Data Acquisition for Automation System

A Comprehensive Overview of Data Collection and Processing in Modern Automation

Course: **23MCT303 - Data Analytics in Automation System**

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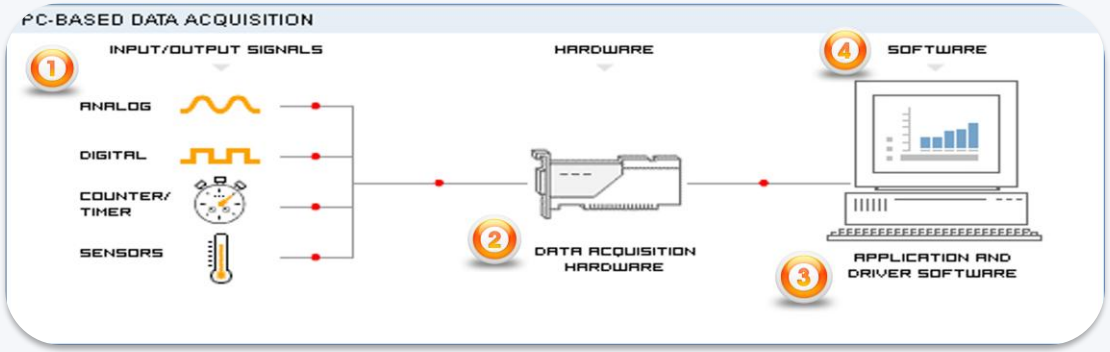
Introduction to Data Acquisition

Definition

Process of **sampling signals** that measure real-world physical phenomena and **converting them** into digital format for analysis

Importance in Automation

- Enables **real-time monitoring** of industrial processes
- Provides data for **decision-making** and control systems
- Forms foundation for **predictive maintenance** and optimization



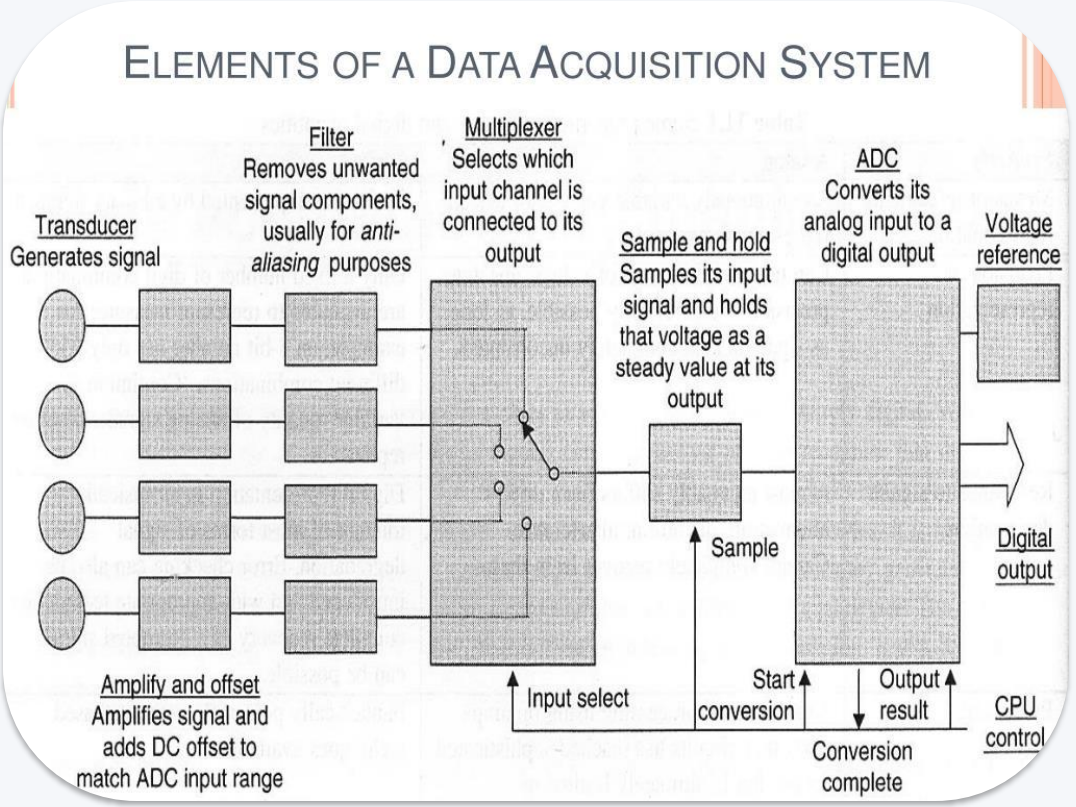
Components of Data Acquisition Systems

Hardware Components

- **Sensors** & Transducers
- **Signal** Conditioning
- Multiplexers
- **ADC** (Analog-to-Digital)

