Course 3: Mechatronics in Agriculture

M3: Sensors and Actuators

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contents

In this module, learners will understand the role of sensors and actuators in agriculture, recognising how these components form the backbone of mechatronic systems, enabling real-time monitoring, intelligent decision-making, and automated control of equipment.

01

SENSORS AND ACTUATORS IN AGRICULTURAL MACHINERY

Sensors and Actuators in Agricultural Machinery

Modern agricultural machinery relies heavily on **sensors and actuators** to enhance **efficiency, automation, and precision** in farming operations. These components form the backbone of **mechatronic systems**, enabling real-time monitoring, intelligent decision-making, and automated control of equipment. This module explores how sensors improve machine efficiency, the role of actuators in farming, and a case study on mechatronics in smart greenhouse systems.

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How Sensors Enhance Machine Efficiency

Sensors play a crucial role in data collection and decision-making in agricultural machinery. By **continuously monitoring** environmental and operational conditions, sensors help optimise processes, reduce resource waste, and improve crop yields.

Example: Smart irrigation systems use soil moisture sensors to trigger water pumps only when necessary, improving water conservation and crop health.

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Key Functions of Sensors in Agriculture:

- **Precision Farming:** GPS and LiDAR sensors guide autonomous tractors and drones for accurate navigation and efficient land use.

- **Irrigation Optimisation:** Soil moisture sensors adjust water supply based on real-time data, preventing overwatering.

- **Pest and Disease Detection:** Multispectral and thermal cameras identify early signs of plant stress, enabling targeted treatment.
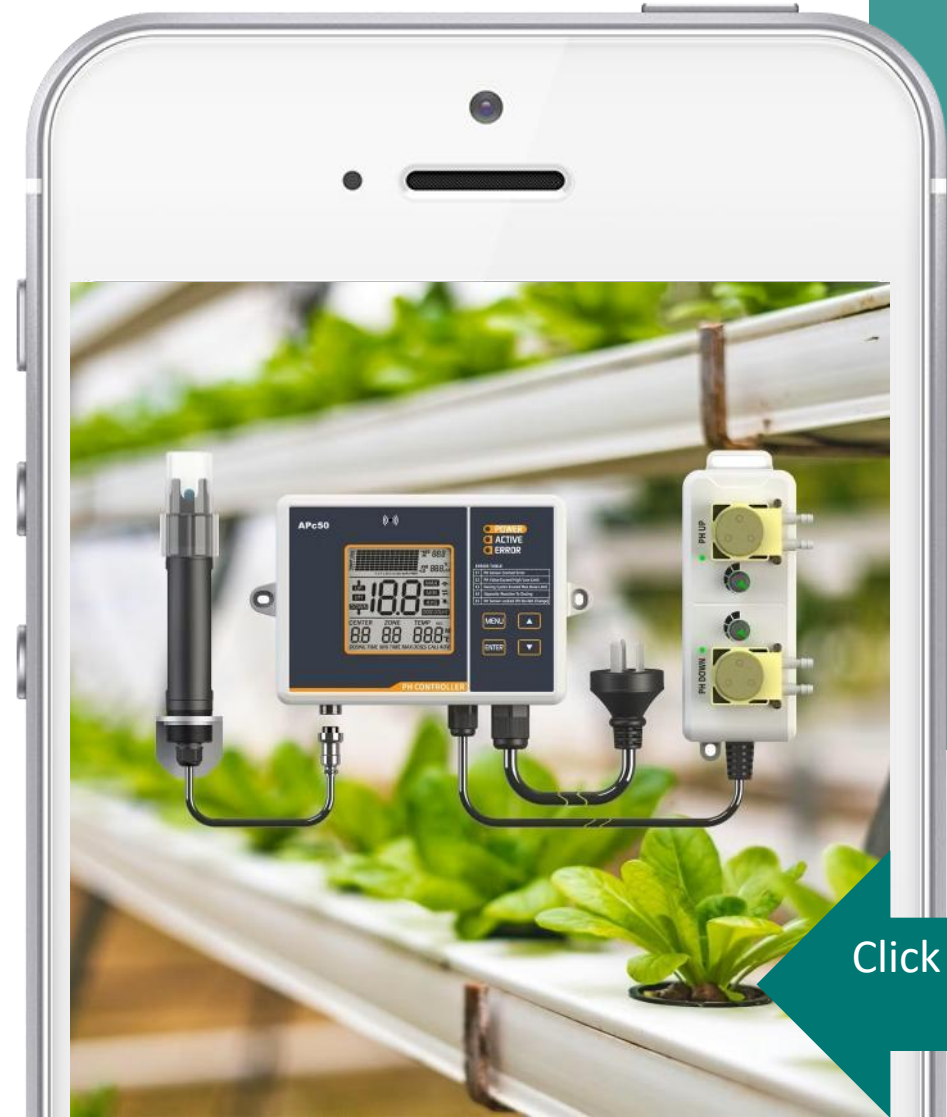
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Key Functions of Sensors in Agriculture:

- **Livestock Monitoring:** RFID tags and biometric sensors track animal health and movement, ensuring better welfare.

