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COMMUNICATION

A low cost microprocessor based multiple pressure measuring system

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A low cost, wide range, six-channel pressure sensor, controlled by a 16-bit microprocessor has been designed and developed. The present design exploits the simplicity and reliability of manometers as well as the acquisition processing and control capabilities of microprocessors. The sensor is of digital output type and hence dispenses with the complex and expensive electronics normally required in conjunction with analogue pressure sensors. The data rate of the developed instrument is six samples/2·5 s for a range of ± 1000 mm of liquid column, with a resolution of 0·1 mm. Accuracy of the present unit is found to be better than 0·2 mm of the liquid column. The hardware and software design and implementation details of the unit are presented in this paper.

1. Introduction

Pressure measurement is often required in scientific research experiments. Multiple pressure measurement is particularly needed in some experiments such as studies on the fluid flow field around or pressure distribution over a body. Several methods do exist for these studies. The simplest low cost pressure measuring devices like a U-tube manometer offer medium range accuracy (up to 1mm of alcohol) with ease of operation and reliability. However the disadvantage of manual reading introduces human error and restricts the speed of measurement. Alternative instruments for multiple channel pressure measurements, like pressure sensors, are very expensive and often require complex instrumentation (McGechin, 1986; Coe *et al.*, 1981). With the advent of low cost microprocessors, most experimentation follows an integrated approach for data acquisition, processing and control. This has formed the motivation for the design of a low cost multichannel pressure sensor controlled by a microprocessor. Based on this design a six-channel pressure measuring system has been developed. The design combined the simplicity and reliability of manometers and the acquisition, processing and control capabilities of a microprocessor.

The six-channel pressure sensor is designed and realized for the usage in the experimental investigations in the closed circuit wind tunnel at the department of Aerospace Engineering, Indian Institute of Science. The sensor unit has been interfaced to a 16-bit microprocessor (Intel 8086) which is a part of the data acquisition and control system of the above-mentioned wind tunnel. The design details of this sensor unit and its interface to the processor are presented below.

2. Principle of operation

The instrument is based on digital reading of the distance between the liquid levels in a

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U-tube manometer by mechanically traversing a carriage to which are fixed a pair of liquid level sensors. The carriage traverse is sensed by a distance sensor which produces a pulse per 0·1 mm movement of the carriage. These pulses are counted by a free running counter. A microprocessor reads the level sensors status and at the instants of the carriage crossing the liquid level meniscus samples the free running counter. The readings are stored in the system memory. Once these readings have been taken for all the channels, the difference in readings for each of the manometers is computed by the microprocessor and the data is available for printing or any further processing.

3. Mechanical construction

The orthographic view of the instrument is given in Figure 1. It consists of a heavy plywood base of 1′ × 2′ fitted with levelling screws, and a pair of vertical circular columns (1·2 m long) are rigidly mounted. The limbs of the U tubes are positioned between the columns as shown in the Figure 1. The carriage (made out of ebonite), on which are mounted the optical liquid level sensors, slides up and down guided by the circular columns. A geared motor which runs at 90 r.p.m. is mounted on the structure as shown in the Figure 1. A one-inch thick circular drum of diameter 9·3 cm is attached to the shaft of the motor. The circumferential face of the drum is threaded and at one edge of this face, teeth have been cut at a pitch of 1 mm. The carriage is connected to the drum with a pulley and nylon thread assembly (Figure 1), so that the carriage moves up as the motor is switched on. When the motor is switched off, the carriage slides down due to gravity. Through a timing belt, the drum is also coupled to a thin 15 cm diameter ebonite disc, at the periphery of which holes are drilled. Another optical sensor pair (referred to as a distance sensor pair) is mounted across this disc, to read the carriage movement, in steps of 0·1 mm, by sensing the holes on the disc.

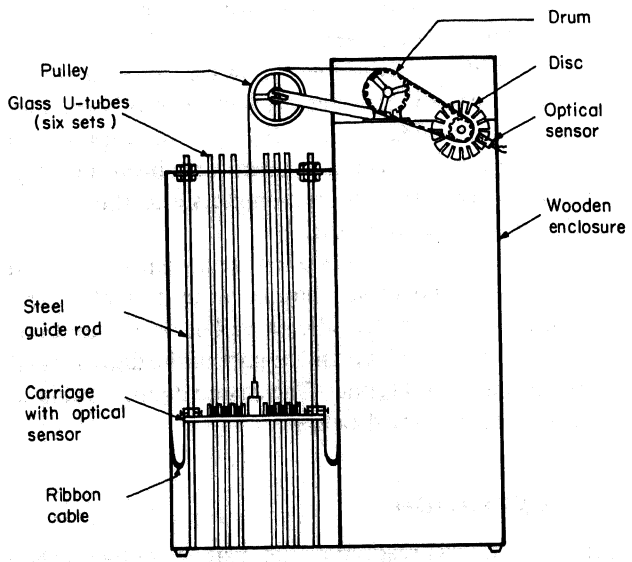

Figure 1. Six-channel pressure sensor.