A Pico Blaze-Based Embedded System for Monitoring Applications

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Abstract : Pico Blaze is an 8-bit soft core microprocessor developed by Xilinx that can be synthesized in some FPGA families. This paper presents a set of peripherals that have been developed to interface with Pico Blaze: VGA control, serial communication, PS/2 keyboard port and LCD control. To demonstrate its capabilities, the system has been implemented in a FPGA board and some typical control and monitoring systems have been developed. The design approach of the peripherals and details of the integration of the systems are explained.

Keywords: The project aims at making the monitoring system by using Pico Blaze soft-core processor, connected the peripheral blocks and transducers are controlees the monitoring system based on user requirement

I. INTRODUCTION

Embedded systems are currently available in the form of FPGA boards; designers are required to have a solid working. Experience in the FPGA intricacies as well as mastering a set of design tools for customizing hardware and software components of the system. For the implementation of embedded systems devoted to basic control and monitoring applications, the requirements of design experience and tool mastering are far excessive. Pico Blaze comes equipped, among other features, with a basic interrupt handling module, generic input/output communication ports and a hardware stack, giving the opportunity to be fully customized according to the designer's needs. This paper reports the customization of an embedded system by adding a set of peripherals, described in VHDL, that are intended to extend the Capabilities of Pico Blaze. Also reported is the implementation of basic monitoring tasks built around this Pico Blaze-based embedded system.

II. HEADINGS

1. Pico Blaze microprocessor is an 8-bit microprocessor developed by Xilinx that can be synthesized in the following FPGA families (in its KCPSM3 version): Spartan3, Virtex-II and VirtexIIPro. Figure 1 shows the internal components of Pico Blaze**, 1.1. Programming** In its current release, Pico Blaze is programmed in assembly language. The instruction set is composed of fifty seven instructions, which can be classified as: program control, arithmetic, logic, interrupt and input/output**, 1.2 Tools and development flow** the assembly language code that is to be run by Pico Blaze is developed as a text file with a psm extension. This file is fed into the KCPSM3 program to generate the program memory as a VHDL module, which can then be attached to the microprocessor.

2. Peripheral blocks that have been developed are: an LCD controller, a PS/2 keyboard controller, a VGA controller and a serial communication module. Details of design are given next. **2.3 VGA controller** is made up of three blocks: a PicoBlaze interface block, a refreshing controller and the SRAM. The interface block allows PicoBlaze to address any pixel in the frame in terms of position and color by accessing a set of registers **3. Complete embedded system** The four peripherals presented in the previous section have been integrated along with a single instantiation of PicoBlaze. Since each peripheral is provided with a set of registers that PicoBlaze can access, all the registers have been given an identifier so that PicoBlaze can use it to access a specific register. **4. Monitoring applications, 4.1. Light control** this system controls the lights of a house. Switching on and off a light is commanded via the keyboard or serial communication. The current state of each light can be visually verified on the screen of a monitor **4.2.Sensor activity control** A deployment of four proximity sensors in a house is emulated. The activation and deactivation of the four sensors is under control of either a remote computer via serial communication (GUI) or in situ via keyboard. **4.4. Speed of DC motors control system** The PicoBlaze system is in charge of controlling the speed of four DC motors using the PWM technique. Each motor can be in one of three conditions: switched off, PWM controlled and full speed. The condition of the four motors and the percentage of the PWM control are visually shown in the screen of the system and in text format in a remote computer via serial communication.

4.5. Temperature alarm system the real-time measurement of four temperature sensors is shown in the screen of a PicoBlaze system. The screen is evenly divided in four regions and in each region a grid is drawn to facilitate the visual measurement of the temperature. **5. Conclusions and future work** the design of four peripherals for PicoBlaze soft core microprocessor has been presented. The design approach consisted in VHDL descriptions and register-based interfaces. Five monitoring and control applications have been developed around PicoBlaze and the designed peripherals and implemented in the Spartan-3 FPGA board.**6. Acknowledgements** would like to acknowledge the support of Xilinx, in terms of tools and boards, which played a vital role in the completion of this work.

