Sensor Controlling Processor Implementation by VHDL

Dr. Pandurangan Ravi, Dr. G. Sreenivasula Reddy, and Dr. V. P. C. Rao

Abstract—With the rapid development of technologies in the world the processor designer become indispensible tool to the people because most of the electronic equipment currently being manufactured is controlled by inbuilt processor. In the modern world it can definitely be considered as very useful tool to the society as it has ability to operate or identify something without the human control. There are various types of sensor controlling microprocessors currently available in the market those are designed to control only by the single relevant sensor connected to the processor. However, the microprocessor is able to control several verities of wide range sensors instead of single sensor. This has been designed and implemented by means of VHDL. The comprehensive description with respect to the designing of said microprocessor is given in the paper.

Keywords—Processor Implementation by VHDL.

I. Introduction

THIS Nowadays various useful automatic sensor controlling systems are being released to the market and therefore several types of processors are made to control those sensors, which makes easier to control various types of sensors by multi- sensor controlling processor rather than using each processor to control each type of sensor. In the world, different kinds of processors are constructed to control various types of systems. Controlling CPU fan speed, Processor system with temperature sensor and control method of the same and new speech processor and ultrasonic sensors based embedded system to improve the control of a motorized wheelchair are few implementations in the real world. Processor by which it is possible to control whole system of green house and the processor which is using to control intelligent traffic light system. Including the relevant ISA based on the desired outputs, which will enable us to obtain the desired output by controlling any type of sensors?

The design of relevant ISA will be included as parallel to the design of the sensor control processor and Whole design is able to implement by using FPGA. The fig.1 shows the clear picture of propose system architecture.

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- AD – Analog to digital converter
- DA – Digital to Analog converter

Main objective of this project is to design Sensor Control Processor to enable us to obtain fruitful output by controlling more out of various types of sensors. The processor the instructions inherent to the said processor are to be designed. It is expected to implement and test the both processor and ISA by using VHDL.

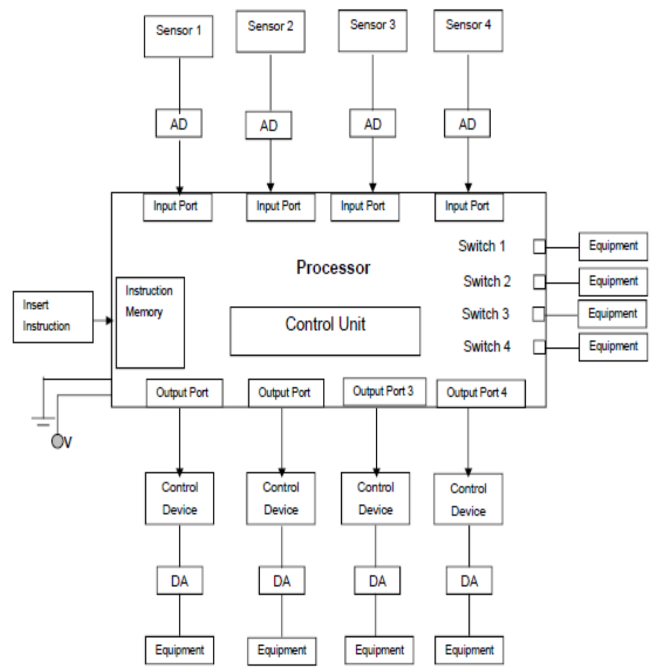

Fig. 1.SCP system architecture

Design of sensor controlling processor diagram, design of relevant ISA documents, implementing of both design using VHDL codes, Test bench, and simulate the design. With the rapid development of technologies in the world the Processor Designer become indispensible tool to the people. Most of the electronic equipment currently being manufactured is controlled by inbuilt processors. In previous days that the lamp posts in the streets need to be switched on or off by a person but nowadays there are light sensitive sensors by which it is possible to control lamp posts without the human touch. There are various types of sensor controlling microprocessors currently available in the market those are designed to control only by the relevant sensor connected with the processor. It is

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enable to gain thorough knowledge in the manufacturing of microprocessors and their functions and the way of getting fruitful work out of it. Likewise designing of microprocessors need to have set of proper criteria to complete the same successfully. In order to optimize a design a number of various techniques and architectures can be used.

