International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 4 Issue: 8 187 - 189

Data Compression to combat tracking issues in RADAR Sensor scenario: An on going case study

N. S. Murti Sarma, V. Dhananjayulu1, S. P.Venumadhava Rao
Sreenidhi Institute of science and technology, Yamnampet, Ghatkesar, Rangareddy, TS, India
1. Defence Electronic Research Laboratories, Hyderabad, TS, India

Abstract: In general , high data transfer rate of RADAR emitter would be a challenge for slow tracking devices. One of the solution to such problems, is adresssed in this paper. Data compression, by differential encoding technique facilitates to implement on available devices with less performance levels.

Keywords: *Radar Emitter, Data Transfer rate, Data Compression,*

*****

1. Introduction

An Electronic support Measure (ESM) or Electronic support (ES) sensor is a part of Electronic warfare system which gives the track the enemy RADAR emitters. ES is a non radiating system which intercepts the RADAR emissions, diagnoses the intercepted emissions and gives the emission characteristics. Generally the interception radar emission is done by antennas and which giver this sensed information to the super heterodyne receivers. This super heterodyne receiver will diagnose the intercepted pulses and gives it to the digital conversion modules. Now after digital conversion of this pulse information they are stamped with time difference of their arrival called time of arrival, after stamping the digital format whole information framed to a single word called Pulse description word (PDW). This PDW is contain of rising edge frequency of pulse, falling edge frequency of pulse, time of arrival of pulse, direction of arrival of pulse, amplitude of pulse, pulse duration or pulse width of pulse.

A. Distributed ESM System

In Distributed ESM Systems single channel ESM sensors are used and are placed at 10 to 25 KM distance between sensors. In this configuration each sensor measures RADAR emitter parameters and transfers data to master station for further computation. The master station receives all sensor information and calculates the location fixing information based on Time Difference of Arrival principle and sends the sensor data to ESM processor and Display to provide track update and display.

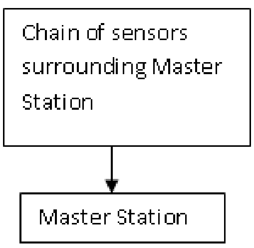

Figure1: ESM system archtecture

In this configuration as shown in above figure, the sensors are single channel systems, where the individual radar sensor data must be transferred to master station through either wired or wireless link to calculate location fix of emitter information. Most systems have a limitation of data transfer rates. To overcome this problem data compression techniques will help us to reduce data link rates and provides practical implementable systems.

2. Related work

Earlier work on proposal was aimed at different communication methods and compression techniques by several authors is briefly as follows.

Y. Ren, et.al[1] have implemented a Run length compression scheme. Here before implementing this algorithm they have studied the type of data that they are needed to transmit in their particular application (Telemetry in Aeronautic Science in multichannel environment) and selected this algorithm as suitable in their field. They have considered device performance levels that on which they are implementing these specific algorithms and they have started modelling this proposed design. Abed et.al[2], described the design of RS232 asynchronous communication on two FPGA devices. They have implemented a roll-dice game with the two FPGA devices., the authors have implemented Real-time Ethernet Communication Using RMII Interface on FPGA is done by Khalilzad et.al [3]. In this, advantages of the FPGA devices over the regular commercial microprocessors and their feasibility to implement the communication protocols is mentioned.. Here the implementation is done by using the IP core of 100 Mbps rated communication channel. Also the timing analysis of Ethernet communication protocol is discussed. The transmission of 128 bit parallel data serially by using the aurora protocol is discussed else where[4].

B. Scope Of The Work

Generally in any network the data compression techniques are used for data transmission at low rates, here the aim deals with data transmission which needed loss less data reception. to achieve this the loss less data transmission is done by dynamic switching of compression ratio levels which results data transmission done at efficient rates.

One requires to consider some practical issues for implementing the compression that are as follows.

a) Compression and decompression should not be an over burden for regular system because the system needs to be reactive for changes that happen in a faction of micro seconds.

b) Compression must be lossless.
c) Compressed data should be generated so that it is easy to transmit on available media means. For example if we use Ethernet media the generated compressed data should be in Ethernet protocol supported format and should be ready for transmission.
d) Data transmission should be done at high speeds
e) There should be limited delays due to application of compression and decompression so that the devices should be able to implement the communication without the overridden nature of results.

