

# Instructor Guide – Module:

## Microcontrollers Explained: Build a Legal WiFi Detector with ESP32

### 1. Introduction: What is a Microcontroller?

#### Definition:

A microcontroller is a small computer built into a single integrated circuit (chip). It contains:

- A processor (CPU)
- Memory (RAM and Flash)
- Input/Output (I/O) pins
- Communication modules (WiFi, Bluetooth, UART, etc.)

Unlike a desktop computer, a microcontroller is designed to control **specific tasks** inside electronic systems.

#### Examples in this module:

- **ESP32** (by Espressif Systems)
- **M5Stack Core** (ESP32-based development kit)

### 2. What Does a Microcontroller Do?

A microcontroller can:

1. **Read inputs** – buttons, sensors, WiFi signals
2. **Process data** – using programmed instructions
3. **Control outputs** – LEDs, screens, motors

#### In this project:

- The ESP32 scans WiFi networks
- Counts the number of networks detected
- Activates LEDs based on network activity:
  - o **Green LED:** Normal

- o **Yellow LED:** Caution

- o **Red LED:** Alert

The ESP32 acts as a **decision-making controller** in this project.

### **3. Microcontroller vs. Microprocessor**

Feature	Microcontroller	Microprocessor
Purpose	Embedded control	General computing
Memory	Built-in	External required
Example	ESP32	Laptop CPU
Used in	IoT devices, robotics	PCs, servers

#### **Common Microcontroller Applications:**

- Washing machines
- Cars
- Smart TVs
- Medical devices
- IoT systems

### **4. Internal Components of ESP32**

The ESP32 contains:

- Dual-core processor
- WiFi module
- Bluetooth module
- GPIO pins (General Purpose Input/Output)
- ADC (Analog to Digital Converter)
- Flash memory

#### **Ideal for:**

- Wireless detection
- Sensor monitoring

- Smart automation

### 5. Why ESP32 is Used in This Project

- Built-in WiFi for scanning nearby networks
- Controls LEDs
- Affordable and educational
- Supports Arduino IDE programming
- Performs **passive detection only** – does **not transmit interference**

### 6. How the Microcontroller Works (Control Loop)

1. Power supplied via USB
2. Program starts running
3. WiFi scan begins
4. Number of networks detected is counted
5. Conditional logic checks thresholds
6. LED output activated
7. Process repeats every 5 seconds

### 7. Instructor Notes

- Compare a microcontroller to a **“tiny brain”** of a device.
- Emphasize that it **follows instructions written in code**.
- Reinforce **embedded systems concept**.
- Stress **legal aspects**: detection is allowed, jamming is illegal.