Medical Region of Interest Watermarking Scheme

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Abstract
In this paper, an improved wavelet based medical image watermarking algorithm is proposed. Initially, the proposed technique decomposes the cover medical image into ROI and NROI regions and embedding three different watermarks into the Non-Region Of Interest (NROI) part of the transformed DWT cover image for compact and secure medical data transmission in E-health environment. In addition, the method addressing the problem of channel noise distortion may lead to faulty watermark by applying Error Correcting Codes (ECCs) before embedding them into the cover image. Further, the Bit Error Rates (BER) performance of the proposed method is determined for different kind of attacks including 'Checkmark' attacks. Experimental results indicate that the Turbo code performs better than BCH (Bose-Chaudhuri-Hochquenghem) error correction code. Furthermore, the experimental results validate the effectiveness of the proposed framework in terms of BER and embedding.

Keywords
Medical image. Electronic patient record. Discrete wavelet transforms. Non-region of interest. BCH and Turbo Error correction codes. Bit error rates

Introduction
Medical imaging is the technique and process used to create images of the human body or for clinical purposes or medical sciences. Although imaging of removed organs and tissues can be performed for medical reasons, as such procedures are not usually signifies to as medical imaging, but although has a part of pathology. It is a part of biological imaging and incorporates radiology which uses the imaging technologies of X-ray radiography, magnetic resonance imaging, medical ultra sonography or ultrasound, endoscopy, elastography, thermography, medical photography and nuclear medicine functional imaging techniques as positron emission tomography. Medical imaging is often perceived to designate the set of techniques that noninvasively produce images of the internal aspect of the body.

Biomedical imaging technologies utilize either x-rays (CT scans), sound (ultrasound), magnetism (MRI), radioactive pharmaceuticals (nuclear medicine: SPECT, PET) or light (endoscopy, OCT) to assess the current condition of an organ or tissue and can monitor a patient over time over time for diagnostic and treatment evaluation.

This is similar in concept to biomedical signal processing in various dimensions. It includes the survey, enhancement and display of images seize via x-ray, ultrasound, MRI, nuclear medicine and optical imaging technologies. Image reconstruction and modeling techniques allow instant processing of 2D signals to create 3D images. Image processing techniques developed for analyzing remote sensing data may be modified to analyse the outputs of medical imaging systems to get best advantage to analyse symptoms of the patients with ease.

A. Advantages of Digital Processing for Medical Applications

1. Digital data will not change when it is replicate any number of times and retains the originality of the data.
2. It offers a mighty tool to physicians by easing the search for re-preventative images;
3. Displaying images instantly after received;
4. magnification of images to make them easier for the Physician to interpret;
5. Quantifying changes over time;
6. Provides a set of images for teaching to manifest examples of diseases or features in any image;
7. Quick comparison of images.

B. Biomedical Image Processing

A particular problem in high-level processing of biomedical images is inherently apparent: resulting from its convoluted nature, it is difficult to formulate medical a priori knowledge such that it can be integrated directly and easily into automatic algorithms of image processing. In the abstract, this is referred to as the signifies gap, which means the disparity between the cognitive interpretation of a diagnostic image by the physician (high level) and the simple structure of separate pixels, which is used in computer programs to represent an image (low level). In the medical domain, there are three main aspects hindering bridging this gap:

1. Heterogeneity of Images

Medical images display living tissue, organs, or body parts. Even if captured with the same modality and following a standardized accession protocol, shape, size, and internal structures of these objects may vary remarkably not only from patient to patient but also among different views of a patient and similar views of the same patients at different times. In other words, biological structures are subject to both inter- and intra-individual variant. Thus, universal formulation of a priori knowledge is impossible.

2. Unknown Delineation of Objects

Frequently, biological structures cannot be separated from the background because the diagnostically or therapeutically relevant object is represented by the entire image. Even if objects which are define as observed in biomedical images, their segmentation is problematic because the shape or borderline itself is represented fuzzily or only partly. Hence, medically related items often can be abstracted at most on the texture level.

