Facility Spotlight: Rapid Prototyping & IoT Lab Projects

Overview

Our laboratory is equipped with **Arduino Uno** and **Raspberry Pi** platforms, serving as the gateway for students to enter the world of Rapid Prototyping and the Internet of Things (IoT). These boards are industry-recognized for their versatility, allowing students to quickly transform theoretical ideas into functional "Proof of Concept" (PoC) models.

1. Arduino Uno: The Foundation of Embedded Control

The Arduino Uno (based on the ATmega328P) is our primary tool for teaching the fundamentals of physical computing.

- **Ease of Use:** Utilizing a simplified C++ framework, students focus on logic rather than complex register configurations.
- **Real-Time Interaction:** Ideal for high-speed sensor reading, motor control, and basic robotics.
- **Shield Ecosystem:** Our lab includes various "Shields" (Ethernet, Motor Driver, Relay) that plug directly into the Uno to expand its hardware capabilities instantly.

2. Raspberry Pi: Edge Computing & Linux Systems

The Raspberry Pi represents the bridge between traditional embedded systems and modern high-level computing.

- **Single Board Computer (SBC):** Unlike microcontrollers, the Pi runs a full **Linux OS**, allowing for Python-based development.
- **IoT & Cloud Connectivity:** Used for projects requiring Wi-Fi/Bluetooth, web servers, or cloud data logging.
- **Advanced Processing:** Capable of running **Computer Vision (OpenCV)** and **Machine Learning** models at the edge.
- **Multimedia:** Integrated HDMI and CSI camera ports for video processing projects.

Learning Objectives & Curriculum

The integration of these boards enables a "Modern-Meet-Classic" engineering approach:

1. **Sensor Networks:** Interfacing I2C/SPI sensors (Temperature, Ultrasonic, PIR) with Arduino.
2. **Home Automation:** Controlling high-voltage appliances using Raspberry Pi web servers.
3. **Robotics:** Building autonomous rovers using Arduino for low-level motor control and Pi for high-level navigation.
4. **Python for Hardware:** Learning to use Python to control physical GPIO pins and process data arrays.

The Prototyping Workflow

We encourage students to follow a professional development path:

- **Stage 1:** Verify the logic using the **SimulIDE** virtual environment.
- **Stage 2:** Prototype the circuit using **Arduino Uno** on a breadboard.
- **Stage 3:** If the project requires networking or heavy data processing, migrate or interface the system with a **Raspberry Pi**.

Facility Resource Kit

- **Development Environments:** Arduino IDE and VS Code (PlatformIO) pre-installed on all workstations.
- **Operating Systems:** Pre-configured MicroSD cards with **Raspberry Pi OS** available for checkout.
- **Sensor Modules:** Wide variety of sensor kits (DHT11, HC-SR04, MPU6050) available in the lab inventory.

> **Note to Students:** While these boards are robust, they are sensitive to short circuits. Always double-check your wiring against the provided pin-out diagrams before connecting the USB power.