FPGA Implementation of MIMO System using Xilinx System Generator for Efficient Hardware/ Software co-design

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Abstract- **To meet rapidly increasing demands for the mu**[Abstract- To meet rapidly increasing demands for the multimedia services and better quality of service over wireless communication systems, MIMO (Multiple Output Multiple Input) systems have been proposed which promise enhanced system capacity, throughput and data reliability. Moreover, the enormous computational requirements for multimedia data call for use of efficient hardware platforms over and above software platforms. In this work, we implement a transceiver system on hardware test-beds, which is useful in video streaming. We employ the 2*2 Alamouti MIMO technique to develop a transmission system and implement the design on FPGA using Xilinx System Generator (XSG) and AccelDSP (for supporting XSG). The state-of-art design tools and methodology lead to superior performance over traditional approach. This reduces the development time and cost and also enhances the reliability. We discuss the salient features of user-friendly model-based design, which enables creation of reusable models and also provides higher level abstraction. A comparison with traditional design methodology using HDL (hardware description language) shows effectiveness of our approach.

Keywords- **FPGA (Field Programmable Gate Arrays); STBC (Space Time Block Coding); MIMO on FPGA; Xilinx System Generator; AccelDSP; hardware/software co-design; simulation**

1. INTRODUCTION

E-learning and multimedia services to provide online educational material (such as videos, lectures) has been considered a major and fundamental agent of transformation in the realm of distance education. Many institutes have opened their web servers for free lecture-on-demand on several courses (e.g. http://ocw.mit.edu/index.html). Also, specialized wireless lecture video streaming servers for distance learning are being setup in various universities. The every-day increasing demands for such vital multimedia services along with the rising expectation of quality for these services render many of the currently used techniques and systems less-useful [1,21]. Existing multimedia software (even those specialized to digital image processing) do not provide par excellence multimedia data service to the common user, due to a lack of unified on-chip video processing and transmission capabilities.

We propose to utilize the simulation approach for efficient hardware-software co-design, since this approach has been recently gaining a lot of popularity [5, 20, 31]. We implement wireless transmission system over FPGA [13], addressing the need of dedicated hardware system for video data transmission using MIMO (Multiple Input Multiple Output) transmission techniques and using high-level synthesis and design language, and superior design-methodologies for effective design. Our work has great significance in making the company managers equipped with technical knowledge required for providing e-learning solutions to masses.

The contributions of our work are as follows:

(1) We present a solution using FPGA as target platform (instead of software), for implementing algorithms for transmission of educational videos using MIMO over and above SISO (Single Input Single Output) or MISO (Multiple Input Single Output) systems.

(2) We develop a model of Alamouti MIMO communication technique using STBC over Xilinx System Generator (XSG) using the modelling and simulation capabilities of Simulink.

(3) We design the hardware using Xilinx System Generator, which offers many advantages over existing implementation platforms. We also perform analysis of various features and design issues for HDL and high-level graphic design language.

The rest of the paper is organized as follows. We first discuss the literature review of on-going work in the area of multimedia communication, MIMO systems, FPGA and its design options and set the stage for the need of

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Table of Contents Fpga Implementation Of Mimo System Using Xilinx System For

1. Understanding the eBook Fpga Implementation Of Mimo System Using Xilinx System For
    - The Rise of Digital Reading Fpga Implementation Of Mimo System Using Xilinx System For
    - Advantages of eBooks Over Traditional Books
2. Identifying Fpga Implementation Of Mimo System Using Xilinx System For
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an Fpga Implementation Of Mimo System Using Xilinx System For
    - User-Friendly Interface
4. Exploring eBook Recommendations from Fpga Implementation Of Mimo System Using Xilinx System For
    - Personalized Recommendations
    - Fpga Implementation Of Mimo System Using Xilinx System For User Reviews and Ratings

- Fpga Implementation Of Mimo System Using Xilinx System For and Bestseller Lists

5. Accessing Fpga Implementation Of Mimo System Using Xilinx System For Free and Paid eBooks
   - Fpga Implementation Of Mimo System Using Xilinx System For Public Domain eBooks
   - Fpga Implementation Of Mimo System Using Xilinx System For eBook Subscription Services
   - Fpga Implementation Of Mimo System Using Xilinx System For Budget-Friendly Options
6. Navigating Fpga Implementation Of Mimo System Using Xilinx System For eBook Formats
   - ePub, PDF, MOBI, and More
   - Fpga Implementation Of Mimo System Using Xilinx System For Compatibility with Devices
   - Fpga Implementation Of Mimo System Using Xilinx System For Enhanced eBook Features
7. Enhancing Your Reading Experience
   - Adjustable Fonts and Text Sizes of Fpga Implementation Of Mimo System Using Xilinx System For
   - Highlighting and Note-Taking Fpga Implementation Of Mimo System Using Xilinx System For
   - Interactive Elements Fpga Implementation Of Mimo System Using Xilinx System For
8. Staying Engaged with Fpga Implementation Of Mimo System Using Xilinx System For
   - Joining Online Reading Communities
   - Participating in Virtual Book Clubs
   - Following Authors and Publishers Fpga Implementation Of Mimo System Using Xilinx System For
9. Balancing eBooks and Physical Books Fpga Implementation Of Mimo System Using Xilinx System For
   - Benefits of a Digital Library
   - Creating a Diverse Reading Collection Fpga Implementation Of Mimo System Using Xilinx System For
10. Overcoming Reading Challenges
    - Dealing with Digital Eye Strain
    - Minimizing Distractions
    - Managing Screen Time
11. Cultivating a Reading Routine Fpga Implementation Of Mimo System Using Xilinx System For
    - Setting Reading Goals Fpga Implementation Of Mimo System Using Xilinx System For
    - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Fpga Implementation Of Mimo System Using Xilinx System For
    - Fact-Checking eBook Content of Fpga Implementation Of Mimo System Using Xilinx System For
    - Distinguishing Credible Sources

13. Promoting Lifelong Learning
    - Utilizing eBooks for Skill Development
    - Exploring Educational eBooks
14. Embracing eBook Trends
    - Integration of Multimedia Elements
    - Interactive and Gamified eBooks

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