Smart Indoor Crop Cultivation System using PIC18F452 with Desktop-Based Environmental Control Interface
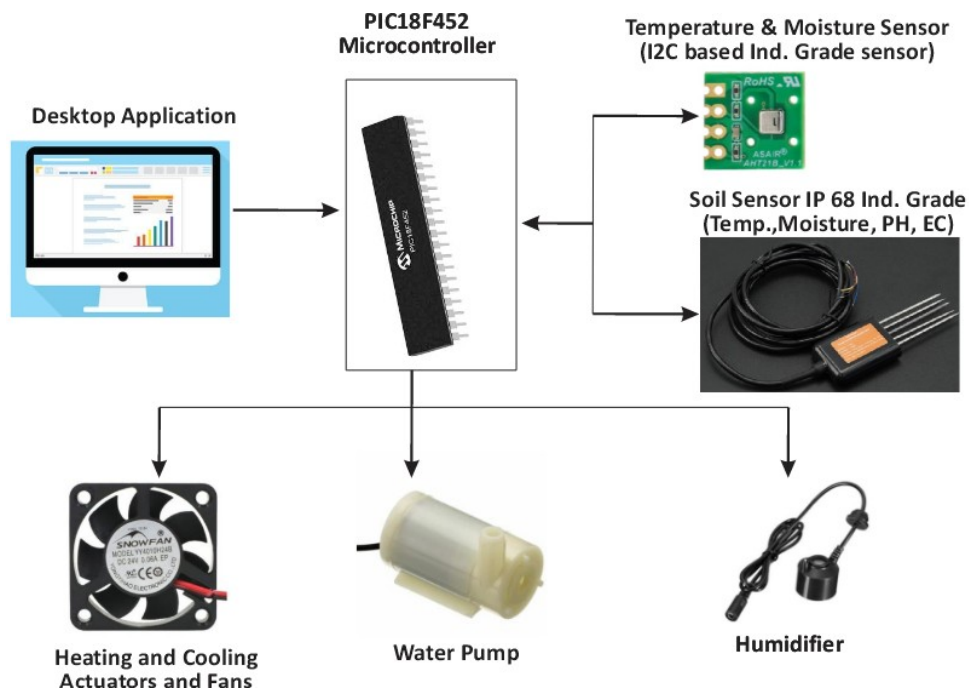
Abstract:

This project proposes a cost-effective and intelligent solution for **automated indoor crop cultivation**, specifically designed to meet the environmental requirements of high-value crops like **saffron**. The system is built around the **PIC18F452 microcontroller**, which serves as the central controller for monitoring and managing key environmental parameters including **temperature**, **humidity**, and **soil moisture**.

The PIC18F452 receives real-time **setpoints for each day of the crop's lifecycle** via **serial (UART) communication** from a **Python-based desktop application**. This desktop GUI allows users to predefine and schedule the desired environmental conditions throughout the cultivation cycle. Based on the received setpoints and sensor feedback, the PIC18F452 controls relevant actuators (e.g., heating/cooling elements, humidifiers/dehumidifiers, irrigation pumps) using **digital I/O and PWM outputs**.

For sensor inputs, reliable industrial-grade temperature, humidity, and soil moisture sensors are used to monitor the indoor environment continuously. The PIC18F452 executes control decisions in real-time to ensure the environment remains within the target thresholds. Alerts can also be displayed on the desktop application in case of deviations or sensor faults.

This microcontroller-based approach offers a **low-cost and customizable alternative** to expensive PLC systems, making it ideal for small-scale or research-oriented indoor farms.

Block Diagram:

Desktop Application

PIC18F452 Microcontroller

Temperature & Moisture Sensor (I2C based Ind. Grade sensor)

Soil Sensor IP 68 Ind. Grade (Temp.,Moisture, PH, EC)

Heating and Cooling Actuators and Fans

Water Pump

Humidifier

Key Features:
- Desktop GUI allows parameter scheduling for entire crop cycle
- Real-time communication between Python app and PIC18F452

- Automatic control of actuators to maintain desired environment
- Sensor-based feedback for precision control
- Data logging and alerts via the desktop interface

Advantages:
- **Cost-effective alternative to PLCs** for small-scale farms
- **Highly customizable** control logic via C and Python
- **Easy integration** using UART/USB-Serial interface
- **Supports industrial-grade sensors** for reliable measurement
- **Scalable solution** for multi-chamber or multi-crop use cases
- **Precision Crop Management:** Provides crop-specific environmental control by adjusting temperature, humidity, and moisture in real time.
- **Energy and Resource Efficiency:** Actuators operate only when needed based on sensor feedback, reducing energy and water consumption.
- **Flexible and Expandable:** Can be easily extended to support more crops, parameters, and data logging features.
- **Ideal for Research & Education:** Combines real-world applications embedded systems, agriculture, and automation in a single academic project.