- **Machine Condition Monitoring:** Vibration and pressure sensors detect wear and mechanical faults in machinery, reducing downtime.
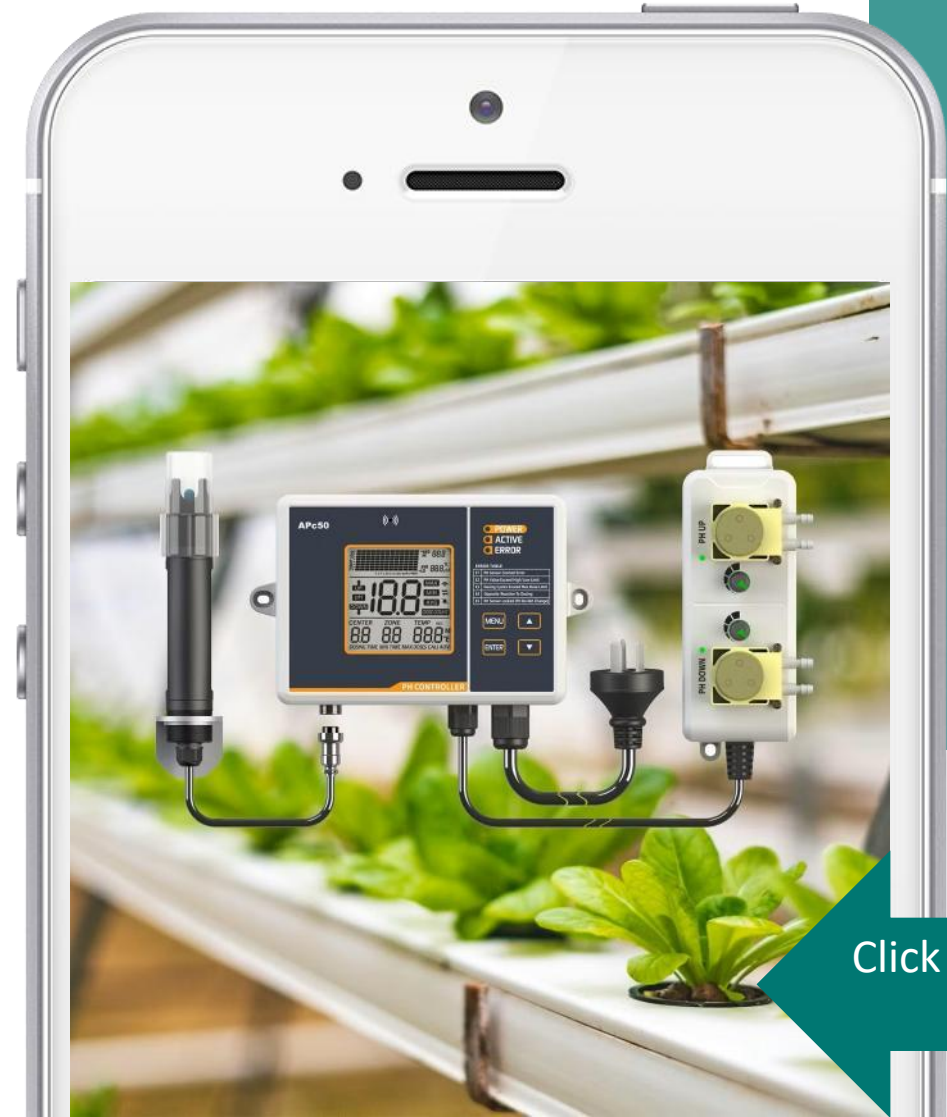
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Actuators & their Applications in Farming Equipment

Actuators are mechanical components that convert electrical or hydraulic signals into physical movement, enabling **precise control** of agricultural machinery. They play a key role in **robotic systems, automated irrigation, and harvesting equipment**.

Actuators offer motions like push, pull, injection, and trigger to agricultural equipment.

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Types of Actuators in Agriculture:

- **Hydraulic Actuators:** Used in heavy-duty machinery like tractors and robotic arms to provide high power and force.
- **Pneumatic Actuators:** Found in lightweight automation systems, such as robotic fruit-picking devices.
- **Electric Motors & Servo Actuators:** Enable precision control in autonomous sprayers, seeders, and robotic weeders.
- **Linear Actuators:** Adjust sprayer nozzles, irrigation valves, and robotic harvesting tools.

Example: Robotic harvesters use **electric servo motors** to gently grasp and pick fruit without damaging it, improving harvest quality.

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Actuators in Agriculture

For a visual demonstration of electromechanical actuators in agricultural machinery, you might find the following video informative:

Ewellix - Electromechanical actuators for agriculture machinery & equipment - YouTube

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02

CASE STUDY: MECHATRONICS FOR SMART GREENHOUSE SYSTEMS

Case Study: Mechatronics for Smart Greenhouse Systems

Greenhouses equipped with **mechatronic control systems** integrate **sensors, actuators, and AI** to create an optimised growing environment. These **smart systems** adjust temperature, humidity, and irrigation based on real-time conditions, enhancing productivity and sustainability.

How It Works:

- **Sensors monitor climate conditions** (temperature, CO_2 levels, soil moisture, and light intensity).

- **Actuators regulate automated processes** such as ventilation, heating, and nutrient delivery.

- **AI-driven controllers** analyse data and make real-time adjustments to optimise plant growth.

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Be Inspired:

In our SmartSkills Good Practice Compendium the Czech case study VESA, demonstrates how they use a *network of environmental sensors to monitor climatic conditions in their greenhouses.*

For more information: **Vesa Velhartice**

LET'S PRACTICE

03

Learner Activity:

Practical Activity: "Exploring Sensor and Actuator Applications in Agriculture"

- Identify one type of sensor and one type of actuator commonly used in modern agricultural machinery.

- Task: Write a brief explanation (100-150 words) of how they function, their role in farming operations, and their benefits.

- Optional: Find an image or video demonstrating these components in action.

Group Activity:

Discussion Prompt:

How do you think advanced sensors and actuators will shape the future of smart farming? What challenges might arise in their widespread adoption?

Purpose: This activity engages learners in understanding real-world applications, encourages critical thinking, and highlights the impact of automation in agriculture.

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