A data transmission system for the phase contrast X-ray human computed tomography prototype

Rongqi Sun[1], Lian Chen[1], Houbing Lu[2], Feng Li[1], Ge Jin[1]
1.State Key Laboratory of Particle Detection and Electronics,
University of Science and Technology of China, Hefei, Anhui 230026,china
2.College of Electronic Engineering,Natinal University of Defense and Technology,
Hefei, Anhui 230026 china

The cross section of X-ray phase contrast caused by these low-Z elements is greatly bigger than the absorption. Therefore, in the field of X-ray imaging, the phase shift information can offer better imaging contrast. In this paper, we present a data transmission system for a phase contrast X-ray human computed tomography prototype. This system contains 3 data collecting boards (DCB) and one data transmitting board (DTB). A slip ring is used to transmit the data from the rotator side to the stator side over a nowadays commonly used multi-mode fiber (MMF). On the rotator side, 3 DCBs act as the controller of these detectors. The function of the DTB is to store all image data from 3 DCBs and implement the commutation with PC. The test shows that this system can meet the requirement of the prototype.

1. Introduction

In 2006, a three-grating interferometry phase-sensitive imaging method is proposed, which is a breakthrough in the field of X-ray phase contrast imaging. This method is shown in Fig.1. By grant G0, the normal laboratory incoherent X-ray source is split into several coherent line sources. These line sources can do phase contrast imaging separately. The role of G1 and G2 is to convert the phase shift information into the intensity of the X-ray.

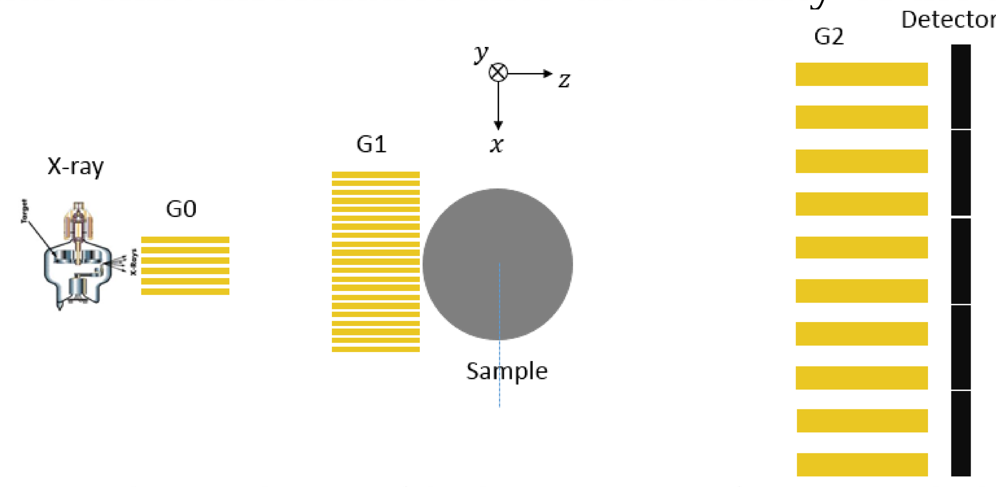

Fig.1 Schematic diagram of the three-grating interferometry methods

NSRL (national synchrotron radiation laboratory) is developing a high phase contrast medical CT relied on three-grating interferometry. In order to obtain 200mm*mm of vision field, this prototype adopt 43 detector boards. Each detector board contain 384 channels coupled with a 20bit ADC. A trigger signal comes every 1.25ms to make 43 detectors start acquisition, which means the total bandwidth of 16512 channels is more than 250Mbps. In addition, as a spiral scanning device, the data of all detectors should be transferred from the rotator side to the stator side. Therefore, in this paper, we present a data transmission system for this prototype to solve the aforementioned problems.

2. System Design

The data transmission system proposed in this paper contains two parts: three DCB and one DTB, as shown in FIG.2. A slip ring including a fiber slip ring and an electrical brush is responsible for bi-communication between the rotator side and the stator side.