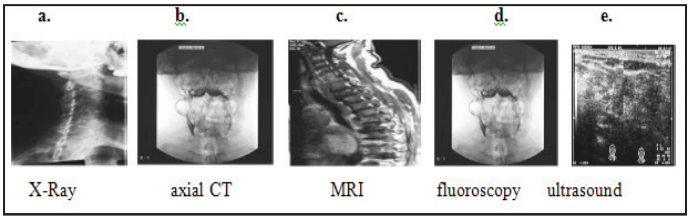
3. Robustness of Algorithms

In addition to these inherent properties of medical images, which makes complex their high-level processing, special requirements of reliability and robustness of medical procedures and, when they are applied daily, image processing algorithms are also demanded in the medical area. As a rule, reflex analysis of images in medicine should not provide wrong computation. That means that images, which cannot be processed correctly, must be positively classified as such, decline and withdrawn from further processing. Consequently, all images that have not been rejected

must be assess correctly. Furthermore, the number of rejected images is not allowed to become large, since most medical imaging procedures are harmful and cannot be repeated just because of image processing errors.

C. Medical Image Formation

Since the discovery of X-rays by Wilhelm Conrad Rontgen in 1895, medical images have become a major component of diagnostics, treatment planning and procedures, and follow-up studies.



Furthermore, medical images are used for education, documentation, and research describing morphology as well as physical and biological functions in 1D, 2D, 3D, and even 4D image data (e.g., cardiac MRI, where up to eight volumes are acquired during a single heart cycle). Today, a large variety of imaging modalities have been established, which are based on mediation, reflection or refraction of light, radiation, temperature, resonance, or spin.

D. Requirements in Bio Medical Imaging

- Calculation of area of the cells of a biomedical image.
- Changing thickness dynamic range of B/W images.
- Color correction in color images.
- Manufacture of 3-D images from 2-D images.
- Contour detection.
- Display of image line profile.
- Generation of negative images.
- Getting relief effect.
- Image enhancements.
- Interfacing Analog outputs of sensors such as microscopes, endoscopes, ultrasound etc., to digitizers and in turn to Digital Image Processing systems.
- Handle of colors within an image.
- Point to point measurements.
- Pseudo coloring.
- Registration of multiple images and mosaicing.
- Removal of artifacts from the image.
- Restoration of images.
- Smoothing of images.
- Zooming of images.

Image processing methods developed for image segmentation, computer assisted detection, to reduce noise and distortion, and to provide advanced visualization to enhance the abnormalities within images. As radiology has evolved from images recorded and viewed on film to being stored, retrieved, and manipulated electronically, radiologists have been confronted with challenges that have created new imperatives for imaging informatics.

Technical advances in CT and MRI are resulting in an explosion in the number of images acquired in each study, necessitating new informatics techniques to manage the growing numbers, size, and complexity of images generated by these and other modern imaging technologies The advent of digital images brought expectations of greater portability and accessibility as patients move within diverse health care systems, resulting in efforts to define protocols to enable institutions to share images.

The vast majority of these digital medical images are stored and manipulated as Digital Imaging and Communications in Medicine (DICOM) standard objects. DICOM contains a large amount of metadata about whom, how and when the images were acquired. It also specifies precisely how the information is stored in the image object and how pixels should be interpreted for display. In a DICOM series of images from one patient at a first point in time and a second . DICOM series of images from the same patient at a second time point. DICOM files can be exchanged between two entities that are capable of receiving image and patient data in DICOM format. Its data object consists of a number of ascribe, including items such as name, ID, etc., and also one special ascribe containing the image pixel data.

For many modalities, this corresponds to a single image. But note that the ascribe may contain multiple "frames", allowing storage of cine loops or other multi-frame data. It was developed to make medical images and associated data standardized for easier exchange. Besides that, DICOM defines network oriented services for transfer or printing of the images, media formats for data interchange, work-flow management, consistency and quality of presentation and requirements of conformance of devices and programs. Information Object Definitions (IODs) are introduced in the standard to define attributes that describe a certain characteristic of the image. IODs have a transparent meaning and their attributes precisely describe type of the object, data of the patient, performed methods or reports as well as the technical information about the medical imaging device used in the procedure. Technical information that contains the name of the imaging device maker, device serial number and other details about the device.

E. Challenges in Bio Medical Imaging

Biomedical imaging is vital to patient care and increasingly prevalent in the basic sciences. These images span the scale from microscopic and molecular to whole body anticipate, and encompasses many areas of clinical medicine, like radiology, pathology, dermatology, and ophthalmology. The rapidly growing image-related data in clinical records and research studies provides enormous opportunities for discovery and personalization of patient care. However, the number of images as well as imaging modalities is detonate, thwarting the ability of physicians and researchers to optimally use them for discovery and patient care. Imaging information is tackling these challenges through computational methods to provide insights into anatomic, functional, elemental and molecular aspects of disease. Biomedical imaging information offers the potential to diagnose disease, tailor optimum consideration, track disease response, and predict outcomes. Ultimately, biomedical imaging informatics will enable physicians to mine the rapidly expanding image databases in hospitals and research institutions to discover new treatments and to learn the optimum treatment for their patients.

