International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 03 | Mar-2018 www.irjet.net p-ISSN: 2395-0072

FORENSIC DETECTION OF INVERSE TONE MAPPING IN HDR IMAGES

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Abstract - *High dynamic range (HDR) imaging is attracting an increasing deal of attention in the multimedia community, yet its forensic problems have been little studied so far. This paper proposes an HDR image forensic method, which aims at differentiating HDR images created from multiple low dynamic range (LDR) images from those created from a single LDR image by inverse tone mapping. For each kind of HDR image, a Gaussian mixture model is learned. Thereafter, an HDR image forensic feature is constructed based on calculating the Fisher scores. With comparison to a steganalytic feature and a texture/facial analysis feature, experimental results demonstrate the efficiency of the proposed method in HDR image forensic classification on whole images as well as small blocks, for three inverse tone mapping methods.*

Key Words: **Digital image forensics, high dynamic range imaging, inverse tone mapping, Gaussian mixture model, Fisher scores**.

1. INTRODUCTION:

Image forensics is a well recognized research field in multimedia security, for achieving image authentication in a blind and passive manner. Image forensic methods designed with the conventional, 8-bit low dynamic range (LDR) image representation. High dynamic range (HDR) image formats is capability to reproduce a much wider gamut of luminance and contrast than traditional imaging techniques.
Very limited work has been done to identify and solve potential forensic problems associated to HDR, e.g., to differentiate LDR images from tone-mapped HDR images.to create HDR images is to fuse several LDR images capturing the same scene with different exposure times.

In imaging science, image processing is processing of images using mathematical operations by using any form of signal processing for which the input is an image, a series of images or a video, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics. In digital imaging, a pixel, pel, dots, or picture element is a physical point in a raster image, or the smallest addressable element in an all points addressable display device; so, it is the smallest controllable element of a picture represented on the screen.

1.1 IMAGE FORENSICS

The digital information revolution and issues concerned with multimedia security have also generated several approaches to digital forensics and tampering detection. We focus on blind methods, as they are regarded as a new direction and in contrast to active methods, they work in absence of any protecting techniques and without using any prior information about the image. To detect the traces of tampering, blind methods use the image function and the fact that forgeries can bring into the image specific detectable changes (e.g., statistical changes).

1.2 FORENSIC DETECTION:

The manipulation of images through forgery influences the perception an observer has of the depicted scene, potentially resulting in ill consequences if created with malicious intentions. This poses a need to verify the authenticity of images originating from unknown sources in absence of any prior digital watermarking or authentication technique. This research explores the ability to detect image forgeries created using multiple image sources and specialized methods tailored to the popular JPEG image format. Four methods are presented for detection of image tampering based on fundamental image attributes common to any forgery. These include discrepancies in lighting levels, brightness levels, underlying edge inconsistencies, and anomalies in JPEG compression blocks.

1.3 INVERSE TONE MAPPING:

Most existing image content has low dynamic range (LDR), which necessitates effective methods to display such legacy content on high dynamic range (HDR) devices. Reverse tone mapping operators (rTMOs) aim to take LDR content as input and adjust the contrast intelligently to yield output that recreates the HDR experience. In this paper we show that current RTMO approaches fall short when the input image is not exposed properly.

2. HDR IMAGE:

High-dynamic-range imaging (HDRI) is a high dynamic range (HDR) technique used in imaging and photography to reproduce a greater dynamic range of luminosity than is possible with standard digital imaging or photographic techniques. The aim is to present a similar range of luminance to that experienced through the human visual system.

