

## Modified Dictionary Based Coding Technique for Video Compression

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**Abstract:** Video is the key element for the growing trends in the mobile industry. Reducing the amount of video data that can be transmitted over a connection is strongly recommended to meet out the bandwidth requirements. Video compression is a coding technique which reduces the actual number of bits than the original data and hence the bandwidth is increased. In this work, a detailed study is done on video compression and proposed a new technique, Modified Dictionary Based Coding (MDBC) for video compression. The MDBC module is coded in Verilog, simulated in Modelsim 10.2c and synthesized in Xilinx ISE compiler. Field Programmable Gate Arrays are reconfigurable hardware devices which are cost effective, the proposed algorithm for video compression is implemented in FPGA.

**Key words:** Modified Dictionary Based Coding (MDBC) • Video Home System (VHS) • Audio Video Interleave (AVI) • Video Compression • Decompressor

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### INTRODUCTION

Video plays a key role in most of the applications like video telephony, video conferencing, video on demand and Internet Television. Consumer products like mobile phone uses standard video coding standards like MPEG-1, MPEG-2, MPEG-4, H.264/AVC to support high video quality and high bandwidth. These video codecs have to process large amount of data within a bounded time for HD video applications. These data are usually stored in an external DRAM. Accessing the video data from an external DRAM results in huge memory traffic, hence consumes high power and degrades the system performance. Numerous video compression algorithms are proposed to reduce the memory traffic. The main concept of the compression algorithms is to compress the video frames before being stored into memory and transmitted [1]. With the increase in demand for high quality video, standardization of compression techniques is still under research since it plays a major role in the modern world of electronics and communication industry where bandwidth is a major constraint.

**Litreature Review:** This section presents the details of well-known compression algorithms that are commonly used in the literature. Compression algorithms are used jointly with encryption algorithms or they are used independently.

**Joint Video Compression and Encryption Algorithms:** In joint compression and encryption algorithms, encryption and compression is done as a single process [2]. Encryption takes less time when performed after compression [3]. Combining compression and encryption provides highly secured and time efficient encryption algorithms.

**SECMPEG Algorithm:** The joint compression and encryption algorithm proposed in SECMPEG, [4], performs selective encryption using conventional encryption algorithms. This has been designed to provide security for high volume video signals such as, ISO standard 11172 or MPEG-1. Before decoding, the video is segmented and converted into block of streams which is represented using four layers and five confidentiality levels (C-levels). Then, Huffman coding is used for

compression and DES is used for encryption. In level 0, encryption is not performed. Level 1 and level 2 consist of details about layers 1 to 4. The level 3 contains all I-frames which are intra-coded macro-black blocks. Encryption takes place in level 4.

**Video Encryption Algorithm (VEA):** The Video Encryption Algorithm (VEA) is introduced by Changgui Shi and Bharat Bhargava for joint compression and encryption of video data [5]. This is an efficient video encryption algorithm which has less computational complexity. Only a streamed video can be encrypted using VEA technique. Before encryption, size of the video data should be reduced using any standard compression method. MPEG-2 or MPEG-4 is used for compression, because VEA and MPEG are mutually dependent on their statistical properties [5].

**MPEG Video Encryption Algorithm (MVEA):** A MPEG Video Encryption Algorithm (MVEA) is proposed in [6] for joint video compression and encryption of video applications. This is an improved version of Video Encryption Algorithm (VEA) [5] where the XOR operation is used with a secret key whereas in VEA, XOR operation is used without passing any secret key [5]. Sign bit of discrete cosine coefficient in I-frame block is also encrypted. In MVEA, the differential sign value of DC coefficient and motion vectors in P-frames and B-frames are XOR-ed with a secret key. This method is used in secure video-on-demand, video conferencing and video email applications. The main disadvantage of MVEA is, the huge size of secret key used in encryption.

**MHT Scheme:** In [7], Multiple Huffman Table (MHT) converts entropy coders into encryption ciphers. In this scheme, a Huffman table is used and the ordering is kept as a secret using a key. The pre-stored multiple Huffman tables are used to quantize the DCT coefficient. Therefore, it is impossible to decode the bit stream without knowing tables and the key. The computational overhead of MHT is less. It is vulnerable to chosen-plaintext attack and random bit attack.

