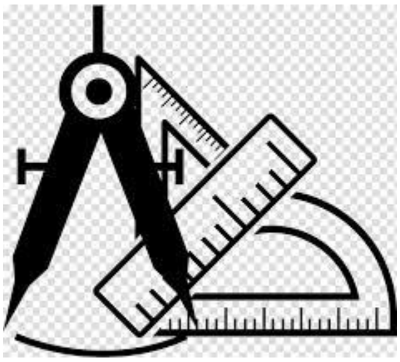
ROHINI
COLLEGE OF ENGINEERING AND TECHNOLOGY
Approved by AICTE and affiliated to Anna University,(An ISO Certified Institution)
Accredited by NAAC with A+ Grade

DEPARTMENT OF MECHANICAL ENGINEERING

24ME403 - METROLOGY & MEASUREMENTS

Dr. A. ARUL MARCEL MOSHI,

ASSOCIATE PROFESSOR / MECH.



UNIT V: ADVANCES IN METROLOGY

CO5: To inspect the quality control in Manufacturing Industries with advances in Measurement.

Role of IoT in real-time data acquisition during machining processes

The Internet of Things (IoT) refers to a network of physical devices embedded with sensors and software to connect and exchange data over the internet. In machining, IoT transforms conventional machine tools into smart, connected assets capable of real-time data acquisition, enabling unprecedented levels of monitoring, control, and optimization.

Core components of IoT data acquisition:

Real-time data acquisition relies on a three-tier architecture:

i) **Sensors and controllers (The Edge):** Vibration, temperature, power, and acoustic emission sensors, along with CNC controllers, generate raw data (e.g., spindle load, axis position, temperature).

ii) **Connectivity (The Pipe):** Protocols like OPC UA or MQTT transmit data from the shop floor to gateways. Edge computing devices often filter and process data locally to reduce latency.

iii) **Cloud platforms (The Brain):** Data is aggregated, stored, and analyzed in the cloud using machine learning algorithms for deep insights.

Key roles in real-time machining:

IoT enables the following during active machining processes:

- **Continuous monitoring:** Shifts data collection from periodic manual checks to continuous, high-frequency streaming (24/7) from every active machine.
- **Real-time visibility:** Provides live dashboards of Key Performance Indicators (OEE, utilization, cycle times) accessible from anywhere, enhancing shop floor transparency.
- **Event capture:** Acquires high-resolution data to capture transient, millisecond-level events like force spikes indicating tool chipping, which were previously invisible.

- **Contextualization:** Data is recorded with context (job ID, tool used, timestamp), transforming raw numbers into meaningful, searchable information.

Practical benefits:

The real-time data acquired serves as the foundation for smart manufacturing functionalities:

a) **Predictive maintenance:** Analyzes vibration/temperature trends to predict bearing or spindle failure, scheduling maintenance before breakdowns occur.
b) **Process optimization:** Real-time tool wear data enables adaptive control, automatically adjusting feeds/speeds to maximize both tool life and material removal rate.
c) **Digital twin synchronization:** Keeps a virtual model of the machine synchronized with its physical counterpart for accurate simulation and remote monitoring.
d) **Quality traceability:** Links machining data to individual parts, creating a "digital passport" for root cause analysis if defects are found later.