Software Components

- **Drivers** & Interfaces
- **Data** Management
- **Analysis** Tools
- **Visualization** Software



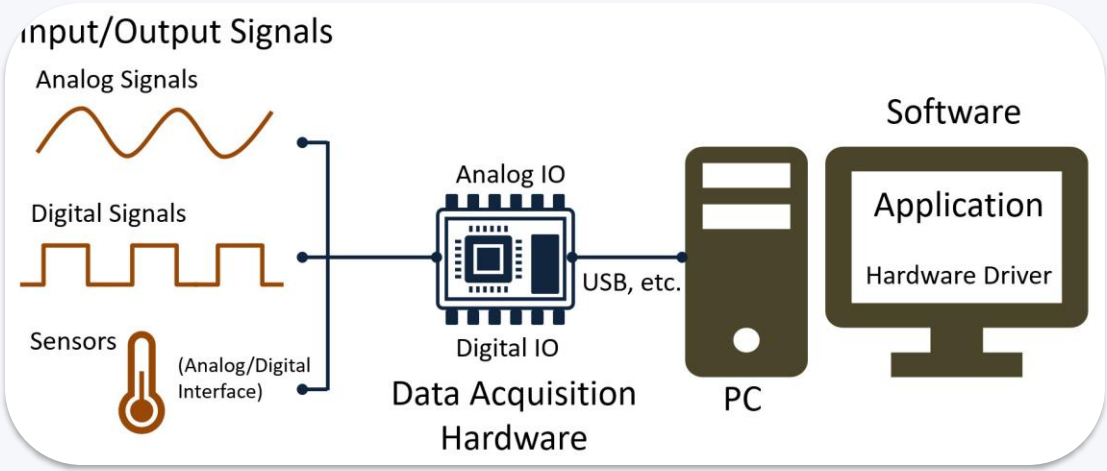
Data Acquisition Process

1. **Signal Sensing**
   Physical phenomena → **Electrical signals** via sensors

2. **Signal Conditioning**
   Amplification • Filtering • **Noise reduction**

3. **Analog-to-Digital Conversion**
   Continuous signals → **Digital data** via ADC

4. **Data Processing & Storage**
   Analysis • **Visualization** • Database storage



Types of Data Acquisition Systems

Analog DAQ

- Captures **continuous signals**
- Voltage • Temperature • Pressure

Digital DAQ

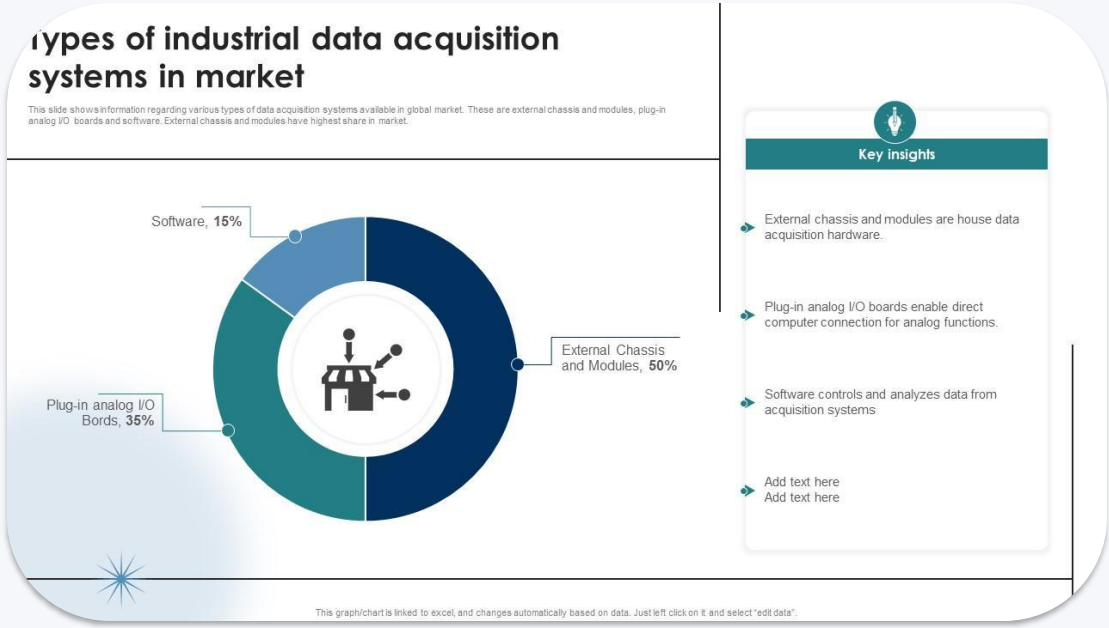
- Records **discrete events**
- Switches • Counters • Timers