C. Objectives Of The Work

i. Lossless compression of PDWs using differential encoding technique
ii. Implement a high speed data transmission of above compressed data serially at the rate of 3.125Gbps using architectural features of virtex-5 FPGA. The data transmission and reception is carried out using Aurora protocol on Multi-Gigabit Transceivers (MGT's). This high speed serial PDWs data are sent to PD and control processor on a dedicated fiber optic link and it is also sent to ESM processor on copper using a back plane for further processing.
iii. Successful Decompression of compressed PDW data.

3. Implementation Issues

Compressor is designed by using differential encoding technique with different levels and the compressor which switches its compression levels dynamically according to the redundancy nature of data. Tx and Rx in above Fig. are data sender and receivers. The FIFO though it shown in above figure as sing box, dedicated devices exists for sender as well as receiver respectively.

Transmission of this compressed data on a high speed medium by utilizing aurora protocol on available devices and the lossless reception of the compressed data.

Design of suitable decompression module by using the controls in received compressed data. For testing the designed modules we apply different types of input vectors for its functionality.

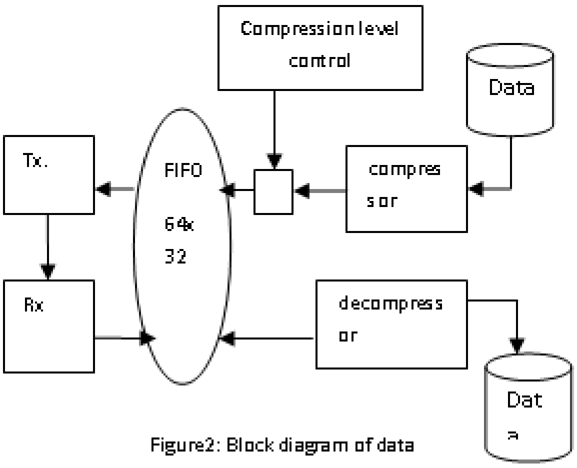

Figure2: Block diagram of data processing

In this work for choosing proper compression technique firstly the data which need to be transmitted is studied for finding its nature of redundancy and then we choose the suitable compression technique which is loss less compression technique.

A suitable communication model is used for data transmission and in the compression module the control signals for data transmission and the data decompression are generated along with the compression and are included in the transmitting compressed date, Here while designing the compressor, it is designed in such a way that it has different levels of compression and depending on the nature of data that comes for compression the compression levels are switched and the compressed data is transformed into the form in which it is communicated using available transmission media. Here we use two FIFO buffers one between the compressor and data transmission modules and the other between the data reception and decompression modules. These FIFOs are useful for synchronizing the clock rates of the sender-compression modules and the receiver-decompression modules and also are useful for data loss prevention.

Then after receiving of data we at receiving end we implement suitable data decompression algorithm for re generation of original data and is done by using the control signals in received compressed data. Core generators of the Xilinx tools are used while developing the FIFO and communication and clock modules.

4. Results And Discussion

The results presented in this section are of the partial work undergoing for a M.Tech dissertation. The compressed PDW before transmission from and Decompressed PDWs after receiving from sensor at master station are shown in figure 3.

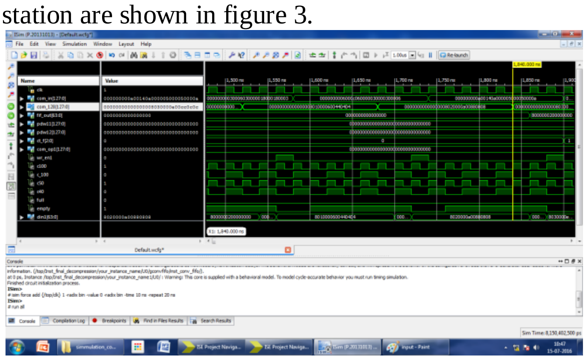

Figure.3 Compression

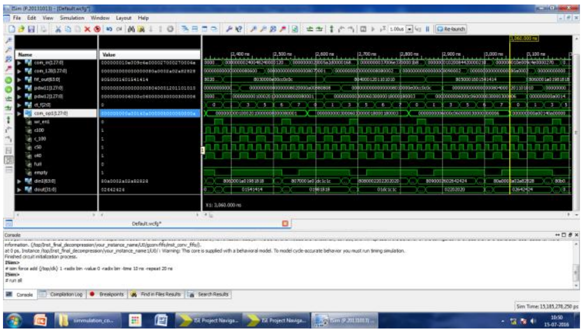

Figure.4 decompression

The transmission and reception between sensors to master station are shown in figure 5.

