PCA ANALYSIS AND DATA TRANSMISSION FORM VESSEL

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1. Introduction

Principal Component analysis (PCA) is a useful statistical technique that has found application in fields such as face recognition and image compression, and is a common technique for finding patterns in data of high dimension.

It is a way of identifying patterns in data, and expressing the data in such a way as to highlight their similarities and differences. Since patterns in data can be hard to find in data of high dimension, where the luxury of graphical representation is not available, PCA is a powerful tool for analysing data.

The other main advantage of PCA is that once you have found these patterns in the data, and you compress the data, ie. by reducing the number of dimensions, without much loss of information. [1-2]

The departure hypothesis is based in that it is possible to use PCA theory to manage great quantity of data recollected onboard form vessel control system to send it through satellite.

2. Results and Discussion

The materials used were the data (numbers) collected in LNG vessel “Castillo de Villalba”. With this information, PCA algorithm was performed and Row Feature vector of eigenvectors, original data means and final data of PCA obtained.

After choosing proper components, was prepared the package of double precision numbers (64 bit) to send once for satellite.

These data was received on shore and the procedure of reconstruction of the data settles down in destination, comparing them with the originals.

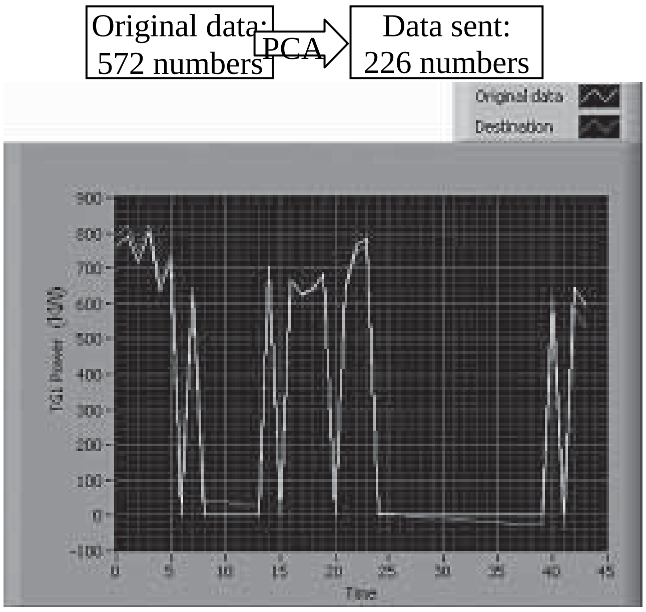

Figure 1.- Comparison between original and reconstructed data in destination. Original data were 572 numbers and transmitted 226.

3. Conclusions

PCA help to reduce significantly data amount e send via satellite, reducing communication costs. This strategy will be proper to take maintenance decision on-shore.

4. References

[1] J., Baró, et al “Estadística II”. Ed. Fundació per a la Universitat Oberta de Catalunya. Barcelona, 2000.

[2] D. Peña Sánchez de Rivera, “Estadística. Modelos y Métodos. Volumen 2”. Ed Alianza. Madrid, 2007.

LOW COMPLEX WIRELESS SENSOR NETWORK UPLINK IN THE HF BAND

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1. Introduction

This paper presents the uplink digital communication system for WSN (Wireless Sensor Network) applications in the HF (High Frequency) band. The downlink connection is presented in another paper. We are currently prototyping the system and we need to conclude this work in order to perfectly define a parameters system. In a WSN in which there is a node working as a BS (Base Station), this node needs to transmit information to all other nodes, so we have proposed a downlink based on a OFDM-DCMA (Orthogonal Frequency Division Multiplexing - Code Division Multiple Access) strategy. The nodes that only collect information and transmit it to the BS will occasionally use an uplink strategy based on OFDM (Orthogonal Frequency Division Multiplexing). The signal from each node to the BS will be composed of a burst of several OFDM symbols. The symbols at the beginning of the burst are known and bring information for synchronization, channel estimation and equalization. As the BS transmits a continuous signal with time and periodic information for all nodes, when a node needs to send information, in order to avoid collisions, it waits for its time and then uses all the uplink bandwidth to transmit its information. Optionally, the nodes can change to a low-power function mode for a time period. [1]

The first issue to take into account in developing a digital communication environment like this, is that, today, it is possible to construct digitally the HF signal to attach the amplifier directly from the DAC (Digital Analogue Converter). It is also possible to take samples just in the output antenna amplifier. The transceivers could almost all be built using digital technology, and the RF (Radio Frequency) subsystem is reduced to an amplifier and an antenna. In the HF band, filters, rough synchronization, base band conversion, fine synchronization, channel equalization, demodulation and decoding processes could be done digitally. Modern FPFA (Field Programmable Gate Arrays) provide the digital hardware resources to build the transceivers.

Another reason to use the HF band is that in this band the space losses are lower than in higher bands and diffraction, which is present in this band, usually extends the area to cover beyond the direct light of the signal.

2. Rapid prototyping and Methodology.

The design flow and the verification process are achieved through the use of the latest generation system level design tools for DSPs (Digital Signal Processing) into FPGAs. To fast prototype both the MS and the BS we use two kits XtremeDSP from Xilinx. These kits have been designed basically for DSP systems. The tools are Matlab/Simulink from Mathwork, and System Generator from Xilinx. Simulink provides a powerful high-level modelling environment for DSP systems and consequently it is widely used in algorithm development and verification. The System Generator for DSP maintains a very friendly abstraction level with the traditional Simulink block sets and, at the same time, it automatically translates designs into hardware implementations that are faithful, synthesizable and efficient. The rapid prototype design flow begins with double precision algorithm exploration and validation.[2]

The System Generator provides the three arithmetic data types: double precision floating points, and signed and unsigned fixed point numbers that allow both exploring and fixedpoint modelling algorithms. An algorithm model is obtained and can be simulated. Once this model is validated, it is translated into efficient hardware (VHDL) and then synthesized, placed and routed into FPGA by means of an automatic process. After this step a co-verification model is obtained, which allows platform exploration with a refinement process.