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III. FIGURES AND TABLES

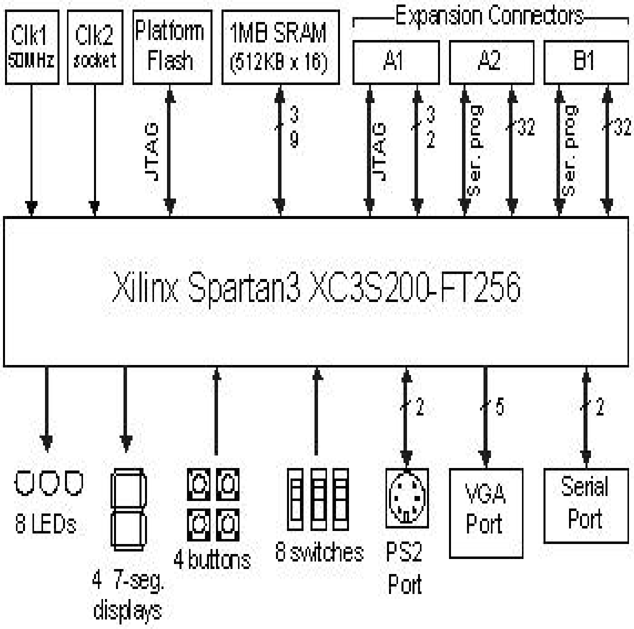

Fig. 1. Schematic diagram of the Spartan- 3 FPGA board

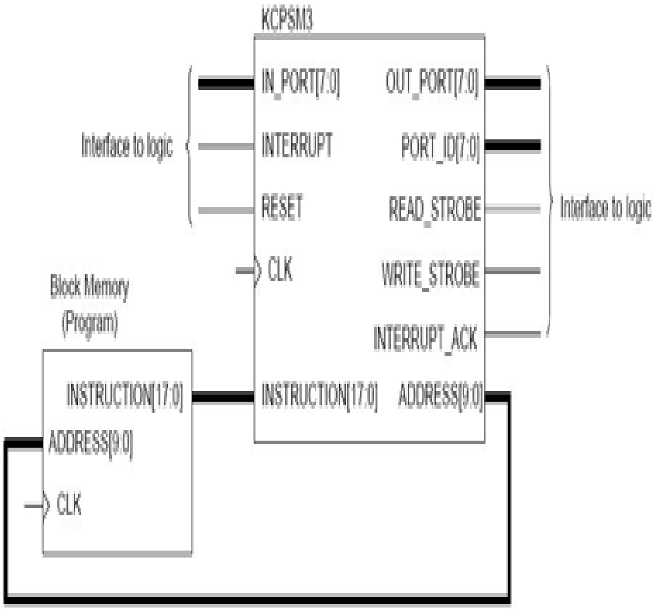

Fig. 2. Internal components of PicoBlaze

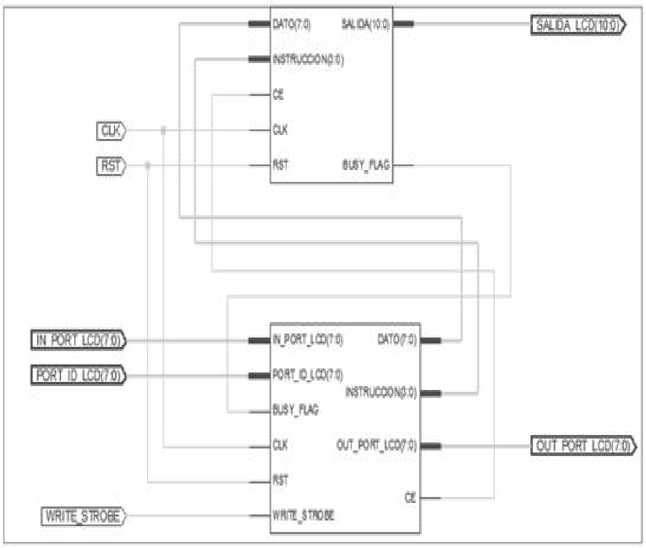

Fig. 3. LCD controller

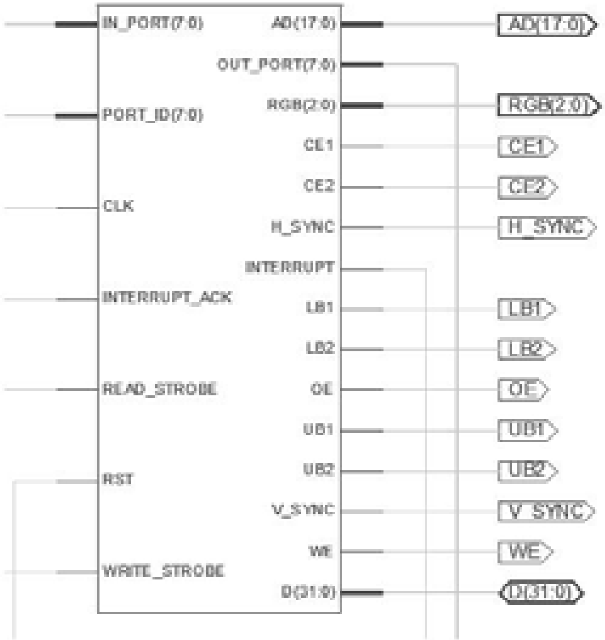

