SUMMARY OF Ph.D THESIS

ENTITLED

DEVELOPMENT, COMPARISON AND SIMULATION STUDIES OF UNIVERSAL SENSOR INTERFACE

BY

Mr. A.V. MANCHARKAR

UNDER THE GUIDANCE OF

DR. S.H. BEHERE
PROFESSOR, DEPARTMENT OF PHYSICS
DR. B.A.M. UNIVERSITY
AURANGABAD

Date:  /12 /05.  Place: Aurnagabad
1. INTRODUCTION

The art of measurement is a wide discipline in both engineering and science, encompassing the areas of detection, acquisition, control and analysis of data. It involves the precise measurement and recording of a physical, chemical, mechanical or an optical parameter. Sensors detect, monitor and respond to these physical parameters and are an integral component of many real world systems straddling a wide range of industrial, consumer automotive, medical and military applications. The commercially available both integrated and discrete types of sensor interfaces allows connection of limited 4–5 sensing elements at inputs and provides limited types of outputs such as voltage or current.

The interfaces that would work with a wide range of sensors that have different output signal formats greatly streamline the ability of sensors. Sensors need signal conditioning electronics to enable them to have desired performance characteristics for a particular application. The designing of signal conditioning circuits is important for such interfaces. Electrical and electronic design requires cost effective and accurate methods for evaluating circuit performance. Computer aided simulation allow the designed systems to be simulated so that the expected circuit behavior can be verified, any design errors can be identified and system performance can be refined by fine-tuning relevant parts of the design. Hence, costly mistakes can be avoided well before the final hardware implementation of the circuit. Spice is simulation programme that can perform analysis on various aspects of electronic circuits.

PSpice is the version of software developed by Microsim company. In the present work the Microsim Eval 7.1 version is used to design the signal conditioning circuits for eight different types of sensors viz. Thermocouples,
Thermistors, RTDs [Resistance Temperature Detectors], LVDTs [Linear Variable Differential Transformers], Strain gauge, LDRs [Light Dependent Resistors], F.O. [Fiber Optic] Displacement sensor and Capacitive sensor. These signal conditioning circuits provide a fixed range of output 0-1V. The programmable gain amplifier [PGA] is also designed such that irrespective of type of sensor [e.g. J or other type] and its measurement range [e.g. 0-100\(^\circ\)C or other] the output of PGA is fixed 0-5V. The microcontroller identifies the signal conditioning circuit used for a specific sensor, its type and measurement range. Over the years the 4-20 mA transmitter has became an accepted standard technique for transferring of information between I/O and control area. So the output of PGA is converted into 4-20 mA using voltage to current converter. The output of PGA is also converted into digital form [12 bit parallel data] for the purpose of processing, transmission, display and storage. It is essential to transmit digital data to the PC or smart instruments for storage or further processing using standard protocol such as RS 232C or GPIB. The designed Universal Sensor Interface accepts eight different sensors at input and provides types of outputs Viz. (1) Analog 0-5 V (2) 4-20 mA (3) Digital parallel port (4) RS-232C protocol. The aim of present work is to design signal-conditioning circuits required for designing of such universal sensor interface.

2. ORGANIZATION OF THESIS

The thesis is organized into six chapters. The first chapter gives a brief background of the work carried out and describes the problem. The second chapter focuses on the reviews carried out for sensors, their classification scheme, various techniques of signal conditioning, circuit simulation, microcontroller, etc. A comparison is made amongst the commercially available both integrated as well as discrete types of sensor interfaces regarding number of sensors at input, provision of various types of outputs and the speed and comparative study of available sensor interfaces. The chapter ends by giving a necessity of designing of signal conditioning circuits using PSpice and necessity of designing of Universal Sensor Interface. The critical problem of
product design and testing is simplified by use of simulations. Electronic simulation of signal conditioners is essential in the design of both signal conditioners and complete system. The third chapter focuses on the circuit simulation in which it gives a brief idea of computer-aided circuit analysis and then about Spice, its compatible simulators and the capabilities of Spice and PSpice. This chapter describes design steps such as drawing the circuit, selecting the types of analysis, simulation with PSpice, varying parameters, displaying the results of simulation. In the present work these steps are used for carrying out simulation of signal conditioning circuits for eight sensors.

The fourth chapter describes various design aspects. First it describes the hardware of universal sensor interface by giving circuit diagrams of signal conditioners used for various sensors. It explains the design and role of programmable gain amplifier, voltage to current converter, analog to digital converter and RS-232 protocol. This chapter also explains the role of microcontroller software in the design of USI. The fifth chapter gives the results of simulations carried out for signal conditioners of various sensors. It also explains how to use a USI and gives specifications of USI. The sixth chapter concludes the thesis by giving first the summary of the work carried out and then it gives various applications of USI. This chapter and thesis ends by giving the directions for future scope.

3. CONCLUSION:

For practical utility of any sensor it is important to tailor its performance according to the need of the application. The present system provides interface for commonly used sensors which are useful in both the scientific research and industrial processes interacting basically with control systems, process instrumentation, etc. Present work particularly deals with the designing of signal conditioners for eight types of sensors using PSpice and a Universal Sensor Interface that reduces the burden of the system designer. The user has to only set the position of DIP switches on the sensor specific signal-
conditioning module, for selection of type and range of measurement. It was found that the output of signal conditioner varies from 0 to 1V over a fixed selected measurement range. Depending upon the need he can use the required outputs. If user wants to use the sensor, whose interface is not provided in this system, then he has to only design and make a signal conditioning circuit for that sensor.

The performance of the system can be improved by increasing the number of sensors connected to the system. The speed of the present system can be improved by using a faster ADC.

REFERENCES
[6] Xiujun Li, M.L. Frank, Van de Goes; G.C.M. Meijer and Rolf de Boer,”


[15] Internet Referances
/www.ni.com


