PROGRESSIVE QUALITY DEGRADATION IN JPEG COMPRESSED IMAGE USING DC BLOCK ORIENTATION WITH REWRITABLE DATA EMBEDDING FUNCTIONALITY

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ABSTRACT
This paper proposes a novel block rotational method to degrade quality and embed external data in JPEG compressed image. The orientation of each non-overlapping DC coefficients block is exploited to embed information while introducing distortion. To achieve progressive quality degradation, size of DC coefficients block is manipulated and the proposed embedding process is applied recursively by shrinking block size in each iteration. Markers are added into the blocks as pre-processing steps to ensure that the original orientation always yields the smallest difference. A post-processing is also proposed to erase the marker introduced for recovering image at higher quality, making the proposed method a rewritable method but not complete reversible. Experiments are conducted to verify the basic performance of the proposed method and comparisons with the conventional methods are also carried out.

Index Terms— Block orientation, progressive quality degradation, rewritable data embedding, JPEG

1. INTRODUCTION
With the ever improving capabilities of affordable smart devices and ubiquitous network environment, image can be easily captured, edited, and broadcasted through social networking site or stored remotely in cloud. JPEG is arguably the most famous image compression standard due to its relatively simple architecture and good trade off between bitrate (i.e., size) and quality [1]. For that, various researches are carried out to manage, protect, or enhance JPEG compressed image (hereinafter referred to as image). In particular, quality degradation techniques were proposed by manipulating the underlying coding structure of JPEG bitstream to protect the image from unauthorized viewing. Data embedding techniques are proposed to encode information, including hyperlink to related contents, hash / check-sum value for integrity checking, watermark for claiming ownership, etc.

For quality degradation, most of the techniques rely on the manipulation of DC and AC coefficients stored in the JPEG bitstream [2, 3]. Some researchers focus on randomizing the sign of transformed coefficients [4, 5] while Niu et al. propose to replace the original DC coefficient by another error belonging to the same category [8]. Minemura et al. partition a JPEG image into regions based on the information obtained from AC coefficients and DC coefficients are handled independently on regional basis [2].

Recently, data embedding and quality degradation are combined for content management purposes [7, 9, 10]. For example, in the cloud storage environment, image can be severely distorted to protect privacy of the owner and metadata describing the image can be embedded. The administrator can extract the embedded metadata to further process the image (e.g., move, copy, delete, etc.) without the need to know the actual visual appearance of the image.

In this work, a progressive quality degradation method equipped with rewritable data embedding capability is proposed. Both quality degradation and data embedding are achieved by exploiting the orientation of DC coefficients grouped in blocks of pre-defined sizes. The level of distortion and embedding capacity are controlled by the block size and the number of times the proposed method is applied recursively. Basic performance of the proposed method are verified through experiments using standard text images.

2. DC BLOCK ROTATIONAL METHOD
The array of DC coefficients $D$ is first constructed by collecting the DC component from each $8 \times 8$ block. $D$ is then divided into non-overlapping blocks $B(i, j)$ each of size $b \times b$ coefficients for $1 \leq i \leq [M/b]$ and $1 \leq j \leq [N/b]$ where $8M \times 8N$ is the dimension of the input image. Each block is rotated to host external data by exploiting the relative orien-