Fig. 4.VGA controller

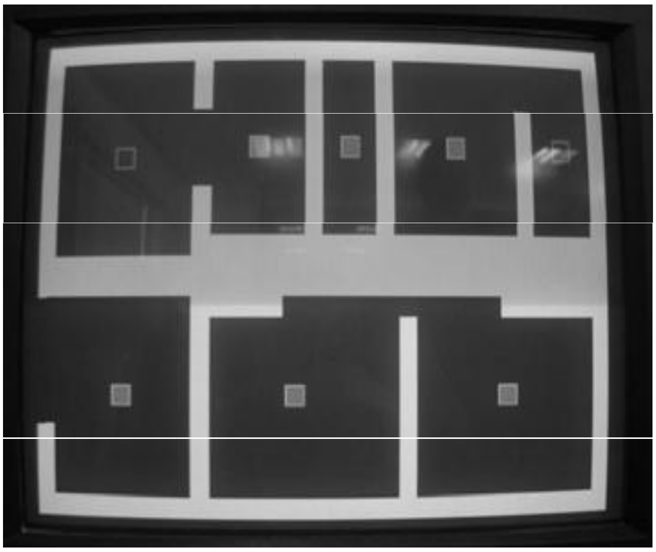

Fig. 5. House layout as shown and controlled by the light control application

Fig. 6. Temperature measurement by the temperature alarm system

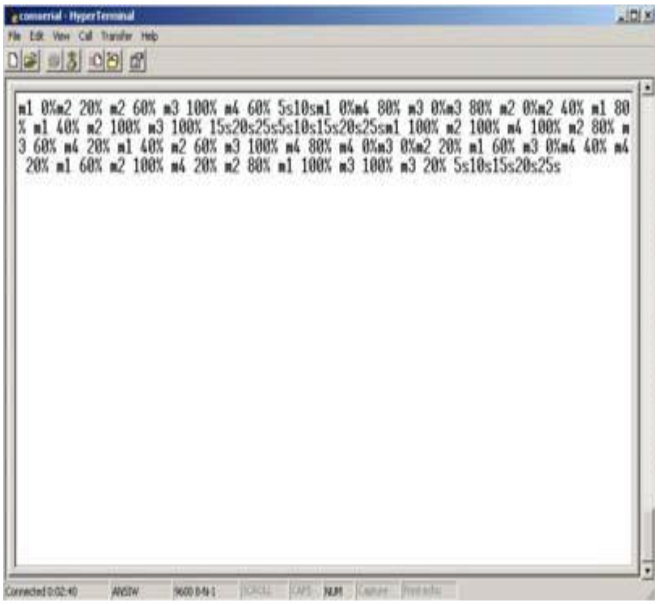

Fig. 7. HyperTerminal of Windows® showing the text messages sent by the DC motor control system