1. Computational Challenges in Medical Imaging

Challenges such as geometrical registration of images of differing modality, for example "lining up " a CAT scan with an MRI image, are being undertaken with a powerful blend of applied **Mathematical and Computational Resources:** Computational requirements of biomedical computing ,namely The CPU,storage, software and connectivity requirements needed to digest, exploit and archive the images produced by the clinical and research biomedical imaging communities.

(i). Computational Challenges are:

- Inadequate CPU cycles
- Computer-assisted qualitative analysis
- Connectivity: Access to remote data
- Full quantitative analysis
- Fused/Merged Images
- Merged DB structures: Images+ parameters
- Query/display tools, access to distributed data
- Insufficient data storage
- Visualization: Meaningful and useful

The emergence of complexity in self-organizing biological systems poses exciting challenges to their quantitative description and prediction. The imaging and visualization of complex biomolecules, such as proteins, DNAs, RNAs, molecular motors and viruses, are crucial in understanding and conceptualization of biomolecular systems, which in turn can have significant impact in biomedicine, rational drug design, drug discovery and gene therapy.

On the other hand, biomedical imaging and visualization are indispensable tools for examining, revealing and diagnosing diseases, and for monitoring the effectiveness of medical treatments. Mathematics provides foundations for visualization and principles for the design of biomolecular/biomedical imaging modalities, such as single-molecule fluorophores, confocal imaging, X-ray crystallography and tomography, cry electron microscopy, and magnetic resonance force microscopy, Nuclear Magnetic Resonance (NMR), magnetic resonance imaging (MRI), ultrasonography, Positron Emission Tomography (PET), etc.

Currently, mean curvature flow, Wilmore flow, level set, discover Laplace-Beltrami operator and partial differential equation transform are commonly used mathematical techniques for biomolecular surface generations and visualization. Additionally, wavelets, frames, harmonic analysis and compressive sensing are popular tools for biomolecular visualization and image processing.

Moreover, topology, differential geometry, and geometric measure theory are powerful approaches for the multistate modeling of biomolecular structure, dynamics and transport. Finally, continual stable manifold, topological consistent, Euler characteristic, Frenetic frame and machine learning are vital to the dimensionality reduction of extremely massive biomolecular data. These ideas have been successfully shared with current investigations and discovery of molecular biosciences. Mathematical challenges include the well-posedness of mathematical models under physical and biological constraints, lack of maximum-minimum principle, numerical analysis of multiply coupled partial different equations, effectiveness of approximation theory and the modeling of complex biomolecular phenomena.

II. Literature Survey

Zhang, Guangcheng et al. (2004) [3] In this paper offers a singular approach for face reputation by boosting statistical nearby functions based totally classifiers. The face photo is scanned with a scalable sub-window from which the Local Binary Pattern (LBP) histograms [14] are obtained to describe the nearby capabilities of a face image. The multi-class trouble of face popularity is transformed into a two-magnificence one with the aid of classifying each two face pictures as intra-non-public or extra-non-public ones [9]. The Chi rectangular distance among corresponding Local Binary Pattern histograms of face photographs is used as discriminative characteristic for intra/more-private class. We use AdaBoost algorithm to research a similarity of each face photograph pairs. The proposed technique become tested on the FERET FA/FB photo sets and yielded an thrilling popularity charge of ninety seven.9%.

Ng, Tian-Tsong et al. (2004) [4] In this paper, image splicing is a easy method that vegetation and pastes areas from the equal or separate assets. It is a fundamental step used in digital photomontage, which refers to a paste-up produced by using sticking together photographs the usage of virtual equipment consisting of Photoshop. Examples of photomontages can be seen in numerous notorious news reporting instances involving using faked pictures. Searching for technical solutions for picture authentication, researchers have currently began improvement of new strategies aiming at blind passive detection of picture splicing. However, like maximum different studies communities handling statistics processing, they need an open facts set with various content and realistic splicing situations so that you can expedite the progresses and facilitate collaborative research. In this record, they describe with details a statistics set of 1845 photo blocks with a fixed length of 128 pixels x 128 pixels. The photograph blocks are extracted from photos in the CalPhotos series [CalPhotos'00], with a small number of additional pictures captured by virtual cameras. The data set consist of about the equal wide variety of actual and spliced image blocks, which might be similarly divided into exceptional subcategories (clean vs. Textured, arbitrary object boundary vs. Straight boundary).

