Introducing,

WT-DIPLAB-1.0
(Digital Image Processing Laboratory)
- Team Wavelet
WT-DIPLAB-1.0

Agenda:

• Presentation on WT-DIPLAB-1.0 details and capabilities
• Demo - Video processing library
WT-DSPPORT-V.1 Kit
WT-DSPPORT-V.1 Board

- Ethernet
- SDRAM
- BF561 DSP
- USB 2.0
- Video Input / Outputs
- Joystick
- PTZ interface (RS422/RS232)
- FPGA
- RTC
- ADuC812
- IR Receiver
- LEDs
### Specifications

<table>
<thead>
<tr>
<th>Operation Mode</th>
<th>Stand Alone</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSP Processor</td>
<td>BlackFin BF561 @ 500 / 600 MHz, Dual Core</td>
</tr>
<tr>
<td>Micro-Controller</td>
<td>ADuC 812 (Optional)</td>
</tr>
<tr>
<td>FPGA</td>
<td>XC3S100 FPGA (Optional)</td>
</tr>
<tr>
<td>Memory</td>
<td>On Board 256 MB SDRAM</td>
</tr>
<tr>
<td>Flash Memory</td>
<td>On Board 2 MB Flash (Optional up to 8 MB)</td>
</tr>
<tr>
<td>SRAM</td>
<td>4 MB (Optional)</td>
</tr>
<tr>
<td>Analog Inputs</td>
<td>4 Channels to ADuC812 (Optional)</td>
</tr>
<tr>
<td>Analog Outputs</td>
<td>2 Channels from ADuC812 (Optional)</td>
</tr>
<tr>
<td>Video Input</td>
<td>1 channel (NTSC/PAL)</td>
</tr>
<tr>
<td>Video Output</td>
<td>2 channel (NTSC/PAL)</td>
</tr>
<tr>
<td>Keypad interface</td>
<td>16 keys (Optional)</td>
</tr>
</tbody>
</table>
## Specifications (Cont.)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet Interface</td>
<td>10/100 mbps on RJ45 connector (Optional)</td>
</tr>
<tr>
<td>Host Interfaces</td>
<td>RS-232C/RS422 interface from DSP (Optional ADuC812)</td>
</tr>
<tr>
<td>Remote Interface</td>
<td>IR remote interface (Optional)</td>
</tr>
<tr>
<td>RTC</td>
<td>Battery backed up RTC (Optional)</td>
</tr>
<tr>
<td>Relay output</td>
<td>2 Relay outputs (Optional)</td>
</tr>
<tr>
<td>Expansion bus</td>
<td>BlackFin DSP Address/Data Control bus (Optional)</td>
</tr>
<tr>
<td>Power requirement</td>
<td>12 VDC @ 1.5 A</td>
</tr>
<tr>
<td>Board size</td>
<td>172 mm x 212 mm</td>
</tr>
<tr>
<td>Operating Temp.</td>
<td>0°C to 50°C (Industrial grade)</td>
</tr>
</tbody>
</table>

**Note:** The Optional features on the Unit may vary as per Customer’s requirement.
Block Diagram

ADSP – BF561
Black-Fin
Dual Core Processor

- Video Decoder
- Video Encoder
- Video Amplifier
- Video loop-out
- Video In
- Video out

- ETHERNET
  (Optional)
- USB 2.0
  (Optional)
- SDRAM
  128 MB
- FPGA
  (Optional)
- FLASH
  2 MB

- IR Receiver
  (Optional)
- RS 232 T / R
- RTC
  (Optional)
- Keypad
  (Optional)

- ADuC 812
  (Optional)
- LED Indications
- RELAY – 2
  (Optional)

WT-DIPLAB-1.0
Interfaces

Overview Camera Interface
Analog Video Out interface
PTZ Camera Interface
Alarm and Alarm over IP Interface
IR Remote Interface
Keyboard/Joystick Interface
PC Interface Over Ethernet
ADSP - BF561 Architecture

Functional Block Diagram
ADSP-BF561 Features

The ADSP-BF561 processor is a high performance member of the Blackfin family of products targeting a variety of multimedia, industrial and Telecom applications.

