1. INTRODUCTION
Digital Image Watermarking [1, 2] is the process of insertion of image watermark in media content and its extraction, if required, for authentication or ownership verification of media content. A digital image watermark is a piece of information that is hidden directly in media content, in such a way that it is imperceptible to a human observer [3]. Different types of watermarking methods for digital contents have been developed that are classified into different categories depending upon the use and the requirement of information required for the extraction/detection of watermark. To check the authenticity of a digital content fragile watermarking is used while, for the purpose of copyright protection, robust watermarking is utilized. This classification is application-dependent. Based on the information required for the extraction/detection process watermarking schemes can be classified into blind, semi-blind, and non-blind categories. Also, one more categorization is possible depending upon the domain of embedding of watermark: spatial and frequency. A detailed review of watermarking schemes can be found in [4, 5].
This paper outlines a brief survey over the earlier developed image watermarking techniques. The complete earlier approaches are classified into two classes; spatial domain approaches and transforms domain approaches. The complete details are described in the further sections. Reminder of the paper is organized as follows; section II describes the survey details and section III concludes the paper.

2. LITERATURE SURVEY
The classifications of earlier developed approaches rely on the domain where the secret information will be embedded and are further classified as
- Spatial domain techniques
- Transform domain techniques.

2.1. Spatial domain techniques
In Spatial domain the watermark is directly embedded by modifying the pixels of the original image without any transformation of the image. This technique is often fragile and applied in the pixel domain and has less complex computation thus consumes less time for archiving and retrieval. The least significant bit (LSB) technique is used to embed information [10] in a cover image. The LSB technique of a cover image is described by changing pixels by bits of the secret message. An embedding scheme which randomly hides messages in the LSB of any/all component of the chosen pixel using polynomial [11]. If polynomial is used, hacker needs to predict more than one number i.e. all coefficients of polynomial has to be decoded correctly and probability of finding all right coefficients is less compared to predicting single bit. Watermarking can be done by embedding watermark into sub images with LSB technique. The watermark can be embedded into specifics blocks [12] of the host image where the selection of blocks is based on entropy value which gives a high PSNR value.
In [8], a novel robust image watermarking scheme is proposed for resisting geometric attacks. Watermark synchronization is first achieved by local invariant regions which can be generated using scale normalization and image feature points. The watermark is embedded into all the local regions repeatedly in spatial domain. During embedding, each circular region is first divided into homocentric cirque regions. Then the watermark bits are embedded by quantizing each cirque region into an “odd” or “even” region using odd–even quantization. In the decoder, an odd–even detector (OED) is designed to extract the watermark from the distorted image directly.

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By utilizing the generating principle and distribution feature of the direct current (DC) coefficient, a novel blind watermarking algorithm is proposed for color host images in [9]. Firstly, the Y luminance of host image is divided into $8 \times 8$ sub-blocks and the DC coefficients of each block are directly calculated in the spatial domain. Secondly, according to the watermark information and the quantization step, the DC coefficients are calculated and their increments are further utilized to modify directly the values of all pixels in the spatial domain. When watermark extraction, only the watermarked image and the quantization step are needed in the spatial domain. Low complexity and ease of implementation are the advantages of spatial domain watermarking approaches. Despite these benefits, spatial watermarking methods are fragile against image processing operations.

2.2. Transformation Domain techniques
Transformation of an image is needed to get more information about the image and to reduce the computational complexity. Even though this technique takes more time and more complex than spatial domain technique the embedded watermarked data cannot be identified easily as the previous technique. In transform domain the watermark is embedded after performing transformations such as, Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), and Discrete Wavelet Transform (DWT), Singular Value Decomposition (SVD) etc. The watermark is embedded in the transformed coefficients. When compared to spatial domain techniques these techniques offer high security and are robust to attacks. In frequency domain watermarking the values of selected frequencies can be altered. Since high frequencies will be lost by compression or scaling, the watermark signal is applied to lower frequencies, or better yet, applied adaptively to frequencies containing important elements of the original picture.

2.3. Discrete Fourier Transform
The DFT based watermark embedding techniques [13-17] are divided in two types: one is the direct embedding and the other one is the template based embedding. A novel design of a DFT-based digital watermarking system for images is proposed in [13]. First of all, the original image is split into the blocks and proceeds DFT transform after that by using Arnold scrambling change water mark and produce pseudo-random sequence, result an image with watermark is produce. The watermark detection is achieved with image segmentation process, DFT transform process and relativity process. A watermarking algorithm based on image segmentation, is also use for improve the security of the watermark with DFT algorithm. A novel design of a DFT-based digital watermarking system for images is proposed in [15]. First, the original image is decomposed into DFT coefficients using a fast Fourier transform. For minimal loss in image fidelity, the watermark is embedded in those DFT coefficients with highest magnitudes except for those in the lowest one. The watermark detection is achieved without use of the original image by computing a similarity measure between the input watermark and the DFT coefficients of the attack image.

