



US006907073B2

(12) **United States Patent**
Sawhney et al.

(10) **Patent No.:** **US 6,907,073 B2**
(45) **Date of Patent:** **Jun. 14, 2005**

(54) **TWEENING-BASED CODEC FOR SCALEABLE ENCODERS AND DECODERS WITH VARYING MOTION COMPUTATION CAPABILITY**

(75) Inventors: **Harpreet Singh Sawhney**, West Windsor, NJ (US); **Rakesh Kumar**, Monmouth Junction, NJ (US); **Keith Hanna**, Princeton, NJ (US); **Peter Burt**, Princeton, NJ (US); **Norman Winarsky**, Princeton, NJ (US)

(73) Assignee: **Sarnoff Corporation**, Princeton, NJ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 596 days.

(21) Appl. No.: **09/731,194**

(22) Filed: **Dec. 6, 2000**

(65) **Prior Publication Data**

US 2001/0031003 A1 Oct. 18, 2001

Related U.S. Application Data

(60) Provisional application No. 60/172,841, filed on Dec. 20, 1999.

(51) **Int. Cl.⁷** **H04B 1/66**

(52) **U.S. Cl.** **375/240.14**

(58) **Field of Search** 375/240.01, 240.03, 375/240.15, 240.16, 240.12, 240.11, 240.14, 240.09, 240.22, 240.23, 240.25, 240.13; 382/234, 236, 238, 250; H04B 1/66

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,121,202 A * 6/1992 Tanoi 375/240.16
5,677,735 A 10/1997 Ueno et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 305 127 A2 3/1989

(Continued)

OTHER PUBLICATIONS

“The Motion Transform: A New Motion Compensation Technique”, by Armitano, R. M. et al; IEEE International Conference on Acoustics, Speech, and Signal Processing Proceedings, vol. CONF. 21, May 7, 1996, pp. 2295–2298. Patent Abstracts of Japan, vol. No. 14, Dec. 31, 1998 and JP 10 257502 A, Matsushita Electric Ind Co Ltd, Sep. 25, 1998 abstract.

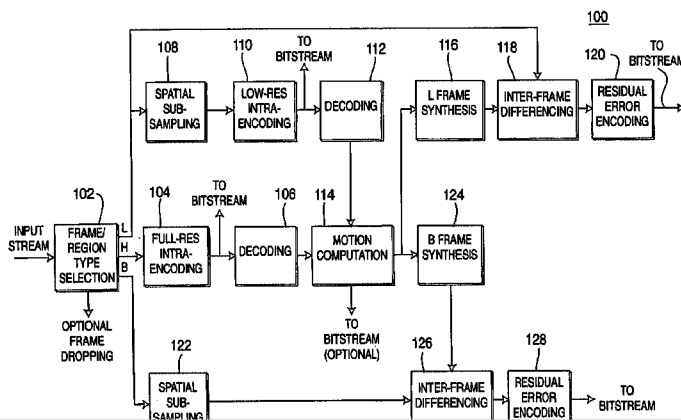
Primary Examiner—Tung Vo

(74) *Attorney, Agent, or Firm*—William J. Burke

(57) **ABSTRACT**

A scaleable video encoder has one or more encoding modes in which at least some, and possibly all, of the motion information used during motion-based predictive encoding of a video stream is excluded from the resulting encoded video bitstream, where a corresponding video decoder is capable of performing its own motion computation to generate its own version of the motion information used to perform motion-based predictive decoding in order to decode the bitstream to generate a decoded video stream. All motion computation, whether at the encoder or the decoder, is preferably performed on decoded data. For example, frames may be encoded as either H, L, or B frames, where H frames are intra-coded at full resolution and L frames are intra-coded at low resolution. The motion information is generated by applying motion computation to decoded L and H frames and used to generate synthesized L frames. L-frame residual errors are generated by performing inter-frame differencing between the synthesized and original L frames and are encoded into the bitstream. In addition, synthesized B frames are generated by tweening between the decoded H and L frames and B-frame residual errors are generated by performing inter-frame differencing between the synthesized B frames and, depending on the implementation, either the original B frames or sub-sampled B frames. These B-frame residual errors are also encoded into the bitstream. The ability of the decoder to perform motion computation enables motion-based predictive encoding to be used to generate an encoded bitstream without having to expend bits for explicitly encoding any motion information.