Networked DAQ

- **Remote monitoring** & control
- Ethernet • Wireless • IoT

Modular DAQ

- **Configurable** & scalable
- Customizable • Expandable



Data Acquisition Hardware

Sensors & Transducers

Temperature

Thermocouples • RTDs • **Thermistors**

Pressure

Strain Gauge • **Piezoelectric**

Signal Conditioning

Amplifiers

Instrumentation • Isolation

Filters

Low-pass • High-pass • **Notch**

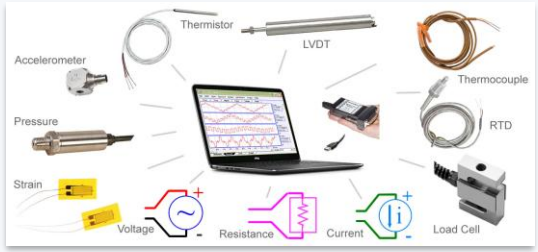
Analog-to-Digital Converters

Resolution

12-bit • 16-bit • **24-bit**

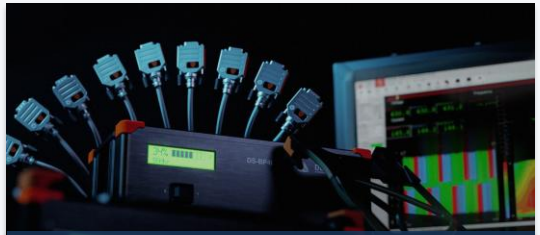
Sampling Rate

kHz • MHz • **GHz**

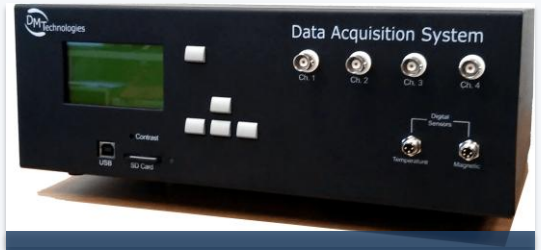


Sensors & Transducers

DAQ Hardware Modules



Modern DAQ Device



Integrated DAQ System

Data Acquisition Software

Software Tools & Applications

DAQ Software

LabVIEW • MATLAB • Python

Communication

OPC • Modbus • Ethernet/IP

Data Visualization & Analysis

Visualization

Dashboards • Charts • HMI