II. Sensor Controling Process

The processes of designing of the Micro Processor the following relevant steps are suppose to be followed:

a. Determination of intrinsic capability of the processor
b. Deciding of relevant parts in the processor according to the requirements
c. Designing of ISA required controlling the relevant accessories
d. Building of the relation to enable ISA to act with the artifact in the Microprocessor

At the beginning of the designing stage the capabilities of SCP has taken into account. To the fundamental capabilities of processor I have considered performance, design time, Complexity and speed of the processor. Due to the limited time factor I am expected to present simply and clearly of fundamental things that are necessary for sensor controlling by keeping the performance of the processor at its level best. Although it is possible to design a processor with large number of sensors, due to time factor I have decided to design a processor with four sensors to obtain four outputs. The processor is equipped with four input ports and four output ports to obtain signals that are released from four sensors and to give four outputs respectively. In order to enhance the performance more registers are connected to the processor. It is possible to make comparisons by keeping those values even in Data Memory the comparison speed can be increased when these values are in registers and therefore number of registers has increased.

By increasing registers in this manner it is possible to enhance the performance of the processor but then it will become more complex. Therefore according to my own designing style I have designed the Sensor Control Processor consisted of Compare unit to compare values, ALU for mathematical works and with other essential components. Third stage the required ISA is going to be designed in order to control the Microprocessor. At the beginning the type of ISA suitable for Microprocessor is need to be decided by considering the RISC and CISC Architecture. CISC and RISK methods I have selected RISK method to prepare ISA compatible with the designed processor.

CISC and RISK: CISC, stand for Complex Instruction Set Computers and RISC stands for Reduced Instruction Set Computers. RISC had inferior quality than CISC. The CISC was the primary type of computer and each CISC instruction given to the CPU did a lot of processing.

Concept behind RISC is for the CPU to have much simpler instructions, each of which can have each section of the fetch / execute cycle executed in one clock cycle. It became evident that compilers preferred simple instructions, and less time was spent coding in assembly language, thus the verbose and difficult code inherent to CISC was no longer necessary. The machine code was now for the machine, not the programmer Caches decreased the time it took to get to memory. The program length increase that results from the use of RISC was now acceptable with all its simpler instructions. It is supposed to be introduced relevant programme language in order to facilitate the functions between the Microprocessor and its ISA. VHDL is a fairly general- purpose language but however it needs a simulator on which to run the code. It can be used to write a test bench that identifies the functionality of the design using files on the host computer to define stimuli interacts with the user and to obtain comparable results with those expected. It can read and write on the host computer's files in such a way that VHDL written program can be generated another VHDL program to be incorporated in the design being developed. VHDL is a strongly typed language and consequently it can be considered to be superior to Verilog language. The top-down methodology is used to design the processor. Methodology is controlled by an ASM charts and fitted it into an FPGA.

III. Algorithmic State Machine Controller

The main purpose is to design the 16-bit microprocessor and implement the same. Top-down methodology is used to design the processor. Methodology is controlled by an ASM charts and fitted it into an FPGA. Firstly, the connections of each component in the Micro Processor and the way of controlling by the control signals. Secondly FSM is described with the help of ASM charts. Thirdly by using Test Bench the function of the Microprocessor is explained and finally the said design has verified with the aid of functional and post route stimulation.

Throughout the section comprehensive description has give step by step on the entire Microprocessor and its functions with the relevant Algorithms. The test results and its functional aspects are clearly explained with the aid of stimulators. To obtain clear idea about the sending of signals to the various parts of the Microprocessor and their functions. A person who does not have fundamental knowledge on the processor designing is not being able to get the clear understanding about the functions of the Microprocessor. To design and implement of automatic room light detector and controller by using both microprocessor and light sensors.

The purpose of this is to describe the designing of a controller in order to control entire light system of a house automatically with the help of relevant sensors and thereby it is possible to switch off all the unnecessary electric bulbs to save the power consumption. HLCM is possible to control entire light system in a house. HICM detects whether the human body enters the detection area or not by means of PIR sensor. Control lights are turned off when the absence of human body in the detection area. HLCM maintains the sufficient light according to the detection of light intensity made by the HLCM. By means of the said system the user will gain advantage because the system is designed in such a way that the bulbs are on/off automatically with the considerable saving of power.

The way of connecting sensors in the circuit and transferring of data are illustrated clearly. It is possible to get a clear idea of the function of the said system through the given flow chart easily. The area of research chosen by the author is very competitive and the product generated seems quite useful for the segment. Lack of proper justifications shows more effort is put in designing the artefact rather than researching whether the artefact which is developed actually relieves the bottleneck situation created by mass data. Intelligent traffic signal simulator is possible to sense whether the vehicles are presence or absence within the certain range by adjusting the appropriate time duration for the traffic signals to react accordingly. Vehicle identifying sensors are used to make decisions on the traffic depending on the length of traffic queue. It is possible to make proper traffic control and reduce the traffic jam which leads to saving the time and money of vehicle owners.