Johnson, Micah K., et al. (2006) [5] In this paper, virtually all optical imaging structures introduce an expansion of aberrations into an photograph. Chromatic aberration, for example, consequences from the failure of an optical machine to flawlessly awareness mild of different wavelengths. Lateral chromatic aberration manifests itself, to a first-order approximation, as a variety/contraction of color channels with recognize to one another. When tampering with an photo, this aberration is regularly disturbed and fails to be steady across the picture. We describe a computational method for robotically estimating lateral chromatic aberration and show its efficacy in detecting digital tampering.

Sokolova, Marina et al. (2006) [6] In this paper, one of a kind evaluation measures examine unique characteristics of device getting to know algorithms. The empirical assessment of algorithms and classifiers is a matter of on-going debate amongst researchers. Most measures in use these days cognizance on a classifier's capability to perceive training efficiently. We observe other useful residences, along with failure avoidance or magnificence discrimination, and that they endorse measures to assess such homes. These measures – Youden's index, probability, Discriminant strength – are used in clinical diagnosis. We show that they're interrelated, and that they follow them to a case examine from the sphere of electronic negotiations. We also list other studying issues which might also benefit from the application of these measures.

Hsu, Yu-Feng et al. (2006) [7] In this paper, recent advances in pc generation have made virtual image tampering an increasing number of common. In this paper, they advocate an proper vs. Spliced photo type method using geometry invariants in a semi-automated way. For a given picture, they become aware of suspicious splicing regions, compute the geometry invariants from the pixels within every area, after which estimate the

Camera Response Characteristic (CRF) from those geometry invariants. The go-becoming errors are fed into a statistical classifier. Experiments show a completely promising accuracy, 87%, over a massive facts set of 363 herbal and spliced pix. To the fine of Their information, that is the primary paintings detecting photo splicing by way of verifying digital camera function consistency from a unmarried-channel photo

Shi, Yun Q., et al. (2007) [8] In this paper, photograph splicing detection is of essential importance in virtual forensics and consequently has attracted increasing attention recently. In this paper, they advocate a blind, passive, but powerful splicing detection method based totally on a herbal picture model. This natural photograph version consists of statistical capabilities extracted from the given check picture as well as 2-D arrays generated with the aid of making use of to the take a look at pics multi-size block discrete cosine remodel (MBDCT). The statistical functions include moments of function features of wavelet sub-bands and Markov transition probabilities of difference 2-D arrays. To evaluate the performance of Their proposed version, they similarly gift a concrete implementation of this model that has been designed for and implemented to the Columbia Image Splicing Detection Evaluation Dataset. Our experimental works have validated that this new splicing detection scheme outperforms the kingdom of the artwork by using a full-size margin whilst implemented to the above-noted dataset, indicating that the proposed method possesses promising functionality in splicing detection.

Zhang, Zhen et al. (2008) [9] In this paper, to enforce photo splicing detection a blind, passive and powerful splicing detection scheme became proposed in this paper. The model changed into primarily based on second functions extracted from the multi-size block discrete cosine rework (MBDCT) and a few picture fine metrics (IQMs) extracted from the given take a look at photograph, which might be sensitive to spliced image. This version can measure statistical differences between authentic photo and spliced image. Experimental consequences exhibit that this new splicing detection algorithm is effective and reliable; indicating that the proposed approach has a huge software prospect.

Dong, Jing et al. (2008) [10] In this paper, a simple but green technique for blind photo splicing detection is proposed. Image splicing is a commonplace and fundamental operation used for picture forgery. The detection of photograph splicing is a initial however desirable look at for image forensics. Passive detection methods of image splicing are usually seemed as sample popularity issues based totally on capabilities that are sensitive to splicing. In the proposed method, they analyze the discontinuity of photograph pixel correlation and coherency as a result of splicing in phrases of image run-period representation and sharp picture traits. The statistical functions extracted from photo run-period illustration and photograph part records are used for splicing detection. The help vector machine (SVM) is used because the classifier. Our experimental consequences show that the 2 proposed functions outperform current ones both in detection accuracy and computational complexity.

