the proposed technique and hence future scope of research.

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