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Chapter-7

Data Acquisition System

The term data acquisition generally relates to the process of collecting the input information as rapidly, accurately, economically and completely as necessary. Data acquisition systems are used to measure and record signals obtained in basically two ways

(a) Signals originating from direct measurement of electricall quantities, which may include DC and AC voltages, frequency or resistance and are typically found in such areas as electronic component testing, environmental studies and quality analysis work.

(b) Signal originating from transducers.

As instruments can be either analog or digital systems, correspondingly we have Analog and Digital Data acquisition system.

Analog Data Acquisition System :-

Analog DAS typically consists of some or all of the following elements.

1) Transducers for translating physical parameters into electrical signal.

2) Signal Conditioners for amplifying, modifying or selecting certain portion of these signals.

3) Multiplexers are used for sharing a single channel with more than one o/p. It accepts multiple analog inputs and connects them sequentially to one measuring i/p. It is necessary in measurement systems when the distance between the transmitting and receiving is large and many quantities are to be transmitted.

4) Visual Display device: for continuous monitoring

of the i/p signals. These devices may include single or multichannel oscilloscopes, storage oscilloscope, pannel meters, numerical display and so on.

5) Graphic recording instruments for obtaining permanent records of the i/p data. These instruments include stylus and ink recorders to provide continuous records on paper charts, optical recording systems, etc.

6) Magnetic tape for acquiring i/p data, preserving their original electrical form and reproducing them at a later date for more detailed analysis.

Digital Data Acquisition System:

A digital DAS may include some or all of the elements ~~shown in~~ mentioned below. The functional operations within a digital system include handling analog signals, making measurement, converting and handling digital data and internal programming and control.

1) Transducers translate the physical parameters to electrical signals acceptable by the acquisition system.

2) Signal conditioners generally include the supporting circuitry for the transducer. This may provide excitation power, balancing circuits and calibration elements.

(3) Scanners or multiplexers accepts multiple analog i/ps and sequentially connects them to one measuring instrument.

(4) Signal converter translates the analog signal to a form acceptable by the analog to digital converter.

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5) Analog to digital converter converts analog voltage to its equivalent digital form. The o/p of ADC may be displayed visually and is also available as voltage o/ps in discrete steps for further processing or recording on a digital recorders.

6) Auxillary equipment contains instruments for system programming functions and digital processing. Typical auxillary functions including linearizing and limit comparing. These functions may be performed by individual instruments or by a digital computers.

7) Digital recorder records digital information on punched cards, perforated paper tape, magnetic recorder or a combination of these systems. The digital recorder may be preceded by a coupling unit (interfacing) that translates the digital information to the proper form for entry into the particular digital recorder selected.

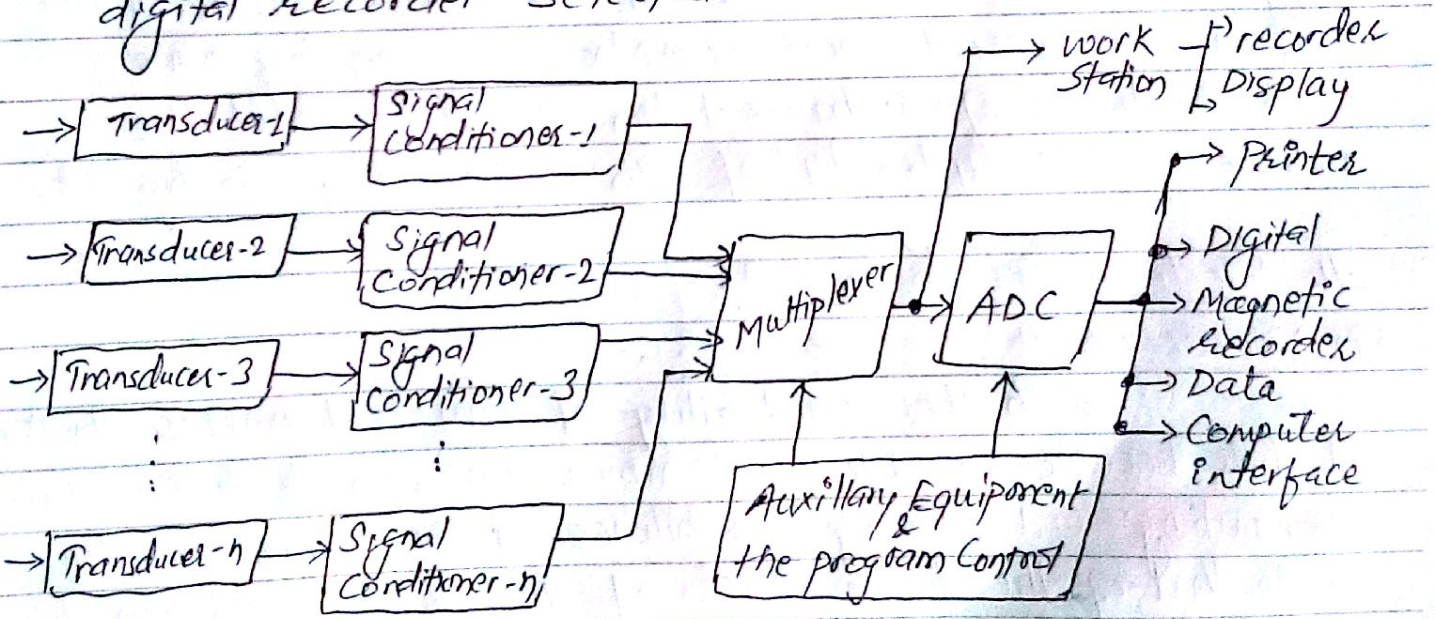

Fig: A generalized data acquisition system.

