# PathPal : A Human Following Robot Using Sensors

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## Project Overview:

This project aims to build an Arduino-powered robot that follows children/elderly people and ensures their safety by detecting smoke/gas or edge hazards, while providing real-time alerts through sound & light communication. The robot will use ultrasonic sensors to detect and follow a person while maintaining a safe distance with the user. It is equipped with a smoke sensor(MQ-2) to identify the presence of smoke or harmful gases indicating a fire hazard, gas leak, and smoky area. In addition, IR sensors are used for edge detection, which will allow the robot to avoid dangerous drops like stairs/cliffs/table edges.

When any potential danger is detected, such as smoke, gas or dangerous edges - the robot immediately activates a buzzer and LED light to alert the user. These real-time alerts help draw attention to hazards and increase the safety of the person being followed. This robot includes a blend of basic robotics, sensor integration and safety systems - making it a valuable prototype for personal assistance and protection.
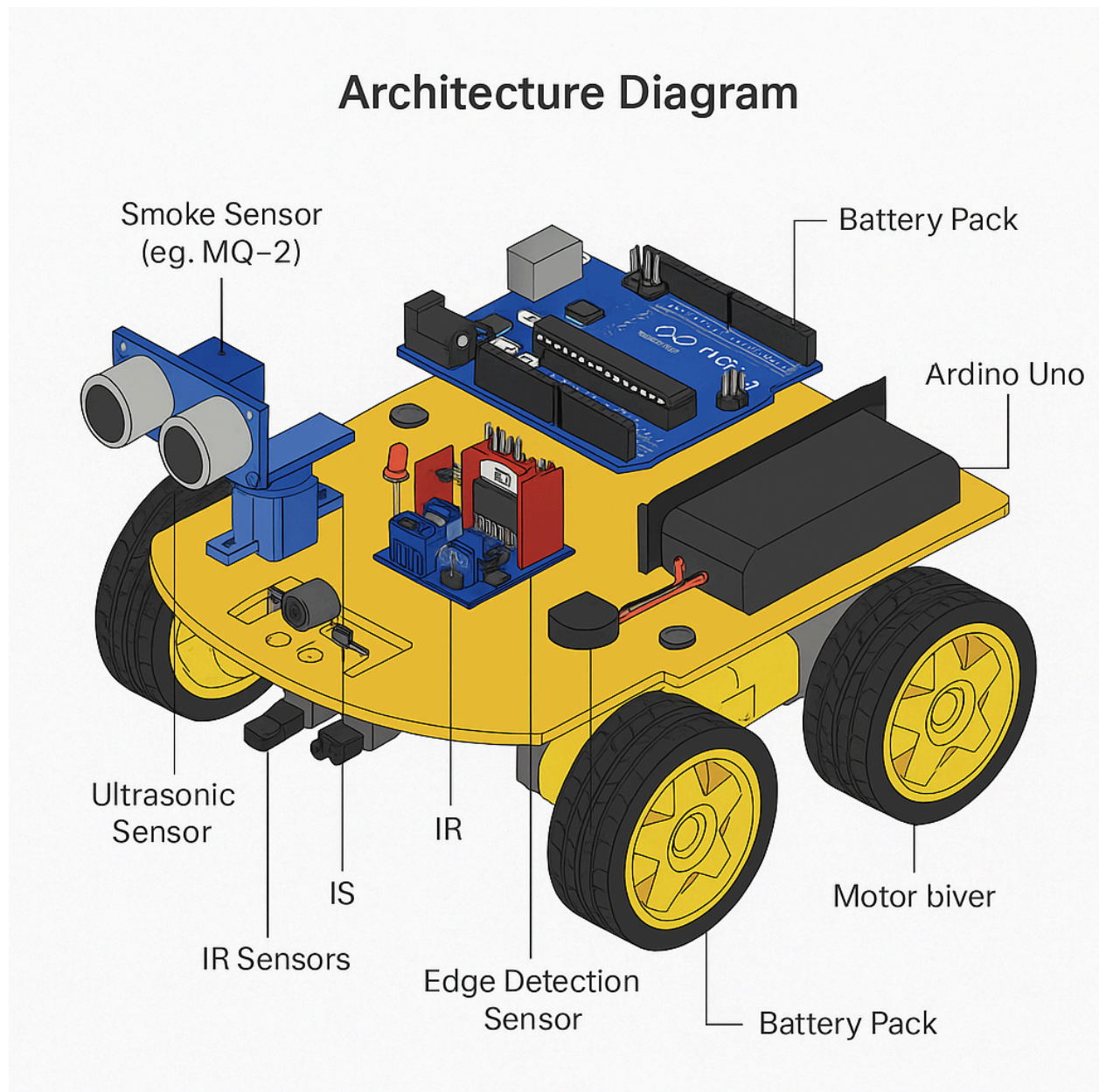
## Hardware Requirements:

| Component | Description |
|---|---|
| **Arduino Uno** | Main microcontroller board |
| **Ultrasonic Sensor (HC-SR04)** | For measuring distance from the human and obstacle detection |
| **IR Sensors** | For human direction tracking and basic obstacle detection |
| **Edge Detection Sensor** | Typically IR or light sensors placed facing downward to detect edges |
| **Smoke Sensor (e.g. MQ-2)** | For detecting smoke or harmful gases |
| **Motor Driver Module (L298N)** | To control direction and speed of DC motors |
| **DC Motors with Wheels** | For movement of the robot |
| **Servo Motor (optional)** | To rotate sensors for wider area scanning |
| **Buzzer** | To beep during emergency or alert situations |
| **LED (Red)** | For visual alert in critical scenarios |
| **Battery Pack (7.4V or 12V)** | Power supply for motors and Arduino |
| **Chassis** | Robot body for mounting all components |
| **Jumper Wires & Breadboard** | For internal wiring and testing |

<u>Software Required:</u>

| Software | Purpose |
| --- | --- |
| **Arduino IDE** | To write, compile, and upload code to the Arduino Uno board |
| **Tinkercad Circuits** | To simulate the robot's electronics, sensor inputs, and Arduino code |
| **CH340 / CP210x Driver** | USB-to-serial driver for uploading code to Arduino Uno clones |
| **Libraries for Arduino IDE** | Required to handle sensors and motors:<br><br>• `NewPing` – for ultrasonic sensor (HC-SR04)<br><br>• `Servo.h` – for servo motor control<br><br>• `MQ2.h` *(or analogRead)* – for smoke sensor<br><br>• `IRremote` or raw analog logic – for IR and edge sensors |
| **TinkerCAD 3D Design / Fusion 360** | To create or refine 3D architecture diagrams |
| **Image/Slide Editing Tools** | For designing the final architecture diagram and presentation slides |

Architecture Diagram:



# Architecture Diagram

- Smoke Sensor (eg. MQ-2)
- Battery Pack
- Ardino Uno
- Ultrasonic Sensor
- IR
- IS
- Motor biver
- IR Sensors
- Edge Detection Sensor
- Battery Pack

## Expected Outcome:

The expected outcome of this project is to develop a fully functional Arduino-based human- following robot capable of enhancing the safety of both children and elderly individuals. The robot will follow the target user using ultrasonic sensors to detect and follow a person by continuously measuring the distance of the user, enabling it to move alongside them without physical contact.

For children, the robot acts as a mobile guardian, maintaining a proximity to keep them within sight and alert them when they enter unsafe environments. The robot integrates an MQ-2 gas and smoke sensor, which detects the presence of flammable gases(LPG/Methane) or smoke. This is important for children who cannot recognize these dangers on their own. In such cases, the robot responds immediately with an audible alert(buzzer) and visual warning(LED) to grab attention and let nearby adults know something is wrong. Additionally, the robot includes IR edge detection sensors to detect the absence of surface below it – such as stairs, ledges or tables edges. The robot will immediately stop and trigger a buzzer and flashing LED to signal the child to hard, preventing accidental falls.

For elderly people, the robot is more than just a guardian, it is a smart companion. Many older adults may have slower reaction times, poor eyesight or hearing problems. The robot helps by walking slightly ahead and scanning for dangers, just like it does for children. If there's smoke, gas, or a risky edge like stairs, the robot stops and gives a clear warning. Even though they are more independent, having a robot like this will make them feel safer moving around alone, especially indoors.

In conclusion, this robot brings together useful sensors like ultrasonic for following, MQ-2 for smoke/gas detection, IR sensors for edges and a buzzer+LED for alerts, to create a simple, low-cost safety assistant. It is especially useful in homes, schools or elder care centers where early warning can prevent serious accidents. The project proves how basic technology can be used to create real-word solutions for protecting people who need extra care.

## Results:

The project has been successfully implemented and simulated:

1. The robot uses ultrasonic sensors to successfully follow a person while keeping a set, secure distance.
2. The robot is successfully kept from falling off surfaces like ledges, table edges, and stairs by the infrared edge detection system.
3. The MQ-2 smoke sensor simulates emergency situations by detecting the presence of gas or smoke.
4. The buzzer and red LED illuminate when any danger (such as smoke or an edge) is detected, giving immediate visual and auditory warnings.
5. The fact that every part functions in unison demonstrates that the robot can serve as a safety-monitoring assistant in an intelligent setting.

## Applications:

1. Elderly Care: By following elderly people and warning them in the event of a gas leak or a fall, the robot can help them.
2. Child Safety: To avoid mishaps in homes, the robot can keep an eye on kids and identify smoke or possible fall areas.
3. Home automation: For mobile safety patrols in indoor spaces, it can be incorporated into smart home systems.
4. Future extension: With more robust hardware, disaster response bots can be used to find and help people in unstable or smoke filled environments.