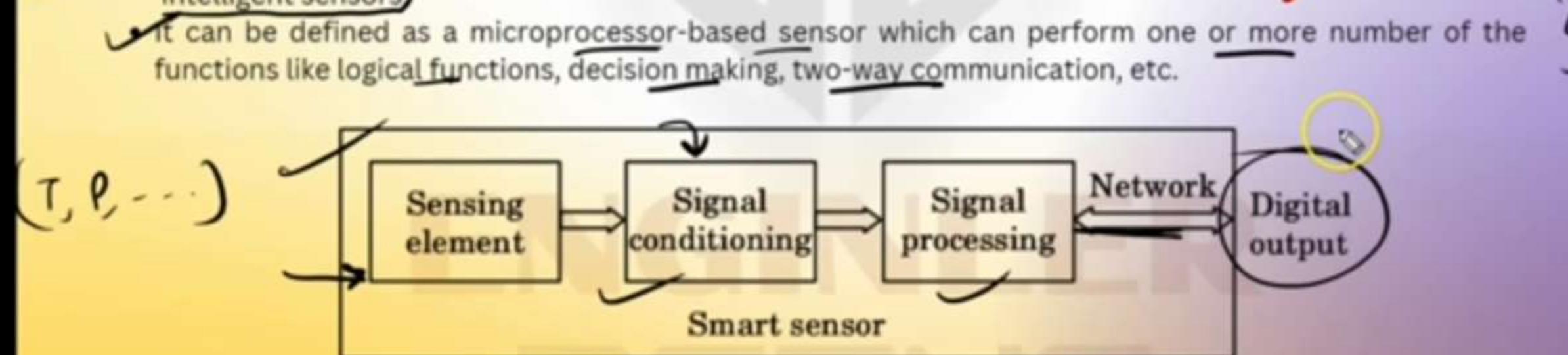




Smart Sensors

- A smart sensor is simply expanded as "Sensing, Monitoring and Remote Transmission" sensor.
- It can be of either analog type or digital type which can be combined with a processing unit and a communication interface. These sensors can provide an electrical output.
- When they combined with suitable interfacing devices, these sensors are also called intelligent sensors.
- It can be defined as a microprocessor-based sensor which can perform one or more number of the functions like logical functions, decision making, two-way communication, etc.

