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Real Time FPGA Communication System Using Ethernet for Robotics

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Abstract

In this paper, Ethernet bridging on Field Programmable Gate Arrays (FPGA) is being discussed. Ethernet has been used widely in the embedded design industry nowadays. The transferring data between FPGAs are essential with the advancement of embedded system technologies. Ethernet bridging between FPGAs has been chosen because its reliability on transferring data. There are a lot of companies producing FPGA boards, one of it is ALTERA. ALTERA has manufactured different kinds of boards to suite the requirement of engineers nowadays. One of the examples of it is the DE2-115 FPGA board. This board has a soft-core processor in it which is called Nios II. Network bridging on DE2-115 FPGA requires the programming of the Nios II. In this paper, the network bridge system on FPGA is set up and an input which is the data is send through the network. The result expected from the experiment is the input is properly displayed and it is send successfully in through the network.

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Keywords: Ethernet; Nios II; FPGA; DE2-115; Triple Speed Ethernet

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1.Introduction

Robots are used in many aspects of human life nowadays. Effective robotics communication is the key for it to complete the task given. Robotics communication system technology plays an important role so that the robots do what they are purposely built for. Engineers working hard to improve the robotics communication system by looking into embedded system as an alternate option. In today's modern world, FPGA technologies are being looking into to help to improve the robotics communication system. FPGAs are equipped with Ethernet technology that has been used widely in the embedded design industry nowadays. Ethernet helps in bridging the network for the FPGA boards. The standard protocol used for the Ethernet is the IEEE 802.3. Network bridging using Ethernet for FPGA can improve in terms of communication because of it assures high throughput and reasonable latency. The paper is organized in four sections which are related work, framework, results and conclusion.

2.Related work

Networking using FPGA boards has been used widely in embedded design technologies. W Zhang et al. [1] have developed networking for high speed data. Using their method, the result of the data transfer of the networking system was clear levels, the simulation of the data of the system was accurate and the testing result was reliable.

According to V. R. Gad et al. [2], their experiment was based on implementation of Ethernet standard using FPGA. Through their experiment, Gigabit Ethernet performance were analysed which is the Gigabit Ethernet Standard 1000Base-LX, 1000 Base-SX and 1000Base-T. D. Qiu et al. [3] on the other hand have worked on networking between FPGAs which used System on Programmable Chip (SOPC) to implement the Gigabit Ethernet. Using their method, the network of the Gigabit system is set up using SOPC builder and the data transmission are connected using TCP/IP protocol. The results of their research are the power dissipation during the networking is reduced and it improves the flexibility of the Gigabit Ethernet system. Fritz Mayer-Lindenberg [4] , implemented networks on FPGA through mapping process. The mapping process is designed on Spartan-3A and Virtex-5 FPGA boards which are from Xilinx. From the research, the performance of the FPGA boards tested are measured and analysed.

G. Brebner et al. [5] implemented networking on chip with platform FPGA. Their method of networking the fpga was by sending data packet using switching network on Xilinx Virtex fpga board. A. S. Bharadwaj et al. [6] have put forward an implementation of the Ethernet Bridge using Avalon Memory-Mapped Interface. The network connection was established between two DE2-115 ALTERA FPGA boards. The two Nios II processors were configured to control the network system. The outcome from their research showed that the speed of the data transfer was increased greatly and the power usage during the networking process on the other hand had been reduced.

P. P. P. Zode [7], has presented a novel approach for the implementation of an embedded web server on Nios embedded platform. Through this method, the web server is used for the networking process. The embedded web server communicates with the web browser through TCP/HTTP. The author came up with a design of the networking system which was simpler and more efficient in terms of re-configurability, and in addition to that, the cost of building the system was lower whilst the power consumption used during the process was greatly reduced. Tercio A.S.Filho et al. [8], introduced the research on Network Nod with Wireless and Wired Interfaces on FPGAs. Their technique involved setting up the network gateway with two interfaces, one using wireless using Zigbee method while the other was directly connected via RS232. The two methods were developed using Nios II soft-core processor and uClinux operating system. They were able to improve the flexibility of the networking, to be more adaptable to network conditions.

According to the research conducted by Kees Goosens et al. [9], utilizing networks on chip are hardwired in FPGA, saves configuration of the footprints (bits) as well as the configuration time. The use of hard busses can result in quicker reprogramming compared to its soft counterparts. The hard interconnects are also disjointed from the soft IPs and layout restrictions were reduced. Chen Xin Zhi et al. [10], implemented Ethernet ports on FPGA as the networking system for the FPGA. Through their method, the systems receive and deal sampled values (SV) data packet from multiple Ethernet ports at the same time. The FPGA is used to implement the independent Ethernet MAC for each port. Through this method, the pre-processor board does some extra work to boost up the performance of the protection processor. From the previous experiments reviewed, the area which can be improve for network bridging using FPGA are throughput and the speed of the data transfer during the network bridging process.