FUZZY LOGIC BASED PARALLEL DATA EMBEDDING TECHNIQUE FOR IMAGE STEGANOGRAPHY

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Abstract- High quality steganography is one of means of storing secured data. Many techniques follow serial embedding, which takes more time to embed data. The goal of this paper is to deals with high payload capacity and good imperceptibility of the stego image with less execution time. To achieve this goal, Fuzzy Inference System (FIS) is integrating with the Human Visual System (HVS). Both mamdani and sugeno type of FIS is used for embedding. Blocks are embedded in parallel instead of sequential operations as it reduces the embedding time. The proposed system the embedding time is reduced by 10% to 15% as compared to serial embedding time. Using mamdani and sugeno algorithm the peak signal to noise ratio obtained is 52dB when all the pixels of cover image are used for embedding.

Keywords- Fuzzy Inference System (FIS); Human Visual System (HVS).

1. INTRODUCTION

Digital information hiding was born with advent of digital technology. Nowadays steganography techniques use text, image, audio, video, binary, or html files as different types of digital media. Modern steganography techniques rely on data hiding techniques using modern media. Cryptography provides data security by applying encryption/decryption techniques. The purpose of Image steganography is to upgrade the safe transmission by concealing different data files into concealing image and to prevent an adversary from extracting the data.

A novel image steganography approach has been proposed in [1] which uses Fuzzy Inference System (FIS) in mamdani type with the Human Visual System (HVS) properties. [2] proposed the secret data is transformed into fuzzy domain. Two image processing techniques like edges and texture are exploiting for fuzzy pixel. LSB steganography substitution is used for embedding and obtained high imperceptibility. Acceleration of LSB Algorithm in GPU [3], presents a method for accelerating the steganography using Computer Unified Device Architecture (CUDA) by parallelizing the computations to a single pixel with a hybrid of message passing and shared memory thereby reducing the runtime of the program. [4] Proposes the secret data is encrypted using fuzzy technique to increase the hidden robustness. [5] Proposes good execution speed is obtained, it is implemented on Graphical Processing Unit (GPU) and OpenCL in CUDA cores from NVIDIA has used for parallel programming.

2. THE PROPOSED METHODOLOGY

Embedded input text

1. Encrypt the input secret data; the data may be either text or image.
2. Split cover image into 9 blocks.
3. Feature extraction from each of the block and input to FIS.
   3.1 Extract Texture feature (Tk)
   3.2 Extract Edge sensitivity (Ek)
   3.3 Extract Brightness sensitivity (Bk)
4. Fuzzy Inference System

4.1 Fuzzifier: Converts crisp input to fuzzy values through membership functions (MFs), inputs are extracted values from feature extraction. Four MFs for Tk, three MFs for Ek, three MFs for Bk as input to fuzzy system.

4.2 Fuzzy inference engine - Mamdani type and sugeno type

4.2.1 Apply fuzzy operator: A fuzzy operator AND is used for combining the antecedents.

4.2.2 Apply implication method: Use fuzzy rules and obtain the output classes.

4.3 Defuzzifier: Convert fuzzy output into a crisp value.

5. Embedding capacity estimation.
6. Embed sequentially and parallely.

Extract the hidden text

Reverse process of the embedding process.

1. Extract confidential data from stego image sequentially.
2. Decrypt the confidential information.

The parallelization is achieved using java threads.

Figure1 and Figure 2 show the embedding and extracting procedure of proposed scheme.

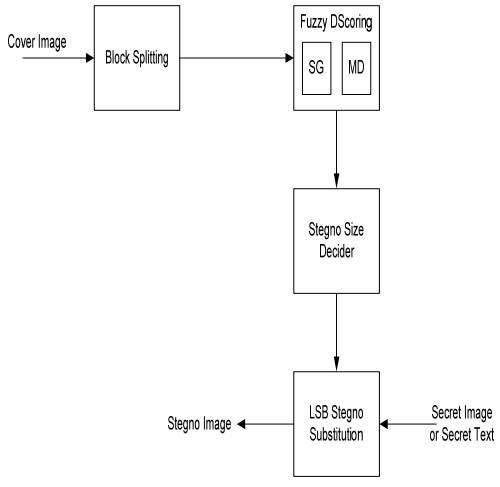

Figure 1. Shows block diagram of embedding procedure.

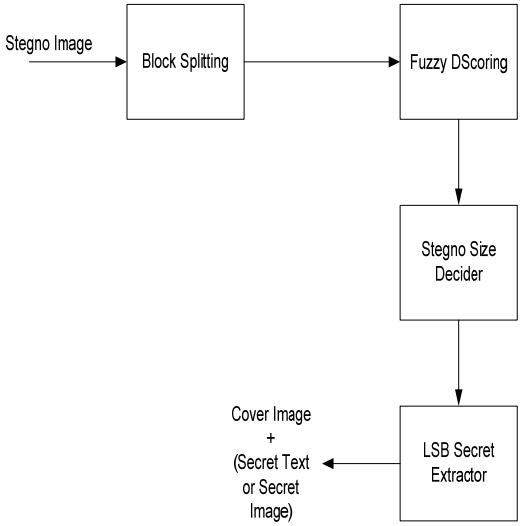

Figure 2. Shows block diagram of extracting procedure.

