Chapter 7

Data Acquisition Systems

Data acquisition systems via analog signals are used in communications, electronic and medical applications. Conversion to digitized systems is widely used today because complex circuits are low cost, accurate, simple to implement.

Data acquisition systems are used to measure and record analog signals in basically two different ways.

i. Signals which originate from direct measurement of electrical quantities. These signals may be d.c or a.c voltages, frequency or resistance etc.
ii. Signals which originate from use of transducers.

Components of analog Data Acquisition system

An analog data acquisition system typically consists of some or all of the following elements.

1. Transducers
   It is desirable that an emf, obtained from the transducer proportional to the quantity being measured, is used as an input to the data-acquisition system. Transducers such as thermocouples, strain gauge bridges, piezo-electric devices and photosensitive devices are used.

2. Signal Conditioning Equipment
   It includes any equipment that assists in transforming the output of transducer to the desired magnitude or form required by the next stage of the data acquisition system. Signal conditioners may include devices for amplifying, refining of selecting certain position of signals. Examples of signal conditioning equipment include voltage amplifiers, servo systems, temperature control devices for thermocouple junctions etc.

3. Multiplexer
   Multiplexing is the process of sharing a single channel with more than one input. it is a means of using the same transmission channel for transmitting more than one quantity. Thus, a multiplexer accepts multiple analog inputs and connects them sequentially to one input measuring system. Multiplexing becomes necessary in measurement when the distance between transmitting and receiving points is large and many quantities are to be transmitted. If a separate channel is used for each quantity, the cost of installation, maintenance, and periodic replacement becomes large and hence, a single channel is used shared by the various quantities. It may be TDM or FDM.

4. Calibrating Equipment
   Before each test there is a pre-calibration and often after each test there is a post-calibration. This usually consists of millivolt calibration of all input circuits and shunt calibration of all bridge type transducer circuits.

5. Integrating Equipment
   It is often desirable to know the integral or summation of quantity. An analog integrating circuit can be used for a qualitative test. It has the possible danger of becoming overloaded and also its accuracy is low. Thus, digital techniques are normally used for integration purposes.

6. Visual Display Devices
   They are required for continuous monitoring of the input signals. Examples are CROs, numerical displays, panel mounted meters etc.

7. Analog Recorders
   They are the means for recording data in analog form. Examples are strip chart recorders, magnetic tape recorders etc.

8. Analog Computers
   An analog computer may be used as data reduction device. The output voltage of an analog computer can either be recorded in analog form or be converted to a digital form for recording and further computations.

9. High speed Cameras and TV equipment
   Closed circuit TV is used to enable the operator to make visual observations of the test. Also, high speed cameras are employed to obtain a complete visual record of the process for further analysis.

Digital Data Acquisition System

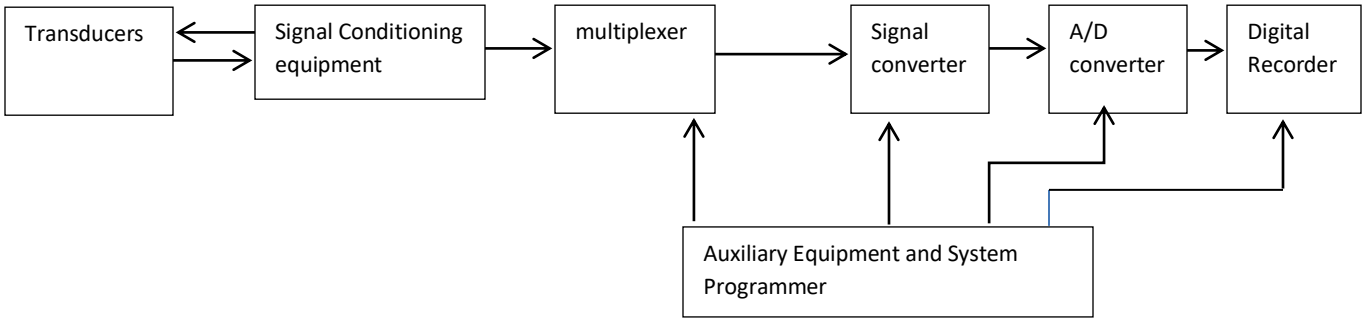


Fig: Digital Data Acquisition System

A digital data acquisition system may include some or all of the components shown. The various components and their functions are described below:

i. Transducers
   They convert a physical quantity into an electrical signal which is acceptable by the data acquisition system.

ii. Signal Conditioning Equipment (Same as Analog Data Acquisition System)
iii. Multiplexer (Same as Analog Data Acquisition System)
iv. Signal converter
   A signal converter translates the analog signal to a form acceptable by the A/D converter. Example is an amplifier for amplifying the low level signal voltages produced by the transducers.

v. A/D converter
   An A/D converter converts the analog voltage to its equivalent digital form. The output of the A/D converter may be fed to digital display devices for visual display or may be fed to digital recorders for recording. It may be fed to digital computer for data reduction and further processing.
vi. Digital Recorder
   They record information in digital form either in optical devices or in magnetic devices.
vii. Auxiliary Equipment
   This contains devices for system programming functions and digital data processing. Typical functions such as linearization and limit comparison of signals, Example is a digital computer.