3. Synchronization and Estimation channel

This system has 60 information subcaniers. The applied modulation is QPSK and the channel coding Reed Solomon scheme (15/9) was used for error protection. The symbol duration is approximately 30ms.

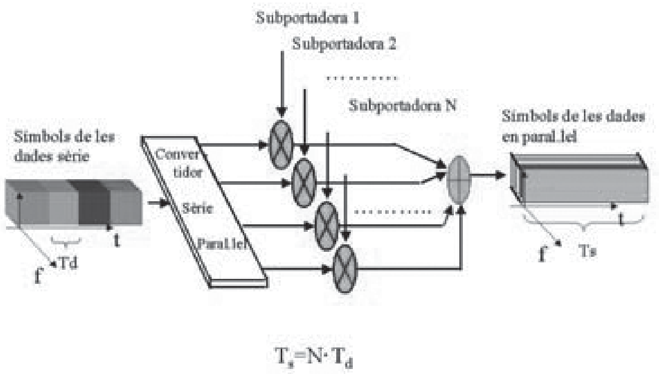

Figure 1. OFDM representation diagram

In packet-type communication systems there are several types of preambles or "training data", which are inserted into the transmitter at the beginning of each data burst, in order to achieve channel synchronization and estimation. (Fig.2)

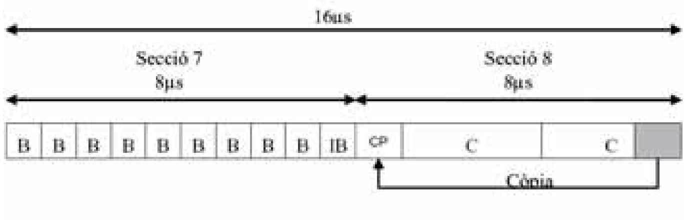

Figure 2. Synchronization and Estimation preambles.

These communication systems generally assume that the channel is constant during the length of the data burst. This greatly simplifies the channel estimation problem. It also avoids relative delays between symbols before the first channel estimates are calculated. The training sequence for channel estimation consists of two OFDM symbols C, preceded by a cyclic prefix CP, which is a copy of the last N samples of the symbol C.(Fig.3) [3][4][5]

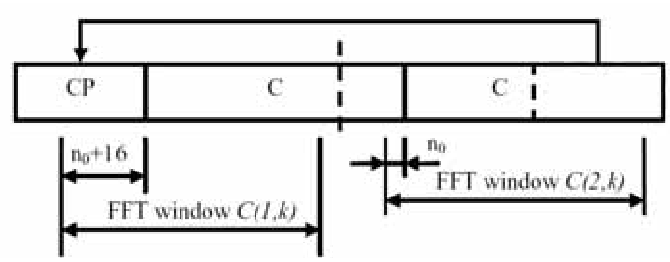

Figure 3. Estimation preamble.

4. Conclusions

We assume a cellular structure for the WSN. OFDM-CDMA is the multiple access strategy used in the downlink.

In most wireless sensor networks the BS does not have low-power limitations which could be used in the down-link to send time information to nodes.

An efficient strategy for the uplink is based on sending a burst of several OFDM symbols from nodes to BS. These symbols have to be extended using cyclic prefixes to avoid ISI (Inter Symbol Interference) and ICI (Inter Carrier Interference). The first burst symbols are known and provide information to obtain the time and frequency synchronization and channel equalization assistance. The introduction of pilot symbols allows the system to operate with low-complex receivers. In the uplink the MAI (Multiple Access Interference) is avoided because each node has its time slot to send information.

OFDM-DCMA modulations in the uplink do not have the same beneficial properties as in the downlink. In the uplink, it is very difficult to obtain perfect code synchronization between different nodes in the receiver so the WH codes are not perfectly aligned and MAI appears. The use of OFDM-DCMA in the uplink means more cost and complexity. Therefore, in order to have low cost transceivers we have chosen OFDM and the different modes access the medium by a TDMA (Time Division Multiple Access) strategy and each node uses its time slot.

5. References

[1] I. Raos, A. Del Cacho, I. Pkrez-Alvarez, S. Zazo, E. Mendieta-Otero, H. Santana-Sosa, J.M. Phz-Borrallo, Performance of an OFDM-CDMA HF modem. Printed and published by The IEE, Michael Faraday House, Six Hills Way, Stevenage, SG1 2AY

[2] J. Hwang, B. Milne, N. Shirazi, J. Stroomer, System Level Tools for DSP in FPGAs, Xilinx Inc, USA.

[3] M.Serra, Prototipatge Ràpid de la Capa Física d'OFDM: cas HIPERLAN2, Phd, UAB, 2005.

[4] M.Serra, J.Ordeix, P.Martí, J.Carrabina, OFDM Demonstrator: transmitter, 7th International OFDM-Workshop, Hamburg, 2002.

[5]M. Serra, P. Martí, J. Carrabina, Implementation of a Channel Equalizer for OFDM Wireless LANs. 15th IEEE International Workshop on Rapid System Prototyping, Geneva, Switzerland, 2004.