35 Claims, 5 Drawing Sheets



US 6,907,073 B2

Page 2

U.S. PATENT DOCUMENTS

5,686,962 A * 11/1997 Chung et al. 375/240.16
5,703,649 A * 12/1997 Kondo 375/240.18
5,764,805 A * 6/1998 Martucci et al. 382/238
5,852,469 A * 12/1998 Nagai et al. 375/240.23
6,097,842 A * 8/2000 Suzuki et al. 382/232
6,427,027 B1 * 7/2002 Suzuki et al. 382/236
6,490,705 B1 * 12/2002 Boyce 714/776
6,535,558 B1 * 3/2003 Suzuki et al. 375/240.12

6,563,549 B1 * 5/2003 Sethuraman 348/700

FOREIGN PATENT DOCUMENTS

EP 0 753 970 A2 1/1997
EP 0 920 214 A2 6/1999
WO WO 93/02526 2/1993
WO WO 99/57906 11/1999

* cited by examiner

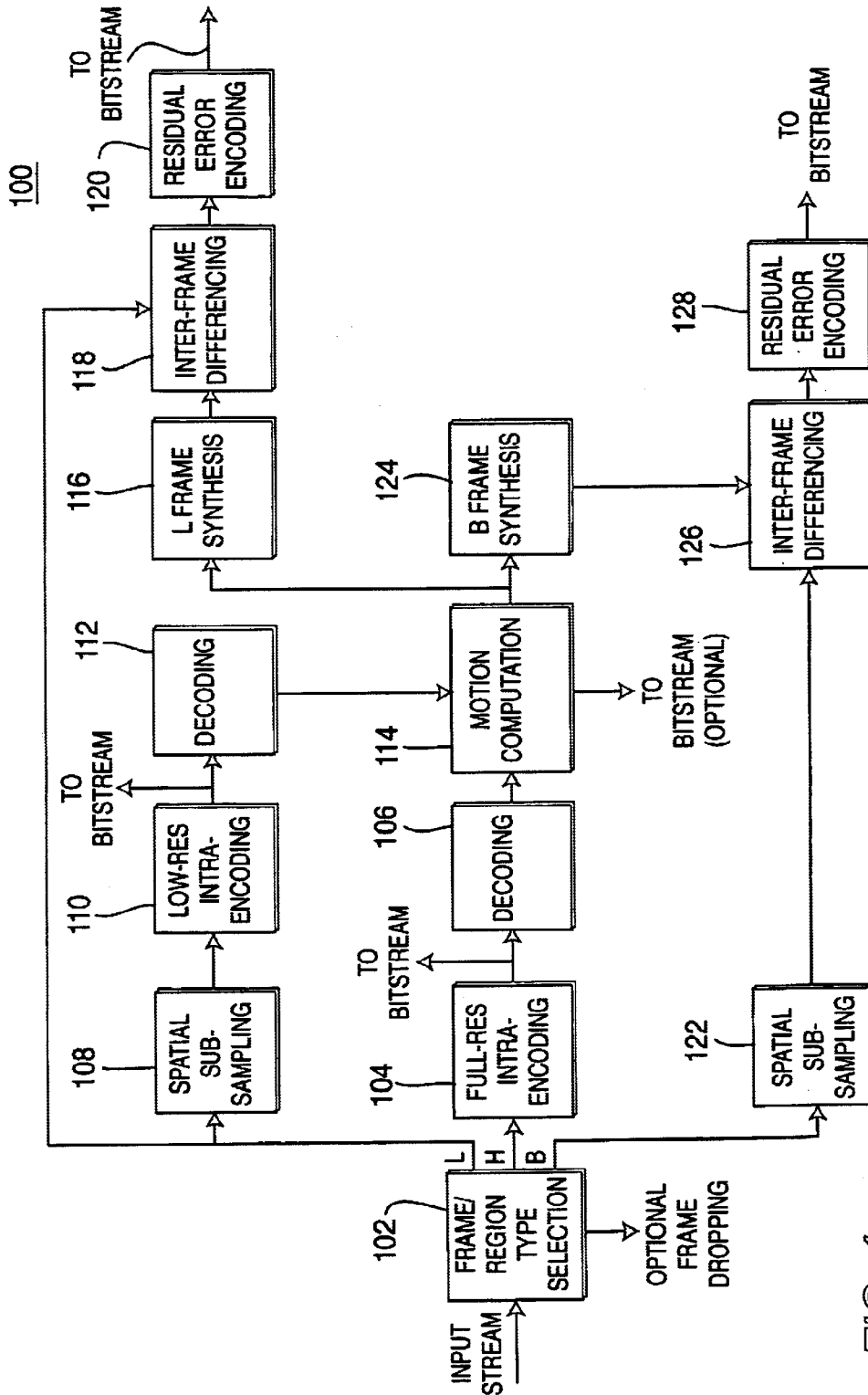


FIG. 1

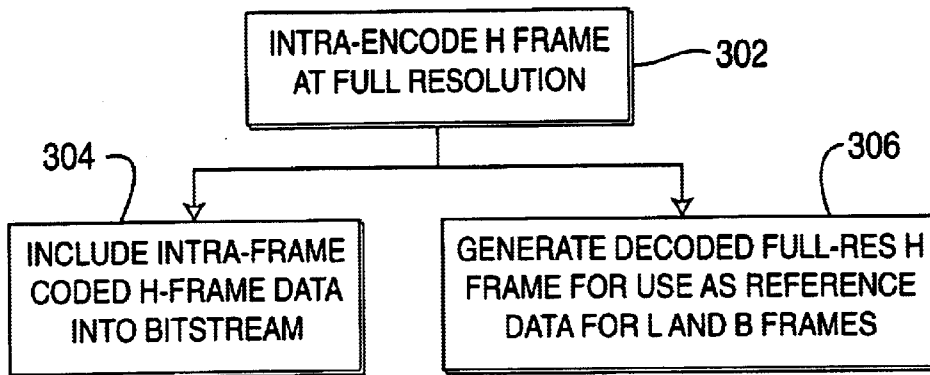
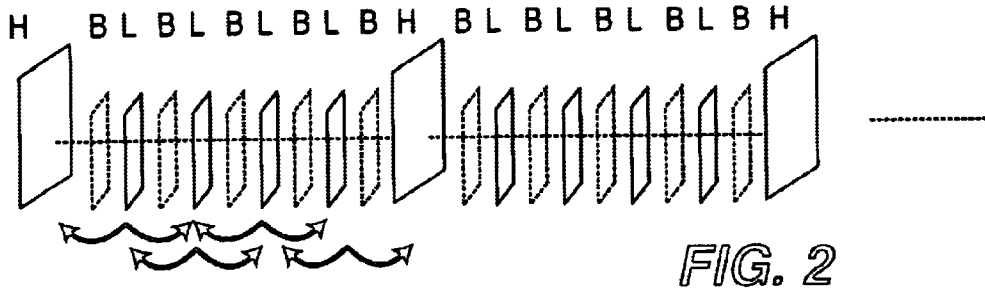