3. EXPERIMENTAL RESULTS AND ANALYSIS

The PSNR values given by Fuzzy Inference System of mamdani and sugeno type for variable percentage of original cover image of resolution 512x512 used for embedding are shown in Table 1. Based on the table values both mamdani and sugeno methods generates identical quality on the image and also PSNR values. The embedding capability can be more with proposed approach. With reference to [1], proposed approach presents increased PSNR values and also good quality. This offered method accomplished greater PSNR value, particularly with increased payloads, even though embedding payload is similar. And as well offered system safeguarded the greater image specifics and prevent critical visual quality destruction with better payloads.

Table 1: The comparison results based on PSNR values between the proposed scheme and relative technique.

Secret image	Baboon (512X512) gray	Baboon (512X512) color		Lena (512X512)gray	Lena (512X512) color	
	Ref [1] method	Proposed method		Ref[1] method	Proposed method	
		Mamdani	Sugeno		Mamdani	Sugeno
128X128	50.64	60.2784	60.2404	52.03	59.7247	59.6624
256X128	48.91	57.343	57.3787	50.92	56.9629	56.9791
256X256	47.71	54.2562	54.2637	49.59	54.0827	54.0821
384X256	46.83	52.749	52.7345	42.25	52.6082	52.6215

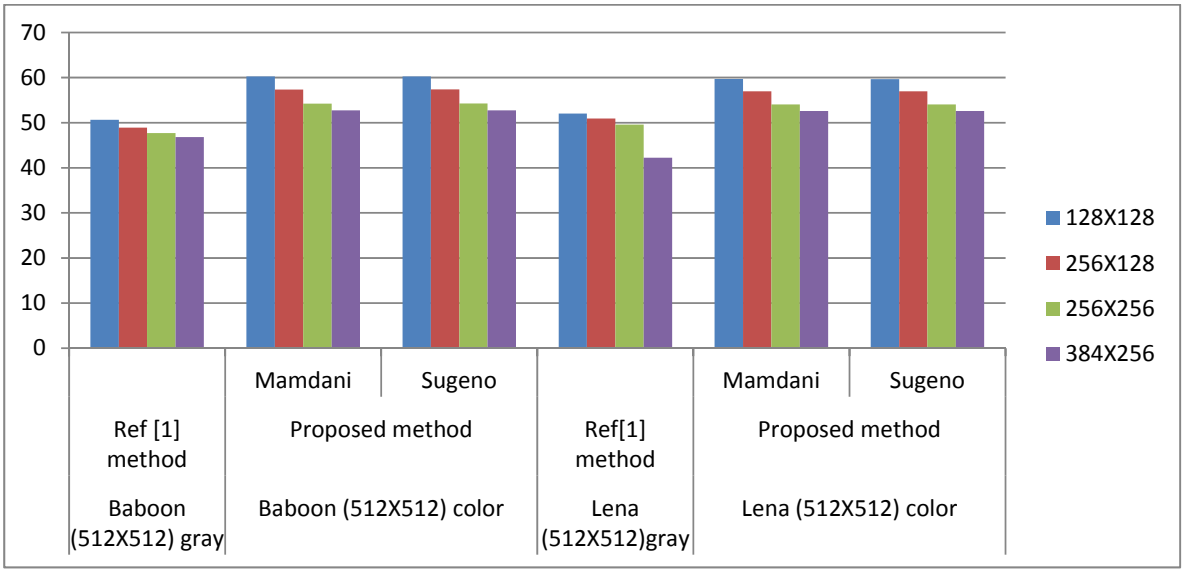

Figure 3: Comparison graph with proposed method and existing method

The Figure 3 shows the graph for the performance analysis of Fuzzy Inference System and existing technique.

The proposed scheme execute sequential or parallel. Both time comparisons have shown in Table 2 and Table 3. Figure 4 and Figure 5 shows the execution time graph of Table 2 and Table 3 respectively. All the data are verified before performing the test

Table 2: Execution Time and PSNR value of cover image Lena with dimension 512x512

Lena 512x512 (color)						
Secret Image (color)	Proposed mamdani			Proposed sugeno		
	PSNR	Serial Time	Parallel Time	PSNR	Serial Time	Parallel Time
32x64	67.6352	4017	3660	67.6451	3864	3751
64x64	65.162	4283	3664	65.0901	4867	3928
128x64	62.5932	4851	4724	62.6025	4867	4696
128x128	59.7247	4764	4712	59.6624	4696	4681
256x128	56.9629	4764	4667	56.9791	4755	4747
256x256	54.0827	4756	4738	54.0821	4754	4740
384x256	52.6082	4604	3756	52.6215	3704	3658