Sensors + Interfacing circuit = Smart Sensor/ Intelligent sensors

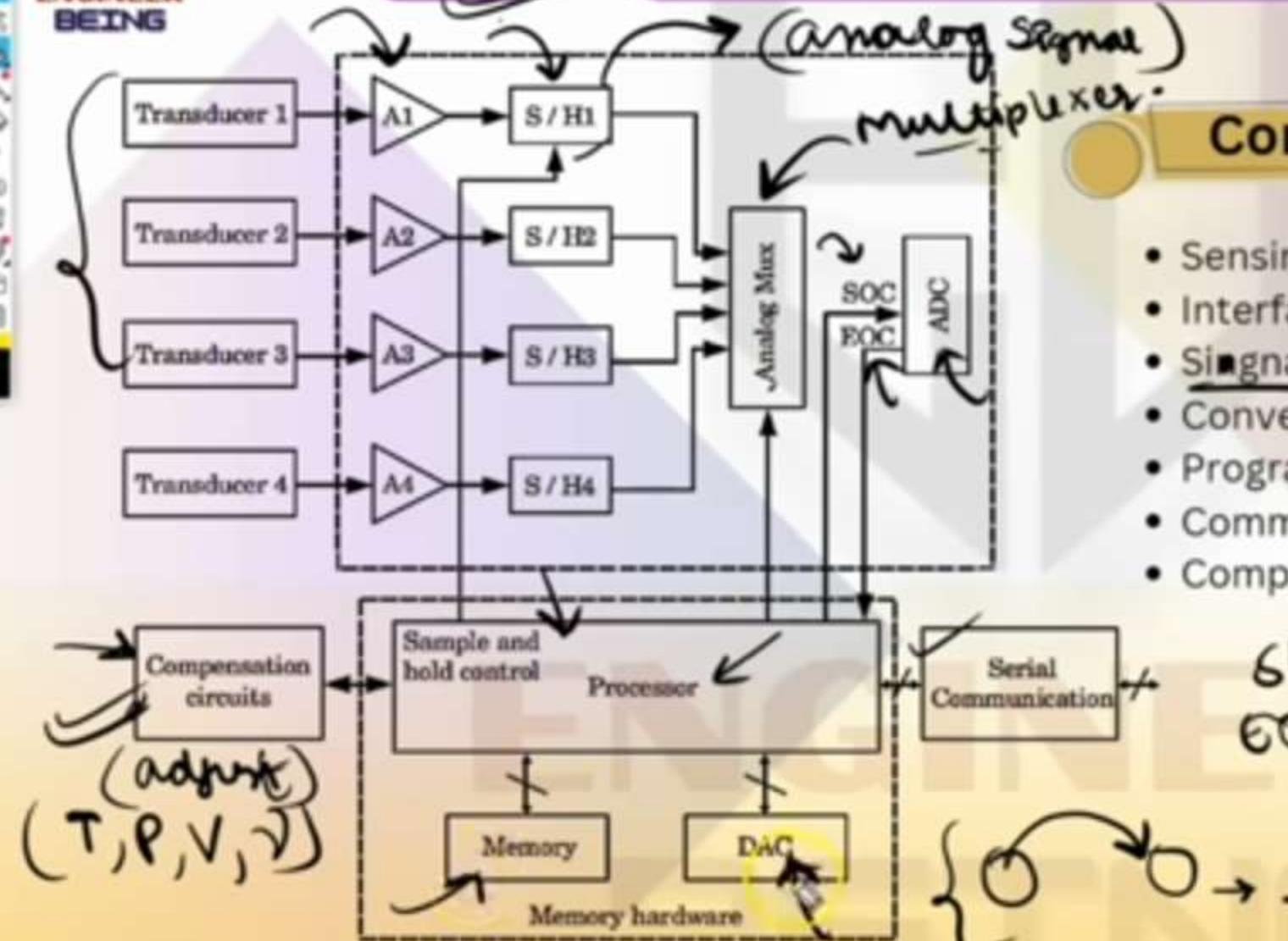




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Architecture of Smart Sensors



Characteristics of Smart Sensors

(Compensation
circuit)

→ {T, P, V, ...}
(output)

1 Self-calibration

Self-calibration in sensors refers to the ability of a sensor to automatically adjust or correct its measurements to account for any changes in its environment or operating conditions. This allows the sensor to maintain accurate and reliable readings over time, without requiring manual calibration.

For example, **a temperature sensor** may be equipped with a built-in reference temperature sensor or an algorithm that allows it to adjust its readings to account for changes in temperature due to factors such as self-heating, aging, or drift over time.

Similarly, **an accelerometer** may have an auto-calibration function that allows it to correct for any biases or offsets that can occur due to changes in temperature or other environmental factors.

* Self-calibration can improve the accuracy and stability of sensor measurements, reduce the need for manual calibration, and help ensure the long-term reliability of the sensor.

(error)



Self-testing



Self-testing in sensors refers to the capability of a sensor to perform automatic tests on itself to identify any faults or malfunctions that may affect its accuracy and reliability. Self-testing can help ensure that a sensor is operating correctly and that its readings are trustworthy.

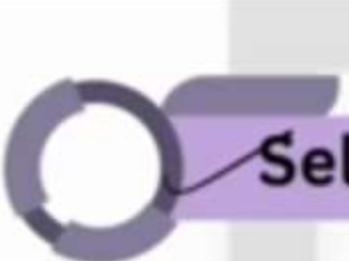
Some of the ways self-testing can be implemented in sensors include:



Sensor internal testing: Sensors can perform self-tests of their own internal components to ensure that they are working correctly. For example, a temperature sensor can measure the temperature of its own internal reference to check if it is within the expected range.

Signal analysis: Sensors can perform signal analysis on their output signals to detect any anomalies or errors. For instance, an accelerometer can compare the output signals in different axes to check if they are consistent.

Environmental testing: Sensors can perform tests to check if their readings are affected by environmental factors such as temperature, humidity, or vibration. For example, a pressure sensor can perform a self-test to check if its readings are stable when subjected to different temperatures.



