Xport, a compact radar for hydrological application

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1   Introduction

Since spring 2005, the Xport, X band polarimetric radar, is installed in Djougou Benin as one of the instrument used during the Africain Monsoon Multidiciplinary Analyses (AMMA).

This radar has been designed for hydrological research to provide real time rain field data, and cloud micro physics studies. It is compact, easy to install, and designed to be operated in rough tropical area.

A low cost Echotek PCI board is in charge of the data acquisition and controlled under RTLinux. The real time core associated with the high performance ICC compiler allows to process the I and Q samples without compromise on the acquisition characteristics on the same single processor PC. A Linux homemade user interface software, named RADON , can be used on the local workstation or on an remote one over internet. This software sends radar acquisition parameters to the radar server, and displays and saves the current data.

This cost-effective solution for radar acquisition management could be implemented on different type of radar, independently of the frequency used.

2   GENERAL DESCRIPTION

Xport is a dual polarisation X band Doppler radar. For the needs of the AMMA experiment, Xport has been installed in Djougou, in the northern Benin, since May 2005. The primary objective is to sample with a high spatial and temporal resolution the rain fields associated to the precipitating systems which cross the Donga shed, a sub-shed of the Ouémé water shed. The main application is to derive from radar measurement the Quantitative Precipitation Estimates (QPE) which are needed as a forcing field to run hydrological models.

Figure 1 : Xport on its tower at Djougou, may 2004

3   HARDWARE RECEPTION SYSTEM

The power transmitted by the SD349 CPI magnetron is sent to the H and V channels through a balanced magic tee. Thus transmission and reception are simultaneous thanks to an orthomode feed.

The characteristics of the transmitted pulse, phase and frequency, are computed in the acquisition PC. This measure can be done on a sample taken directly on the wave guide through a directive coppler , so called burst mode, or on the signal provided by the transmission leakage through the circulator, the leakage mode. This choice of mode is control by an IF switch connecting the burst channel during few microseconds after the trigger or in bypass mode.

Due to the under sampling technique used by the acquisition board , the IF signal at 60 Mhz can be directly digitalize and then send to the numerical receivers.
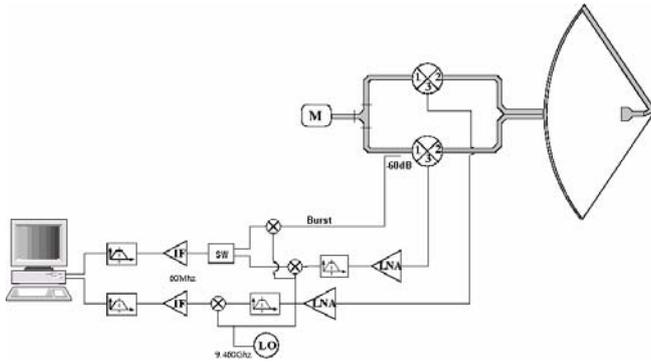
Fig 2 : Xport reception schematic

4 REAL TIME ACQUISITION CONTROL

The data acquisition is done by a low cost board ECDR-GC214-PCI, provided by the Echotek company, formely Mercury Computer Systems Inc. This off the shelf product, can be mounted on a standart PC trough this PCI bus. It guaranties to get the lastest processor, bus and chipset performances of the market for a very low price.

In the same way, all the control programs have been developed over free software operating systems. To guaranty the real time acquisition control of the ECDR board, we have designed our own driver under the RTLinuxFree realtime system and Linux core 2.4.29 and higher so we can take benefit of all the tools done under linux in terms of development, graphic libraries, network and security.

RTLinux guaranties the acquisition and the computation of the pulse pair products in respect of the PRF (1000Hz). The use of the Intel Compiler ICC, gives enough improvement to the realtime part that is possible to run all the application on a single P4 at 3 Ghz.
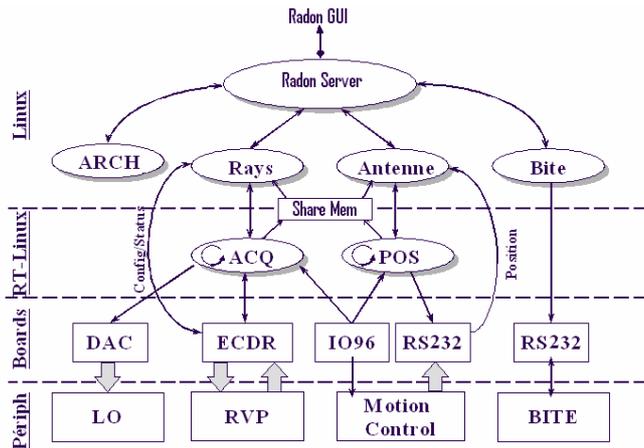

Fig 3 : schematic of the RADON server

5 THE RADON SOFTWARE

To control radar motion and data acquisition, the software RADON, has been designed. The server has to run on the computer attach to the radar and the GUI could connected through a remote link or on the local machine. RADON is doted with a small vocabulary. It's possible to establish a communication between the GUI and the server. Thus, a script built on the GUI is sent to the server to be executed by itself. Today, only the basic functionalities have been implemented : PPI, RHI, FIXE, WHILE, WAIT and WAIT_UNTIL. Soon, we will code some more vocabulary to add intelligent functionalities such as cell detection with automatic modification of the current script.
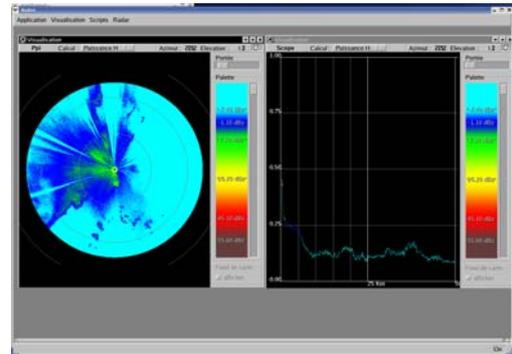
6 SOME RESULTS

Example of radar reflectivities on channel H, differential phase shift, and correlation between the 2 polarizations. Z Hydro is the corrected reflectivity field : the radar constant has been adjusted using the raw reflectivity and the PHIdp field. This field is superimposed on the water shed contours and used to set alarms to start gaging the rivers when necessery

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