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Design of Barrel Shifter Using FPGA

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ABSTRACT

The digital signal processing and graphics applications, the shifter is an important module, consuming a significant amount of delay. This brief presents an architectural optimization approach to synthesize a faster barrel shifter block, which can be useful to reduce the delay of the design without significantly increasing the area. We have divided the problem of generating the shifter into two steps: i) timing-driven selection of multiple stages for merging, and ii) the design of the merged stage. In our proposed method, we define the notion of dual mergedstage, where two stages are merged and thetriple merged stage, where three stages are merged into a single composite stage. These merged stages are identified by using a timing-driven algorithm and are used in conjunction with some single stages of the traditional barrel shifter. The use of these merged stages helps reduce the depth of the proposed barrel shifter architecture, thereby improving the delay. The timing-driven nature of our algorithm helps produce a faster implementation for the overall shifter block. We have evaluated the performance of our design by using a number of technology libraries, timing constraints and shifter bit-widths. Our experimental data shows that the shifter block generated by our algorithm is significantly faster than the shifter block generated by a commercially available datapath synthesis tool. These improvements were verified on placed-and-routed designs as well.

Keywords : **Switches, LED, LCD Display, FPGA Spartan**

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I. INTRODUCTION

The barrel shifter is a very important part of any combinational logic block. A Barrel Shifter is a logic component that perform shift or rotate operations. It is widely used in Microprocessors & Microcontrollers. The designed circuit should shift a data word by any number of bits in a single operation. An N-bit shifter would require log2N number of levels to implement. For an 8 bit barrel shifter, it would require 3 logic levels.

This component design is for natural size (4,8,16..etc.) barrel shifters that perform shift right logical, shift left logical, rotate left and rotate right operations depending on the instantiation parameters. The left and right operation is implemented through inversion of the input and output vectors. The number of multiplexing stages is relative to the width of the input vector.It can be implemented as a sequence of multiplexers (MUX), and in such an implementation the output of one MUX is connected to the input of the next\ MUX in a way that depends on the shift distance. A barrel shifter is often implemented as a cascade of parallel 2×1 multiplexers. For a 8-bit barrel shifter, two intermediate signals are used which shifts by four and two bits, or passes the same data, based on the value of S[2] and S[1]. This signal is then shifted by another multiplexer, which is controlled by S [0].

The main purpose behind using FPGA is its flexible architecture. By using FPGA it is possible to implement number of gates. And as it is a programmable device it can simulate various types of ICs. That is why for barrel shifter it is convenient to use FPGA as it is used for shifting and rotating operations.

Parameter	Valid values	Description
DATA_SIZE	4,8,16…	Barrel shifter natural size width
ROTAION	0,1	Rotation enable:0 – for logic shift, 1 – for rotate
DIRECTION	0,1	Rotation/shift direction:0 – left rotation/shift1 – right rotation/shift

Table No. 1. Parameters Table

II. LITERATURE SURVEY

There are different types of shifters as follows:

- Binary Shifter
- Barrel Shifters
- Logarithmic Shifter

Logarithmic Shifter:
a 4-bit logarithmic shifter. The logarithmic converter takes the 4-bit output from the previous stage as the control word, and the 16-bit input word as input. The logarithmic converter takes the 4-bit output from the previous stage as the control word, and the 16-bit input word as input. Depending on the value of the control word, it shifts the input word to the right and stores them in a 12-bit register which is meant to store the mantissa of the logarithm. These 12 bits are placed to the right of the 4-bit characteristic to obtain a 16-bit logarithm of the input 16-bit number. A logical right shifter using a fore mentioned approach is shown in the above figure .The first row corresponds to a shift of one, while the last row corresponds to a shift of four, As required, zeros fill the high order region. Hence, interconnects route zero into the high order multiplexers. The values [x] represents the bit in position x of the shift amount, and as such represents the value 2^x, In worst case, when the leading one occurs at the MSB of the 16-bit input word, then we truncate the LSB 3-bits of the mantissa will be truncated.

Comparison of General Shifters and Barrel Shifter:
There are three main constraints while designing any VLSI Architecture that are as follows:

- Area
- Combinational Path Delay
- Power Consumption

In general shifter, while designing if it is required to reduce power consumption, we need to increase the area of our hardware design. And if we want to reduce the area of design , it consumes more power. Or in case of reduced area, it may increase the combinational path delay of device. It means general shifter may not fulfil all the above conditions like reduced area , less power consumption, less combinational path delay simultaneously.