**DCT Based Bitwise XOR Encryption:** An algorithm for the practical lossless compression and encryption of gray scale video has been proposed in [8]. This is based on temporal correlations in the video. It uses distributed source-coding technique for compressing the encrypted video data. The video has been encrypted by applying bitwise exclusive-OR (XOR) between key bits and the

source. Then DCT and localized predictors are used on the encrypted bit frames.

**Video Compression Standards:** Several techniques are proposed for video compression. Some of the video compression techniques used for text and image compression show better performance when compared to compressed video data. This is due to large sizes of video files. The compressed video data should maintain its resolution and quality [9]. Well known compression techniques are accepted by International Telecommunication Union (ITU) and International Standard Organization (ISO). Subsequent section discusses some of the popularly used video compression techniques.

**H.264:** H.264 was introduced in 2002 to mitigate disadvantages of MPEG and to improve the compression performance in broadcasting. The H.264 standard is widely used in satellite and cable TV since it is more convenient than other compression standards [10]. It is currently used for video recording, video telephony, video streaming and HDTV streaming over the Internet. When compared to MPEG-2, it provides better video quality with half data rate which is more useful for real-time video data transfer with high speed during video conferencing.

**MPEG-1:** The Motion Pictures Expert Group-1 (MPEG-1) compression standard is designed for compressing low quality video, such as Video Home System (VHS). This can be used for making CDs, in cable TV and digital audio broadcasting [4]. MPEG-1 is a lossy compression standard. Many products and technologies are introduced based on MPEG-1.

**MPEG-2:** The MPEG-2 standard comes in three main parts, such as systems, video and audio. MPEG-2 extends functions provided by MPEG-1 to enable efficient encoding of video and associated audio at a wide range of resolutions and bit rates. Part-1 of MPEG-2 standard specifies two types of multiplexed bitstreams. They are program stream and transport stream. The program stream is analogous to systems part in MPEG-1. It is designed for flexible processing of multiplexed stream and for environments with low error probabilities. The transport stream is constructed in a different way and includes a number of features that are designed to support video communications or storage in environments with significantly higher error probabilities [11].

Table 1: Dictionary Based Compression Algorithm

Input		Output	
Pixel Data	Pixel Dictionary	Codeword	Prediction-failed Pixel
8'h51	{8'hff,8'h00,8'h01}	2'b11	8'h51
8'h52	{8'h50,8'h51,8'h52}	2'b10	-
8'h52	{8'h51,8'h52,8'h53}	2'b01	-
8'h53	{8'h51,8'h52,8'h53}	2'b10	-
8'h54	{8'h52,8'h53,8'h54}	2'b10	-
8'h54	{8'h53,8'h54,8'h55}	2'b01	-
8'h54	{8'h53,8'h54,8'h55}	2'b01	-
8'h52	{8'h53,8'h54,8'h55}	2'b11	8'h52
8'h51	{8'h51,8'h52,8'h53}	2'b00	-

**Audio Video Inter Leave:** Audio Video Interleave (AVI) format is introduced as a built-in feature of the Windows Operating System in 1992. Digital file format is used to store the audio and video data. AVI is derived from Resource Interchange File Format (RIFF), which divides a file's data into several blocks [12].

**Modified Dictionary Based Coding:** This algorithm is used to perform lossless video compression. Pixels that can be encoded using dictionary coding are known as dictionary-predict pixels otherwise it is called as dictionary miss pixels [13]. The incoming pixels are classified whether it can be encoded using dictionary coding or not. The dictionary coding scheme used in this algorithm is based on the previous studies that the differences between every pair of horizontally adjacent pixels can be modeled using two sided geometric distributions centered at zero. If the pixel data is in the dictionary, then the corresponding code word is transmitted. The encoding for dictionary-predict pixels are done as explained in Table 1. The pixel dictionary contains three pixels. First, the pixel dictionary is initialized with the values {8'hff, 8'h00, 8'h01}. Let us consider the current pixel as "Pix" and the first display frame pixel is 8'h51. Without any reference pixels in the dictionary that are equal to 8'h51, the outputs are 2'b11 and 8'h51 for code word and prediction-failed pixel, respectively. Then, the pixel dictionary is updated to 8'h50, 8'h51 and 8'h52 that is {pix-1, pix, pix + 1} before encoding the second pixel. Since the third reference pixel, 8'h52, is identical to the second input pixel, only the code word is encoded as 2'b10. After that, the pixel dictionary is updated to 8'h51, 8'h52 and 8'h53 (52-1, 52 and 52+1). Adapting this compression algorithm, the nine original pixels (totally 72 bits) are compressed to nine code words (totally 18 bits) and two prediction-failed pixels (totally 16 bits).

