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MATLAB Implementation of Efficient Data Encapsulation Technique using Stereoscopic Depth Map Estimation

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ABSTRACT: Video is the kind of multimedia that is turning out to be progressively prominent in the field of art, education, entertainment, engineering, medicine, scientific research and spatial temporal applications. The presence of depth in 3D video makes it different and more helpful than its 2D counterpart. 3D video broadcasting is still miniscule compared to 2D due to complexity in 3D content production. To conquer this complexity, an automatic technique to transform a monoscopic input video into a stereo for 3D visualization is proposed in the literature. The technique depends on evaluating the global depth from the 2D video followed by depth based rendering to generate its 3D version. This paper addresses the MATLAB implementation of stereoscopic depth map estimation and use of stereoscopic video as a cover media in data encapsulation. The implementation incorporates RDH technique involving LSB substitution and DWT to recuperate the lossless cover video after the extraction of secret message.

KEYWORDS: Monoscopic, Stereo, Depth map, Data encapsulation, RDH, LSB, DWT, MATLAB

I.INTRODUCTION

Video or Motion picture is a progression of still images which, when shown on a screen, creates the figment of moving images due to optical phenomenon. At present, the availability of 3D capable hardware is not yet matched by 3D content generartion. The main benefit of 3D videos over 2D videos, beyond the obvious ability to create a more lifelike character with realistic textures, is that 3D objects, once created, can be dealt much like a physical object which helps in editing of movies. Objects in 2D videos appears flatter and can only be measured in height and width while a 3D object has a surface, casts a shadow, and can be measured by length, width and the third dimension Depth. Hence there exists an urgent need to cover this gap and extract 3D content from available 2D content. Depth map of an image is an image or channel that contains information relating to the distance of the surface of scene objects from a view point. Depth can be used to make rendering of 3D scenes more efficient.

Two basic approaches to deal with 2D-to-3D transformation are semi-automatic and automatic methods. One that requires a human intervention and one that does not. Semiautomatic methods have been proposed where a skilled operator assigns depth to various parts of an image or video. Based on this sparse depth assignment, a computer algorithm deduces dense depth over the entire image or video sequence. Semi-automatic methods have been effectively used to convert many films to 3D.Automatic methods in which computer algorithm automatically deduces the depth of a video are developed to reduce operator involvement, bring down the cost and to accelerate the conversion process. One such method that automatically converts input 2D video into 3D based on global nearest neighbor depth learning and depth based rendering is addressed in this paper. The work also extends to use the subsequent 3D video as cover media to conceal text information.

Steganography is the practice of concealing or encapsulating a file, message, image, or video within another file, message, image, or video. The advantage of steganography over cryptography alone is that the intended secret message does not attract attention to itself as an object of scrutiny. Some of the regular terms that are important to comprehend any steganography system are Cover Media, Stego-Media, Secret data and Steganalysis. Cover media is the medium in which secret information is embedded in such a way that it is hard to detect the presence of data. Stego-media is medium obtained after embedding the secret information. Secret data is the information to be hidden or encapsulated in cover media. Steganalysis is the process of distinguishing the presence of secret data in cover media.

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II.RELATED WORK

Many 2D to 3D conversion techniques have been proposed. Data-driven approach to 2D-to-3D conversion has been roused by the recent trend to use large image databases for various computer vision tasks, such as object recognition and image saliency detection. Early versions of Data-driven approach to 2D-to-3D image conversion, either experienced high computational complexity or were tried only on a single dataset[1]. Detailed 3D models are created which are both quantitatively more precise and visually pleasing using Markov Random Field that infer a set of parameters that capture both 3D location and 3D orientation of the patch [4].
In [5] few trials were led to test the SIFT flow algorithm on video database, 7 candidates from each frame were chosen as the query image. The SIFT flow algorithm was then used to assess the dense correspondence (represented as a pixel displacement field) between the query image and each of its neighbor.Very recently a non-parametric model for depth estimation of 2D image that takes into account the SIFT-aligned depth maps selected from a large 3D database is proposed[3].However this method is complex and computationally demanding. This paper presents the simulation results of Matlab based stereoscopic depth map generation for data encapsulation. The 2D to 3D conversion technique addressed in this paper is simple, requires no human intervention and is computationally efficient compared to previous conversion methods reported. The generated stereoscopic 3D video is used as cover media in data encapsulation thereby adding more security and efficiency to the usual video steganography technique.

III.IMPLEMENTATION

Matlab implementation of efficient Data Encapsulation technique using Stereoscopic Depth Map Estimation is divided into two parts:

1. Stereoscopic depth map estimation
2. Data encapsulation using stereoscopic video

Stereoscopic depth map estimation

2D to 3D video conversion is the procedure of transforming the 2D flat film into 3D film format, which in most cases is stereo format. Stereoscopic conversion is the technique for creating or enhancing illusion of depth to a flat image.

