PROJECT DOCUMENTATION

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1. Introduction

The Intelligent Sliding Door System is an advanced automated entry solution that leverages machine learning and computer vision technologies to enhance the functionality, safety, and efficiency of sliding doors. This system is designed for use in various environments such as academic institutions, hospitals, commercial buildings, and airports.

1.1 Project Objectives

* Improve detection accuracy of individuals approaching the door
* Enhance safety by reducing false triggers and unnecessary door operations
* Optimize energy usage by minimizing unnecessary door openings
* Provide a more intuitive and responsive user experience

2. System Architecture

The Intelligent Sliding Door System consists of the following main components:

* Raspberry Pi (central processing unit)
* Picamera2 (video input)
* YOLO object detection model
* LED indicators for visual feedback
* Buzzer for audio feedback
* Door control mechanism (simulated in the current implementation)

The system uses a modular architecture with the following key modules:

* Video Capture Module
* Object Detection Module
* Decision-Making Module
* Control Module

3. Hardware Components

* + Raspberry Pi (with Picamera2 support)
  + Camera: Picamera2 (640x480 resolution, RGB888 format)
  + LED indicators:
  + Green LED (GPIO 17): Door open
  + Red LED (GPIO 27): Door closed
  + Yellow LED (GPIO 22): Detection in progress
  + Blue LED (GPIO 23): System standby
  + Buzzer (GPIO 24): Audio feedback for door actions

4. Software Components

4.1 Dependencies

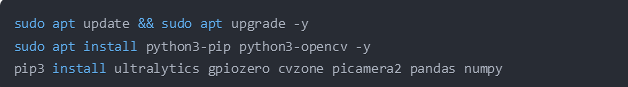
* + Python 3.x
  + OpenCV (cv2)
  + Picamera2
  + Pandas
  + Ultralytics YOLO
  + cvzone
  + NumPy
  + gpiozero

4.2 Key Files

* + `main.py`: Main script containing the system logic
  + `best.pt`: Pre-trained YOLO model weights
  + `coco2.txt`: Class list for object detection

5. Installation and Setup

* Install Raspberry Pi OS on your Raspberry Pi.
* Connect the camera, LEDs, and buzzer to the appropriate GPIO pins.
* Install required Python packages:



* Clone the project repository and navigate to the project directory.
* Ensure `best.pt` and `coco2.txt` are present in the project directory.

6. Usage Instructions

* Run the main script:

python3 main.py

* 2. The system will initialize and enter standby mode (Blue LED on).
* 3. As people approach, the system will detect them and control the door:
  + Front approach: Door opens (Green LED on, Buzzer sounds)
  + Side approach: Door remains closed (Red LED on)
* 4. To stop the system, press 'q' in the camera window or use Ctrl+C in the terminal.

7. Data Collection and Model Training

7.1 Data Collection

* + Capture diverse images of people approaching the door
  + Include various lighting conditions, angles, and scenarios
  + Aim for at least 850 images

7.2 Data Annotation

* Use tools like CVAT or Roboflow
* Label classes: 'front' and 'side'
* Export annotations in COCO and YOLO formats

7.3 Model Training

* Use Google Colab or Kaggle Notebooks for GPU acceleration
* Train YOLOv8n model with the following initial hyperparameters:
* Learning rate: 0.001
* Batch size: 16
* Epochs: 20 to 150

8. Performance Metrics

* + Detection Accuracy: >95%
  + Response Time: <0.5 seconds
  + F1 Score: 0.98 (achieved with YOLOv8n model)

9. Troubleshooting

* + Check GPIO connections if LEDs or buzzer not working
  + Ensure camera is properly connected and recognized
  + Verify presence of `best.pt` and `coco2.txt` files
  + Check console output for error messages

10. Future Enhancements

* Implement advanced features like multiple person tracking
* Integrate with building management systems
* Develop a user interface for remote monitoring and control
* Explore use of infrared sensors for improved low-light performance

11. References

1. Ultralytics YOLO: https://docs.ultralytics.com/
2. Picamera2 Documentation: https://picamera.readthedocs.io/en/release-1.13/
3. Raspberry Pi GPIO Zero: https://gpiozero.readthedocs.io/en/latest/
4. Raspberry Pi: https://www.raspberrypi.com/documentation/