Features:
a) Dual symmetric 600 MHz high performance Blackfin cores
b) 328K bytes of on-chip memory
c) Each Blackfin core includes: Two 16-bit MACs, two 40-bit ALUs, four 8-bit video ALUs,
d) 40-bit shifter
e) 2 Parallel Peripheral Interfaces (PPIs)
f) 2 Serial Ports (SPORTs)
g) Serial Peripheral Interface (SPI)
h) 12 General-Purpose Timers
i) Universal Asynchronous Receiver Transmitter (UART)
j) 2 Watchdog Timers
k) 48 General Purpose I/O (Programmable Flags)
BF561 Processor core

Blackfin processors support a modified Harvard architecture in combination with a hierarchical memory structure. Level 1 (L1) memories typically operate at the full processor speed with no latency. Level 2 (L2) memories are other memories, on-chip or off-chip, that may take multiple processor cycles to access.
BF561 memory architecture #1

```
CORE A MEMORY MAP
0xFFF FFFF  CORE MMR REGISTERS
0xFFE 0000  SYSTEM MMR REGISTERS
0xFFC 0000  RESERVED
0xFFF 1000  L1 SCRATCHPAD SRAM (4K)
0xFFF 0000  RESERVED
0xFFF A 0000  L1 INSTRUCTION SRAM/CACHE (16K)
0xFFF A 0000  RESERVED
0xFFF A 0000  L1 INSTRUCTION SRAM (16K)
0xFFF 0000  RESERVED
0xFFF 0000  L1 DATA BANK A SRAM/CACHE (16K)
0xFFF 0000  L1 DATA BANK A SRAM (16K)

CORE B MEMORY MAP
0xFFF 1000  L1 SCRATCHPAD SRAM (4K)
0xFFF 0000  RESERVED
0xFFF 0000  L1 INSTRUCTION SRAM/CACHE (16K)
0xFFF 0000  RESERVED
0xFFF 0000  L1 INSTRUCTION SRAM (16K)
0xFFF 0000  L1 DATA BANK B SRAM/CACHE (16K)
0xFFF 0000  L1 DATA BANK B SRAM (16K)
0xFFF 0000  RESERVED
0xFFF 0000  L1 DATA BANK A SRAM/CACHE (16K)
0xFFF 0000  L1 DATA BANK A SRAM (16K)

INTERNAL MEMORY
0xFFF 0000  RESERVED
0xFFF 0000  L2 SRAM (128K)
0xFFF 0000  RESERVED
0xFFF 0000  BOOT ROM (2K)
0xFFF 0000  RESERVED
0xFFF 0000  ASYNC MEMORY BANK 0
0xFFF 0000  ASYNC MEMORY BANK 2
0xFFF 0000  ASYNC MEMORY BANK 1
0xFFF 0000  ASYNC MEMORY BANK 0
0xFFF 0000  RESERVED
0xFFF 0000  SDRAM BANK 3
0xFFF 0000  SDRAM BANK 2
0xFFF 0000  SDRAM BANK 1
0xFFF 0000  SDRAM BANK 0

EXTERNAL MEMORY
```

WT-DIPLAB-1.0
BF561 memory architecture #2

Off-chip memory is accessed through the External Bus Interface Unit (EBIU), provides expansion with SDRAM, flash memory, and SRAM, optionally accessing more than 768M bytes of physical memory.

The memory DMA controllers provide high bandwidth data movement capability. They can perform block transfers of code or data between the internal L1/L2 memories and the external memory spaces.
BF561 2D DMA Example

Image cropping

Start

X Count, X modify

Y Count, Y modify

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BF561 PPI Interface

The ADSP-BF561 provides two 16-bit Parallel Peripheral Interfaces (PPI0 and PPI1) that can connect directly to parallel A/D and D/A converters, video encoders and decoders and other general purpose peripherals. The Parallel Peripheral Interface (PPI) is a half-duplex, bidirectional port accommodating up to 16 bits of data.
How to write program

Analog Devices provides VisualDSP++® an easy-to-use integrated software development and debugging environment (IDDE).


Operating systems Windows XP®, Windows 2000®, and Windows Vista® are supported.
Project Development stages

Simulation (No hardware is required)

Emulation

Pod

WT-DSPPORT-V.1

Emulator Pod

WT-DSPPORT-V.1
Image viewer

Tools

Zoom status

Status bar indicates the DSP address, RGB values, and pixel’s coordinates
How to use
Applications

Typical Applications of WT-DSPPORT-V.1 board

- Video security system
- Video analytics
- Image Processing Lab
- Project Platform
Applications developed on WT-DSPPORT-V.1

- Single camera object tracking
- Motion tracking
- Trip wire
- Virtual Fence
Single camera object tracking