Self-communication



wireless
communication
technology

Self-communication in smart sensors refers to the ability of a sensor to communicate with other devices or systems without requiring external communication interfaces. This is made possible through the integration of microprocessors and wireless communication technologies such as Bluetooth, Wi-Fi, or Zigbee.

Some of the ways in which self-communication can be implemented in smart sensors include:

Self-diagnosis and error reporting: Smart sensors can perform self-diagnosis tests and report any issues or errors detected to the user or system via a wireless communication interface. This can help prevent sensor failure or malfunction and ensure the accuracy and reliability of the sensor's readings.

Sensor-to-sensor communication: Smart sensors can communicate with each other wirelessly, enabling them to work together to perform complex tasks. For example, a group of sensors can coordinate their measurements to track the movement of an object or monitor the status of a system.





Multi-sensing (Testing)

- Some smart sensor also has ability to measure more than one physical or chemical variable simultaneously.
- A single smart sensor can measure pressure, temperature, humidity gas flow, and infrared, chemical reaction surface acoustic vapour etc.

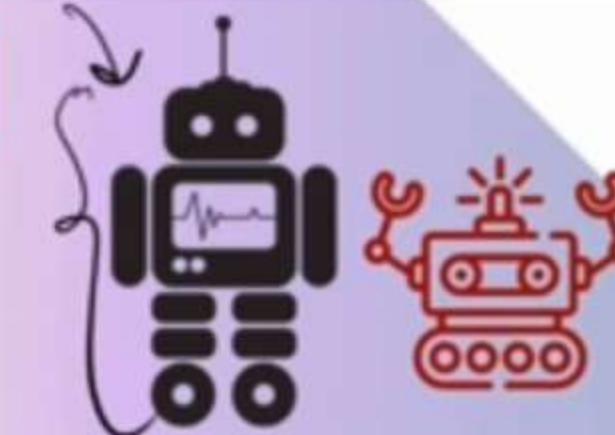


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Applications of Smart Sensors



Automatic Robot Control



Smart sensors can be used in automatic robot control to improve the accuracy and efficiency of the robot's operations. Smart sensors can provide real-time data about the robot's environment, such as its position, orientation, and surroundings, allowing the robot to make informed decisions. Some examples are:

- ✓ **Vision sensors:** Vision sensors can capture images and videos of the robot's surroundings, allowing the robot to detect and recognize objects, people, or obstacles & avoid collisions
- ✓ **Force/torque sensors:** Force/torque sensors can measure the forces and torques applied to the robot's end effector, allowing the robot to adjust its grip or force to handle delicate or heavy objects more accurately.
- ✓ **Inertial sensors:** Inertial sensors such as accelerometers and gyroscopes can measure the robot's motion and orientation, allowing it to maintain balance, stability, and orientation while moving or performing tasks.
- ✓ **Proximity sensors:** Proximity sensors can detect the presence or absence of objects or obstacles in the robot's path, allowing the robot to adjust its trajectory or speed to avoid collisions.



Automobile Engine Control



Smart sensors can be used in automatic engine control to improve the performance, efficiency, and safety of the engine. Smart sensors can provide real-time data such as temperature, pressure, and fuel flow, allowing the engine control system to make informed decisions and optimize the performance. Some examples are:

- **Temperature sensors:** Temperature sensors can measure the temperature of the engine's components, such as the coolant, oil, or exhaust gas, allowing the engine control system to adjust the engine's fuel-air ratio or ignition timing to optimize its performance and reduce emissions.
- **Pressure sensors:** Pressure sensors can measure the pressure of the engine's air intake, fuel system, or exhaust gas, allowing the engine control system to adjust the engine's parameters to optimize its efficiency and power output.
- **Flow sensors:** Flow sensors can measure the flow rate of the engine's air intake or fuel system, allowing the engine control system to adjust the engine's parameters to optimize its fuel efficiency and reduce emissions.

Application of smart sensors in smart cities

✓ traffic flow, accidents.

Traffic and transportation management



Pollution - air quality



✓ Environmental monitoring

✓ disaster

✓ Energy management



✓ Waste management



✓ Public safety