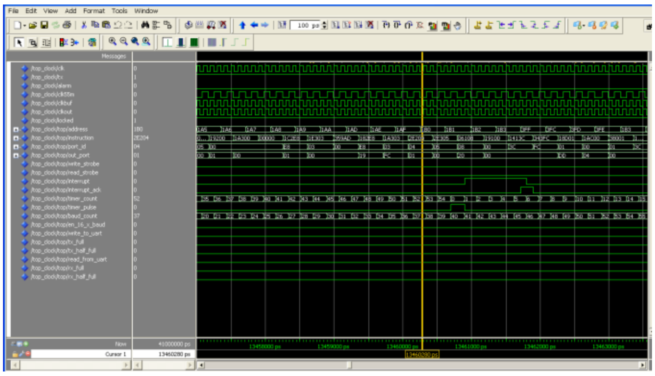

Fig. 8. Simulations Results for Pico blaze application

Fig. 9. Spartan3 FPGA Board start up

Fig. 10. The alarm is raised when the time is set at 12.10. The indication is the red dots blinking below the digits

Table 1Voltage Supplies and Sources of Spartan-3 FPGA Starter Kit

Voltage	**Source**	**Supplies**
+5V DC	AC Wall Adapter, 5V switching power supply	3.3V regulator Optionally, PS/2 port via jumper JP2 setting Pin 1 (VU) on A1, A2, B1 expansion connectors
+3.3V DC	National Semiconductor LM1086CS-ADJ 3.3V regulator	2.5V and 1.2V regulators VCCO supply input for all FPGA I/O banks Most components on the board Pin 3 on A1, A2, B1 expansion connectors
+2.5V DC	STMicroelectronics LF25CDT 2.5V regulator	VCCAUX supply input to FPGA
+1.2V DC	Fairchild Semiconductor FAN1112 1.2V regulator *A.*	VCCINT supply input to FPGA *B.*

Table 2. Summary of Spartan-3A FPGA Attributes

Device	System Gates	Equivalent Logic Cells	CLB Array (One CLB = Four Slices)				Distributed RAM Bits	Block RAM Bits	Dedicated Multipliers	DCMs	Maximum User I/O	Maximum Differential I/O Pairs
			Rows	Columns	Total CLBs	Total Slices						
XC3S50A	50K	1,584	16	12	176	704	11K	54K	3	2	144	64
XC3S200A	200K	4,032	32	16	448	1,792	28K	288K	16	4	248	112
XC3S400A	400K	8,064	40	24	896	3,584	56K	360K	20	4	311	142
XC3S700A	700K	13,248	48	32	1472	5,888	92K	360K	20	8	372	165
XC3S1400A	1400K	25,344	72	40	2816	11,264	176K	576K	32	8	502	227

IV. CONCLUSION

The design of four peripherals for PicoBlaze soft core microprocessor has been presented. The design approach consisted in VHDL descriptions and register- based interfaces. Five monitoring and control applications have been developed around PicoBlaze and the designed peripherals and implemented in the Spartan-3 FPGA board. A limitation that some of the applications faced were the program memory of PicoBlaze. This led to the inclusion of more PicoBlaze instances in the system. Exploration of schemes of communication between microprocessor instances is underway.

ACKNOWLEDGE

The support of Xilinx, in terms of tools and boards, which played a vital role in the completion of this work.

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