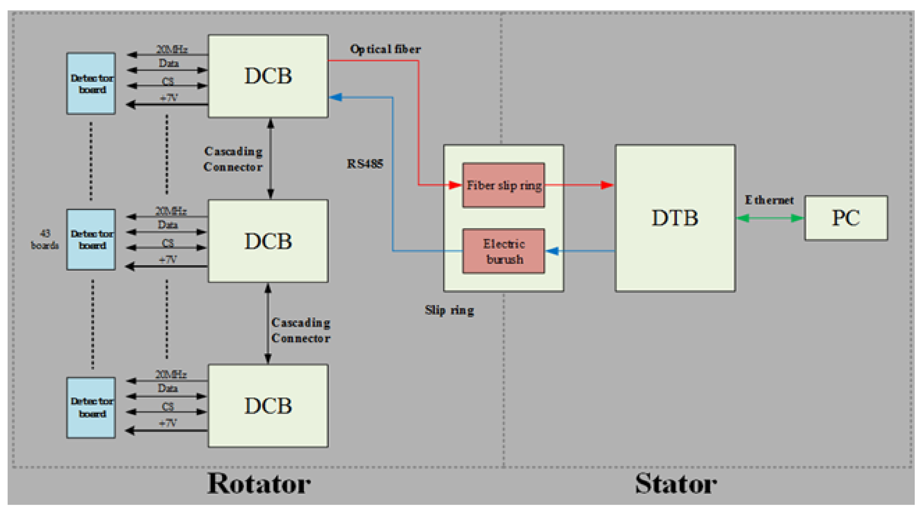

FIG. 2. Schematic Block diagram of the Data transmission System

The design of one DTB and DCB is illustrated in FIG.3 and FIG.4 separately. The RS485 transceiver is used to distribute the commands and configuration bits from the stator side to rotator side.

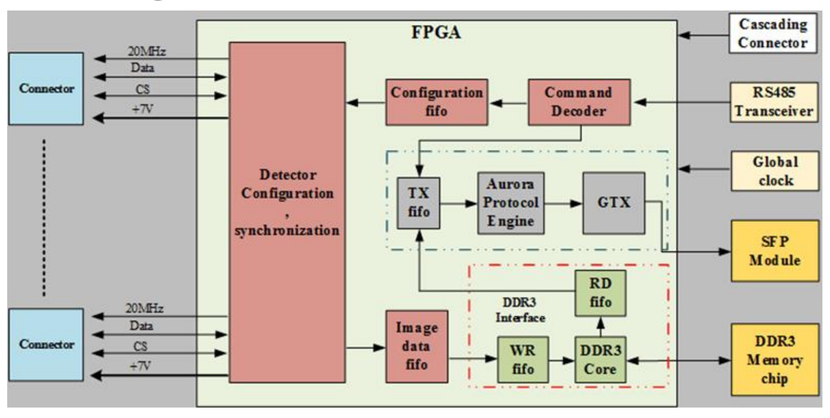

FIG. 3. Schematic Block diagram of the DCB board

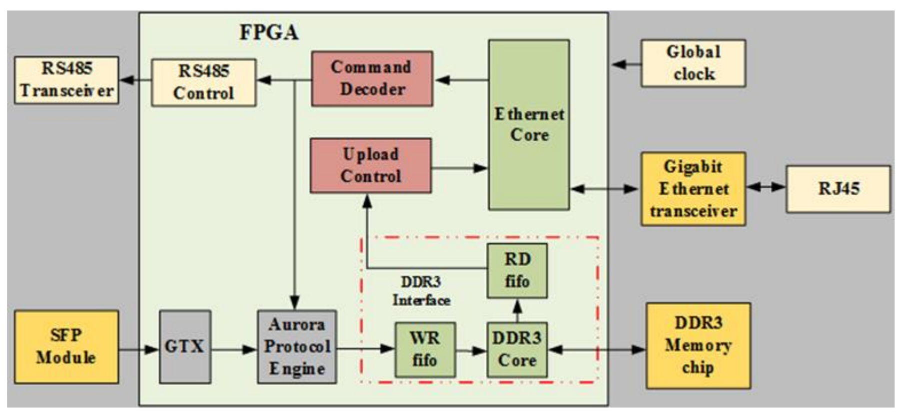

FIG. 4. Schematic Block diagram of the DTB board

On the rotator side, the communication between DCB and detectors is based on SPI protocol. The image data from 43 detector boards are cached in an extern DDR3 on the DCB. We use a aurora8b10b protocol engine that contains a GTX to serialize all image data. Then all serial data are delivered to the stator by the SFP module. On the stator side, The SFP module receives the data and does photoelectric conversion. After that, these data are deserializered by GTX, unpacked by Aurora engine and stored in the DDR3, waiting for uploading. The communication between DTB and PC is relied on a Gigabit Ethernet Transceiver. To simplify the design, the DCB and DTB share the same PCB with different FPGA logic. The PCB is shown in FIG.5.

