Real Time Implementation of Strain Measurement System on FPGA and ARM

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Abstract: **A new dynamic strain measurement system is the integration of signal conditioning, data acquiring and data issuing. It can work independently, and can also be connected to the upper computer through the ethernet port for data process and data analysis through the network communication with TCP/IP protocol. This system has enough sampling channels, high sampling frequency and resolution, it can be used in a variety of testing environment. In this project it is expected that the system works on safety and stability, the measuring data is accurate and reliable. Thus this overcomes lot of disadvantages, such as large outlines, inconvenient usage, few channels and low sampling frequency which were caused using conventional dynamic strain measurement system. In order to make the system smart and portable, and to reach the goal of working independently, an embedded processor is chosen as a control center for issuing command and setting sample parameter. Therefore, this strain measurement system will be designed based on the FPGA device by creating an Asynchronous FIFO which is used as buffer of ADC and AR and ARM with WINCE6.0 operating system is the control core of this system; it can modify the sampling parameters in FPGA with great flexibility. Thus the whole system integrates the strain testing, data record, curve display and data analysis in one body, it greatly expand the general function of the traditional strain test equipment. It can meet the complex needs of modern industrial tests with the advantages of high precision, fast data transfer and ease of use.**

KEYWORDS--Strain, TCP/IP Protocol, FPGA, ARM

I.INTRODUCTION

Now a days, Structural Health Monitoring (SHM) technology has been widely applied in the field of aerospace, ships and building structures. The metal structure health monitoring system usually needs to use high-speed dynamic strain gauge to continuously acquire the strain data in different position of the structure, so as to analyze the stress state of reliability degree, it is of great significance to ensure personal and production safety. This project work proposes implementation of a new dynamic strain measurement system which is the integration of signal conditioning, data acquiring and data issuing. It can work independently by employing an embedded processor as a control center for issuing command and setting sample parameter and also can be connected to the upper computer for data process and analysis through the ethernet port.

II. RELATED WORK

"The status and advance on structure health monitoring" proposed by Fang Yu [4] described that, Structural Health Monitoring (SHM) aims to give, at every moment during the life of a structure, a diagnosis of the "state" of the constituent materials, of the different parts, and of the full assembly of these parts constituting the structure as a whole. Also explained how the state of the structure can be altered by normal aging due to usage, by the action of the environment, and by accidental events. The diagnosis could estimate that Structural Health Monitoring is a new and improved way to make a Non- Destructive Evaluation. It involves the integration of sensors, possibly smart materials, data transmission, computational power, and processing ability inside the structures.

"Development of structural health management technology for aerospace vehicles" proposed by W. H. Prosser [6] explained that, part of the overall goal of developing Integrated Vehicle Health Management (IVHM) systems for aerospace vehicles, NASA has focused on the development of technologies for Structural Health Management (SHM).The motivation is to increase the safety and reliability of aerospace structural systems, while at the same time decreasing operating and maintenance costs. Research and development of SHM technologies has been supported under a variety of programs for both aircraft and spacecraft including the Space Launch Initiative, X-33, Next Generation Launch Technology, and Aviation Safety Program. And specified a wide range of sensor technologies including fiber-optic sensors, active and passive acoustic sensors, electromagnetic sensors, wireless sensing systems, MEMS, and nano sensors. Because of their numerous advantages for aerospace applications, most notably being extremely light weight, fiber-optic sensors.

"Multi-channel High Speed Data Acquisition System Based on FPGA" by Lin Chang-qing, and Sun Sheng-li[2] introduces a kind of multi-channel data acquisition system based on FPGA and high-speed SRAM, and the hardware schematics is also presented. Application in practice demonstrates the validity of data acquisition system. The acquisition systems are to develop a "distributed" data acquisition interface. The development of instruments such as personal computers and engineering workstations based on "standard" platforms is the motivation behind this paper. Using standard platforms as the controlling unit allows independence in hardware from a particular vendor and hardware platform. The distributed approach also has advantages from a functional point of view: acquisition resources become available to multiple instruments; the acquisition front-end can be physically remote from the rest of the instrument.

"Study of Dynamic Strain Measurement System Based on Embedded Technology" by Li Ding-zhen and Tian Jin-yun [5] described a new dynamic strain measurement system, which is designed based on the modern strain measurement technology and embedded computer technology, which is the integration of signal conditioning, data acquiring and data issuing. This measurement system is built based on the advanced ARM9 processor, which is the controller of A/D converter part, signal condition part, data memory part and others. Further the data transmission and communication is realized via the Ethernet interface. Users may access this measurement instrument for setting sample parameter, starting a sample, viewing data curve and downloading data directly by any web server without special application software. The result shows that the properties of the system are superior to the existing measurement system.