Data Management

Databases • Historians • Cloud

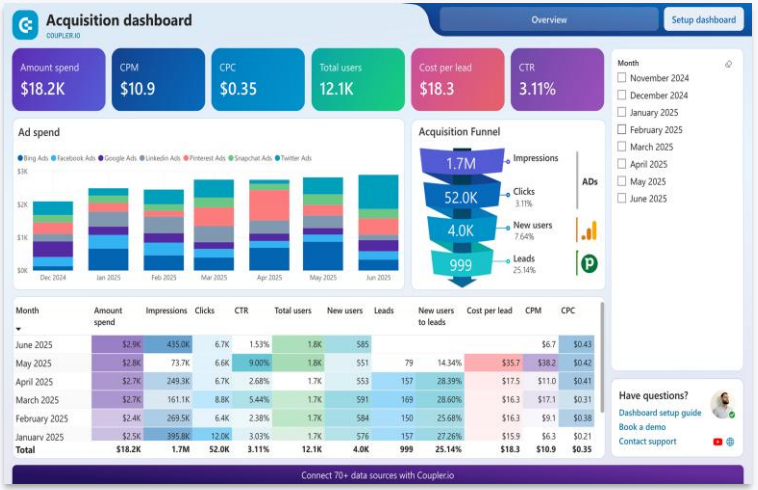
Advanced Analytics

Machine Learning

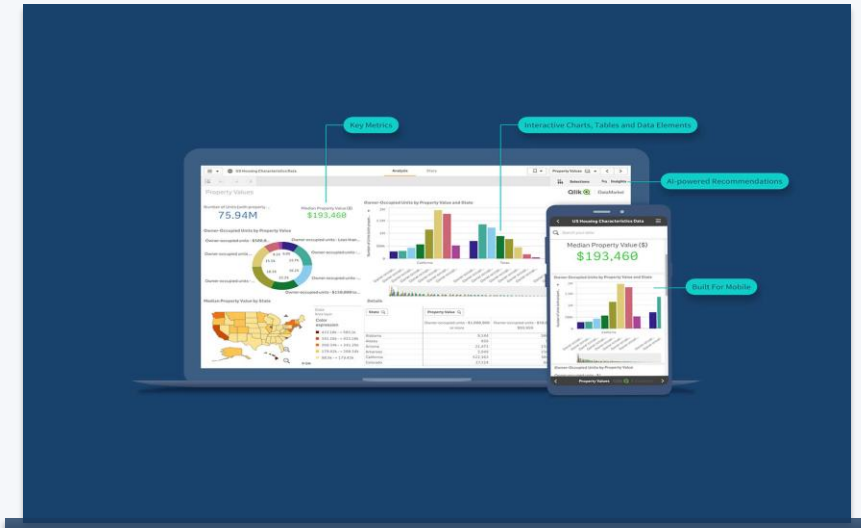
Predictive • Classification

AI Integration

Pattern • Anomaly Detection



Data Acquisition Dashboard



Data Visualization Interface

Data Acquisition in Automation Systems

Integration with Automation Systems

PLC Integration

Real-time data exchange • Control loops

SCADA Systems

Centralized monitoring • Remote control

Industrial Applications

Manufacturing

Quality control • Process optimization

Energy Management

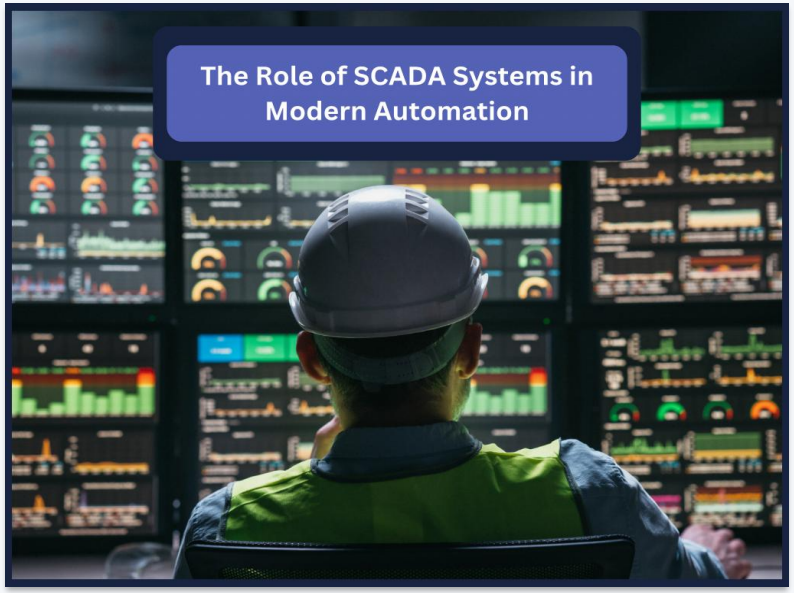
Efficiency monitoring • Load balancing

Predictive Maintenance

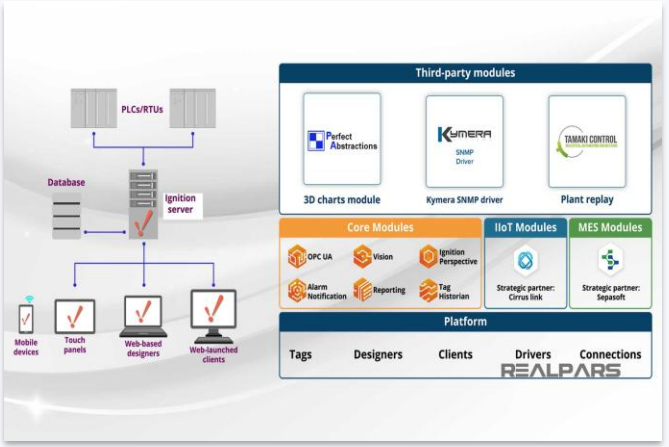
Vibration analysis • Failure prediction

Process Control

Temperature • Pressure • Flow



SCADA System in Modern Automation



Industrial Automation System Architecture

Challenges in Data Acquisition

