Test Procedure Document – Smart Secure Access Gate

1. Introduction

This document describes the proposed **test procedure** for the *Smart Secure Access Gate* Capstone project. The goal of testing is to verify the **correct functionality, safety, and reliability** of all system components.

Testing is divided into three phases:

1. **Laboratory-Based Baseline Testing**
2. **Component-Level Testing**
3. **Integration Testing**

This structured approach allows early fault detection and simplifies troubleshooting during system integration.

2. Laboratory-Based Baseline Testing (Test Infrastructure)

Before testing system components, all laboratory equipment is verified to ensure accurate measurements.

2.1 Test Equipment Used

- Adjustable DC Power Supply
- Digital Multimeter
- Oscilloscope
- Signal Generator
- Logic-Level Test Loads

2.2 Equipment Verification

- Power supply output voltage is measured using a multimeter.
- Oscilloscope probes are calibrated.
- Signal generator output frequency and amplitude are verified.

Purpose:

Ensure that all measurements used during component testing are reliable and repeatable.

3. Component-Level Testing

Each component is tested independently using laboratory tools before integration.

3.1 Power Supply and Buck Converter

- Apply 12V input from lab power supply.
- Measure output voltage (5V) using multimeter.
- Observe output ripple using oscilloscope.
- Apply load and verify voltage stability.

Pass Criteria:

Stable output voltage within ±5% tolerance under load.

3.2 Arduino Uno

- Powered via regulated lab power supply.
- Upload basic I/O and serial test firmware.
- Verify logic-level signals using oscilloscope.
- Test UART communication.

Pass Criteria:

Correct logic levels, stable execution, and reliable communication.

3.3 DC Motor and Motor Driver

- Driver powered from lab supply.
- PWM signal generated from Arduino or signal generator.
- Observe PWM waveform using oscilloscope.
- Measure motor current using multimeter.

Pass Criteria:

Smooth speed control and safe current consumption.

3.4 IR Safety Sensor

- Power sensor from lab supply.
- Measure output voltage change using multimeter.
- Verify clean digital transitions on oscilloscope.

Pass Criteria:

Reliable and fast obstruction detection.

3.5 Limit Switches (Open / Close)

- Manually actuate switches.
- Verify continuity using multimeter.
- Observe digital input transitions on Arduino.

Pass Criteria:

Accurate detection of door end positions.

3.6 Current / Pressure Sensor

- Simulate load increase using controlled resistance.
- Measure sensor output voltage.
- Validate ADC readings on Arduino.

Pass Criteria:

Overcurrent conditions detected within defined thresholds.

3.7 Emergency Stop Button

- Test mechanical operation using continuity test.
- Activate during motor operation.

Pass Criteria:

Immediate system shutdown.

3.8 Keypad (4×4)

- Test individual key presses.
- Verify debounce handling.
- Confirm data transmission to Raspberry Pi.

Pass Criteria:

Correct and consistent key detection.

3.9 LEDs and Alarm Buzzer

- Test LEDs using current-limited supply.
- Activate buzzer manually via Arduino.

Pass Criteria:

Clear visual and audible feedback.

3.10 Raspberry Pi 4

- Verify OS stability.
- Test Python services.
- Test UART communication with Arduino.
- Verify database operations.

Pass Criteria:

Stable processing and reliable data storage.

3.11 IP Camera

- Connect camera directly to a router.
- Access live video stream from:
    - Windows
    - Linux
    - Mobile devices
- Test using standard web browser or RTSP client.

Pass Criteria:

Live video and recording accessible from any operating system without special drivers.

4. Integration Testing

Integration testing is performed incrementally to reduce complexity.

4.1 Motor + Safety Sensors Integration

- Combine motor driver, IR sensor, current sensor, and limit switches.
- Simulate obstruction and overload.

Expected Result:

Motor stops or reverses immediately.

4.2 Arduino ↔ Raspberry Pi Communication

- Exchange control and status messages.
- Verify error handling.

Expected Result:

Reliable bidirectional communication.

4.3 Authentication + Door Control

- Test valid and invalid access codes.
- Verify LEDs and door response.

Expected Result:

Only authorized access opens the door.

4.4 Camera + Event Logging

- Capture image at door opening.
- Store user ID and image.

- Verify remote access.

Expected Result:

Correct event logging and online availability.

4.5 Tailgating Detection and Alarm

- Simulate multiple persons entering.
- Trigger alarm and 30-second video recording.

Expected Result:

Alarm and recording activate reliably.

4.6 Full System Validation

- Perform complete open–pass–close cycle.
- Test emergency stop.
- Test system with network interruption.

Expected Result:

System remains safe, predictable, and stable.

5. Conclusion

This test procedure ensures that **all components are verified using laboratory-grade tools**, tested independently, and then integrated step-by-step. The methodology minimizes risk, ensures safety, and guarantees reliable system behavior suitable for real-world deployment.

Document Information

This Test Procedure Document was prepared for the course
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