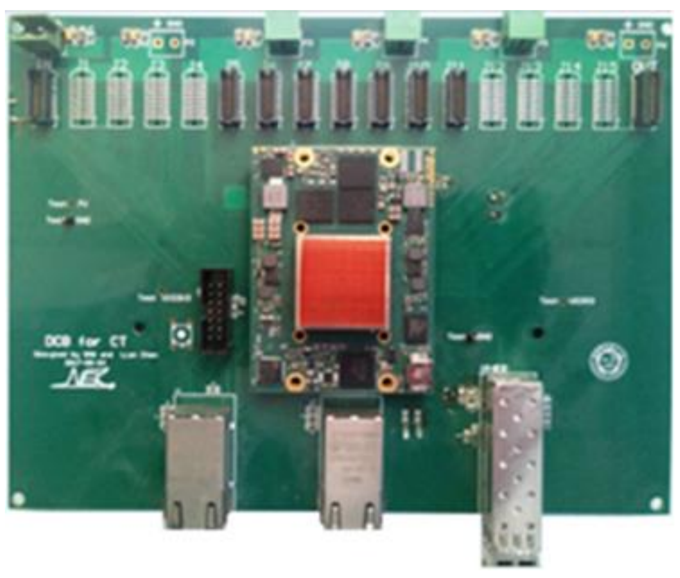

FIG.5. The PCB of the DCB and DTB.

3. Test RESULT

A pseudo-random binary sequence generator (PRBS) is used to the error rate of optical fiber communication., which is carried out by the IBERT tool. The DTB and DTB are interconnected by an optical fiber. The speed is set to 1Gbps. The test result is illustrated in FIG.6. The code error rate is as low as 10E-12 and no bit error occurs during the test. A Long-term stability test of the gigabit Ethernet is performed for 10 hours. When PC sends a reading command, the DTB replies with 256 data packets. Each packet contains 1024B. The average Ethernet speed is calculated per 2 minutes. As shown in FIG.7, the speed can reach up to 850Mbps.

FIG.6 The test result of bit error rate

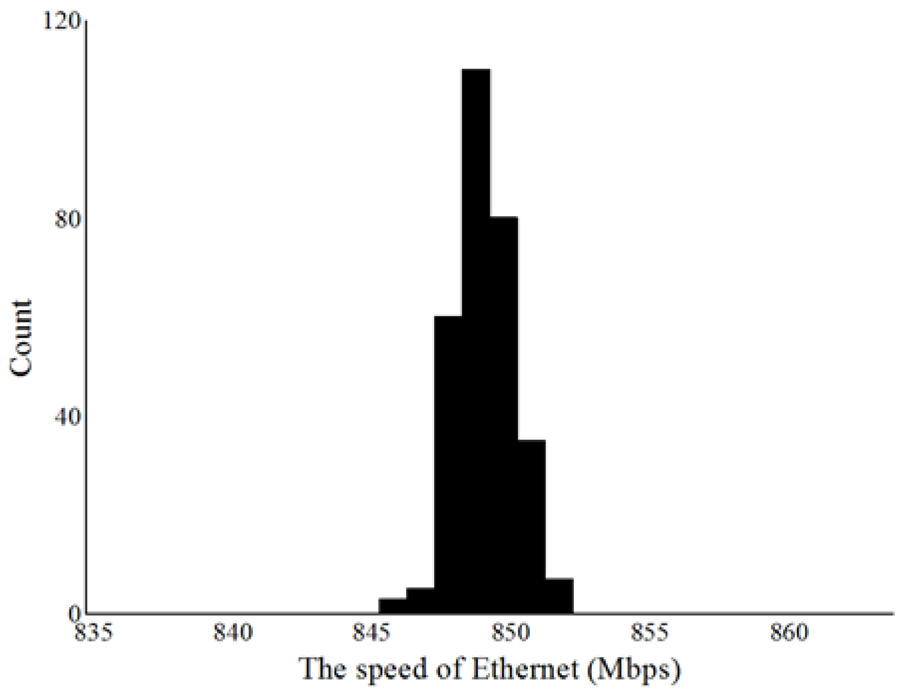

FIG.7. Long-term stability test of the gigabit Ethernet

4. Conclusion

This paper presents a data transmission system for a phase contrast X-ray human computed tomography prototype. The test shows that this system can meet the requirement of data transmission. This system has been applied into a test platform for the prototype successfully.