FIG. 3

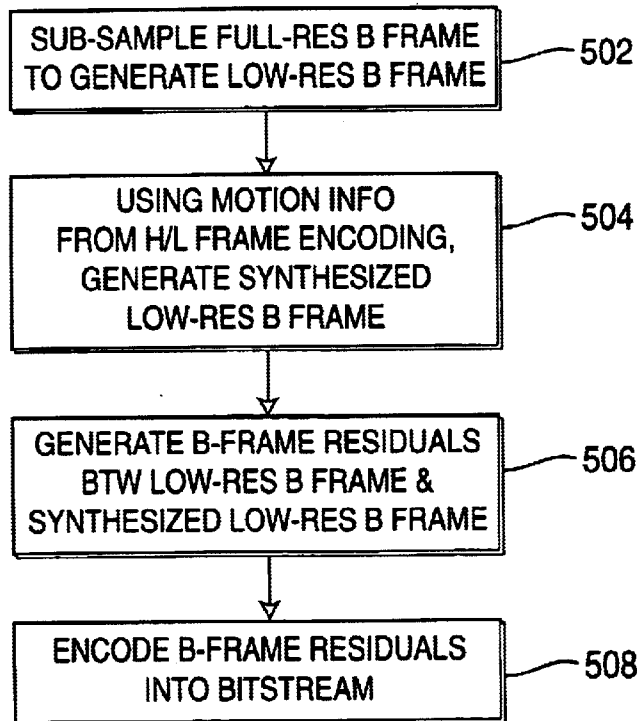


FIG. 5

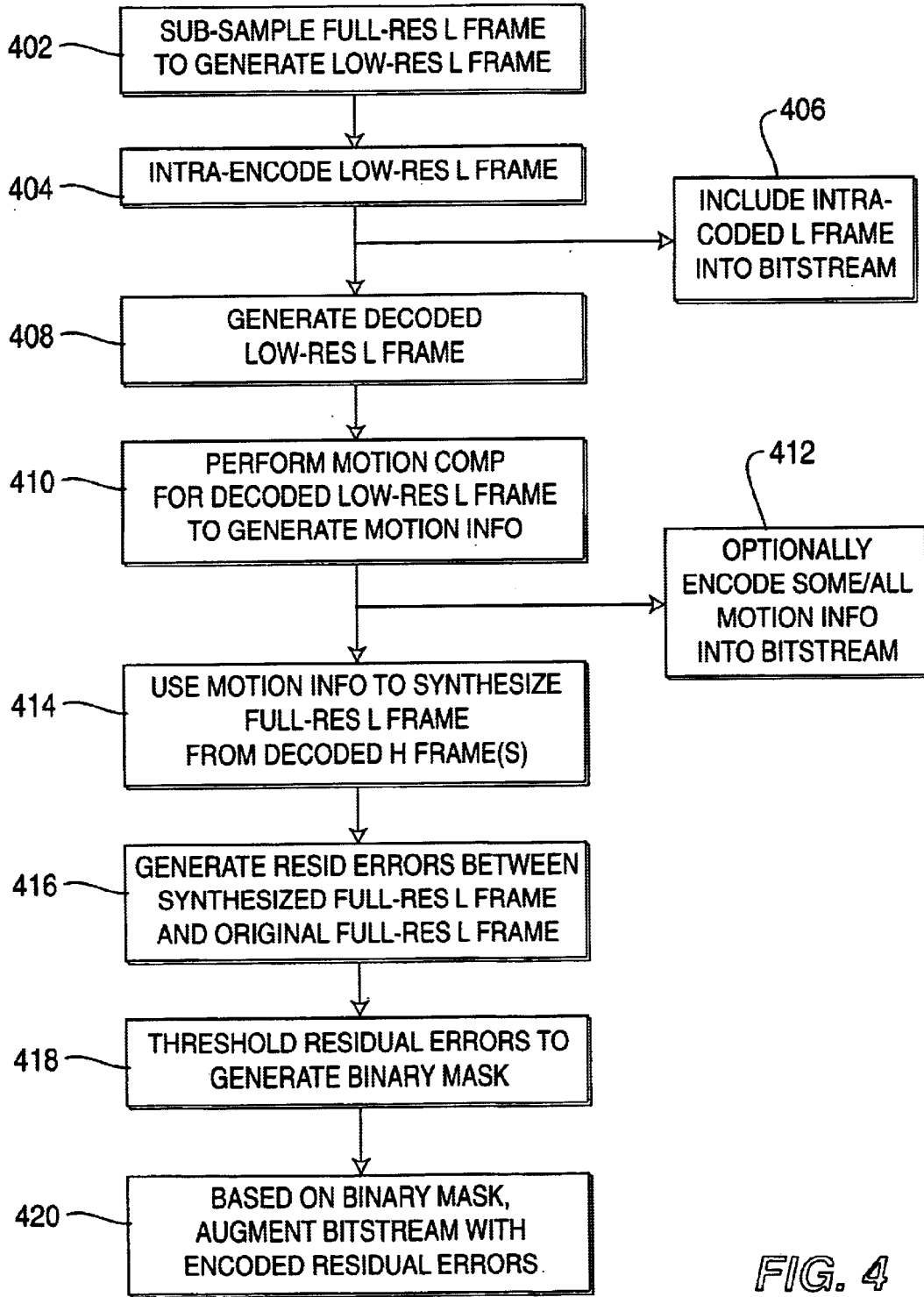


FIG. 4

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.