

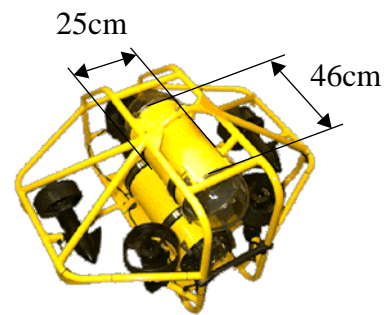
# Computing System Design

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## 1.0 Requirements

As Kambara is intended to be an autonomous underwater vehicle, its primary control computing will be carried onboard. This and the nature of the experiments we would like to perform lead to some design requirements.

- The processor should provide adequate processing capacity for simultaneous filtering, servo control, vision computation, and communication.
- There is a strong preference for the VxWorks operating system and because a BSP is already available, for an Intel processor such as a Pentium-chip.
- The computing system and card cage must fit within the upper pressure cylinder, 25cm diameter and 46cm length.
- The computing enclosure should be able withstand high-frequency vibration and occasional shock loads (from thrusters) all less than 1 G.
- There are 5 brushed DC motors with power amplifiers driven by PWM signals, so at least 5 PWM output channels are required. A sixth channel could be used to control light levels.
- The AUV will carry at least two matched color NTSC cameras as two color and one color with integral pan/tilt, so 3 channels of video digitizing will be required.
- At least 2 serial communication, RS-232, lines (for compass and pan/tilt) are needed and 4 lines are preferred.
- At least 9 digital signal lines (16 preferred) are required: camera controls (6), temperature (2), and water leakage.
- At least 16 A/D channels are required (16+ preferred) at 12 bits resolution: tachometers (5), accelerometers (3), gyros (3), inclinometers (3), pressure (1), and battery voltage (1). No more than 6 channels may prefer greater than 12 bits resolution. Some channels may require/prefer optical isolation.
- No D/A channels are required.
- The component selection should attempt to minimize power draw on batteries.



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## 2.0 Considerations

Physical size and compatibility with the VxWorks operating system seem to be dominant constraints in selecting components.

### 2.1 Size

The computing system must fit inside the AUV's upper enclosure: 25cm diameter by 46cm length. This diameter is too small for a 6U card cage (unless at most three cards are mounted with frontplates facing up, a possibility) and too small for a typical PCI motherboard, although a narrow passive PCI motherboard may fit.

Cards in the 3U form-factor, both CompactPCI and VME, will fit.

Cards of the PC/104 standard will fit.

## 2.2 Operating System

The choice of VxWorks as the operating system and an Intel Pentium processor as the CPU (preferred because a BSP is already available) also constrain the available options. There are no PC/104 single board computers supporting VxWorks as yet. Similarly, available 3U VME Pentium boards (from Matrix and Force) do not support VxWorks.

We are left with 3U CompactPCI or a narrow PCI motherboard.

*Are there other possibilities?*

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## 3.0 CompactPCI-based System Design

### 3.1 Main Processor

There are three processor boards in CompactPCI 3U which seem suitable Gespac, PEP, and Ziatech.

*Eurotech not support VxWorks, is this correct*

*OR has standard PC BIOS, therefore it will support VxWorks?*

Make	Model	Processor	Clock	Features	VxWorks	Price (\$A)
Eurotech	ETH0996	Pentium/ AMD K5	166Mhz	64M DRAM, 2 serial ports	Unknown	
Gespac	PCISYS-57	Pentium MMX	233MHz	64M DRAM, 4M Flash, 2 serial ports, 10bT Ethernet (driver extra), IDE, KBD	Yes (PC BIOS)	\$3010 +\$550
OR	CC5	Pentium	200MHz	64M DRAM, 80M Flash, VGA, SCSI-2, 4 serial ports, 2 parallel ports, 2 USB ports	Probably	\$5516
PEP	CP310	Pentium	166MHz	64M DRAM, 1M Flash, 2 IDE, KBD, 2 serial ports, 9 digital I/O	Yes (PC BIOS)	\$7157
Ziatech	ZT 6500	Pentium	200MHz	48M DRAM, 4M Flash, 2 serial ports, 1 parallel port, 24 digital I/O	Maybe (6/98)	\$4677 +BSP

**Table 3-1:** Single board CompactPCI 3U Computer Options

General Micro Systems, Concurrent Technologies, Matrix and Force were also studied by did not provide CompactPCI, Pentium-based single-board computers.

### 3.2 Video Digitizer

Video digitizers in the CompactPCI 3U format.

Make	Model	Inputs	Features	VxWorks	Price (\$A)
ImageNation	PCX200	1 (4)		Eventually	\$1153
PEP	CP335	2	70M/sec	Unknown	\$3970

**Table 3-2:** Video Digitizer Options

All seem to be based on the Brooktree Bt848 chip.

*Are there other framegrabbers available in CompactPCI?*

*Do any have an existing VxWorks driver?*

### 3.3 Motion Control

There are very few dedicated motion control boards which still produce PWM output directly (due to changes in the basic chip sets). There are several PC/104 motion control boards based on the LM629 chip which produce PWM output. There are two IP mezzanine boards based on the LM629 chip and one board based on an Altera chip which produce PWM output.

