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 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.

I. 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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Design and FPGA Implementation of a SISO and a MIMO Wireless System for Software Defined Radio Peng Dong,2009 *An FPGA Implementation of MIMO Baseband Systems* Yuming Liang,2007 **MIMO Systems** Hossein Khaleghi Bizaki,2011-04-04 In recent years it was realized that the MIMO communication systems seems to be inevitable in accelerated evolution of high data rates applications due to their potential to dramatically increase the spectral efficiency and simultaneously sending individual information to the corresponding users in wireless systems This book intends to provide highlights of the current research topics in the field of MIMO system to offer a snapshot of the recent advances and major issues faced today by the researchers in the MIMO related areas The book is written by specialists working in universities and research centers all over the world to cover the fundamental principles and main advanced topics on high data rates wireless communications systems over MIMO channels Moreover the book has the advantage of providing a collection of applications that are completely independent and self contained thus the interested reader can choose any chapter and skip to another without losing continuity **Nanoelectronics, Circuits and Communication Systems** Vijay Nath,J.K. Mandal,2020-11-17 This book features selected papers presented at the Fifth International Conference on Nanoelectronics Circuits and Communication Systems NCCS 2019 It covers a range of topics including nanoelectronic devices microelectronics devices material science machine learning Internet of things cloud computing computing systems wireless communication systems advances in communication 5G and beyond Further it discusses VLSI circuits and systems MEMS IC design and testing electronic system design and manufacturing speech signal processing digital signal processing FPGA based wireless communication systems and FPGA based system design Industry 4 0 e farming semiconductor memories and IC fault detection and correction *ICT for Intelligent Systems* Jyoti Choudrie,Parikshit N. Mahalle,Thinagaran Perumal,Amit Joshi,2026-01-01 This book gathers papers addressing state of the art research in all areas of information and communication technologies and their applications in intelligent computing cloud storage data mining and software analysis It presents the outcomes of the 9th International Conference on Information and Communication Technology for Intelligent Systems ICTIS 2025 held in Bangkok Thailand The book discusses the fundamentals of various data analysis techniques and algorithms making it a valuable resource for researchers and practitioners alike *MATLAB* Vasilios Katsikis,2012-09-26 This excellent book represents the second part of three volumes regarding MATLAB based applications in almost every branch of science The present textbook contains a collection of 13 exceptional articles In particular the book consists of three sections the first one is devoted to electronic engineering and computer science the second is devoted to MATLAB SIMULINK as a tool for engineering applications the third one is about Telecommunication and communication systems and the last one discusses MATLAB toolboxes Proceedings of the 3rd International Conference on Frontiers of Intelligent Computing: Theory and Applications (FICTA) 2014 Suresh Chandra

Satapathy,Bhabendra Narayan Biswal,Siba K. Udgata,J.K. Mandal,2014-10-17 This volume contains 95 papers presented at FICTA 2014 Third International Conference on Frontiers in Intelligent Computing Theory and Applications The conference was held during 14 15 November 2014 at Bhubaneswar Odisha India This volume contains papers mainly focused on Data Warehousing and Mining Machine Learning Mobile and Ubiquitous Computing AI E commerce Distributed Computing and Soft Computing Evolutionary Computing Bio inspired Computing and its Applications **FPGA Implementation of MIMO System for Symbol-wavelength-spaced Antennas** Harshal Desai,2007 **Signal Processing Techniques for Computational Health Informatics** Md Atiqur Rahman Ahad,Mosabber Uddin Ahmed,2020-10-07 This book focuses on signal processing techniques used in computational health informatics As computational health informatics is the interdisciplinary study of the design development adoption and application of information and technology based innovations specifically computational techniques that are relevant in health care the book covers a comprehensive and representative range of signal processing techniques used in biomedical applications including bio signal origin and dynamics sensors used for data acquisition artefact and noise removal techniques feature extraction techniques in the time frequency time frequency and complexity domain and image processing techniques in different image modalities Moreover it includes an extensive discussion of security and privacy challenges opportunities and future directions for computational health informatics in the big data age and addresses the incorporation of recent techniques from the areas of artificial intelligence deep learning and human computer interaction The systematic analysis of the state of the art techniques covered here helps to further our understanding of the physiological processes involved and expandour capabilities in medical diagnosis and prognosis In closing the book the first of its kind blends state of the art theory and practices of signal processing techniques inthe health informatics domain with real world case studies building on those theories As a result it can be used as a text for health informatics courses to provide medics with cutting edge signal processing techniques or to introducehealth professionals who are already serving in this sector to some of the most exciting computational ideas that paved the way for the development of computational health informatics **Silicon Systems For Wireless Lan** Zoran Stamenkovic,Gildas Leger,Alberto Bosio,2020-11-27 Today s integrated silicon circuits and systems for wireless communications are of a huge complexity This unique compendium covers all the steps from the system level to the transistor level necessary to design model verify implement and test a silicon system It bridges the gap between the system world and the transistor world between communication system circuit device and test engineers It is extremely important nowadays and will be more important in the future for communication system and circuit engineers to understand the physical implications of system and circuit solutions based on hardware software co design as well as for device and test engineers to cope with the system and circuit requirements in terms of power speed and data throughput Related Link s **Proceedings** ,2004 *Proceedings of the ... ACM Great Lakes Symposium on VLSI.* ,2007 *The 14th IEEE 2003 International Symposium on*

Personal, Indoor, and Mobile Radio Communications Ke Gong,Zhisheng Niu,2003 **VLSI Architecture for High-capacity Wireless Communications** Wen-Chih Kan,2007 **Conference Record of the Thirty-Seventh Asilomar Conference on Signals, Systems & Computers, November 9-12, 2003, Pacific Grove, California** Michael B. Matthews,2003 **Dissertation Abstracts International** ,2007 **Journal of VLSI Signal Processing Systems for Signal, Image, and Video Technology** ,2007 2002 International Zurich Seminar on Broadband Communications ,2001 These conference notes on communication networks and systems cover topics including wireless local area networks power line communications smart antennas and space time signal processing xDSL cable modem technologies and signal propogation and channel modelling **DSP for Embedded and Real-Time Systems** Robert Oshana,2012-07-12 This book includes a range of techniques for developing digital signal processing code tips and tricks for optimizing DSP software and various options available for constructing DSP systems from numerous software components MIMO System Implementation for WSN Using Xilinx Tools Wael M El-Medany,2011

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