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INTER-BLOCK DIRECT-SEQUENCE AND FREQUENCY-HOP SPREAD SPECTRUM IMAGE WATERMARKS

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Abstract. *One of the most popular image watermark embedding methods is the spread spectrum (SS) technique. The original SS technique proposed by Cox et al. divides the image into N×N blocks and the pseudo-noise (PN) sequence generated from each watermark bit is embedded in one of the blocks. Since there is only one watermark bit embedded in each block, we call this method "intra-block" method. In this paper, we proposed a new approach called "inter-block" method. In our method, we embedded the PN sequence from one watermark bit into several different blocks as opposed to just one block. In other words, we comprehensively studied the effects of different embedding locations in this paper and to the best of our knowledge, whereas this study has not been done before. To thoroughly study the differences between the new "inter-block" method and the old "intra-block" method, we subjected both methods to various watermark attacks and compared their performances. From the experiments, we found that "inter-block" techniques perform better against all attacks.*

Keywords: Image watermark, Direct sequence spread spectrum, Frequency hop spread spectrum

1. **Introduction.** One of the most popular image watermark embedding methods is the block-based spread spectrum (SS) method [1-15]. The reason that SS techniques are well suited for watermarking is that they perform well under fading such as frequency-selective or multipath interferences. Therefore, SS watermarks perform well when the watermark attacks have characteristics similar to fading. The original DSSS technique [1] divides the image into N×N blocks. These blocks are transformed by discrete cosine transform (DCT). Then, the pseudo-noise (PN) sequence from each watermark bit is embedded in one of the blocks. Since there is only one watermark bit embedded in each block, we call this method "intra-block" method.

In this paper, we proposed a new block-based SS approach called "inter-block" method. In our new method, we embed the PN sequence from one watermark bit into several different DCT blocks. The rationale for this "inter-block" approach is that it spreads the same bit into a wider region in the image. The research in digital communication [16] has revealed that a wider spreading in time is beneficial in frequency-selective fading channel. Therefore, wider spreading in space should be beneficial in watermark counter-attack. From another perspective, our "inter-block" method adds another layer of randomization into the watermark, i.e., the randomization of the embedding locations. This additional