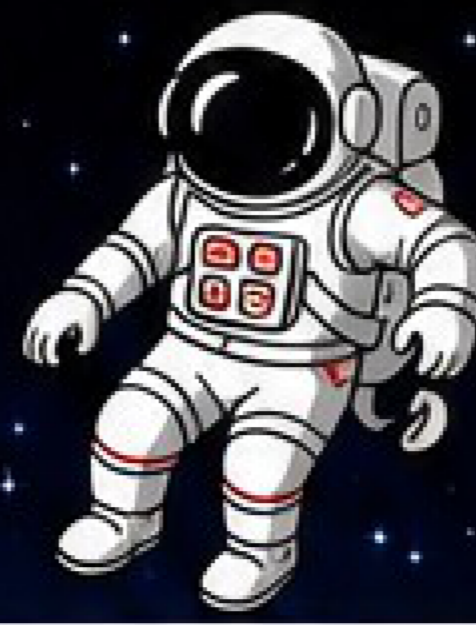


# SPACE CABIN PRESSURE MONITOR



★ MONITORING CABIN PRESSURE FOR A SAFER SPACE JOURNEY ★

## HOW IT WORKS

**SAFE (90 – 110 kPa)**  
 Green LED ON  
 Buzzer OFF  
 Cabin pressure is normal.

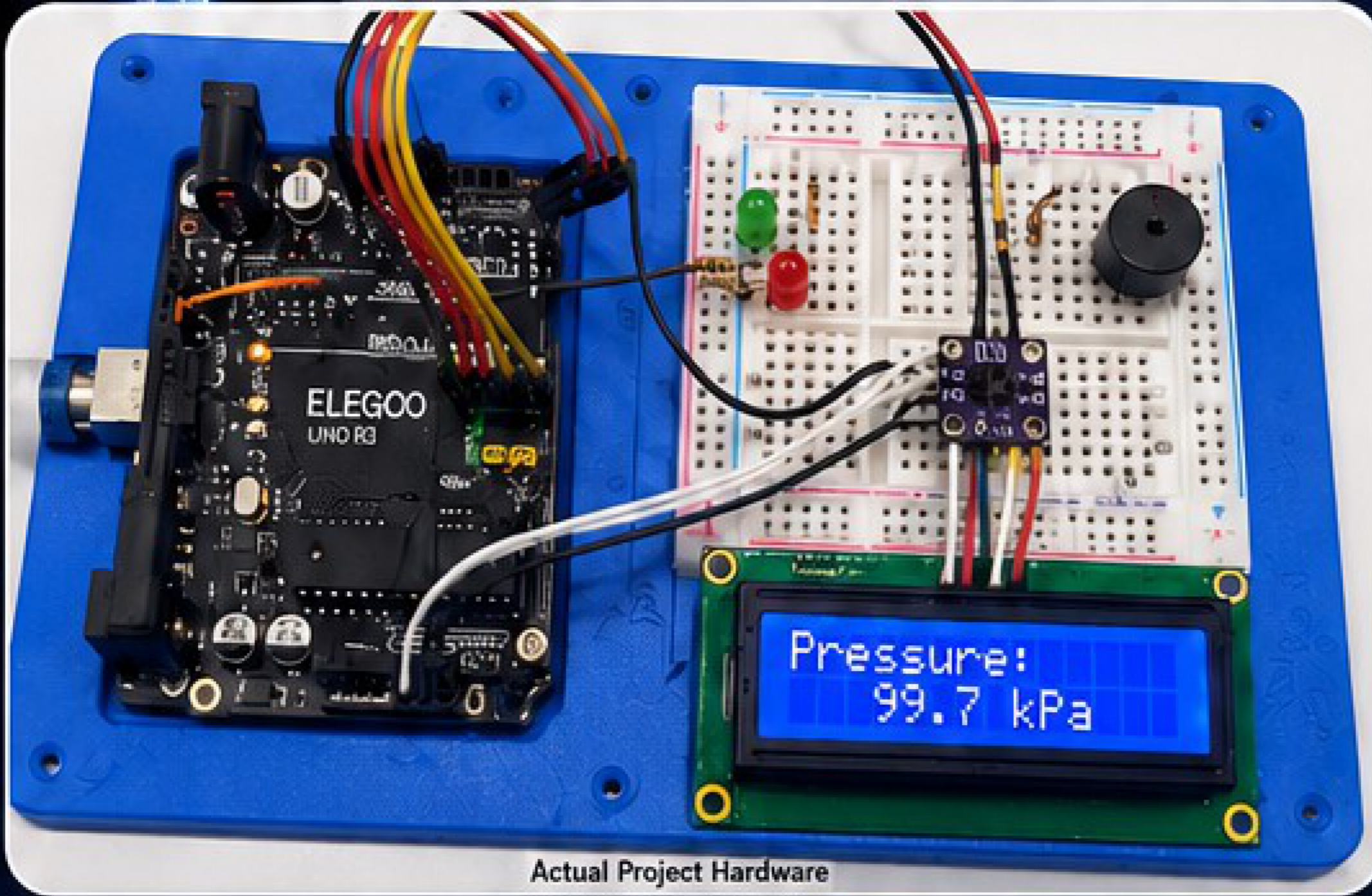
**WARNING (70 – 90 kPa or 110 – 115 kPa)**  
 Yellow LED ON  
 Buzzer beeps slowly  
 Pressure is outside the safe range.