2.4. Discrete Cosine Transform
DCT based image watermarking [19-25] is more robust as compared to the spatial domain watermarking techniques. DCT is a fast transformation technique provides excellent energy compaction for highly correlated data and most of the information (DC coefficient) is in the first pixel. [22] Proposes a robust watermarking approach based on Discrete Cosine Transform (DCT) domain that combines Quick Response (QR) Code and chaotic system. When embed the watermark, the high error correction performance and the strong decoding capability of QR Code are utilized to decode the text watermark information which improves the robustness of the watermarking algorithm. Then the QR Code image is encrypted with chaotic system to enhance the security of this approach. Finally the encrypted image is embedded to the carrier image’s DCT blocks after they underwent block-based Arnold scrambling transformation. During the extraction process, as long as the QR Code image can be decoded, the completeness and accuracy of the text watermarking information can be guaranteed. In [24] a new DCT based additive watermarking scheme was proposed which provides higher resistance to image processing attacks mainly JPEG compression. In this approach the watermark is embedded in the mid frequency band of the DCT blocks only in the sub band which is carrying low frequency components and the high frequency sub band components remain untouched. A DCT based image watermarking framework is proposed in [25] to enhance the robustness of the watermark in the watermarked image against high level lossy JPEG compression. Several proposed watermark frameworks in last few years have considered binary watermarks and watermark pixels are directly embedded at the DCT coefficients of host images. Whereas in this framework used color host images and grayscale watermarks and DCT is performed on both the host image and watermark image. Watermark frequencies are embedded in the DCT coefficients of several blocks of the host image. A secret key is used that determines the embedding blocks of the host image.

2.5. Discrete Wavelet Transform
Compared with DCT, DWT has merits such as no blockiness, fast processing time, and high compression ability. In [28], cover image is decomposed into low and high frequency components by the application of 1-level Discrete Wavelet Transform. Average of each subband is calculated. The watermark is embedded into the 1-level high-high, high-low, low-high subband of cover image using Arithmetic Progression technique. The subband which has the smallest average is to be embedded first. After that, the watermarked image is projected to several attacks like median filtering, JPEG compression,
Gaussian low-pass filtering, shearing, cropping, rotation etc. with different distortion strengths. The watermark which is embedded in the middle frequency subbands and high frequency subband is taken out by similar mechanism. The imperceptibility and robustness of the watermarked image is checked out by measuring the Peak Signal to Noise Ratio (PSNR) and Structural Similarity Index values.

In [29] discrete wavelet transform technique is used for embedding and extraction of watermark in original image by using alpha blending. A technique based on 1-level discrete wavelet transform is used for insertion and extraction of watermark in original image by using alpha blending [32]. This technique is much simpler and robust than others. A robust image watermarking technique for the copyright protection is proposed on 3-level discrete wavelet transform (DWT) [31]. In [33], a multi-bit watermark is embedded into the low frequency sub-band of a cover image by using alpha blending technique. The insertion and extraction of the watermark in the grayscale cover image is found to be simpler than other transform techniques. The proposed method is compared with the 1-level and 2-level DWT based image watermarking methods by using statistical parameters such as peak-signal-to-noise-ratio (PSNR) and mean square error (MSE). [35] Proposed an image watermarking algorithm based on DWT transform. Utilizing Human visual system, this Algorithm scrambles the watermarking image, and puts the watermarking image and original image in three layers wavelet transform, eventually embeds the watermarking image in the original image to realize the embedding of watermarking.

[36] Proposed a wavelet-tree-based blind watermarking scheme for copyright protection. The wavelet coefficients of the host image are grouped into so-called super trees. The watermark is embedded by quantizing super trees. In [37], a blind watermarking method based on discrete wavelet transform (DWT) using maximum wavelet coefficient quantization is proposed. The wavelet coefficients are grouped into different block size with each block being randomly selected from different subbands. The watermark is embedded in the local maximum coefficient which can effectively resist attacks. In [38], we proposed a novel wavelet-tree based watermarking method by using structure-based quantization. First, wavelet-trees are arranged into super-trees. Secondly, the watermark bits are embedded into the super-trees by the proposed structure-based quantization method. According to these bits, the super-trees will be quantized into a significant structure. Based on this character, the watermark bits could be extracted robustly from the attack of image distortion.

[40] Proposed a blind watermarking scheme based on wavelet tree quantization for copyright protection. In such a quantization scheme, there exists a large significant difference while embedding a watermark bit 1 and a watermark bit 0; it then does not require any original image or watermark during watermark extraction process. As a result, the watermarked images look lossless in comparison with the original ones, and the proposed method can effectively resist common image processing attacks; especially for JPEG compression and low-pass filtering. Two semi-blind watermarking techniques are proposed in [41] based on sets of significant wavelet coefficients, in the three lowest detail subbands of a cover-image. The first method modifies the magnitude of triplets of significant coefficients, according to a sequence of information bits. An adaptive block-based blind watermarking algorithm using DWT in [42]. By analyzing the characteristic of detail subband coefficients of the image after discrete wavelet transform, we use the mean and variance of the detail subbands to modify the wavelet coefficients adaptively to embed the watermark. An adaptive blind image watermarking technique based on wavelet transform using a random sequence of real numbers is developed in [43]. First, the image is decomposed into non-overlapping blocks. Then, each block is classified as uniform or non-uniform by using a JND-based classifier.