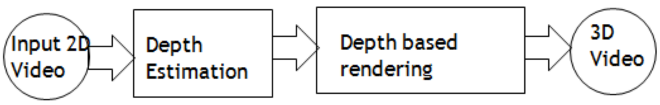

Fig.1. 2D to 3D Conversion

As shown in Fig.1, the challenging task in 2D to 3D conversion is the estimation of depth from input video followed by depth based rendering to form a stereo pair. The proposed technique for 2D to 3D video conversion is based on Global nearest neighbor depth learning that automatically estimates depth of input video and provides improved quality images with help of depth based rendering.
Depth estimation involves k Nearest Neighbor (kNN) search for depth fields, Depth Fusion and Depth Smoothing. In order to generate stereo pair we need to compute disparity from estimated depth, this is called depth based rendering.

Steps followed to convert input video into 3D are as follows:

1. Input video is read and divided into number of frames. The frames are converted to standard size and all the frames are stored in a folder.

2. Video is converted from RGB to HSV and gray scale format. The Edges of frames are found and the results are stored in different folders.

3. kNN search is applied on each frame. Similar pixels in each frame form a group. Exact gray pixels are replaced by 0 to extract 3D label for depth fusion. kNN search make use of Euclidean distance function to get useful subset of depths.

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4. To combine the k representative depth fields depth fusion is performed by means of Median filtering.

5. Depth smoothing is done to remove spurious variations in fused depth field while preserving depth discontinuities. Cross-bilateral filtering is used for this purpose.

6. Final depth is obtained using prior depth hypothesis and edge calculation. Bilateral filtering is applied.

7. Depth image based rendering is 3D image warping which enables rendering of a synthetic image, using a reference 2D image and a corresponding depth image. This is the final step in 2D to 3D video conversion.

Data encapsulation using stereoscopic video

Usually just a steganography is process in x-y axis only which can store less number of data. 3D videos have XYZ planes and it is possible to hide more amount of data in a single image or frame of a 3D video. Data can be stored in X-Y ,Y-Z or Z-X plane and hence keeping the information secret from unauthorized person. Reversible Data Hiding (RDH) in videos is a technique used to recover the original cover video without any loss after the embedded message is extracted.

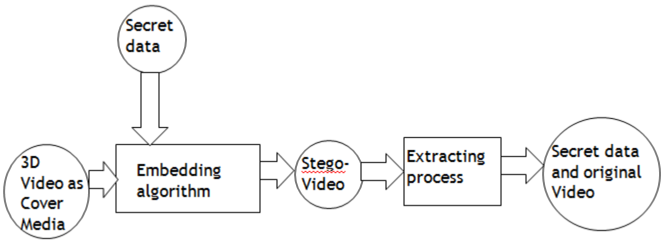

Fig.2. Data encapsulation

The block diagram of data encapsulation is shown in Fig.2.The embedding algorithm used here is LSB substitution that uses Least Significant Bit of every pixel of frames to hide the secret information bit[7]. It is simple and requires less computational power. Discrete Wavelet Transform (DWT) is used in this paper that splits the signal into high and low frequency parts. The low frequency part is split again into high and low frequency parts. The high frequency components are usually used for data encapsulation since the human eye is less sensitive to changes in edges. Data encapsulation using 3D videos involves embedding and extracting process.
Steps involved in embedding data within the cover video are as follows:

1. 3D video is taken as cover media. It is converted into number of frames or images. Particular frames/images are selected for data hiding and they act as cover images.
2. Secret text is loaded. Depending on the size of both secret text and cover media, the text is converted into binary form if it can be embedded within a cover 3D video. Password is added to ensure security.
3. LSB technique is applied. The LSB bit of the image pixel is replaced by the binary data. The least significant bit of selected bytes in an image is changed to a bit of the secret message. As a result we get stego image.
4. This process is continued until all the message bits are embedded.
5. DWT is applied to stego frames and all the stego frames are converted into a video called stego-video. The stego-video is then transmitted.

Steps involved in recovering original video from stego-video are as follows:

1. Stego-video is loaded.
2. Password is entered to get the secret message.
3. Inverse DWT is applied on stego-video to get the stego image.
4. Extracting LSB technique is applied on each stego image to recover the secret message and original cover image/frame. The original video is then obtained using recovered frames.

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IV. RESULTS

The proposed modules for 2D to 3D Video conversion and Data encapsulation are programmed in Matlab environment. 2D video in AVI or MP4 format can be taken as input and transformed into 3D. The simulation result in Fig.3 shows the HSV frame, Depth of frame and the converted 3D frame for a given input 2D frame. The outcome is for single frame of AVI format input 2D video.