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USES: DAS are used in a large and ever increasing number of applications in a variety of industrial and scientific areas such as biomedical, aerospace and telemetry industries. The type of DAS whether digital or analog, depends largely on the intended use of the recorded i/p data. In general, analog DAS are used when wide bandwidth is required or when ~~power acc~~ lower accuracy can be tolerated. ~~DAS~~ Digital systems ~~range in complexity~~ are used when the physical process being monitored is slowly varying (narrow bandwidth) and high accuracy and low per channel cost is required. Digital systems range in complexity from single channel DC voltage measuring and recording systems to sophisticated automatic multi-channel systems that measure a large number of i/p parameters, compare against preset conditions and perform computations and decisions on the i/p signals. Digital DAS are in general more complex than analog DAS both in terms of instrumentation involved and the volume and complexity of i/p data they can handle.

Modern Trends in DAS

(i) Microcontroller based DAS :-

With the availability of low cost microcontroller, it has become possible to combine various features like computing and storing capabilities of the microcomputer with that of the basic block of the data acquisition system to achieve a microcontroller based DAS. It incorporates additional features like linearization, limit checking and conversions for engineering units and serial/

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parallel interface to computer and printers. There are also dedicated microcontrollers which make the data acquisition for particular application more reliable and efficient. Schematic block diagram of an 8051 based data acquisition system is shown in the fig. below:

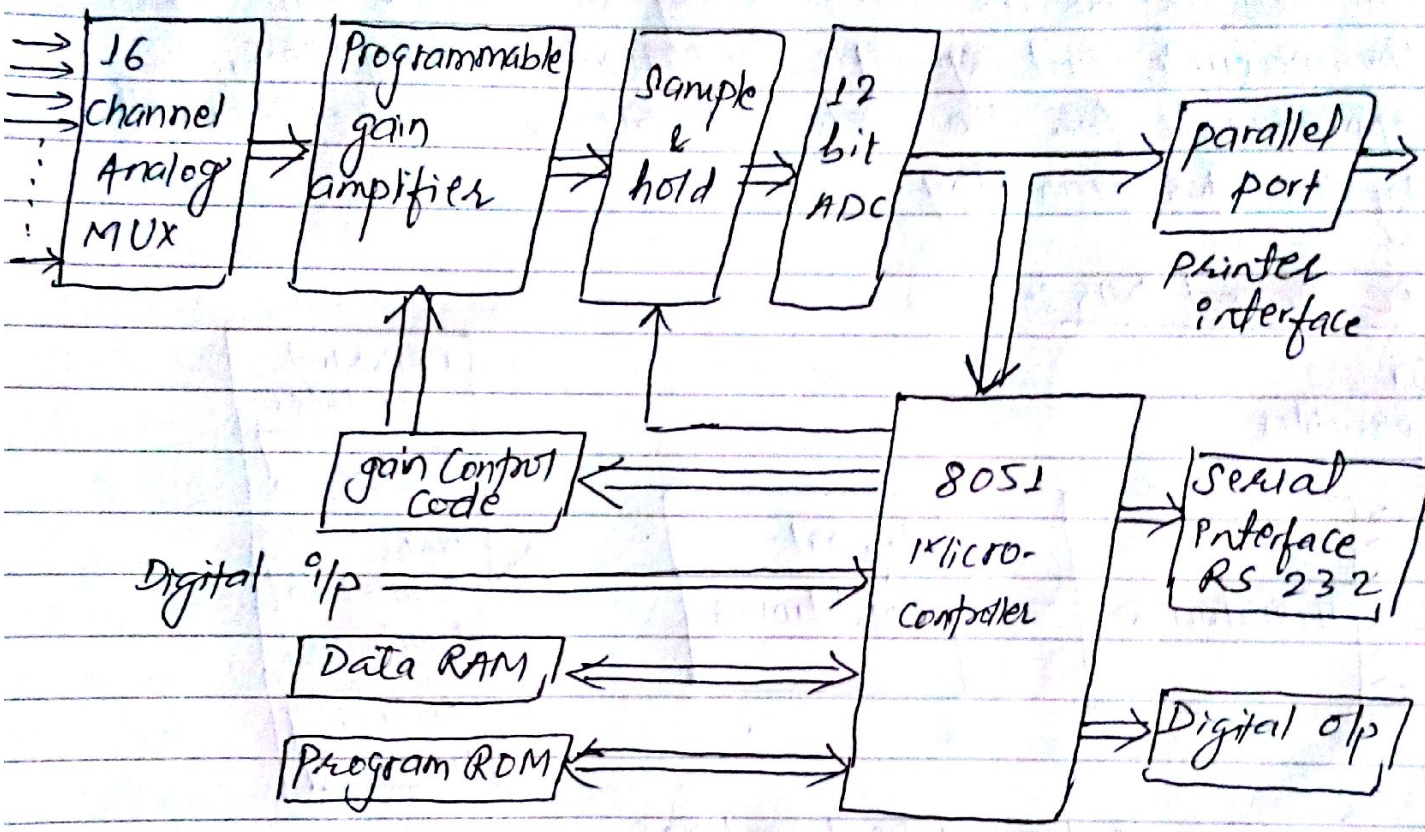

Fig: Microcontroller based DAS

The analog channels are scanned continuously at the rate up to 100 channels per second and the resultant data are stored in RAM. This data is refreshed continuously so that a request for data from the host computer enables the computer to acquire the latest data. The host can also assign any particular channel as active and request for data from a single channel or even from a set of several active channels. Similarly by sending data commands, the digital i/ps can be read & digital o/p

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can be set for any specified analog channel, the limit value can be set and the DAS can be programmed to identify and report any channel to the host when the data therefrom falls outside the set limits. In a typical case of measurement with thermocouples any specific channel can be assigned to any particular type of thermocouple and specific linearization programs, appropriate for the selected sensor can be involved by the programming.

(ii) PC Based DAS :-

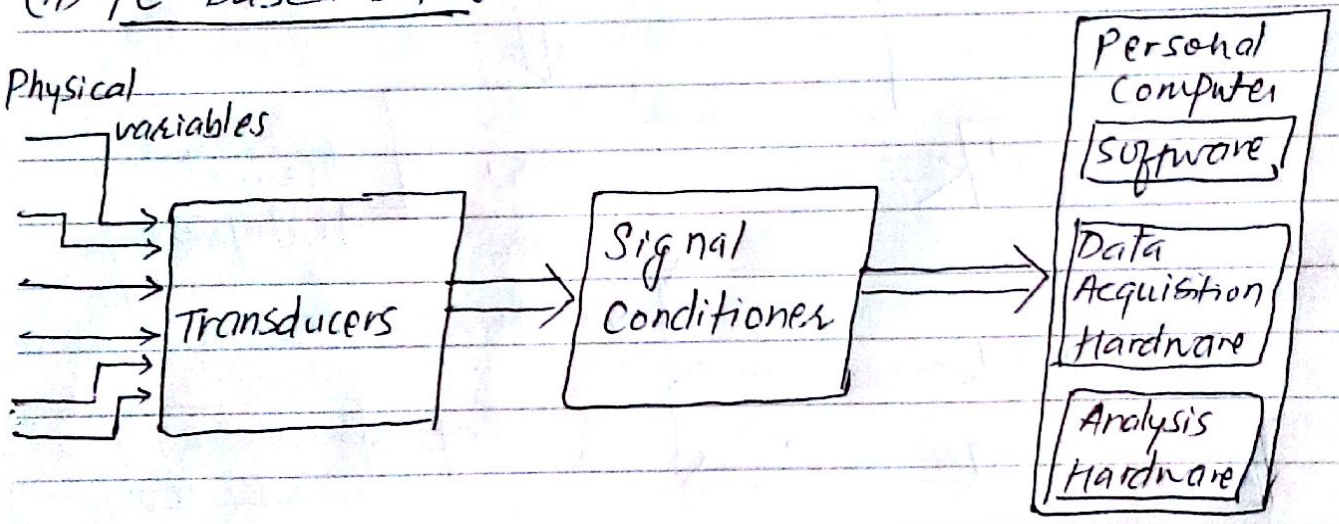

Fig: A typical PC based DAS

A PC has been widely used for data acquisition and control system. A typical PC based DAS is shown above. In addition to the general block of DAS, a PC based DAS consists of Data acquisition hardware, analysis hardware and the software. The software includes program to access data, perform computation on the same and present the result on the visual display unit or an external plotter. The analysis hardware enhances the speed of ~~continuous~~

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computation and analysis, particularly w.r.to digital signal processing applications. The data acquisition hardware generally takes a form of a multi function card. this board accepts an i/p analog voltage of the order of 10mV to 10V which is amplified by a digitally programmable gain amplifier to a standard level of 10V and digitized by high speed ADC interface to the PC bus. There are various options available for the choice of DAS hardware and the user can design the DAS hardware. One of the most important thing that the user of any DAS, be it pc based or otherwise digital hardware of is the relationship between the number of channels, sampling rate per channel and the o/p rate of ADC used to digitize the multiplexed data. The ADC samples the channel at a time and then switches to the next channel, samples this i/p and further switches to the next channel continuing the sequence. Careful consideration regarding the sampling rate should be taken. For avoiding error, the sampling rate per channel should be more than twice the maximum frequency fm of the i/p to that channel.