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

Sparsh Mittal* and Saket Gupta

*Corresponding Author Address: Department of Electrical and Computer Engineering
Iowa State University, Ames, Iowa, USA
Email : sparshomittal@gmail.com

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 Array); 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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