Farid, Hany et al. (2009) [11] In this paper, they are absolutely living in an age wherein they are uncovered to a super array of visible imagery. While they may have traditionally had self belief inside the integrity of this imagery, trendy digital era has began to erode this trust. From the tabloid magazines to the fashion enterprise and in mainstream media retailers, medical journals, political campaigns, courtrooms, and the image hoaxes that land in Their email in-bins, doctored images are performing with a growing frequency and sophistication. Over the beyond five years, the field of virtual forensics has emerged to help repair a few agree with to virtual photos. The author reviews the country of the art on this new and interesting field.

Mahdian, Babak, et al. (2010) [12] In this paper, verifying the integrity of virtual pix and detecting the lines of tampering without the usage of any protecting pre-extracted or pre-embedded statistics have grow to be an critical and hot research discipline. The reputation of this area and the fast increase in papers published during the last years have put widespread want on developing a whole bibliography addressing published papers in this area. In this paper, an extensive listing of blind strategies for detecting photo forgery is presented. By the word blind they talk to those strategies that use most effective the photograph function. An attempt has been made to make this paper whole by list most of the existing references and by presenting a detailed category group.

Chih-wei Hsu et al. (2010) [13] In this paper, the guide vector machine (SVM) is a popular category approach. However, novices who are not acquainted with SVM regularly get unsatisfactory results given that they pass over some smooth however tremendous steps. In this guide, they advocate a easy procedure which generally offers reasonable effects

Wang, Wei et al. (2010) [14] In this paper, they suggest a passive photo tampering detection method primarily based on modeling side records. We model the threshold image of image chroma element as a finite-country Markov chain and extract low dimensional feature vector from its stationary distribution for tampering detection. The guide vector machine (SVM) is utilized as classifier to evaluate the effectiveness of the proposed algorithm. The experimental effects in a large scale of evaluation database illustrates that Their proposed method is promising.

Zhao, Xudong et al. (2010) [15] In this paper, detecting splicing strains within the tampering colour area is often a tough work. However, it's miles discovered that photo splicing that is hard to be detected in one shade area is probably tons less difficult to be detected in some other one. In this paper, an green method for passive color photograph splicing detection is proposed. Chroma spaces are delivered in Their work in comparison with generally used RGB and luminance spaces. Their gray level run-length run-quantity (RLRN) vectors with one of a kind instructions extracted from de-correlated chroma channels are hired as distinguishing features for photograph splicing detection. Support vector device (SVM) is used as a classifier to illustrate the performance of the proposed feature extraction approach. Experimental outcomes have proven that that RLRN functions extracted from chroma channels provide a whole lot higher performance than that extracted from R, G, B and luminance channels.

Shivakumar, B. L., et al. (2010) [16] In this paper, as one of the most a success packages of picture analysis and information, virtual picture forgery detection has currently acquired good sized attention, specially for the duration of the past few years. At least two trend account for this: the primary accepting digital photo as official report has turn out to be a not unusual practice, and the

second the provision of low fee era wherein the photo could be without problems manipulated. Even even though there are many structures to stumble on the virtual image forgery, their success is restrained by the conditions imposed by means of many programs. For example, detecting duplicated area that have been rotated in specific angles remains largely unsolved problem. In an try and help those efforts, this paper surveys the recent development in the discipline of Copy-Move virtual image forgery detection.

Huang, Di, et al. (2011) [17] In this paper, local binary pattern (LBP) is a nonparametric descriptor, which effectively summarizes the neighborhood structures of pictures. In recent years, it has aroused increasing hobby in many areas of photo processing and pc vision and has shown its effectiveness in a number of programs, mainly for facial image evaluation, consisting of tasks as various as face detection, face recognition, facial features evaluation, and demographic category. This paper presents a complete survey of LBP method, inclusive of several extra recent variations. As a regular application of the LBP technique, LBP-based totally facial photo evaluation is appreciably reviewed, at the same time as its successful extensions, which address various obligations of facial photo analysis, are also highlighted.

Hussain, Muhammad et al. (2011) [18] In this paper, aid vector machines outperform other classification methods for breast most cancers detection. However the performance of SVM is substantially tormented by the selection of a kernel function among different factors. This article affords a comparative take a look at of different kernel features for breast most cancers detection. The recognition is on category the usage of SVM with specific kernel capabilities. The comparison with neural community based approach the use of MLP is likewise given. Furthermore, they examine the affect of choosing function subsets earlier than making use of type with one-of-a-kind kernels. For functions subset choice they used genetic algorithm. The evaluation is based on five X 2 go validation.