Uses of Data Acquisition Systems

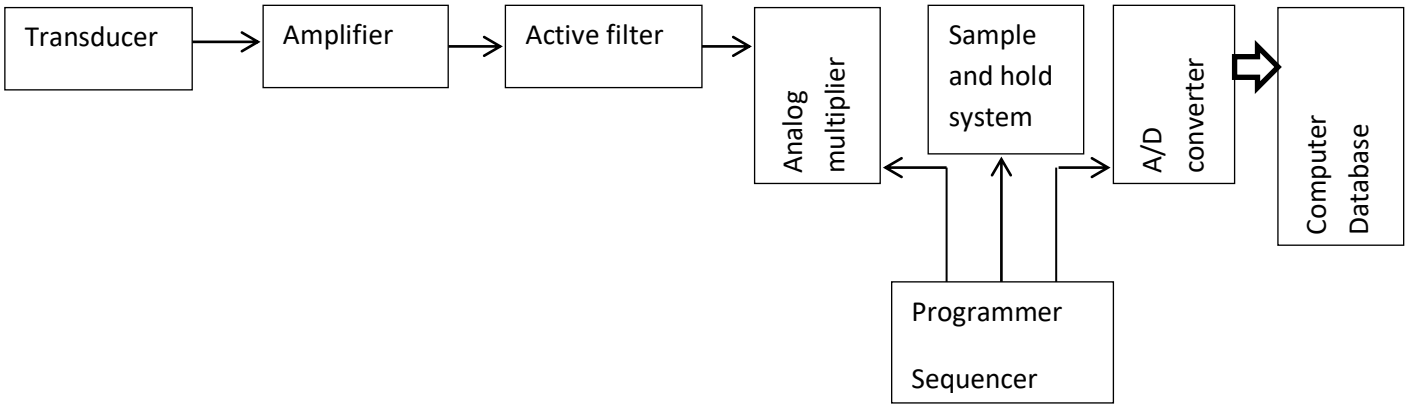
Data acquisition systems are being used in a variety of industrial and scientific areas including aerospace, biomedical and telemetry industries. The type of data acquisition system to be used depend upon the application and the intended use of recorded input data.

Analog data acquisition systems are used when wide frequency width is required or when lower accuracies can be tolerated.

Digital Data Acquisition systems are used when the physical quantity being monitored has a narrow bandwidth i.e when the quantity varies slowly. They are also used when high accuracy and low per channel cost is required.

Digital data Acquisition systems are in general more complex than analog systems both in terms of instrumentation involved and the volume and complexity of the data they can handle.

Modern Digital Data Acquisition System/ modern Trends in data Acquisition system



The input to the system is a physical parameter such as temperature pressure, flow, acceleration or position which are analog quantities .The parameters is first converted into an electrical signal by means of a transducer; once in electrical form all further processing is done by electronic circuits.

Next an amplifier or signal conditioner boosts the amplitude of the transducer output signal to a useful level for further processing. Transducer outputs may be microvolt or millivolt level signals, which are then amplified to 1 to 10 V levels. Furthermore, the transducer output may be impedance signal, a differential signal with common-mode noise , a current output, a signal superimposed on a high voltage or a combination of these. The amplifier, in order to convert such signals into a high level voltage may be one of the several specialized types.

The amplifier is frequently followed by a low-pass active filter which reduces high frequency signal components, unwanted electrical interference noise or electronic noise from the signal. The amplifier is sometimes also followed by a special nonlinear analog function circuit that performs a nonlinear operation (squaring, multiplication, division, rms conversion, log conversion or linearization) on the high level signal.

The processed analog signal next goes to an analog multiplexer, which sequentially switches between a number if different analog input channels. Each input is in turn connected to the input of the multiplexer for specified period of time by the multiplexer switch. During this connection time, a sample hold circuit acquires the signal voltage and then holds its value while an analog to digital converter converts the value into digital form. The resultant digital word goes to a computer data bus or to the input of a digital circuit.

Thus, the analog multiplexer, together with the sample-hold time shares the A/D converter with a number of analog input channels. The timing and control of the complete data-acquisition system is done by a digital circuit called a programmer- sequencer which in turn is under control of the computer. In some cases, the computer itself may control the entire data-acquisition system.