Barrel Shifter is a device which reduces combinational path delay without significantly increasing area. That is why we use barrel shifter for shifting and rotation operation. Barrel shifter shifts the data word by n number of bits in one cycle.

In barrel shifter, we define the notion of dual merged stage, where two stages are merged and the triple merged stage, where three stages are merged into a single composite stage. These merged stages are identified by using a timing-driven algorithm and are used in conjunction with some single stages of the traditional barrel shifter. The use of these merged stages helps reduce the depth of the proposed barrel shifter architecture, thereby improving the delay. The timing-driven nature of our algorithm helps produce a faster implementation for the overall shifter block. Hence it will be good to prefer barrel shifter over general shifters.

III. PROPOSED SYSTEM

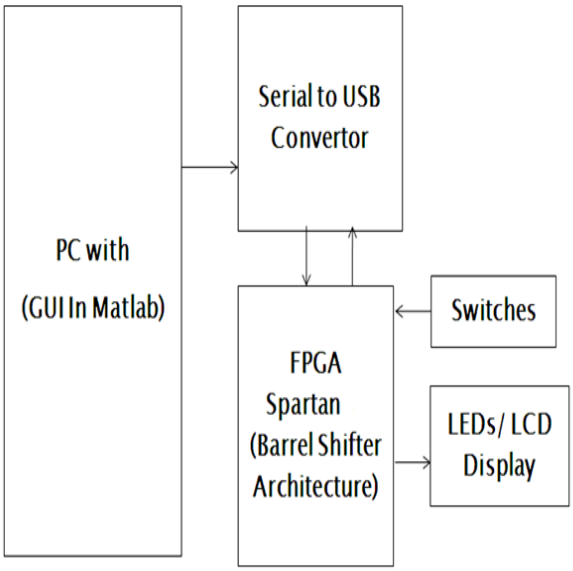

Fig 1. Block Diagram of Barrel Shifter

FPGA Spartan:
Mimas is an easy to use FPGA Development board featuring Xilinx Spartan-6 FPGA. Mimas is specially designed for experimenting and learning system design with FPGAs. This development board features Xilinx XC6SLX9 TQG144 FPGA with maximum 70 user IOs. The USB 2.0 interface provides fast and easy configuration download to the on-board SPI flash. You don't need a programmer or special downloader cable to download the bit stream to the board.The on board full speed USB controller helps a PC/Linux/Mac computer to communicate with this module. Use a USB A to Mini B cable to connect with a PC.8 LEDs and four micro switches are provided on-board for user defined purposes. These peripherals are connected to FPGA IOs and can be controlled from user RTL. The switches do not have pull-ups on board so make sure to enable week pull ups on corresponding IOs in your design.

Serial to USB Convertor
A serial to USB converter is a type of protocol converter which is used for converting serial data signals to and from other communications standards. When the serial to USB adapter is connected to the computer via the USB port the drivers on the computer creates a virtual COM port which shows up in Device Manager. This virtual COM port can be accessed and used as if it was a built-in serial COM port.

Switches:

A switch may be directly manipulated by a human as a control signal to a system, such as a computer keyboard button, or to control power flow in a circuit.
These switches are used To adjust the input and output of barrel shifter manually. Also theses are used to set mode of operation such as 8, 16 bit.

LEDs:
LEDs are used to display the output of barrel shifter i.e. shifting and rotation operation, it may be right or left shift or right or left rotation.

PC with GUI:
In computer science, a graphical user interface or GUI, is a type of interface that allows users to interact with electronic devices through graphical icons and visual indicators such as secondary notation, as opposed to text-based interfaces, typed command labels or text navigation. GUIs were introduced in reaction to the perceived steep learning curve of command-line interfaces which require commands to be typed on the keyboard.

IV. CONCLUSION

In the proposed system, we are going to design a Barrel shifter with the help of FPGA to serve the needs of general shifters such as binary shifter, logarithmic shifter. Barrel Shifter is a device which reduces combinational path delay without significantly increasing area. It also reduces the power consumption of device. That is why we are going to design barrel shifter for shifting and rotation operation as it is advantageous over general shifter.

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