**DANGER (< 70 kPa or > 115 kPa)**  
 Red LED ON  
 Buzzer ON  
 Leak or extreme pressure detected!

The HW-611 (BMP280) pressure sensor measures the air pressure inside the cabin. The Arduino processes the data and displays the pressure on the LCD screen.

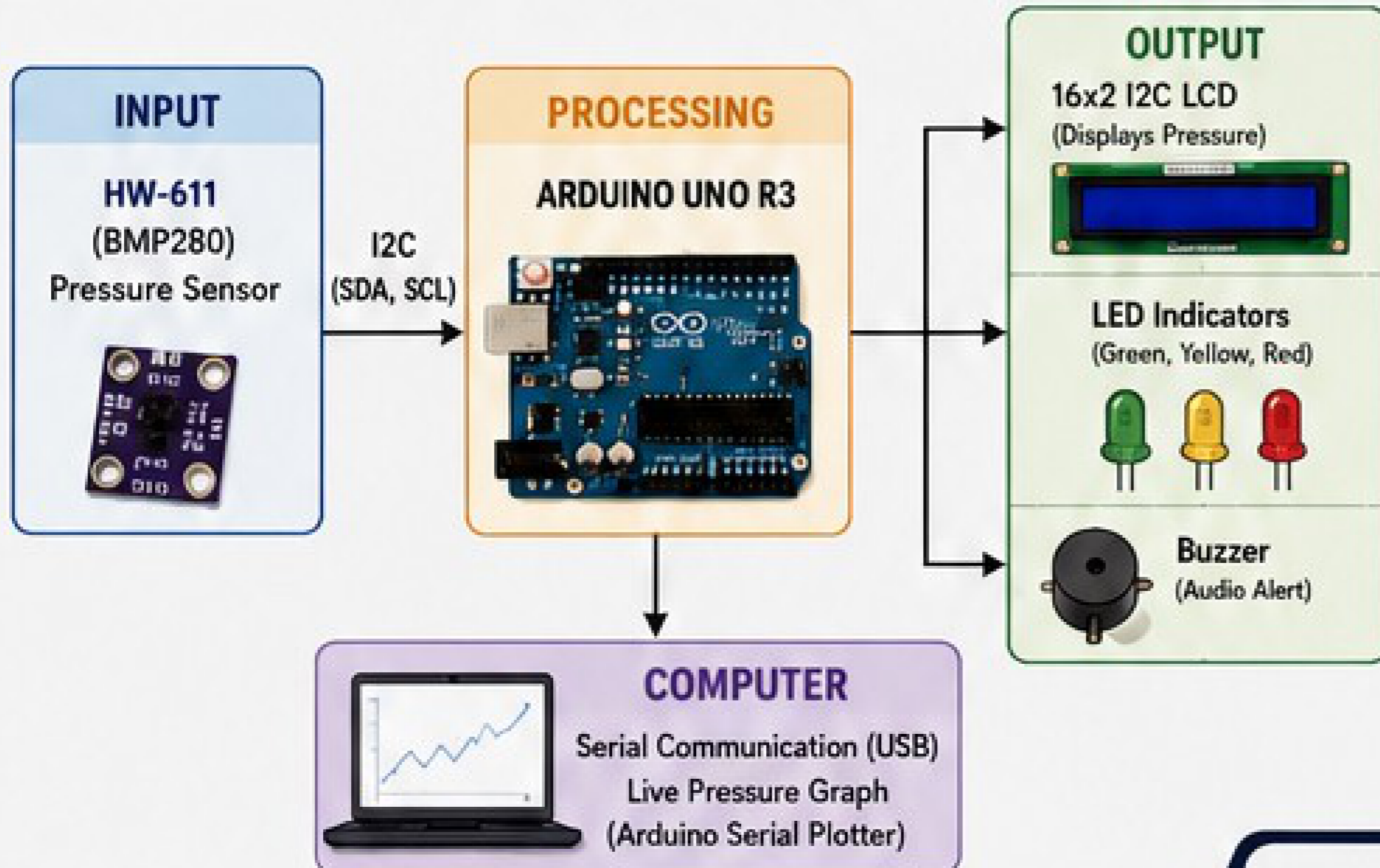
According to the pressure level: The system provides visual (LEDs) and audio (buzzer) alerts.