Common Challenges

Data Quality
Noise • Missing values • Inconsistency

System Integration
Compatibility • Protocol differences

Security Concerns
Cyber threats • Data breaches

Performance
Latency • Throughput limitations

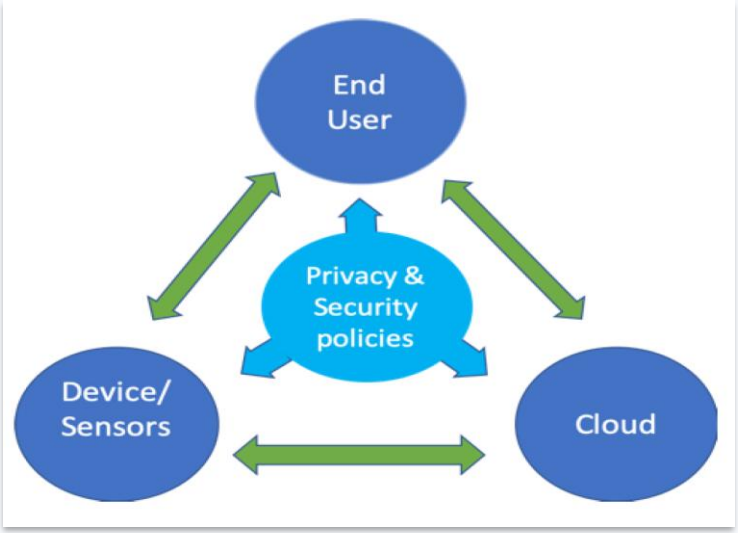
Solutions

Signal Processing
Filtering • Calibration • Validation

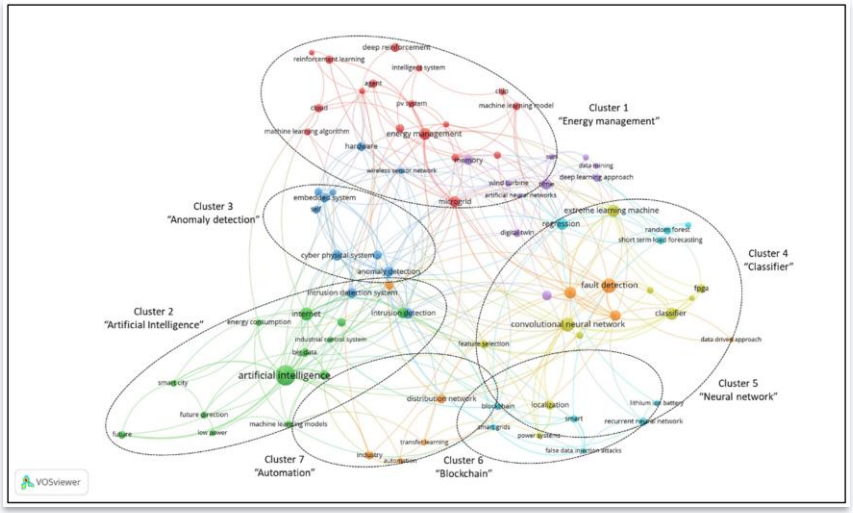
Standardization
OPC UA • MQTT • Industry 4.0

Security Measures
Encryption • Access control • Auditing

Optimization
Edge computing • Data compression



Data Security & Privacy Challenges



Complex Data Acquisition Networks

Mind Map: Data Acquisition Concepts

Summary & Recap

Key Takeaways

1. Data acquisition is **essential** for automation systems
2. Components include **sensors**, signal conditioning, ADCs, and software
3. Integration with **PLCs** and **SCADA** enables industrial automation
4. Addressing challenges ensures **reliable** data acquisition