A VIDEO COMPRESSION CHIP SET

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OUTLINE

• APPLICATIONS/GOALS
• VIDEO COMPRESSION
• IMAGE COMPRESSION
• THE PROCESSORS
  - L64720 MOTION ESTIMATION
  - L64730 DCT PROCESSOR
  - L64740 QUANTIZATION
  - L64716 BCH ENCODER/DECODER
• SUMMARY
A VIDEO COMPRESSION CHIP SET

APPLICATIONS

- 64 Kbit/S VIDEO PHONES (CCITT)
- 1 Mbit/S VIDEO CONFERENCING (CCITT)
- 1 Mbit/S MULTIMEDIA (MPEG)
- 10 Mbit/S TV TRANSMISSION
- 50 Mbit/S "HDTV" TRANSMISSION
- IMAGE STORAGE (JPEG)

GOALS

- SOLVE CORE PROBLEMS
- REUSABLE BUILDING BLOCKS
- COMPATIBLE WITH "STANDARDS"
- FAST DESIGN/REDESIGN
- LOW COST

A VIDEO COMPRESSION CHIP SET

VIDEO ENCODER (CCITT)

- LOSSLESS OPERATIONS
  - Optional Temporal Prediction (ME)
  - Variable Length Coding (VLC,VLD)
  - Error Correction

- LOSSY OPERATIONS
  - Spatial Prediction (DCT)
  - Quantization
VIDEO DECODER (CCITT)

- Inter-frame Mode Select
- Step Size
- VLD
- Buf
- Q
- IDCT
- Frame Memory
- Motion Comp
- Filter
- Prediction
- Motion Vector
- Decoded Data

- SUBSET OF ENCODER
- INV Q, IDCT, FILTER MUST TRACK

IMAGE COMPRESSION

- JPEG IMAGE COMPRESSION
  - Similar to Video Compression
  - in Intra Mode
  - Images May be Very Large

- JPEG ENCODER

- JPEG DECODER
VIDEO COMPRESSION - THE PROCESSORS

L64720 - MOTION ESTIMATION

• COMPUTES FOR ALL $N^2$ $(i,j)$:
  $$\text{error}(i,j) = \sum_{y=0}^{N-1} \sum_{x=0}^{N-1} \text{abs} \left( \text{SW}(x+i,y+j) - \text{DB}(x,y) \right)$$

- 8-BIT INPUT DATA
- 56μSec EXECUTION TIME ($N=16$)
- OUTPUT: error$(i,j)$, min error, error(0,0)

LARGER SEARCH WINDOWS

$N_xN$ Block of Data

SEARCH WINDOW OVER ORIGINAL IMAGE

DESIZED $3N \times 3N$ SEARCH WINDOWS

$2N \times 2N$ SEARCH WINDOWS FOR EACH PROCESSOR

• EACH PROC COMPUTES SOME ERRORS
• SAME DATA BLOCK FOR EACH PROC
L64730 - DCT, IDCT, FILTER

- **8 X 8 DATA BLOCK**
- **THREE OPERATING MODES**

```
INTER        AUX
DI → DCT → DO DI → IDCT → DO DI → FILTER → DO

AUX
```

- **12-BIT I/O**
- **CONFORMS TO H.261 ERROR SPECS**
- **SUSTAINED PIXEL RATES TO 40 MHz**
- **HANDLES INTER MODE PREDICTION**

**COMPUTES:**

\[
BD(u,v) = \frac{1}{32} C(u)C(v) \sum_{x=0}^{7} \sum_{y=0}^{7} bd(x,y) \cos \left( \frac{\pi u (2x+1)}{16} \right) \cos \left( \frac{\pi v (2y+1)}{16} \right)
\]

\[
b(x,y) = 2 \sum_{u=0}^{7} \sum_{v=0}^{7} C(u)C(v)BD(u,v) \cos \left( \frac{\pi u (2x+1)}{16} \right) \cos \left( \frac{\pi v (2y+1)}{16} \right)
\]

VIDEO COMPRESSION - THE PROCESSORS

L64730 - DCT, IDCT, FILTER

- **INTERNAL CONTROLLER**
- **SEPARABLE PROCESSOR**
- **STREAM DATA I/O**
VIDEO COMPRESSION - THE PROCESSORS

L64730 - DCT, IDCT, FILTER

- 1-STAGE FAST TRANSFORM
  - 4 Mults

- ROUND CARRY SAVE FORMAT
  - "Eat Away" Low Mult Bits
  - Has Unpredictable Error Props

WALLACE TREE ADDER ARRAY

L64740 - QUANTIZATION PROCESSOR

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>JPEG</th>
<th>CCITT</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUANTIZATION STEP SIZE</td>
<td>FREQ DEPEND</td>
<td>FIXED</td>
</tr>
<tr>
<td>ZIG-ZAG RUN CODING</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>CLIP QUANT COEFF</td>
<td>NO</td>
<td>8-BITS</td>
</tr>
<tr>
<td>DPCM FOR DC COEFF</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>VAR THRESHOLD</td>
<td>NO</td>
<td>OPTIONAL</td>
</tr>
</tbody>
</table>

- TWO QUANTIZATION TABLES
- CAN CASCADE WITH DCT, IDCT
- 12-BIT DCT COEFFICIENTS
**VIDEO COMPRESSION - THE PROCESSORS**

**L64740 - QUANTIZATION PROCESSOR**

- **CCITT MODE**

**L64715 - BCH CODEC**

- **BCH (511,493) ENCODER/DECODER**
  - CORRECTS TWO ERRORS
  - PERFORMS FRAMING AND SYNCHRONIZATION
- **20 MBIT/SEC FULL D UPLEX**
- **DETECTS DECODING FAILURE**

**QUANTIZATION**

\[ Y = \frac{X}{q} \]

\[ X = q Y \]
SYNCHRONIZATION

- INFORMATION
  - Sync Pattern (1-bit/Block)
  - Error Count (511-bits/Block)
- TRADE OFF HARDWARE, SYNC TIME
  - Search 256-Positions in Parallel
  - Use Error Count for Stability

SUMMARY

- CHIP SET DEVELOPED FOR:
  - VIDEO COMPRESSION
  - IMAGE COMPRESSION
- PIPELINED OR "CO-PROCESSOR" MODES
- BLOCK ORIENTED DATA I/O
- BUILDING BLOCK PROCESSORS