The Arduino also sends live pressure data to the computer so we can see a real-time graph using the Serial Plotter.



Actual Project Hardware

## SYSTEM ARCHITECTURE



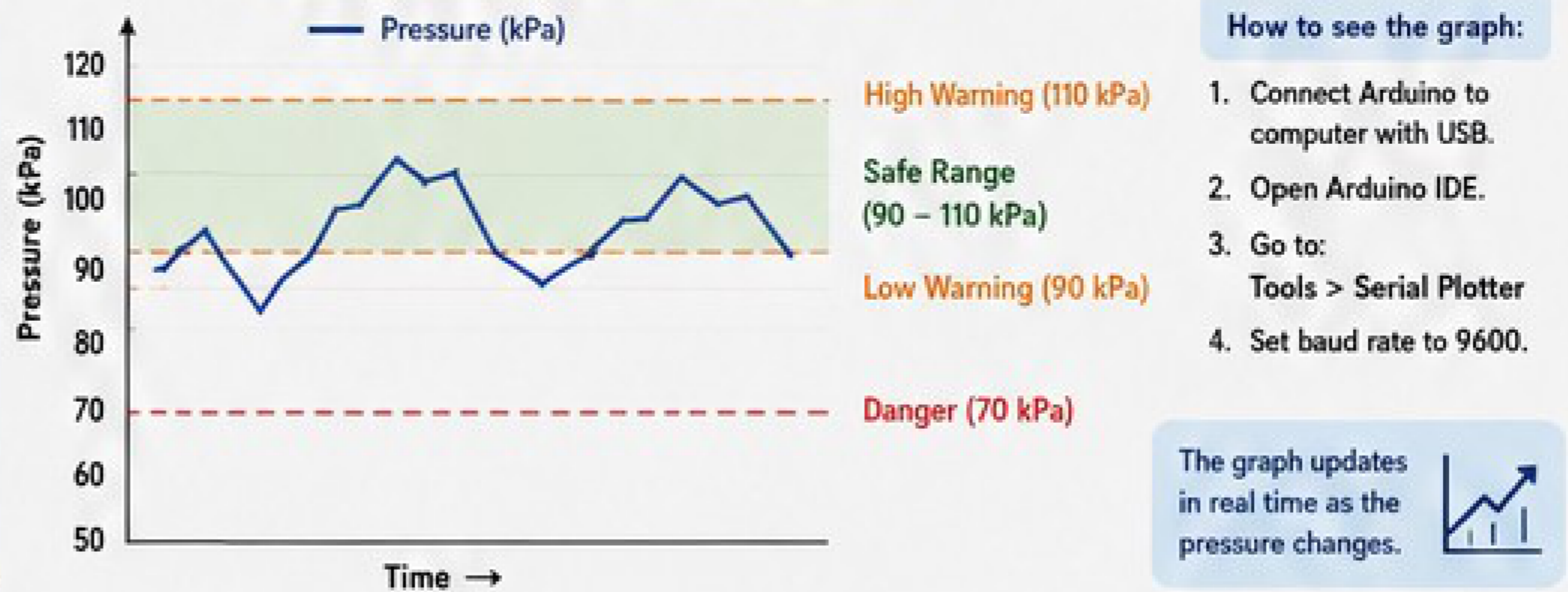
## COMPONENTS & THEIR FUNCTION

	<b>HW-611 (BMP280) Pressure Sensor</b> Measures air pressure and temperature. Communicates with Arduino via I2C.
	<b>Arduino UNO R3</b> The brain of the system. Reads sensor data, processes it, controls outputs and sends data to the computer.
	<b>16x2 I2C LCD Display</b> Shows live pressure value to the user.
	<b>LEDs (Green, Yellow, Red)</b> Indicate the current pressure status.
	<b>Buzzer</b> Gives an audio alert during warning or danger.
	<b>Breadboard &amp; Jumper Wires</b> Used to build and connect the circuit.

## CONNECTION OVERVIEW

HW-611 to Arduino (I2C)	LEDs to Arduino	Buzzer	LCD (I2C)
VCC → 3.3V	Green LED → D2 (via 220Ω)	+ → D5	VCC → 5V
GND → GND	Yellow LED → D3 (via 220Ω)	- → GND	GND → GND
SCL → A5	Red LED → D4 (via 220Ω)		SDA → A4
SDA → A4			SCL → A5
CSB → 3.3V	220Ω Resistor		
SDO → GND			

## LIVE PRESSURE GRAPH



## ENHANCEMENTS ADDED

### 1 SENSOR FILTERING

Noise is reduced using Moving Average and Exponential Moving Average (EMA) for smooth and stable readings.



- 10–20 samples averaged
- EMA for faster response
- Fewer false alarms

### 3 TEMPERATURE COMPENSATION

BMP280 measures both pressure and temperature. Temperature affects pressure inside a sealed cabin.

**Ideal Gas Law:  $PV = nRT$**   
(If volume is constant,  $P \propto T$ )

**Example (Sealed Cabin):**  
 20°C → 100 kPa  
 40°C → ~106–107 kPa

- Display temp & pressure together
- Prevents false alerts due to temperature changes

