System Modeling and Software Implementation of MPEG-4 Encoder

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Problem Statement

• Real-time implementation of MPEG-4 encoder
  – Computation-intensive
  – Inherent parallelism
  – Precedence preservation
  – Flexible configuration
Our Approach

• System modeling using Computational Process Networks
  – Deterministic concurrent model
  – Precedence-preserving

• Software implementation
  – C++, POSIX Threads
  – Allen’s CPN framework
PN Model of the Core Encoder
Finer Hierarchical Model of Motion Estimation Node
Software Implementation

• Node and queue design
  – Data type and structure for node input, node output and tokens

• Code generation (time-consuming!)
  – Based on existing C source code on the web

• Simulation
  – Frame-based top level core encoder
  – Platform: Single Intel Pentium III Xeon (733MHz?) processor, Linux, 256MB memory
Example of Nodes Execution

... Encoding frame 0 ...
ForkNode starting.
ForkNode processed 1 frame(s).
ForkNode starting.
ForkNode processed 1 frame(s).
MENode starting.
MENode processed 1 frame(s).
MCNode starting.
MCNode processed 1 frame(s).
ForkNode starting.
ForkNode processed 1 frame(s).
SUBPredNode starting.
SUBPredNode processed 1 frame(s).
DCTNode starting.
DCTNode processed 1 frame(s).
QvlcNode starting.
QvlcNode processed 1 frame(s).
IQUANTNode starting.
IQUANTNode processed 1 frame(s).
IDCTNode starting.
IDCTNode processed 1 frame(s).
ADDPredNode starting.
ADDPredNode processed 1 frame(s).
...

Simulation Results

• Successful encoding results
  – On test sequences (128*128, color format 4:2:0)
  – Decodable and playable by existing MPEG player

• Faster than the original sequential encoder
  – Even on a single processor!
  – Benefits from concurrent model and Pthread implementation outweigh thread overheads
  – Benefit margin may depend on the inherent parallelism exposed by the designed model and node granularity
Performance Evaluation

Comparison of Encoding Time

Number of Frames Encoded vs. Encoding Time (Seconds)

Sequential

Proposed

Encoding Time Difference

Number of Frames Encoded vs. Encoding Time Improvement (%)
Conclusion

• Our approach is
  – Scalable to multi-processor environment (expected to have approximate linear speedup thus potentially feasible for real-time implementation)
  – Faster due to concurrent execution (Pthread implementation of PN nodes)

• Future work
  – Profiling the computation load of each node
  – Evaluation on multi-processor platform