H.26L Video Server Modeling Using Computational Process Networks

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Embedded Software Systems
Class Project: Final Presentation
Problem Statement

- **H.26L Video Encoder Modeling**
  - Model computation and communication in encoder
  - Exploit inherent parallelism
  - Preserve functional precedence
  - Bounded memory implementation exists

- **Design Domain**
  - Computational process networks [Allen and Evans; 1999]
  - C code for H.26L video encoder [PictureTel Corp.; 2002]
Encoder Modeling

Input Frame

Transform (4x4 ints.)

Quantize (Modified step size)

Inverse Quantize

Inverse Transform

Entropy Code (VLC/CABAC)

Output Stream

Displaced Frame Difference

Motion Compensated Prediction

Motion Compensate

Motion Estimate (7 block sizes)

Frame Memory

Motion Vectors and Mode

Loop Filter

VLC: Variable length coding

CABAC: Context based adaptive arithmetic coding
Implementation

- **Domain: CPN**
  - Scalable design
  - Precedence preserving
- **‘Foreman’ Input Sequence**
  - QCIF resolution (176 x 144)
  - 3 frames: Intra (I), Bi-directional (B), and Predicted (P)
Results

- **Successful Encoding**
  - Nodes and queue designs [He and Zhong; 2000]
  - Generated sequence decoded with H.26L decoder

- **Timing**
  - Speedup could be obtained for encoding more frames
  - Parallel execution of I-frames on multiple processors
Compression Results

- **Compression:** 25:1 (comparing file sizes)
- **Time:** 20 sec for 3 frames with 10 sec for B-frame

Original frame 2 of QCIF (176 x 144) resolution foreman sequence

Decoded frame 2 of QCIF (176 x 144) resolution foreman sequence
Applications

- **Video and POSIX Threads**
  - On-line scene change detection in multicast video
    - Buffering of frames, and processing of frames can be modeled on separate processors for scene change detection
  - Video conferencing
  - Video streaming

- **Real-time H.26L Encoding Products [2002]**
  - Texas Instruments with UB Video Inc. and Ingenient Technologies: On TMS320C64x digital signal processor
Conclusions

- **Deliverables**
  - Data and control flow modeling of H.26L encoder
  - Computational process networks modeling
  - Applications where parallelism can be exploited

- **Results Summary**
  - Time taken is more than expected
    - Unoptimized code
    - Number of frames being processed is less
  - Compression is 50% more than state-of-the-art (H.263, MPEG-2, MPEG-4) encoders for same quality