2. Project Definition: Design of a Micro-Air Conditioner

Air conditioning can be described as the process of cooling, heating, moisturizing, dehumidifying, etc. This method is utilized to create a more pleasant interior environment. In this project, you are required to design an air conditioner system for small spaces. The system acquires heating, and cooling functions and consists of one variable set input and four subsystems, namely, the control unit, display unit, sensing unit, and the operation unit. The sensing unit provides the ambient temperature to the control unit, and the temperature adjustment unit provides the desired temperature to the control unit. Figure 1 shows the block diagram of the system.

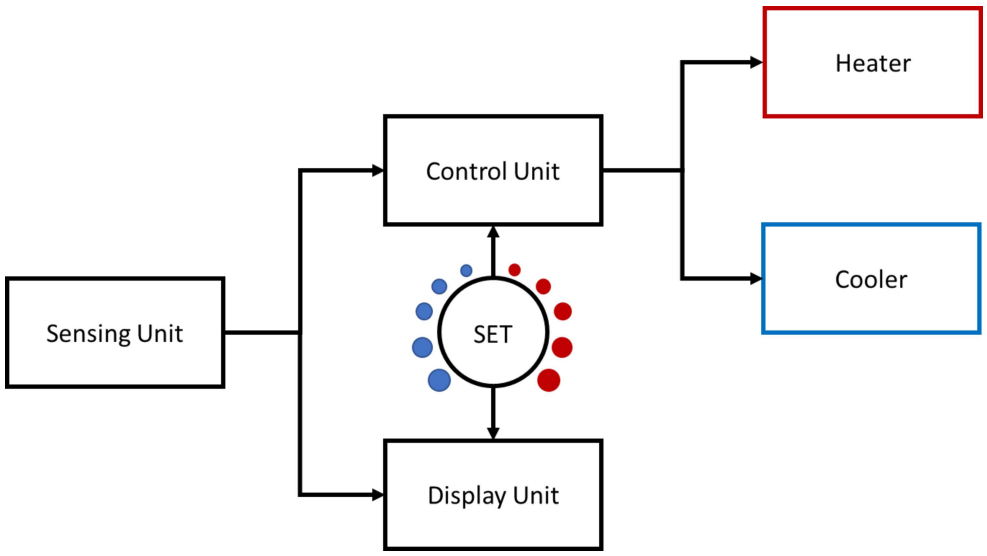

Figure 1. Micro-air conditioner system block diagram.

2.1. Control Unit

The control unit contains decision and function subunits. The decision subunit compares the ambient and desired temperatures and informs the function subunit accordingly. The function subunit, then, starts the heater or the cooler and indicates the performing action by using indicators (LEDs).

The system continues heating or cooling until the desired temperature is reached. Then, the function subunit stops the operation and enters the idle mode. In this mode, the ambient temperature is continuously checked, and if it deviates 1 degree from the desired temperature, the required operation starts automatically.

2.2. Operation Unit: Heating and Cooling

The heating element is an electrical resistor. To achieve a high temperature, the current passing through the resistor should be sufficiently high. Since the resistors used in the laboratory cannot endure high currents, stone resistors can be used. The heating element can be placed close to the sensing device for ease of implementation.

The cooling element is a DC electric fan. For this purpose, you may use 5 or 12 Volts computer case fan, or you can make your own fan with a DC motor and a small propeller that fits to your DC motor. The cooling element can be placed close to the sensing device for ease of implementation.

2.3. Sensing Unit

The sensing unit contains an analog temperature sensor in order to sense the ambient temperature. The sensor represents the decrease or increase in temperature by a variable parameter level that will be fed to the control unit. (As a temperature sensor, resistive temperature detectors (RTDs), LM35…)

2.4. Display Unit

The display unit contains a RGB led and a switch to show the set or the ambient temperature level. The display unit must cover the visible spectrum continuously, which means it must be designed with an analog perspective.

3. Design Specifications

- The system must be modular to test individual parts.
- Temperature range: 24°C - 40°C.
- The RGB Led indicator for both set temperature and ambient temperature should cover the visible spectrum in a continuous manner. Figure 2 illustrates the spectrum.

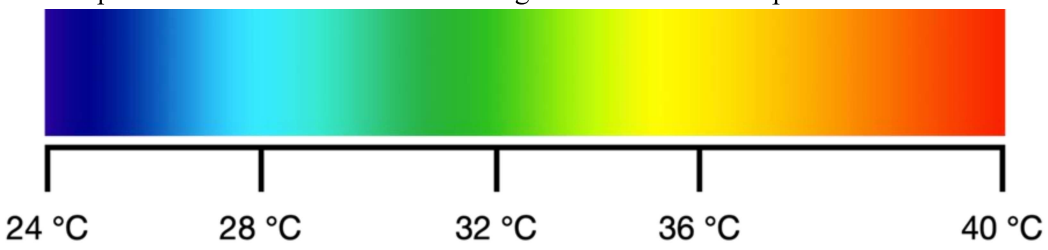

Figure 2. Temperature and color spectrum.

- The SET value will be adjusted with a potentiometer.
- The heater and cooler cannot work simultaneously.
- The system must be autonomous when there is a 1°C difference.
- You must use blue led for cooler and red led for heater operations.
- The system must reach the desired condition with at least a 5°C/min rate.
- Not required but you can cover the system with a visible material.
- The display unit must show ambient/set temperature.
- Selection in the display unit can be arranged with any kind of switch, sensor, button, etc.
- Your circuit must be capable of delivering at least 3W power. The allowed maximum total power is 15 W.
- Allowed Voltage range: ±12 V

4. Components Allowed

- You can use any kind of temperature sensor,
- You can use a 5 or 12 Volts computer case for cooling.
- You can use general-purpose op-amps, any transistor (BJT, MOSFET, JFET, etc.), regulators, diodes, resistors, stone resistors, capacitors, inductors, LEDs, relays.
- You are not allowed to use motor drivers.
- For components of optical transmission and receiving part, please refer to the "Full Specifications" part of this manual.
- The instruments are available in the laboratory. You can use all terminals of the DC supply.
- If you are not sure whether you can use a component you consider, please contact Cem Şahiner (csahiner@metu.edu.tr) or M. Berat Yüksel (mbyuksel@metu.edu.tr) before using it.

5. Remarks and Tips

- To be able to continuously show the set and ambient temperature, you somehow need to control the current in an analog fashion through the 3 individual LEDs contained in a single RBG Led.

  As a guideline, for $T = 24$, 32 and 40 °C, only the blue, green, and red LED is lit up, respectively, while, for example, for $T = 28$ °C, blue and green LED are ON with same amounts of optical power so that we get cyan color.

- If the temperature is lower than 24 °C, the LED should continue to show blue, and if the temperature is greater than 40 °C, it should continue to light up red—as these values are out of range.
- RGB LEDs are available in two configurations of common-anode or common-cathode. Select the proper one to suit your design.
- Note that you should be able to sustain any temperature between 24–40 °C with an error margin of ±1 °C. If a set temperature is 30 °C, ambient temperature should be sustained within 29–31 °C after the steady-state is reached.
- You can either use two different RGB LEDs for showing ambient and set temperature settings or use a single RGB LED and utilize a switch to show one of them at a time depending on the switch direction.
- You can glue your temperature sensor onto the heating element to have a precise control over the temperature. Note that we only care about the temperature of the sensor itself, not the surroundings of it. You may think that our temperature sensor itself is our 'room' to be air-conditioned.