### 5 LEAK-RATE DETECTION

Detects how fast pressure is changing (not just the value).

$$\text{Rate} = \frac{P_{\text{current}} - P_{\text{previous}}}{\Delta t}$$

(kPa per second)

If rate < -3 kPa/s → Warning  
 If rate < -6 kPa/s → Danger

- Detect leaks early
- Predict future pressure drop
- More like real spacecraft systems

### 9 REDUNDANT SENSORS

Uses two BMP280 sensors for reliability and fault detection.

Compare both sensors:  
 If  $|P_1 - P_2| > 2 \text{ kPa} \rightarrow$  Sensor Fault

With 3 sensors → Majority voting  
 (If one sensor is wrong, system still works safely.)

- Detects hardware faults
- Improves mission reliability
- Aerospace standard practice

## MORE ENHANCEMENTS ADDED

**Oversampling & Filtering (BMP280)**  
Higher accuracy using oversampling, IIR filter & standby time.

**Dynamic Thresholds**  
Thresholds based on baseline pressure (startup reference).

**SD Card Data Logging**  
Stores time, pressure & temperature for later analysis.

**Upgraded OLED Display**  
Shows more data, graphs & status clearly.

**Wireless Monitoring (ESP32)**  
Send live data to phone/PC via Wi-Fi dashboard.

**Upgrade to BMP388**  
Better accuracy, lower noise, higher resolution.

**Predictive Alerts**  
Predict future pressure and warn before danger.

**Self-Test at Startup**  
Checks sensor, LCD, LEDs & buzzer before operation.

## PRESSURE LEVEL GUIDE (kPa)

<b>SAFE</b> 90 – 110 kPa Normal cabin pressure. Everything is OK.	<b>WARNING</b> 70 – 90 kPa or 110 – 115 kPa Pressure outside safe range. Check system.	<b>DANGER</b> < 70 kPa or > 115 kPa Leak or extreme pressure. Take immediate action!
---	--	--

(Normal Earth sea-level pressure = 101.3 kPa)

## APPLICATIONS



★ SAFE PRESSURE • SAFE MISSION • SUCCESSFUL JOURNEY ★