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United States Patent [19] Rhee

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[54] **SYSTEM AND METHOD OF ERROR CONTROL FOR INTERACTIVE LOW-BIT RATE VIDEO TRANSMISSION**

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[52] U.S. Cl. **375/240; 348/409; 348/412; 348/845.1; 714/18; 714/48**

[58] Field of Search **375/240; 348/845.1, 348/409, 412; 714/18, 48**

[56] **References Cited**

U.S. PATENT DOCUMENTS

5,680,322	10/1997	Shinoda	714/18
5,767,907	6/1998	Pearlstein	348/392
5,794,018	8/1998	Vrvilo	713/400

OTHER PUBLICATIONS

Albanese et al., "Priority Encoding Transmission", *IEEE Transactions on Information Theory*, vol. 42, No. 6, (written Aug. 1994; published Nov. 1996), pp. 1-34.

Amir et al., "A Layered DCT Coder for Internet Video", *The Proceedings of IEEE International Conference on Image Processing*, (Sep. 1996).

Bolot, "Characterizing End-to-End Packet Delay and Loss in the Internet", *Journal of High-Speed Networks*, vol. 2, No. 3, (Dec. 1993), pp. 305-323.

Bolot et al., "The Case for FEC-Based Error Control for Packet Audio in the Internet", to appear in *ACM Multimedia Systems*, (believed to be no earlier than Mar. 1996).

Dempsey et al., "On Retransmission-Based Error Control for Continuous Media Traffic in Packet-Switching Networks", *Computer Networks and ISDN Systems*, (1996), pp. 1-24.

Dorcey, "CU-SeeMe Desktop Video Conferencing Software", *ConneXions*, vol. 9, No. 3, (Mar. 1995).

Ghanbari, "Two-Layer Coding of Video Signals for VBR Networks", *IEEE Journal on Selected Areas in Communications*, vol. 7, No. 5, (Jun. 1989), pp. 771-781.

Li et al., "Layered Video Multicast with Retransmission (LVMR): Evaluation of Error Recovery Schemes", *Proceedings of the Sixth International Workshop on Network and Operating System Support for Digital Audio and Video*, (May 1997), pp. 1-5.

McCanne et al., "vic: A Flexible Framework for Packet Video", *Proceedings of ACM Multimedia '95*, (Nov. 1995), pp. 511-522.

McCanne et al., "Low-Complexity Video Coding for Receiver-Driven Layered Multicast", *IEEE Journal on Selected Areas in Communications*, vol. 16, No. 6, (Aug. 1997), pp. 983-1001.

McCanne et al., "Receiver-Driven Layered Multicast", *Proceedings of ACM SIGCOMM*, (Aug. 1996), pp. 117-130.

Papadopoulos et al., "Retransmission-Based Error Control for Continuous Media Applications", *Proceedings from the Sixth International Workshop on Network and Operating System Support for Digital Audio and Video*, (1996), pp. 5-12.

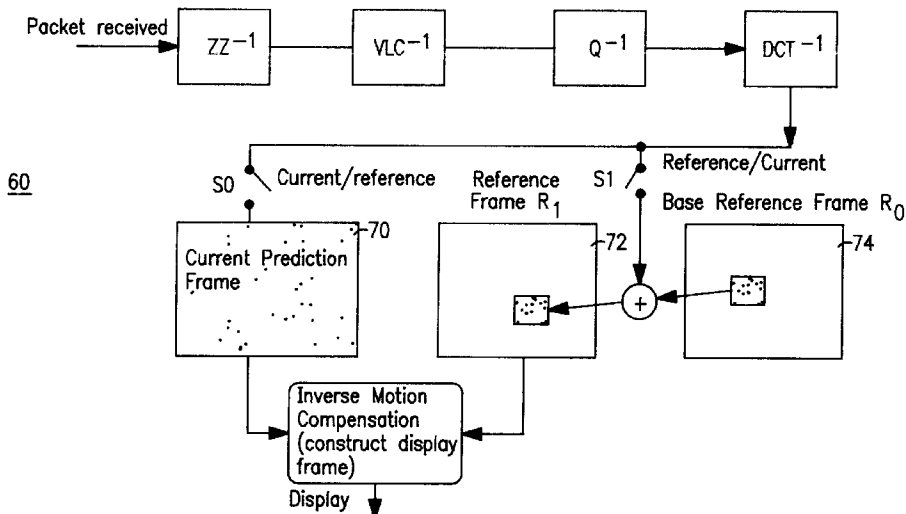
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[57] **ABSTRACT**

A new retransmission-based error control technique that does not incur any additional latency in frame playout times and is suitable for interactive video applications. This retransmission technique combined with layered video coding yields good error resilience for interactive video conferencing. The technique exploits the temporal dependency of inter-coded frames and can be easily incorporated into motion-compensation based coding standards such as MPEG and H.261, achieving very good compression efficiency.

22 Claims, 18 Drawing Sheets



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