IV. Design of Sensor controlling processor

The way of sending signals to the relevant components (compare unit, Instruction Memory, Instruction register, Data memory, Instruction decoder, Registers). The connections made for Data Bus and Address Bus in the microprocessor and the locations of components corresponding to the ISA are shown fig.2. Data is provided to the In-Puts in the Microprocessor by the sensor which is connected by AD. This is controlled by the signal IN receiving from Control Unit. According to the user's wish it is possible to provide particular out-put by managing the data receiving to the in – put with the help of relevant ISA of the microprocessor. During this process the necessary data provides to functioning the components connected with the Out-Put ports after comparing the data obtaining from In-Put ports with the data stored by the user. This is depending on the type of sensor connected by the user and it is user's responsibility to provide sample data to the relevant sensor for comparison. The Instruction Register is divided into two parts:

- Opcode: It is sent to the Control unit
- Operand: It provided to the Instruction Decoder.

According to the Opcode provided to the Control unit the signals are systematically sent to the relevant components in order to fulfil the respective function of the given instruction.

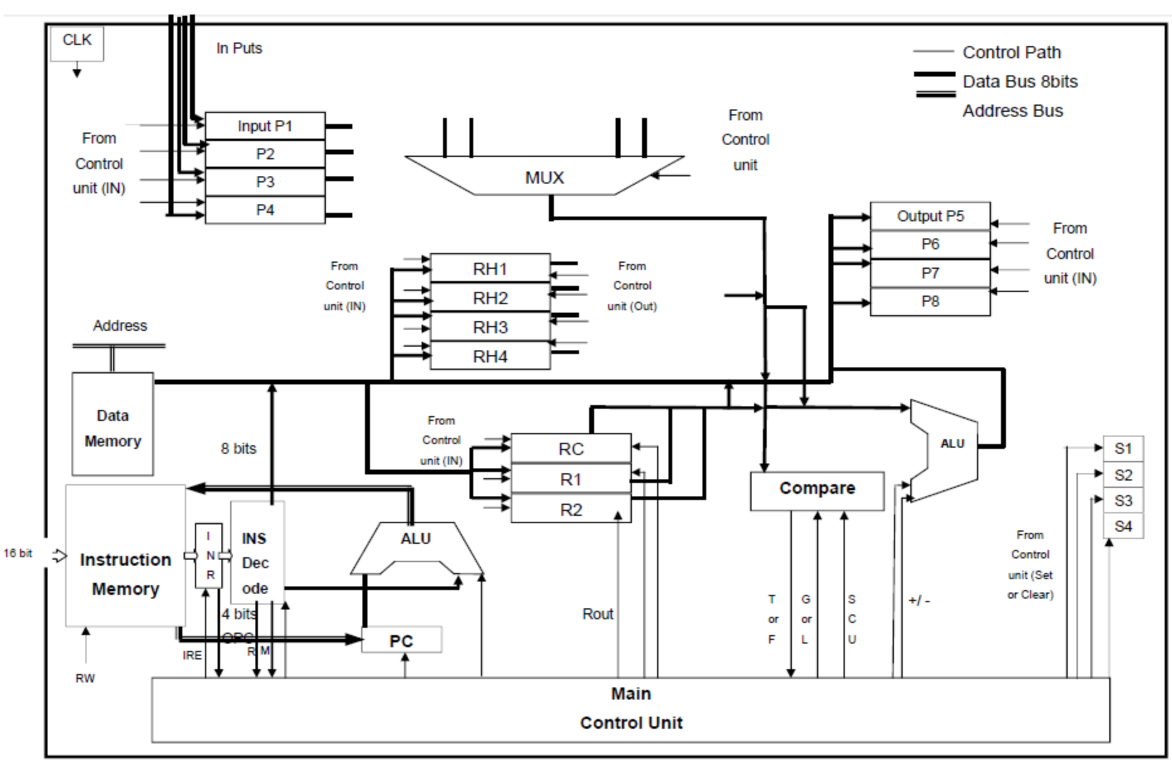

Fig. 2 Design of propose sensor controlling processor main diagram

A. Block Functioning:

Comparing of data which receiving from sensors and providing of compatible output are the main functions of the processor. The user has to provide the data to the microprocessor through the relevant sensor connected with it.

INPUT PORTS: Input ports P1, P2, P3 and P4 are shown in the fig.2. The data provided by the sensors through AD are delivered to the processor through the ports mentioned in the diagram. Releasing and receiving of data through the port is controlled by the control unit in the processor. Extraction of data by the ports are controlled by the in-signal of the control unit while outgoing data from the ports are controlled by the out-signals of the control unit.

