Requirements Specification Document – Smart Secure Access Gate

1. Introduction

The Smart Secure Access Gate is an IoT-enabled system designed to **control access for authorized personnel, ensure safety during door operation, and record all entry events**. The system integrates an **Arduino Uno** for real-time motor and safety control with a **Raspberry Pi 4** for authentication, video monitoring, logging, and remote access.

2. User Perspective

2.1 System Usage

1. **Authentication**
    a. Users enter their **personal access code** via a 4×4 keypad or use a **fingerprint scanner**.
    b. Upon valid authentication, a **green LED** lights up to indicate access approval.
    c. If the code or fingerprint is invalid, a **red LED** lights up and access is denied.
2. **Door Operation**
    a. Once access is approved, the door automatically opens via a **DC motor controlled by Arduino**.
    b. Users pass through the door while the system continuously monitors for safety (obstructions or excess force).
    c. After the user passes, the door automatically closes.

    d. If an obstruction is detected during closing, the door reopens and an alert message **"Please step aside"** is displayed.
3. **Monitoring**
    a. An **IP camera** captures a photo of the user entering and, in case of multiple simultaneous entries, records a **30-second video** and triggers an **alarm**.
    b. All photos, videos, and entry logs are **stored in a database on the Raspberry Pi** and can be accessed **remotely via a web interface**.

2.2 User Interface

- Visual indicators (LEDs) for access approval or denial.
- Optional web dashboard for administrators to view logs and live video.

3. Designer Perspective

3.1 System Behavior

1. **Authentication Module (Raspberry Pi)**
    a. Receives code/fingerprint input.
    b. Validates against stored credentials.
    c. Sends **OPEN or DENY command** to Arduino.
    d. Logs all events (user ID, timestamp, photo).
2. **Door Control Module (Arduino)**
    a. Receives **OPEN/CLOSE/STOP commands** via UART from Raspberry Pi.
    b. Activates DC motor via **PWM control** and monitors:
        i. IR beam sensors
        ii. Limit switches (open/close)
        iii. Current sensor for excess force
        iv. Emergency stop button
    c. Halts movement and triggers buzzer/LED in case of obstruction or fault.
3. **Video Monitoring Module (Raspberry Pi)**
    a. Activates IP camera when door opens.
    b. Confirms **presence of a single person** using image detection.
    c. Triggers alarm and video recording if **more than one person enters** simultaneously.
4. **Database & Remote Access**
    a. Stores user entry logs, photos, and videos.
    b. Provides web dashboard for viewing live feed and historical events.

3.2 Safety Logic

- Door cannot move if emergency stop is pressed.
- Motor halts if IR beam is broken during closing or if current exceeds safe threshold.

- Alerts user and reopens door in case of obstruction.

4. Constraints

- **Cost Constraints:** Total component cost < $150 (including Arduino, Raspberry Pi, motor, sensors, camera).
- **Time Constraints:** Complete system implementation within **2 month**.
- **Performance Constraints:**
  - Door response < 0.5 seconds from authentication approval.
  - Safety sensors react **real-time (<100 ms)** to prevent injury.
  - IP camera live feed accessible with <1-second latency over local network.
- **Design Constraints:**
  - Real-time safety logic must be handled by Arduino.
  - Raspberry Pi handles all high-level processing and remote access.
  - System must operate reliably in a miniaturized physical setup.

5. Summary

This specification provides a clear description of the Smart Secure Access Gate from both **user and designer perspectives**, ensuring that the system is safe, functional, and accessible. Users can easily authenticate and pass through the door, while designers have a complete specification to implement all real-time control, monitoring, and remote access requirements within the defined constraints.

Document Information

This Requirements Specification Document was prepared for the course
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