Muhammad, Ghulam et al. (2012) [19] In this paper, a blind copy pass photo forgery detection approach using un decimated dyadic wavelet rework (DyWT) is proposed. DyWT is shift invariant and consequently more suitable than discrete wavelet transform (DWT) for statistics analysis. First, the input photo is decomposed into approximation (LL1) and element (HH1) sub bands. Then the LL1 and HH1 sub bands are divided into overlapping blocks and the similarity between blocks is calculated. The key idea is that the similarity between the copied and moved blocks from the LL1 sub band should be high, while that from the HH1 sub band ought to be low because of noise inconsistency inside the moved block. Therefore, pairs of blocks are taken care of based on high similarity the use of the LL1 sub band and high dissimilarity using the HH1 sub band. Using thresholding, matched pairs are obtained from the taken care of list as copied and moved blocks. Experimental consequences display the effectiveness of the proposed method over aggressive techniques the usage of DWT and the LL1 or HH1 subbands only.

Zhang, Yujin, et al. (2012) [20] In this paper, the wide use of powerful picture processing software has made it clean to tamper images for malicious functions. Image splicing, which has constituted a risk to integrity and authenticity of images, is a very common and simple trick in image tampering. Therefore, image splicing detection is of super significance in digital forensics. In this bankruptcy, an effective framework for revealing photo splicing forgery is proposed. The nearby binary sample (LBP) operator is used to model value components of two-D arrays received by way of applying multi-size block discrete cosine remodel (MBDCT) to the take a look at pix, all of packing containers of histograms computed from LBP codes are served as discriminative capabilities for image splicing detection. To keep away from the excessive computational complexity and feasible overfitting for help vector gadget (SVM) classifier, primary aspect evaluation (PCA) is applied to lessen the dimensionality of the proposed capabilities. Our test effects display the performance of the proposed technique over the Columbia picture splicing detection evaluation dataset.

He, Zhongwei et al. (2012) [21] In this paper, photograph splicing could be very common and essential in picture tampering. To get better human being's consider in digital pix, the detection of photo splicing is in top notch need. In this paper, a Markov primarily based method is proposed to locate this particular artifact. Firstly, the unique Markov features generated from the transition probability matrices in DCT domain by using Shi et al. Is elevated to capture now not simplest the intra-block but additionally the inter-block correlation among block DCT coefficients. Then, greater features are built in DWT domain to symbolize the 3 varieties of dependency among wavelet coefficients across positions, scales and orientations. After that, function choice approach SVM-RFE is used to satisfy the mission of feature discount, making the computational value extra achievable. Finally, assist vector system (SVM) is exploited to categories the genuine and spliced pics the use of the final dimensionality-reduced feature vector. The test results show that the proposed approach can outperform some cutting-edge strategies.

Alahmadi, Amani A., et al. (2013) [22] In this paper, the authenticity of a virtual picture suffers from intense threats due to the upward thrust of powerful digital picture enhancing tools that without difficulty regulate the image contents with out leaving any seen strains of such adjustments. In this paper, a singular passive splicing photograph forgery detection scheme primarily based on Local Binary Pattern (LBP) and Discrete Cosine Transform (DCT) is proposed. First, the chrominance thing of the enter picture is split into overlapping blocks. Then, for every block, LBP is calculated and transformed into frequency domain the usage of 2D DCT. Finally, fashionable deviations are calculated of respective frequency coefficients of all blocks and they may be used as features. For class, a help vector system (SVM) is used. Experimental results on benchmark splicing photograph forgery databases show that the detection accuracy of the proposed technique is as much as 97%, which is the pleasant accuracy to date.

III. Future Scope and Conclusion

This paper proposed an efficient quantization based multiple watermarking techniques in wavelet domain considering medical watermarks in the form of text. The suggested method used wavelet based watermarking where the encoded text watermarks were embedded into the NROI part of the DWT cover gray image. The BER performance of the developed scheme was tested for different attacks. The robustness of the three different text watermarks is enhanced by using BCH and Turbo error correcting codes. Out of the two ECCs, it was found that the Turbo code showed the better performance in terms of BER. In recent years,

Turbo Codes are the one of the best error correction codes that has been rapidly adopted for application in various commercial transmissions systems. Researcher has been concluded that the performance of the turbo code is better than BCH and Hamming code. In this research, the gray scale images have been considered for the experimental purpose. However, the embedding capacity of color image is better than gray image. The robustness and imperceptibility performance of the watermarking method will greatly depends on the choice of color space and selection of embedding color channel. The Quantization Index Modulation (QIM), directional wavelet transforms and neural networks are also a future consideration for integration with the proposed framework to make it more resilience against attacks and improve the performance of the work.

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