### 2.6 Singular Value Decomposition

In [44], the singular value decomposition (SVD) based image watermarking scheme is proposed. The output result of SVD is more secure and robust. In the proposed scheme D and U components are used for embedding watermark. Unlike other transforms which uses fixed orthogonal bases, SVD uses non-fixed orthogonal bases. The result of SVD gives good accuracy, good robustness and good imperceptibility in resolving rightful ownership of watermarked image. In [48], we propose a digital color image watermarking method using Singular Value Decomposition (SVD). The whole process including embedding and extracting could be finished in RGB components in spatial domain. In [49], a singular value decomposition (SVD)-based watermarking scheme is proposed. SVD transformation preserves both one-way and non-symmetric properties, usually not obtainable in DCT and DFT transformations. In the proposed scheme, both of the D and U components are explored for embedding the watermark. In [51], a new SVD-based digital watermarking scheme for ownership protection is proposed. The proposed algorithm solves the problem of false-positive detection. In addition, it enjoys all the advantages of SVD-based schemes. Instead of using a randomly generated Gaussian sequence, a meaningful text message is used. Thus, clarity of the extracted message determines the performance of the algorithm.

### 2.7 Hybrid Techniques

The all the above mentioned transform approaches have pros and cons. The performance of watermarking methods was further improved by combining two or more transformations. Under this case various watermarking approaches are proposed by combining different transforms. Some of earlier hybrid image watermarking approaches [52-64] are described here.

[52] Presents a novel scheme to implement blind image watermarking based on the feature parameters extracted from a composite domain including the discrete wavelet transform (DWT), singular value decomposition (SVD), and discrete cosine transform (DCT). Multiple bits can be embedded into a single image block by adjusting designated parameters via a progressive quantization index modulation technique. The quantization with respect to the feature parameters obtained in the
DWT–SVD–DCT domain leads to efficient watermark extraction without referring to the original image. In [53], a robust lossless copyright protection scheme, based on overlapping discrete cosine transform (DCT) and singular value decomposition (SVD), is presented. The original host image is separated into overlapping blocks, to which the DCT is applied. Direct current (DC) coefficients are extracted from the transformed blocks to form a DC-map. A series of random positions are selected on the map and SVD is performed to construct an ownership share which is used for copyright verification. In [54], a novel copyright protection scheme that combines the discrete wavelet transform (DWT) and the singular value decomposition (SVD) is proposed. Instead of modifying the original host image to conceal a secret image, the proposed scheme first extracts the image features from the host image by applying the DWT and the SVD [56]. The extracted features are then classified into two clusters by employing the k-means clustering technique, and a master share is generated using the clustering result. Finally, the master share is used together with a secret image to construct an ownership share according to a two-out-of-two visual cryptography (VC) [60] technique. When rightful ownership needs to be determined, the secret image for ownership identification can be revealed by stacking the master share and the ownership share. In this [55], a discrete cosine transform (DCT) and singular value decomposition (SVD) based hybrid robust image watermarking method using Arnold scrambling is proposed and simulated to protect the copyright of natural images. In this proposed scheme, before embedding, watermark is scrambled with Arnold scrambling. Then, the greyscale cover image and encrypted watermark logo are decomposed into non-overlapping blocks and subsequently some selected image blocks are transformed into the DCT domain for inserting the watermark blocks permanently. For better imperceptibility and effectiveness, in this proposed algorithm, watermark image blocks are embedded into singular values of selected blocks by multiplying with a feasible scaling factor. In [57] adopted the frequency domain watermarking scheme which is embedded using discrete wavelet transform (DWT) singular value decomposition (SVD) and High Boost Filtering (HF). By singular values factoring it represent smaller set of values and it can preserve constructive feature of an original image. After that, apply high boost filtering in decomposed in high frequency sub-band on both images to improve the value PSNR. A hybrid robust digital watermarking algorithm based on finite Radon transform (FRAT) and Singular Value Decomposition (SVD) is proposed in [58]. The Discrete Wavelet Transform (DWT) is popularly used as it possesses properties similar to the human visual system (HVS). [58] Presents a new image watermarking scheme based on the Redundant Discrete Wavelet Transform (RDWT) and the Singular Value Decomposition (SVD). The gray scale image watermark was embedded directly in the singular values of the RDWT sub-bands of the host image. The scheme achieved a large capacity due to the redundancy in the RDWT [63-64] domain and at the same time preserved high imperceptibility due to SVD properties. Embedding the watermarking pixel’s value without any modification inside the wavelet coefficient of the host image overcomes the security issue.

3. CONCLUSION
Digital Image watermarking is a more comprehensive technique which ensures the security for multimedia content. A brief outline is given in this paper over different image watermarking techniques. According to the domain the image getting watermarked, the earlier proposed approaches are categorized as spatial domain and transform domain approaches. Further the transform domain approaches are classified into the transform in which they are running like DCT, DFT, SVD and DWT etc. For all the methods, respective advantages and disadvantages are discussed more clearly.

4. REFERENCES