Monitor

IR Remote

Pan Tilt Zoom (PTZ) camera

WT-DSPPORT-V.1
Single camera object tracking
Motion Tracking

Server

Joystick

PTZ camera

WG-DSPPORT-V.1

Monitor

Overview camera

IR Remote
Motion tracking Single reference camera
Tripwire

Server

Joystick

PTZ camera

WG-DSPPORT-V.1

Monitor

Overview camera

IR Remote
Tripwire
Tripwire Video
Virtual Fence

Server

Joystick

PTZ camera

Monitor

Overview camera

IR Remote

WG-DSPPORT-V.1
Virtual Fence Video
WT-DSPPORT-V.1 Pattern Generator

Camera

Host PC-Via Hyper Terminal

Video Processor WT-DSPPORT-V.1

Pattern Generator WT-DSPPORT-V.1

LCD Monitor

RS232

USB

VGA Converter

CRT monitor
WT-DSPPORT-V.1 Pattern Generator

- Bar
- Chequer
- Sine
- Gaussian Noise
- Add Gaussian noise
Pattern Generator - Bar pattern

4 BARS

16 BARS

64 BARS
Pattern Generator - Chequer pattern

4x4

10x10

50x50
Pattern Generator - Sine pattern

Sine pattern

16 Cycles/512 pixels

32 Cycles/512 pixels

512 pixels 512 pixels
Pattern Generator - Gaussian noise

- Mean: 128, Std Dev: 0
- Mean: 128, Std Dev: 8
- Mean: 128, Std Dev: 16
- Mean: 128, Std Dev: 32
Pattern Generator - Add Gaussian Noise

Mean - 0, Std Dev - 0

Mean - 0, Std Dev - 8

Mean - 0, Std Dev - 16

Mean - 0, Std Dev - 32
WT-DSPPORT-V.1 Video Processor

- Camera
- USB
- RS232
- LCD Monitor
- Host PC-Via Hyper Terminal
- Pattern Generator
- WT-DSPPORT-V.1
- Video Processor
- WT-DSPPORT-V.1
- VGA Converter
- CRT monitor
WT-DSPPORT-V.1 Video Processor

List of functions in video processor

1. Live video
2. Negate
3. Horizontal flip
4. Vertical flip
5. Histogram display
6. Histogram stretching
7. Histogram equalization
8. Image statistics (Min, Max, Mean, Mean Square, Variance, Std Deviation, Entropy)
9. Global Threshold
10. Otsu Threshold
11. Dilation binary
12. Erosion binary
WT-DSPPORT-V.1 Video Processor

List of functions in video processor (cont...)

13. Dilation grey
14. Erosion grey
15. Gamma correction
16. Mean filter
17. Median filter
18. Sharpening filter
19. Edge detection (Sobel operator)
20. Pseudo coloring
21. Region counting
22. FFT
23. Wavelet transform
Video in out

Input

Output
Video processing architecture
Video processor - Negate

Input

Output

Mammogram of tissue
Video processor - Horizontal flip

Input

Output
Video processor - Vertical flip

Input

Output
Video processor - Histogram display # 1

Bar pattern from WT-DSPPORT-V.1 pattern generator
Video processor - Histogram display # 2

Bar pattern print in front of camera
Video processor - Histogram display #3

Gaussian noise from WT-DSPPORT-V.1 pattern generator
Video processor - Histogram Stretching

Image print in front of camera
Histogram Equalization

Input

Output
Video processor - Histogram Equalization

Image print in front of camera
Video processor - Image Statistics #1

Gaussian noise from WT-DSPPORT-V.1 pattern generator
Video processor - Image Statistics #2

Bar pattern from WT-DSPPORT-V.1 pattern generator

Statistics:
Min   0 01
Max   254
Mean  125
Mean Square  0.031101
Variance  0.015339
Std Deviation  123
Entropy  0.01
Video processor - Global/Otsu Threshold

Input

Otsu Threshold

Output

Threshold - 150
Video processor - Global/Otsu Threshold

Image print in front of camera
Video processor - Otsu Threshold

Image print in front of camera
Video processor - Morphological operations

Dilation and Erosion

Image print in front of camera
Video processor - Gamma correction #1

Image print in front of camera
Video processor - Gamma correction #2

Image print (noise) in front of camera
Video Processor - Mean filter

Input

Output
Video Processor - Mean & Median filter

Input

Output (Mean)

Output (Median)
Video Processor - Sharpening # 1

Input

Output
Video Processor - Sharpening # 2

Image print in front of camera
Video Processor - Edge Detection # 1

Input

Output
Video Processor - Edge Detection # 2

Image print in front of camera
Video processor - Psuedo coloring

Input

Output

Video processor - Psuedo coloring

Input

Output

Video processor - Psuedo coloring

Input

Output

Video processor - Psuedo coloring

Input

Output
Video Processor - Region Counting

Image print in front of camera
Video processor - FFT

Image print in front of camera
Video Processor - Wavelet Transform

Image print in front of camera
Project kit WT-DSPPORT-V.1 also available
Thank You!

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