III. SYSTEM DESIGN

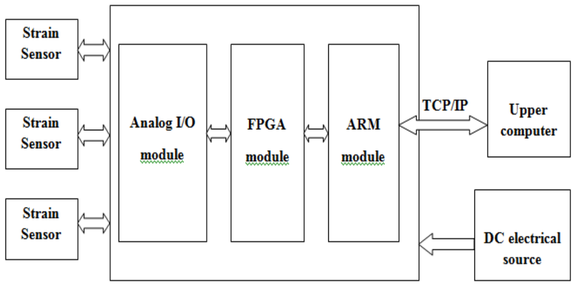

Fig 1: Strain measurement system diagram

To make the system smart and portable, and to reach the goal of working independently, an embedded processor is chosen as a control center for issuing command and setting sample parameter. Upload the high speed sampling data directly to the ARM, the tremendous data throughput will be a big challenge to the data process. FPGA can overcome this problem by creating an Asynchronous FIFO. Therefore, this strain measurement system is designed based on the FPGA device and ARM processor, the overall system solution is illustrated in figure 2.This system is mainly composed of five modules: the strain sensors, analog input and output module, FPGA module, ARM module and the upper computer.

IV. METHODOLOGY

Below flow graph shows the method or procedure of the project, and each block present in the flow graph is briefly explained below:

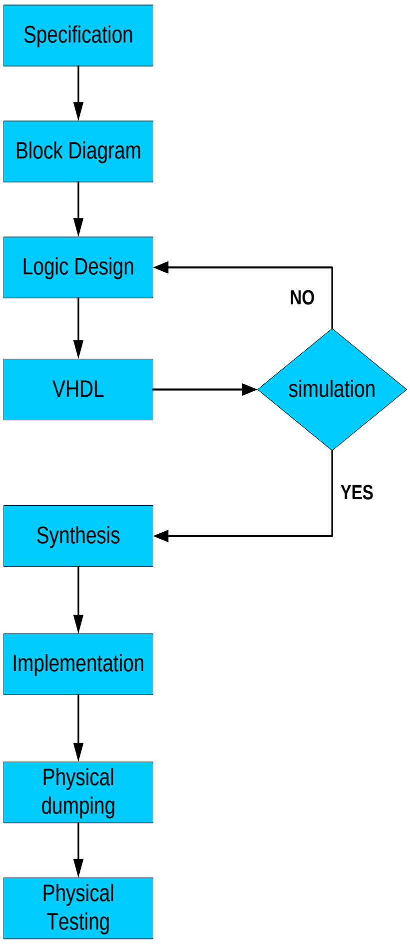

Fig 2: Flow chart of network communication

Specification: The Spartan 3E tool has been used, it has the operating speed of 100MHZ on board, and it also has soft processor Micro Blaze. And are used tools like Xilinx ISE 12.2 and also work on simulation software ModelSim6.3c.

Block Diagram: In this case strain measurement system is implemented on FPGA and ARM.

Logic Design: In this project logic design will be use to design a strain measurement system.

VHDL: To work on this project VHDL language will use for the implementation of strain measurement system in Xilinx ISE 12.2.

Synthesis: After combining, testing has to do, i.e whether the program is working properly or not, if yes it will continue with next process else it has to rewrite or correct. After correction again test the program, if its successfully working then it will be implement.

Implementation: All the process till testing will implement in this step.

Physical Dumping: In this step implementation of the project will dump into the FPGA.

Physical Testing: Finally the project will be test in the FPGA kit.

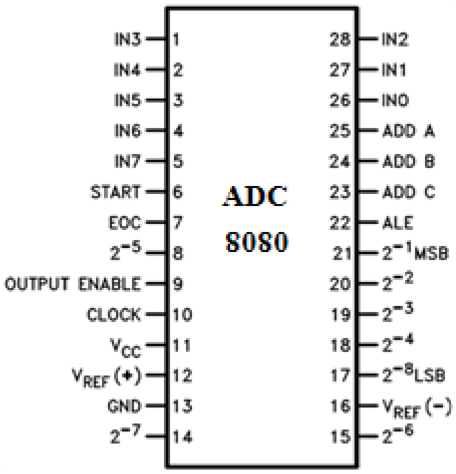

Fig 3: Pin diagram of ADC8080

V. RESULT

The proposed system developed using VHDL language. During execution, the main class displays the following simulation output waveforms which contains the values of analog I/O. These values are used for further implementation using FPGA module.

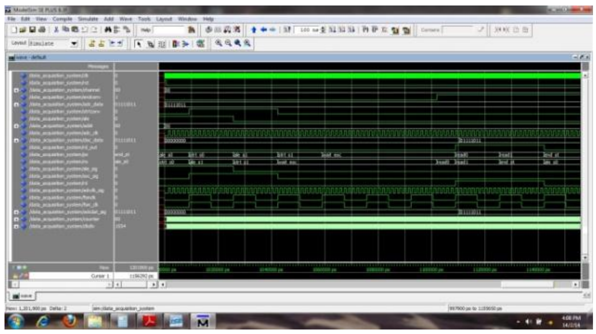

Fig 4: Simulation output

VI. CONCLUSION

A comparative study from the survey of previous methodologies about the strain measurement has been made, the whole system will integrates the strain testing, data record, curve display and data analysis in one body, it will greatly expand the general function of the traditional strain test equipment. Presently, ADC has been designed and the overall performance of ADC output has been recorded, system performance and overall strain measurement on FPGA device can be improved from this design.

VII. REFERENCES

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