Parallel MPEG-2 Encoder on ATM and Ethernet-Connected Workstations

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Abstract. We present a software-based parallel MPEG-2 video encoder implemented on a cluster of workstations connected via an ATM switch and also via Ethernet. We exploit parallelism on a Group of Picture (GOP) basis such that each GOP of the video is encoded by a particular processor. We propose a scheme for efficient I/O and data distribution.

1 Introduction

Video compression can be hardware-based [1] or software-based [2,3]. However, a software solution is more flexible, and thus allows algorithmic improvements. Nonetheless, very high computation requirements of video applications can often overwhelm a single-processor sequential computer [2]. Therefore, it is natural to exploit the enormous computing power offered by parallel computing systems. With their high performance-cost ratio and efficient communication hardware/software, clusters of workstations are the most suitable candidates for computation-intensive applications like video compression.

In this work, we explore the use of general-purpose workstations enabling other jobs to run while compressing video data. The environment is off-line, but the aim is to achieve maximum possible encoding rate beyond the real-time speed. We compare the performance of the encoder when the interconnection is via Ethernet with that when it is via an ATM switch. We propose a scheme for efficient I/O and data distribution. This scheme provides fast data retrieval as well as efficient scheduling and matching of I/O and compression rates such that the entire system operates in a highly balanced fashion without any bottlenecks.

2 The Parallel Encoder

In order to achieve maximum possible encoding rate, we keep all of the processors busy in reading the data, performing the encoding, and writing the coded bitstream by scheduling the disks, I/O processors, and computing processors. In other words, the processor waiting times are minimized.

In distributing data, an I/O processor reads m batches of uncompressed video frames and sends one batch to each compute processor in the group. While the

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m compute processors are encoding, the I/O processor reads the next m batches and waits. As soon as a compute processor finishes the encoding of a batch it sends a request to the I/O processor, which sends the next batch to the requester. After serving all the requests, the I/O processor reads the next m batches and waits for the requests. The compute processors save the compressed data into a buffer, and write it to the disk when the buffer is full.

3 Experimental Results

We use a video test sequence named *football* of CCIR-601 format (720×480) and SIF format (360×240) as input to our parallel encoder. For message-passing among the workstations in the cluster, which consists of 20 Sun Ultra-1 workstations, we use Message Passing Interface (MPI) environment.

Table 1. The frame encoding rate for the *football* sequence.

No. of Processors	Group Size	Frame/sec. using ATM switch			Frame/sec. using Ethernet		
		SIF		CCIR-601	SIF		CCIR-601
		$B = 3$	$B = 6$	$B = 1$	$B = 3$	$B = 6$	$B = 1$
4	3	5.32	5.41	1.05	5.19	5.28	0.90
8	7	12.55	12.78	2.13	6.92	7.31	1.31
12	11	19.38	20.15	4.20	6.98	7.64	1.84
16	15	23.81	24.15	4.85	7.17	7.72	2.42
20	19	24.20	25.66	5.11	7.33	7.57	2.77

There is only one I/O processor which reads the uncompressed data from only one disk and sends to 3, 7, 11, 15 and 19 compute processors respectively. For SIF, a batch size (B) of 6 frames results in less overall waiting time and therefore yields better results than a smaller batch size. However, for CCIR-601, due to limitation of memory, only a batch of one frame is used. The cluster of workstations performs significantly better while connected via the ATM switch due to its higher bandwidth (155 Mb/s) compared to the Ethernet (10 Mb/s).

4 Conclusion

We have discussed a scheme for combined scheduling of I/O, disks and processors. We have achieved an encoding rate of 25.66 and 5.11 frames/sec. for SIF and CCIR-601 respectively, using only 20 workstations. However, for optimal performance, a careful balance is necessary in determining the batch and group sizes (depending on the I/O processor's memory), for which work is currently underway. This work was partially supported by HKTIIT grant 92/93.001.

References

1. T. Akiyama *et al.*, "MPEG2 Video Codec using Image Compression DSP", *IEEE Tran. on Consumer Electronics*, VOL. 40, NO. 3, Aug. 1994, pp. 466-472.
2. S. M. Akramullah, I. Ahmad and M. L. Liou, "Performance of a Software-Based MPEG-2 Video Encoder on Parallel and Distributed Systems", *IEEE Tran. on Circuits and Systems for Video Technology*, VOL. 7, NO. 4, Aug. 1997, pp. 687-695.
3. K. Shen, L. A. Rowe, E. J. Delp, "A Spatial-Temporal Parallel Approach for Real-time MPEG Video Compression", *Proc. of 1996 International Conf. on Parallel Processing*, VOL. 2, 1996, pp. 100-107.