Make	Model	Chip	Axes	Features	VxWorks	Price
Tech80	50A (double IP)	Altera	4	S-profile, encoder input, digital I/O	Maybe	
Tech80	29A	LM629	2	Encoder input	Maybe	
SBS- Greenspring	IP- 629Servo-2	LM629	2	3 TTL, Encoder input	Yes	

**Table 3-3:** Motion Control IP Options

### 3.4 Analog/Digital, Digital I/O, Serial I/O

Gespac makes CompactPCI boards, Greenspring makes IP modules.

*Is optical isolation needed in our system?*

Make	Model	Channels	Resolution	Input	Features	VxWorks	Price
Gespac	PCIADC-32	32 (16)	14-bits	+/-10V @ 0-20mA		Unknown	
SBS-Greenspring	IP-ADIO (double IP)	16 (8 diff)	13-bits	+/-10V	2 D/A 68 I/O 2 clocks	Unknown	
SBS-Greenspring	IP-16ADC	16 (8 diff)	16-bits	+/-10V, 0-10V, +/- 5V, 0-5V	Voltage protection	Yes	
SBS-Greenspring	IP-AD16SS	16	16-bit	+/- 10V		Yes	
SBS-Greenspring	IP-OptoAD16	16 (8 diff)	16-bit	+/-10V, 0-10V	Optical Isolation	Yes	

**Table 3-4:** Analog Signal Digitizer Options

*Other A/D IP modules or CompactPCI boards?*

Make	Model	Channels	Features	VxWorks	Price
Gespac	PCICIO-12	12/4		Unknown	
SBS-Greenspring	IP-Digital24	24	2 Interrupts	Unknown	
SBS-Greenspring	IP-Digital48	48	8 Interrupts 2 Timers	Unknown	
SBS-Greenspring	IP-OptoOutput	16	Optical Isolation	Yes	
SBS-Greenspring	IP-OptoInput	16	Optical Isolation	Yes	

**Table 3-5:** Digital I/O Options

*Other Digital I/O IP modules or CompactPCI boards?*

Make	Model	Channels	Protocols	Features	VxWorks	Price
SBS-Greenspring	IP-Serial	2	EIA-232 EIA-422		Unknown	
SBS-Greenspring	IP-Octal 232	8	EIA-232	8TTL Inputs	Unknown	
SBS-Greenspring	IP-OctalOpto (double-IP)	8	EIA-232, EIA-422	Optical Isolation	Unknown	

**Table 3-6:** Serial I/O Options

*Other Serial I/O IP modules or CPCI boards?*

### 3.5 Mezzanine Card Carrier

Mezzanine (IP) card carriers in the CompactPCI 3U format all carry two IPs.

Make	Model	IPs	Features	VxWorks	Price
Gespac	PCIIPC-1	2		Yes	
OR	CSIPC	2	DSP available	Maybe	
SBS-Greenspring	CPC100	2		Maybe	

**Table 3-7:** Mezzanine Card Carrier Options

### 3.6 Enclosure

The critical feature of the enclosure is its ability to fit within the cylindrical pressure vessel. At least five slots will be required. No power supply is needed since the backplane will be powered by batteries (with DC/DC conversion to 5 volts or 3.3 volts as needed).

Make	Model	Slot	Width	Height	Depth	Diagonal	Price
Elma	Type 11	6	21.3cm	3U	16.0cm	25.1cm	\$405
Vector	Vector-Pac CCK 26-36-03	4	18.8cm	3U	12.7cm	23.7cm	\$450
Zero	DotTen CPCI6S160ST	6	17.7cm	13.3cm	20.7cm	22.7cm	\$450

**Table 3-8:** Enclosure Options

## 4.0 Other System Designs

### 4.1 On-board Laptop

The possibility of mounting an laptop computer inside Kambara was considered as this would provide a number of useful features, like Ethernet support and an integral hard disk. There are challenges/unknowns in running VxWorks (or a suitable multi-tasking operating system), interfacing the various devices including PWM signal production, and integrating high-rate video digitizing.

#### 4.2 Ruggedized PCI System

Advantech makes a ruggedized PCI system, the IPC 6806, that fits within our enclosure. This backplane is passive and thus requires a processor board occupying one of the 5 slots. An advantage of such system might be that IP Carrier boards will hold 4 IP modules. A much larger selection of video framegrabbers are available.

A ruggedized PCI system may be worth further investigation. After an initial look it seems unlikely that such a system could be configured running the VxWorks operating system, neither processor boards nor framegrabbers are available, yet.

*Is it worth dropping VxWorks and picking a new operating system to configure a ruggedized PCI system?*

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#### 5.0 Proposed Computing System Design

Given the trade study thus far, the following computing system is proposed:

A CompactPCI system comprised of the Gespac PCISYS-57, ImageNation PCX200, and three Gespac PCIIPC-1 boards carrying three IP-629Servo-2, one IP-16ADC, one IP-Digital24, and one IP-Serial (all from Greenspring), mounted in a Zero CPCI6S160ST 6-slot 3U card cage.