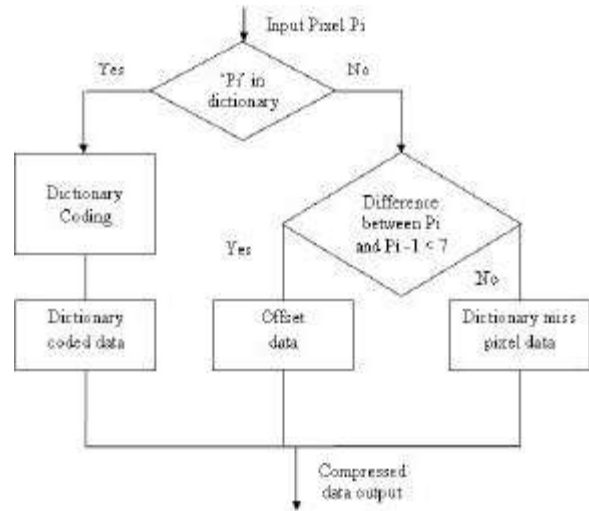


Fig. 1: Flow Diagram of Modified Dictionary Based Coding (MDBC)

This example achieves 53% reduction of display frame data[13].

If the current pixel data is not in the dictionary, then the difference between the previous pixel and the current pixel is calculated. If the difference between the two adjacent pixels falls within a threshold value then the offset value between the current pixel and the previous pixel is transmitted. In this project the threshold value is selected as 7. The flow diagram for the MDBC is shown in Figure 1.

**Decompression Process:** Steps employed in the compression process are applied in the reverse order to decompress the video data. Since the compression process used in this system is lossless, the decompressed data will not have any degradation in its quality when compared with the original video data.

## RESULTS AND DISCUSSION

The dictionary based coding scheme with adaptive difference of adjacent pixel module is simulated in Modelsim PE 10.2c. Figure 2 shows the setup of the test environment for testing the dictionary based coder block. The video pattern generator generates the video pixel data which is driven to the Modified dictionary based coder. The compressed data which is the output of the enhanced dictionary based coder is decompressed and checked for correctness by the decompressor and the data checker.