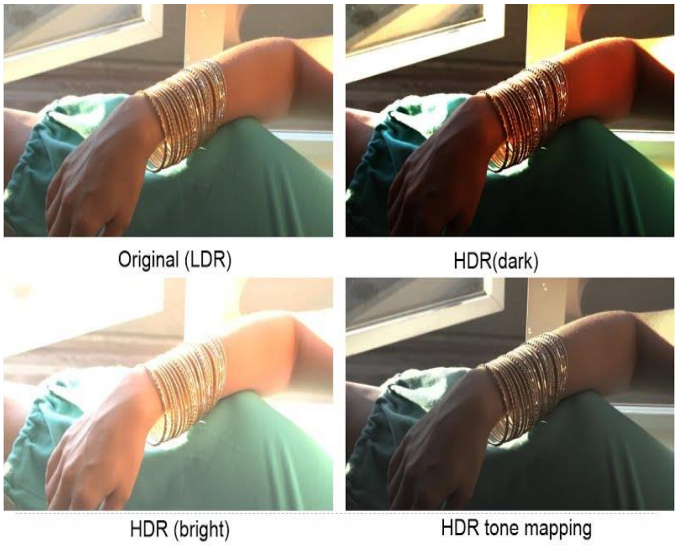


Fig - 1: Comparison between LDR and HDR

HDR images can represent a greater range of luminance levels than can be achieved using more 'traditional' methods, such as many real-world scenes containing very bright, direct sunlight to extreme shade, or very faint nebulae. This is often achieved by capturing and then combining several different, narrower range, exposures of the same subject matter. Non-HDR cameras take photographs with a limited exposure range, referred to as LDR, resulting in the loss of detail in highlights or shadows.

3. SYSTEM ARHITECTURE:

The concept of optical flow was introduced by the American psychologist James J. Gibson in the 1940s to describe the visual stimulus provided to animals moving through the world. Gibson stressed the importance of optic flow for affordance perception, the ability to discern possibilities for action within the environment. Followers of Gibson and his ecological approach to psychology have further demonstrated the role of the optical flow stimulus for the perception of movement by the observer in the world; perception of the shape, distance and movement of objects in the world; and the control of locomotion.

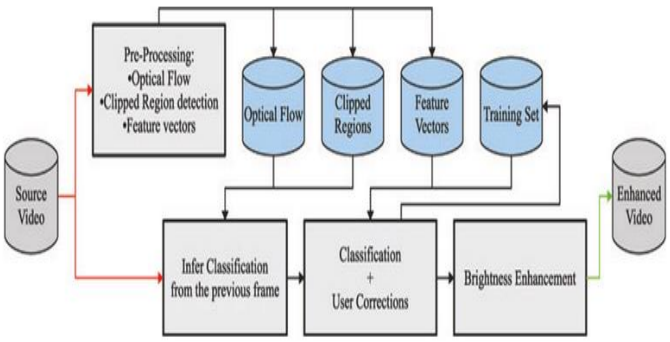


Fig - 2: System architecture of source LDR to enhanced HDR.

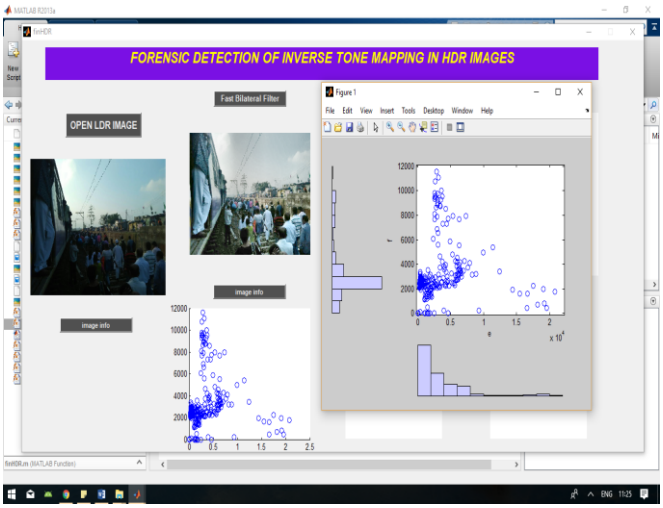
Preprocessing of an image is a common name for operations with images at the lowest level of abstraction -- both input and output are intensity images. The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhances some image features important for further processing.

4. METHODOLOGY:

Primarily the three methods that have been used to filter and enhance the parameters of the LDR image to convert it into HDR images are as follows-

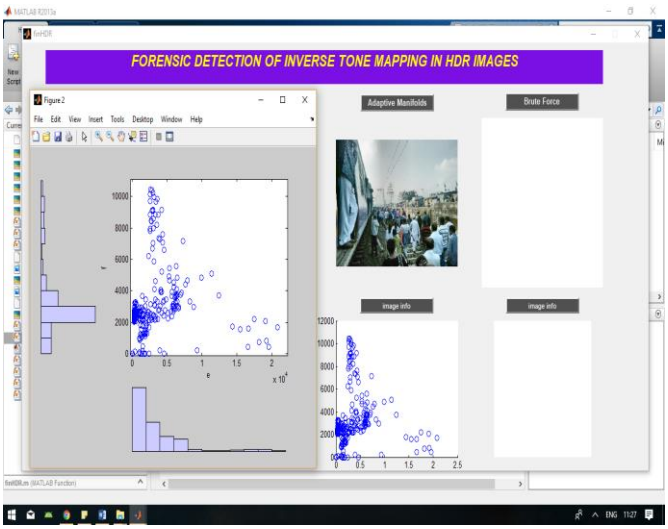
4.1. FAST BILATERAL FILTER:

A bilateral filter is a non-linear, edge-preserving, and noise-reducing smoothing filter for images. It replaces the intensity of each pixel with a weighted average of intensity values from nearby pixels. This weight can be based on a Gaussian distribution. Crucially, the weights depend not only on Euclidean distance of pixels, but also on the radiometric differences (e.g., range differences, such as color intensity, depth distance, etc.).



4.2. ADAPTIVE MANIFOLD FILTER:

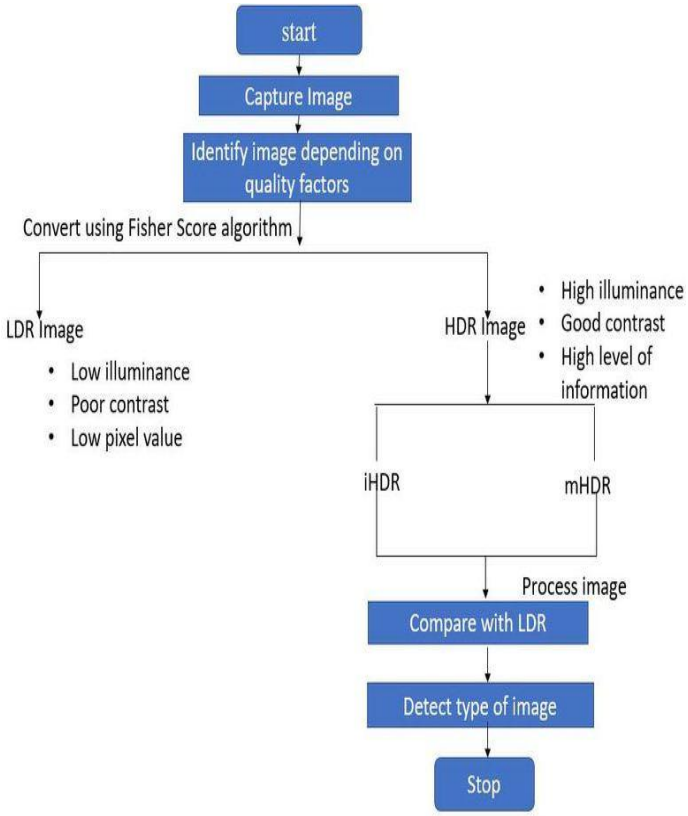
An adaptive filter is a system with a linear filter that has a transfer function controlled by variable parameters and a means to adjust those parameters according to an optimization algorithm. Because of the complexity of the optimization algorithms, almost all adaptive filters are digital filters. Adaptive filters are required for some applications because some parameters of the desired processing operation (for instance, the locations of reflective surfaces in a reverberant space) are not known in advance or are changing. The closed loop adaptive filter uses feedback in the form of an error signal to refine its transfer function.



4.3. BRUTE FORCE FILTER:

In cryptography, a brute-force attack consists of an attacker trying many passwords or passphrases with the hope of eventually guessing correctly. The attacker systematically checks all possible passwords and passphrases until the correct one is found. Alternatively, the attacker can attempt to guess the key which is typically created from the password using a key derivation function. This is known as an exhaustive key search.

5. FLOW DIAGRAM:



5. CONCLUSION:

Image processing is processing of image using mathematical operations by using any form of signal processing which depend on dynamic quality factors such as intensity i.e. illuminance and contrast. These dynamic range expansion techniques are generally called ITM. LDR image (Low Dynamic Range image) is an image which has low illuminance, poor contrast and low pixel value but it is still widely used because of its less memory requirements. HDR image (High Dynamic Range image) is a good quality image such as good illuminance contrast and pixel value it is widely used in forensic analysis because it contains high level of information. Various algorithm are available for conversion of LDR image to HDR image one of them is Fisher Scores algorithm. After conversion we can also compare LDR and HDR image and even detect the type of HDR image i.e. iHDR or mHDR.

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