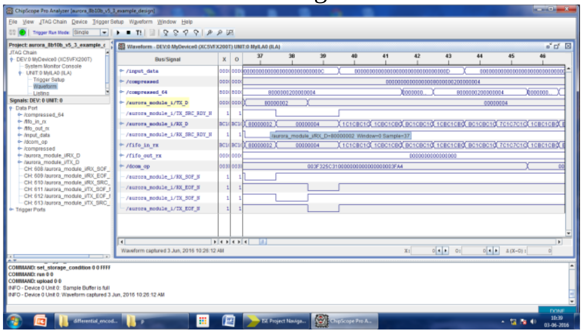

Figure.5 transmission and reception

5. Conclusions

The RADAR data pulse description words are compressed using differential encoding technique at the sensor design and transmitter by using aurora protocol to master station end, here at master station end the transmitted data is received and decompressed. Finally the original data is reconstructed.

Acknowledgements

Part of the work represented in this paper is under dissertation of M.Tech, carried out at DLRL, Hyderabad.

References

[1]. Yongfeng Ren, Xiaohua Liu, Wenqiang Xu & Wendong Zhang, “Multi-Channel Data Structure andReal-Time Compression Algorithm Research,” *IEEE A&E systems magazine*, November 2009.

[2]. Sa’ed Abed, Bassam Jamil Mohd, Bassam Alnaami and Sahel Alouneh, "Design and Implementation of Interfacing two FPGAs," *International Conference on Innovations in Information Technology*IEEE. , Dec. 2012

[3]. Nima Moghaddami Khalilzad, Farahnaz Yekeh, Lars Asplund and Mostafa Pordel,"FPGA Implementation of Real-time Ethernet Communication Using RMII Interface," *Communication Software and Networks (ICCSN), 2011 IEEE 3rd International Conference*, 2/11 2011 IEEE.

[4]. S.Venkata Kishore M.Srilatha Mr.Y.S.Chakrapani Dr. M. Kamaraju, and Mr. S.R.Pankaj Kumar," Design and Implementation of High Speed Data Transmission over Dual Independent Aurora Channels on One GTX dual tile usingVirtex-5 FPGA," *International Journal of Scientific & Engineering Research*, December-2013.

[5]. Masayuki Omote, Kanemitsu Ootsu, Takeshi Ohkawa, "Efficient Data Communication using Dynamic Switching of Compression Method," *2013 First International Symposium on Computing and Networking IEEE*, DEC 2013.

[6]. Ziv. J, Lempel. A, “A Universal Algorithm for Sequential Data Compression,” *IEEE Transactions on Information Theory*, vol.23, pp.337–342, 1977.

[7]. Yingsheng Ji, Shunqiang Song, Shu Wang and Guangwen Yang" Runtime Message Compression To Improve The Coupling In Earth System Modeling," *Information Science and Control Engineering 2012 (ICISCE 2012), IET International Conference*, Dec. 2012.

[8]. ZHOU Dexiang1 , ZHENG Liping2," Study of Aurora IP Nuclear Communication Module Based on FPGA," *Communication Software and Networks (ICCSN)*, 2011.

[9]. Alex Harding, Kevin Ellsworth, Brent Nelson, and Michael Wirthlin," Characterization and Mitigation of the MGT-Based Aurora Protocol in a Radiation Environment," *IEEE Radiation Effects Data Workshop (REDW)*, 2013 *A.Supporting Data/manuals*

[10]. LogiCORETM IPAurora 8B/10B v5.3,DS637,2012.

[11]. Virtex-5 FPGA RocketIO GTX Transceiver

[12]. *User Guide*, UG198 (v3.0) October 30, 2009