**RTL Schematic:** The RTL Schematic of the enhanced dictionary based coder is shown in Figure 3.

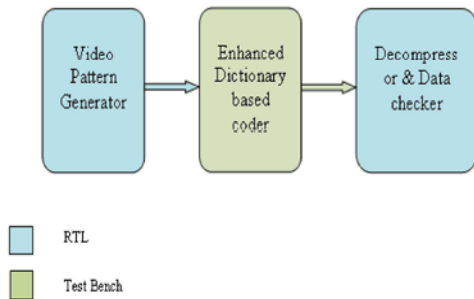


Fig. 2: Test Environment for Simulation

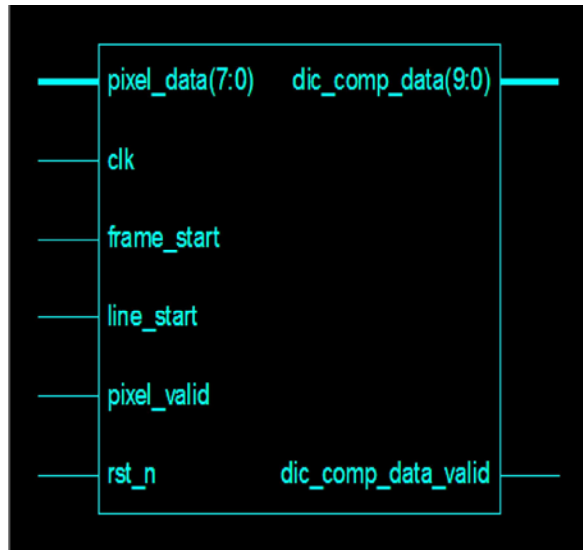


Fig. 3: RTL Schematic

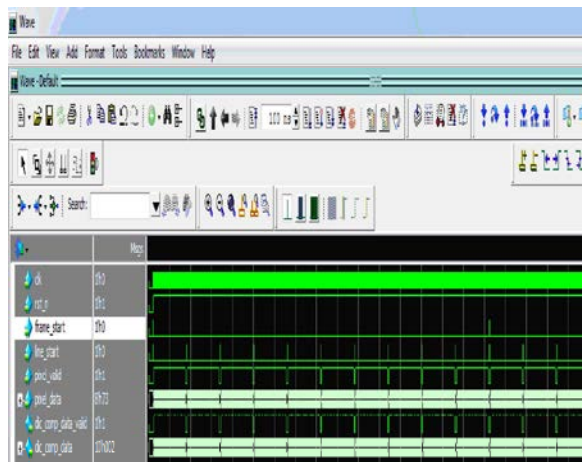


Fig. 4: Simulation in Modelsim-Wave 1

The enhanced dictionary based coder has the pixel clock as input. The incoming pixel data is sampled using this clock. This block also gets the frame start and line start as the input signals. The output data is in the compressed form which is validated using a signal.



Fig. 5: Simulation in Modelsim-Wave 2

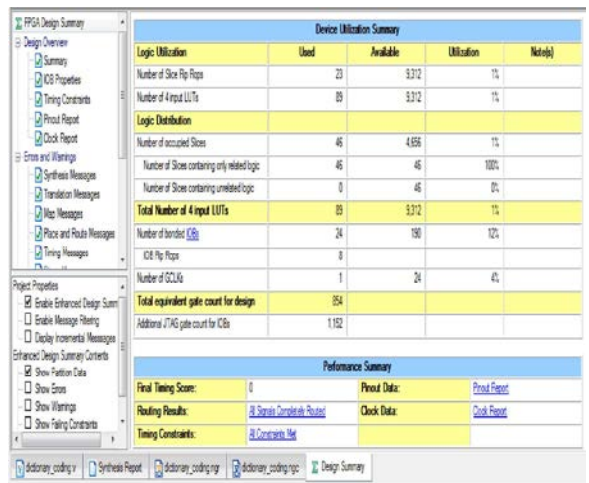


Fig. 6: HDL Synthesis Report

The dictionary based coding is a variable length coding scheme and hence only the required number of bit in the 10 bit output data taken as the valid data by the decompressor based on the logic.

**Simulation Result in ModelSIM:** The RTL coded in verilog is simulated using Modelsim. The simulation waveform is shown in Figure 4 and Figure 5.

**Advanced hdl Synthesis Report:** The simulated design is then synthesized in Xilinx ISE. The HDL Synthesis report is shown in Figure 6 shows the device utilization summary and the performance summary of the enhanced dictionary based coder.

## CONCLUSION

With the advent of multimedia technologies, the information shared across the network are in various forms such as text, audio and video. Video sharing over

Internet gains considerable importance with the increasing use of e-governance, e-business and social networking. Security, speed and resource requirement are some key factors that need to be considered during video transmission across networks. Various compression and encryption techniques have been proposed in the literature for secured video transmission. The proposed system uses a simple line based lossless compression algorithm. Implementing the system in FPGA permits enhancements to the proposed algorithm. The Modified dictionary based coding scheme of the proposed system is coded in Verilog and the module is simulated in Modelsim. Report on area utilization is taken by synthesizing the module in Xilinx ISE.

Security being the major constraint while transmitting the video data, the proposed Modified Dictionary Based Coding algorithm can be integrated with an efficient encryption algorithm to provide security for the video data. The integrated system can handle both the bandwidth and the security requirements jointly in a single process.

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