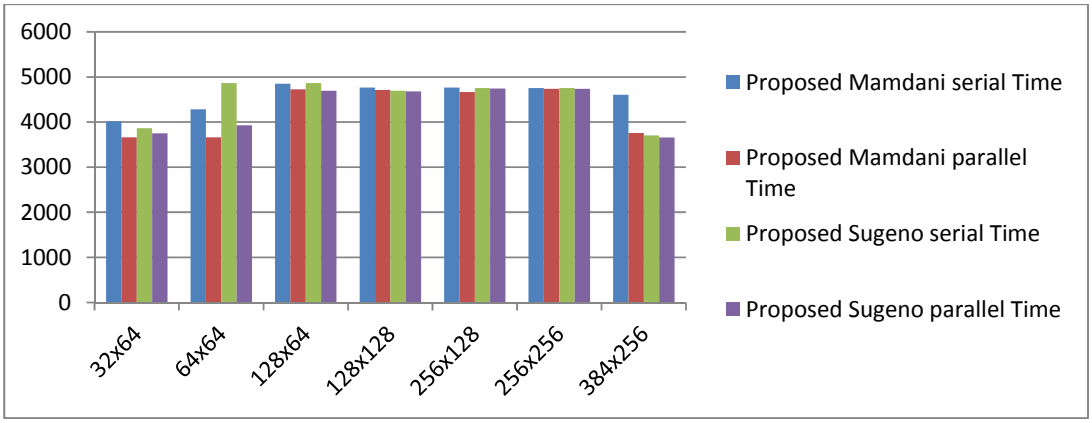

Figure 4: Execution time of Table 2

Table 3: Execution Time and PSNR value of cover image Penguin with dimension 512x512

Penguin 512x512 (color)						
Secret Image (color)	Proposed mamdani			Proposed sugeno		
	PSNR	Serial Time	Parallel Time	PSNR	Serial Time	Parallel Time
32x64	66.0882	6442	6348	65.9879	6498	6242
64x64	63.2755	6575	6203	63.2887	6334	6287
128x64	60.6805	6318	6178	60.7015	6895	6287
128x128	57.7757	6552	6224	57.766	6287	6209
256x128	55.2399	6225	6193	55.2198	6225	6147
256x256	52.754	6483	6243	52.77	6236	6223
384x256	51.433	6166	4652	51.4485	6434	4661

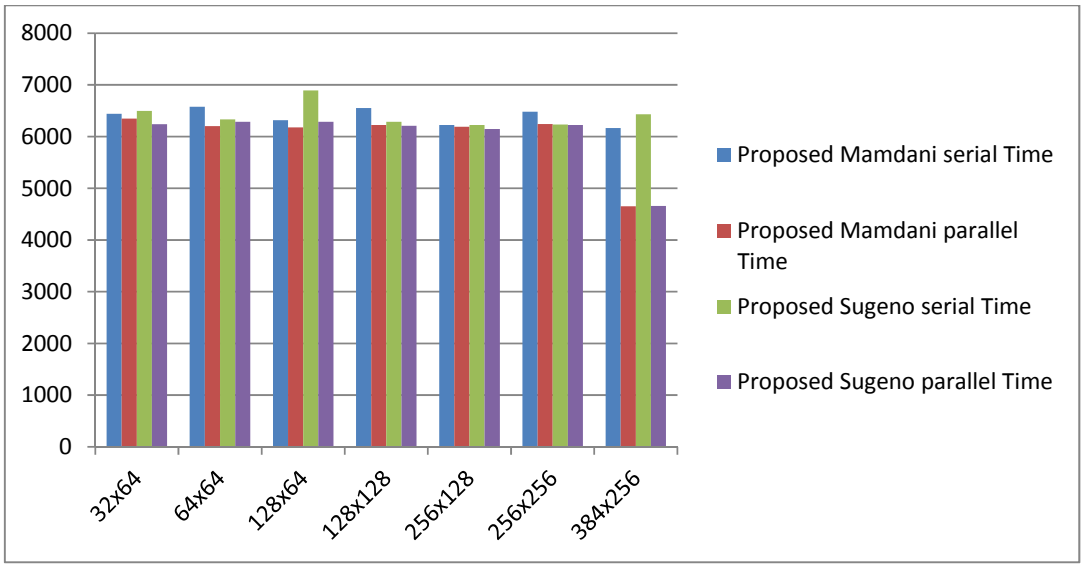

Figure 5: Execution time of Table 3

4. CONCLUSION AND FUTURE WORK

An adaptive Steganographic scheme is proposed based on Fizzy Inference System (FIS) and Human Visual System (HVS). The Mamdani and Sugeno method of fuzzy inference system is developed and can conclude that both types performs similar functions sugeno takes less time than mamdani. Embedding time is reduced by 10% to 15% as compared to serial embedding time. Using mamdani and sugeno algorithm the peak signal to noise ratio obtained is 52dB when all the pixels of cover image are used for embedding.

Future work: Some of the further enhancements that could be overcome on proposed approach as follows:

1. Application can be enhanced to support BMP, JPEG, TIFF and PPM image formats.
2. Other image properties can be considered to increase payload.
3. Separate and more efficient compression techniques can be used for compressing image.

After embedding data, stego images are lossless images which are shared. Instead of lossless image, use of lossy stego images will minimize the amount of data to be sent across the network.

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