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Mathematical Transform Based Set Partition Hyperspectral Image Compression Algorithms : A Comparative Review

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***Abstract*— Hyperspectral imaging has been extensively investigated as an emerging, promising technique for multiple domains. Originally derived from remote sensing, this technology now incorporates both machine vision and point spectroscopy within its scope of use. The end result is the transfer of hyperspectral images in large quantities from sensors to analysis centers and then, finally, to data centers using this method. Compression algorithms are used to ensure that these large-sized hyperspectral images are stored in a manner that is both efficient and secure. Compression algorithms using mathematical transforms works for lossy and lossless environment, which make it proper choice for the image sensors. Set partitioned based compression algorithms is a sub category of mathematical transform based algorithms which utilized the property of wavelet transform set structure to achieve the compression of image.. This survey focuses on different hyperspectral image compression algorithms which utilized mathematical transform to achieve the compression. Additionally, we evaluate the most effective algorithms in terms of their coding efficiency and provide a detailed analysis of the primary factors that influence compression performance. Also, coding memory and embeddedness is also covered in the comparative analysis.**

Keywords—Compression Methods , Set Partition Hyperspectral Image Compression Algorithm , Mathematical Transform, Energy , Spectral Reconstruction

I. INTRODUCTION

The previous few decades, there are multiple significant changes in the remote sensing technologies in which hyperspectral (HS) image technologies plays a significant role [1]. Researchers have shown a significant amount of interest in this subject over the past few years due to the fact that it has applications in the areas of target detection, classification, anomaly detection, denoising, and spectrum unmixing applications [2]. The hyperspectral image sensors are able to gather data (hyper cube) in continuous frequency frames of wavelengths spanning from 400 nm to 2500 nm, which is outwith the range of human eyesight [3]. Each frequency frame makes use of the same number of pixels and maintains constant spectral resolution, which is determined by the capabilities of the HS image sensors [4]. The enormous size of hyperspectral images, which are compiled from hundreds of consecutive spectral bands, is a significant issue. Size of any HS image can easily exceed hundreds of megabytes [5]. Because of this, there may be difficulties in terms of sensor depository, data transmission process, and data processing time (complexity)[6]. As a consequence of this, it is imperative that effective compression algorithms be utilised in order to reduce size of these HS images without sacrificing the information that they contain that represents their value [7]. One of the most important factors that will allow for the full potential of this strong technology to be realised is the availability of compression algorithms for hyperspectral images on the domain [8]. It would pave the way for the full use of its capabilities and the substantial enhancement of our understanding of the world that surrounds us [9].

HS image compression algorithms (HSICAs) are divided into eight varieties on the basis of the encoding process of the compression of HS image named as predictive coding (PC) [10], transform coding (TC) [11], vector quantization (VQ) [12], compressive sensing [13], tensor decomposition (TD) [14], sparse representation (SR) [15], machine learning (ML) based HSICA [16] and hybrid HSICA [17]. Among the above-mentioned type of HSICAs, transform coding and few hybrid (having transform coding as a part in compression process) works for lossy and lossless compression while other type of HSICA works only for lossless compression [18].

II. PERFORMANCE METRICS

The key performance indicators for any compression algorithm includes its coding efficiency (coding gain), the complexity of the coding process (encoding & decoding), and the associated memory requirements [19]. Coding efficiency is generally measured in terms of the average number of bits per pixel per frequency frame in the coded bit-stream to achieve a minimum desired quality of the reconstructed HS image. The Peak Signal-to-Noise Ratio (PSNR) is the major performance metric that is utilized to assess objective quality of HS image that has been reconstructed after the compression process [20]. Compression Ratio (CR) Structural Similarity

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