

Course 3:
Mechatronics in
Agriculture
M3: Sensors and
Actuators

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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.

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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.

How Sensors Enhance Machine Efficiency



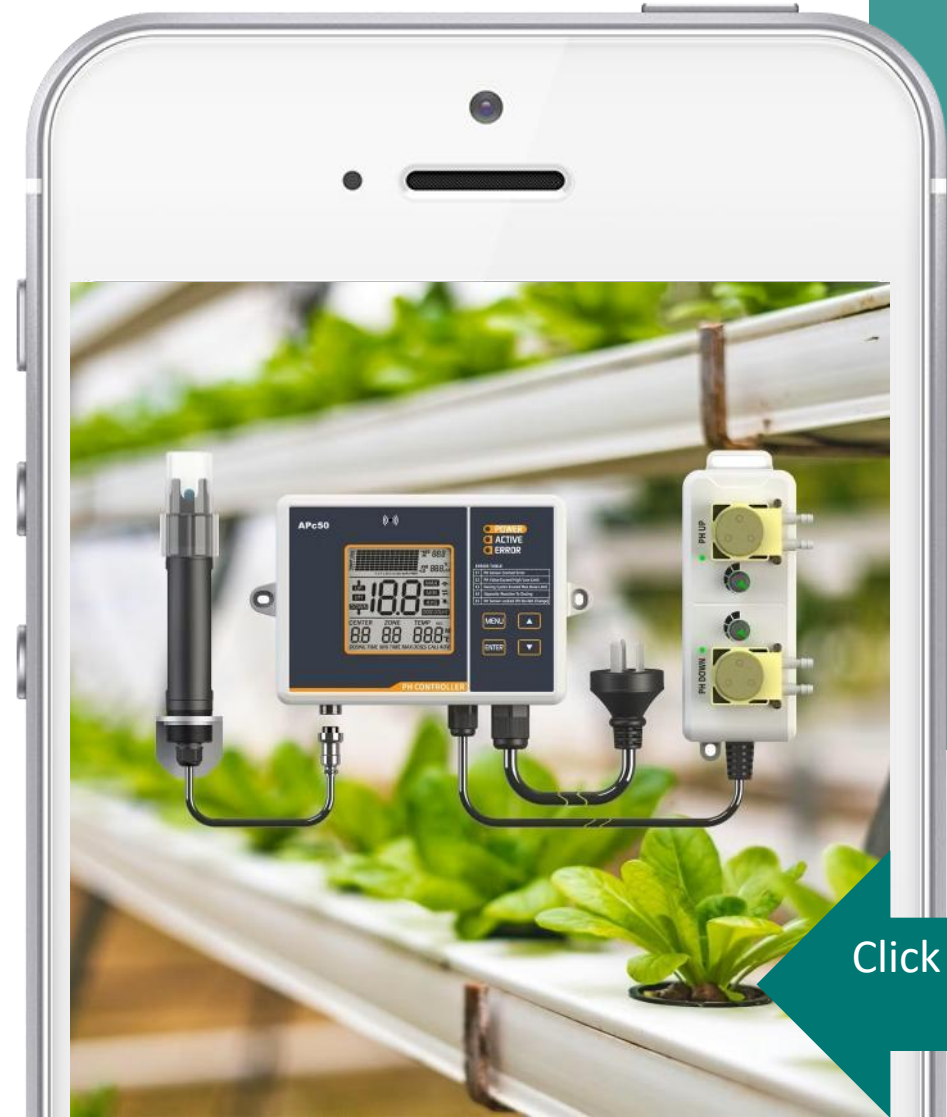
<https://www.instructables.com/ESP32-Soil-Moisture-Sensors-DIY-Automatic-Watering/>

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.

Key Functions of Sensors in Agriculture:

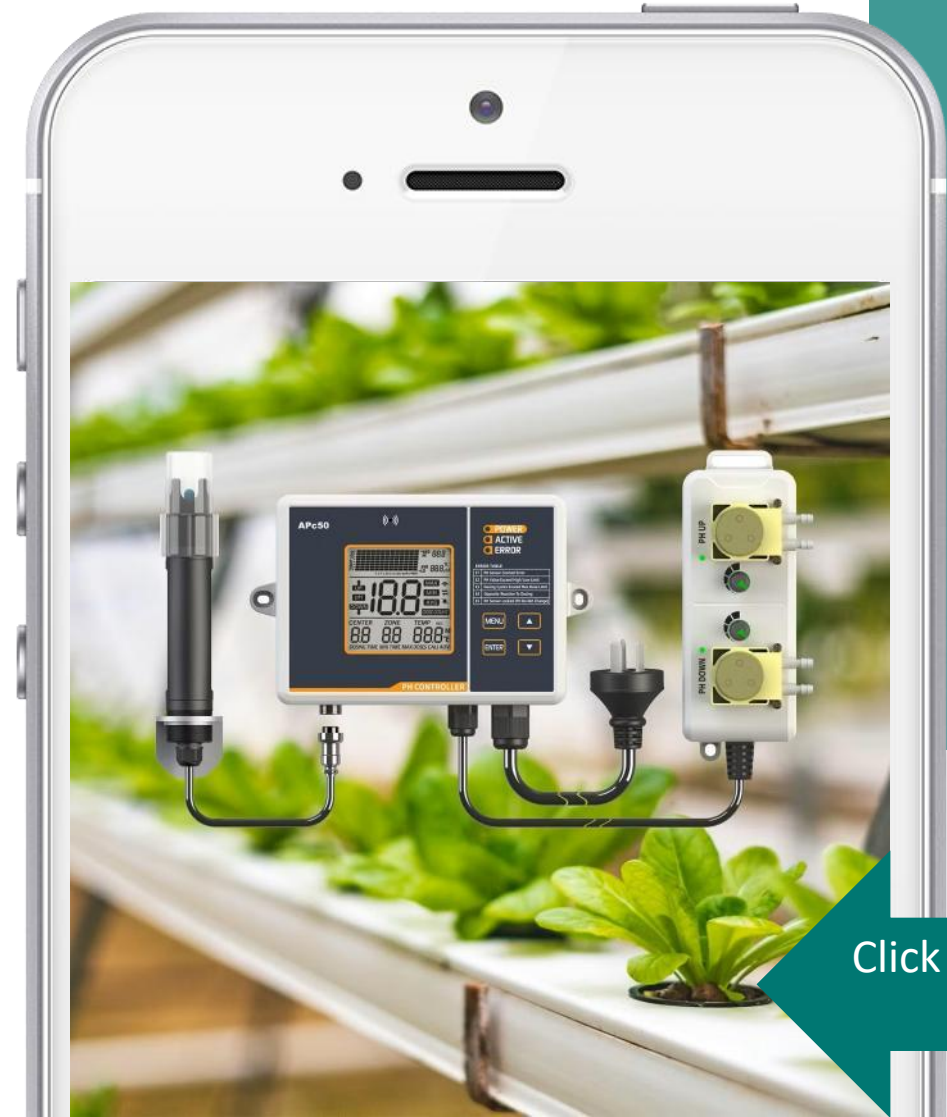
- **Precision Farming:** GPS and LiDAR sensors guide autonomous tractors and drones for accurate navigation and efficient land use.
- **Irrigation Optimisation:** Soil moisture sensors adjust water supply based on real-time data, preventing overwatering.
- **Pest and Disease Detection:** Multispectral 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.



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](#)

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, CO₂ 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.

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](#)



VESA Velhartice a.s.

Type of technology used:

- ✓ Internet of Things
- ✓ Smart Sensors

Does the Practice relate to hardware, software or both?

- ✓ Hardware

The Vesa Velhartice farm is engaged in breeding new quality potato varieties, propagating potato seedlings, trading in seed, consumer and industrial potatoes, and, last but not least, providing advice to potato growers and users.

The company manages approximately 430 hectares of agricultural land, and its Czech potato varieties are gaining popularity and are successful throughout Europe. They use automatic weather stations and environmental sensors both outdoors and indoors (greenhouses where potato varieties are bred from seeds). In particular, the aforementioned greenhouses are closed microclimatic systems with precise sensors. The company also operates a unique automatic potato vending machine, where customers can buy potatoes almost at any time.



How is this technology being used?

A network of environmental sensors is implemented to monitor climatic conditions in breeding greenhouses.

The implemented technology is focused on the management of potato variety breeding using various environmental sensors for monitoring the temperature and humidity of air, soil, and sunlight in closed microclimate greenhouses. The data is automatically sent to a central data warehouse, from which reports are created for users. Based on this measured data, the required optimal climatic conditions can be precisely determined and maintained.





smart sustainable agriculture

03

LET'S PRACTICE



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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