OUTPUT PORTS: Output ports P5, P6, P7 and P8 are shown in the fig.2. Data received by the processor are released through these output ports. It is controlled by the control Unit.

SWITCHES: These can be used as four switches to control the equipment (on/off function). 1-Bit four ports are as S1, S2, S3 and S4.

COMPARE UNIT: By means of Compare unit it is possible to identify the comparison status of data receiving through the input ports against the data that are stored in the RH. It is controlled by the control unit and can be on/off by the 1-Bit signal which is shown in the diagram as SCU. To clarify the expected comparison status the part named as G or L in the diagram is used and to convey the expected result back to the control unit by the compare unit is done by the TOF 1-Bit signal.

Memory Unit: There include two memories there are Instruction memory and Data memory, data memory is 8bit and 128 memory addresses. Instruction length is 16bit, first 4 bits for instructions and others for operand.

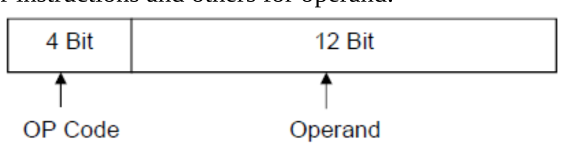

Fig. 3 Instruction format

There are number of reasons to take the length of the Instruction memory as 16-bit. The sum of the registers and ports in this processor is 16 (four numbers of each in-put port, out-put port, special purpose register and two numbers of General purpose registers). Therefore the Op-code and the Operand of the processor are needed to be 4-bit and 12-bit respectively. 4-bit need to be allocated in order to introduce 16 registers separately and the maximum length of each data in this processor is limited to 8-bit and therefore it makes the total 12-bit. Total sum of the opcode and operand is 16-bit and therefore it is required maximum of 16-bit to store each instruction.

B. Process In Scp

SPC consists of four 8-Bit input ports to absorb signals receiving from sensors and four out -put ports through the sensor to send out the signals. And there are four 1-Bit ports are available to use On/Off states. It consist of four Special Purpose registers are used to maintain the inside threshold values and in addition to that it is equipped with another one special purpose register for support to compare unit and ALU and Two general purpose resistors, one ALU, one Instruction Memory, one Data memory unit, and one compare unit. The Compared Unit's function is to compare the threshold values with the values received by Input Ports and if both values are compatible then according to the requirement and it will send to output ports. By means of ISA exists in the SCP it is possible to control one or more sensors to obtain out-put of our choice.

V. Test Analysis

The test Bench is used to test the Microprocessor. It can be created by means of this programme and its function can be seen with the help of ISim Simulator provided. Everything is tested according to the Clock. Its mean that every incident is taking place only at the rising edge and the falling edge of the Clock.

Testing for Instruction: The necessary results can be obtained by providing Instruction to the Test Bench which is created for the ProcessorCU. MV is an Instruction by which data can be entered to a Register or Port. When writing this particular Instruction it is need to be written Opcode first and then Operand. That is denoted as "0000". First 4 bit out of the 12-bit of Operand is used to find out the relevant register the data to be entered and the last eight bit shows the 8-bit data. With the help of that the releasing of data into the Buswires and then entering of data into the R1 through the activation of R1's IN (RIN).

VI. Conclusion

The main objective is to design a sensor controlling microprocessor and implement the same by means of VHDL. The ISA has been designed according to the requirements of the processor. Functions of the sensor controlling processor are decided by considering the time duration therefore it is presented in simple way rather than making it more complex. After that the Microprocessor has been designed in order to align with the ISA. Base on the given time frame for the project the number of components need to be included are decided. The Microprocessor is equipped with 4 numbers of Output Ports, 4 numbers of Input ports, two general Purpose Resistors, five special purpose Resistors, a compare unit, one ALU. The suitable Hardware descriptive language had to be selected in order to implement the functions of the microprocessor. The several language is available, here mainly emphasized on the language known as VHDL and Verilog. Each component of the microprocessor is implemented separately and after that these components are interconnected according to the existing ISA. After testing of each component separately that the Instruction test is used to confirm the combine functions of components. Due to the limited time factor it was not possible to design a Microprocessor with superior standard. By increasing length of instruction, number of Registers, data size and memory size it would have enhance the efficiency of the Microprocessor. It is realized that it could be done again it would have increased the performance of the processor by increasing the Instruction length, number of Registers and the sensor control range.

With the help of this SCP it is able to control number of types of sensors and thereby equipments corresponding to the sensors. Further to that when adding of two registers there should be a problem if the total sum value is greater than 8-bit. In the case of subtracting if the final value is minus there should be a problem in values. Finally it is important to mention here that it is possible to obtain any output you wish by implementing the processor with a FPGA

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