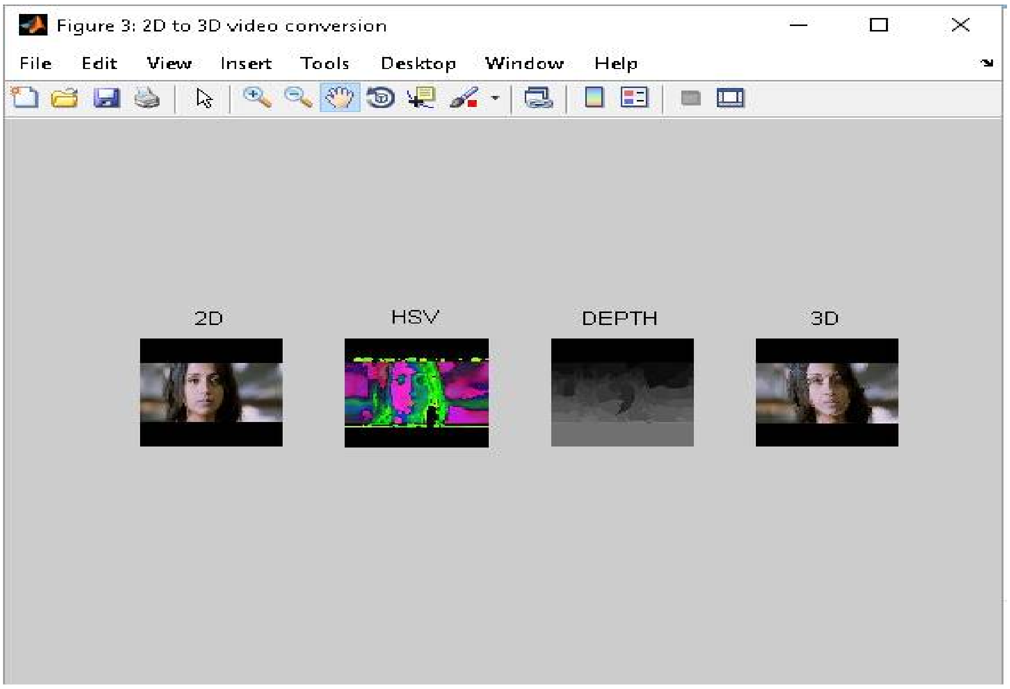

Fig.3. Matlab simulation of 2D to 3D conversion of a video frame

Fig.4.Text extraction

Data encapsulation uses the converted 3D video, first the 3D video is divided into number of frames and LSB technique is applied to 3D cover frames to get stego-frames.DWT is applied to all stego frames, finally Stego-video is obtained.

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Matlab command window in Fig.4 shows the total number of frames present in input video and the text extracted from Stego-video.

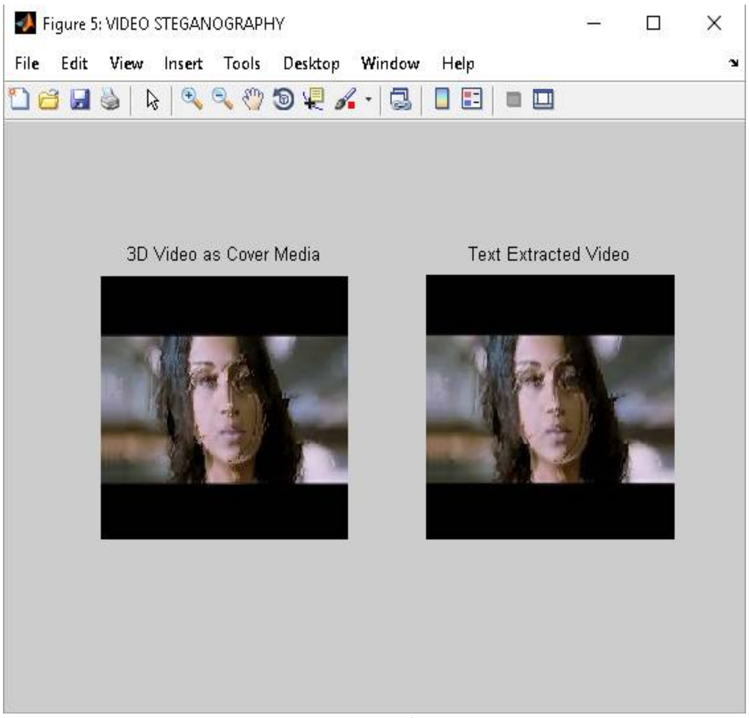

Fig.5. Matlab simulation of Data encapsulation

Cover image and text extracted image for single frame of a 3D video is shown in Fig.5.Hence from the simulation results we can say that the image recovered after the text message extraction using inverse DWT and LSB is lossless and is the original cover frame.

V.CONCLUSION

An automatic technique for generating 3D video using depth estimation and depth based image rendering of input 2D video is executed in Matlab environment.3D videos contrasts significantly from 2D, both in terms of the process used to create it but the end result as well. The technique can be applied for videos with different number of frames and of different formats supported in the Matlab. Covert information is then sent using resulting 3D video. This is beneficial since more amount of data can be disguised in 3D videos than its 2D counter parts. Results demonstrate that the original cover video can be recovered without any loss using Reversible Data Hiding strategy once the covert message is separated.

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