Embedded Software Development

Budnitski Vladi

SmartGuard: Integrated Home Entry System

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Introduction:

Environment:
Arduino IDE, Python for image recognition on PC.

Sensors:
PIR Sensor: Detects motion.
Ultrasonic Sensor: Measures distance.
Servo Motor: Simulates door lock.
Webcam: Recognitionize people.

Goal:
Create a secure, automated home entrance system that identifies and grants access to authorized individuals.

Overview:
The Smart Home Entrance System is an automated security solution designed to enhance home safety. It utilizes an Arduino microcontroller integrated with a Python-based recognition system to identify individuals at the door. The system employs a PIR sensor to detect motion and an ultrasonic sensor to measure distance, ensuring that a person is present. Upon detecting valid motion, the system activates the Python script, which processes the individual's image and determines if they are authorized. If access is granted, the servo motor, acting as a smart lock, rotates to unlock the door. This project demonstrates how embedded systems and machine learning can be combined to create a responsive and secure home automation solution.

Conclusions:

Achieved Goals:
The Smart Home Entrance System successfully met its primary objectives. The system was able to reliably detect motion using the PIR sensor, accurately measure the distance of individuals using the ultrasonic sensor, and correctly identify authorized individuals through the Python-based image recognition system. When an authorized individual was detected, the servo motor consistently performed its role as a smart lock, simulating the unlocking of the door.

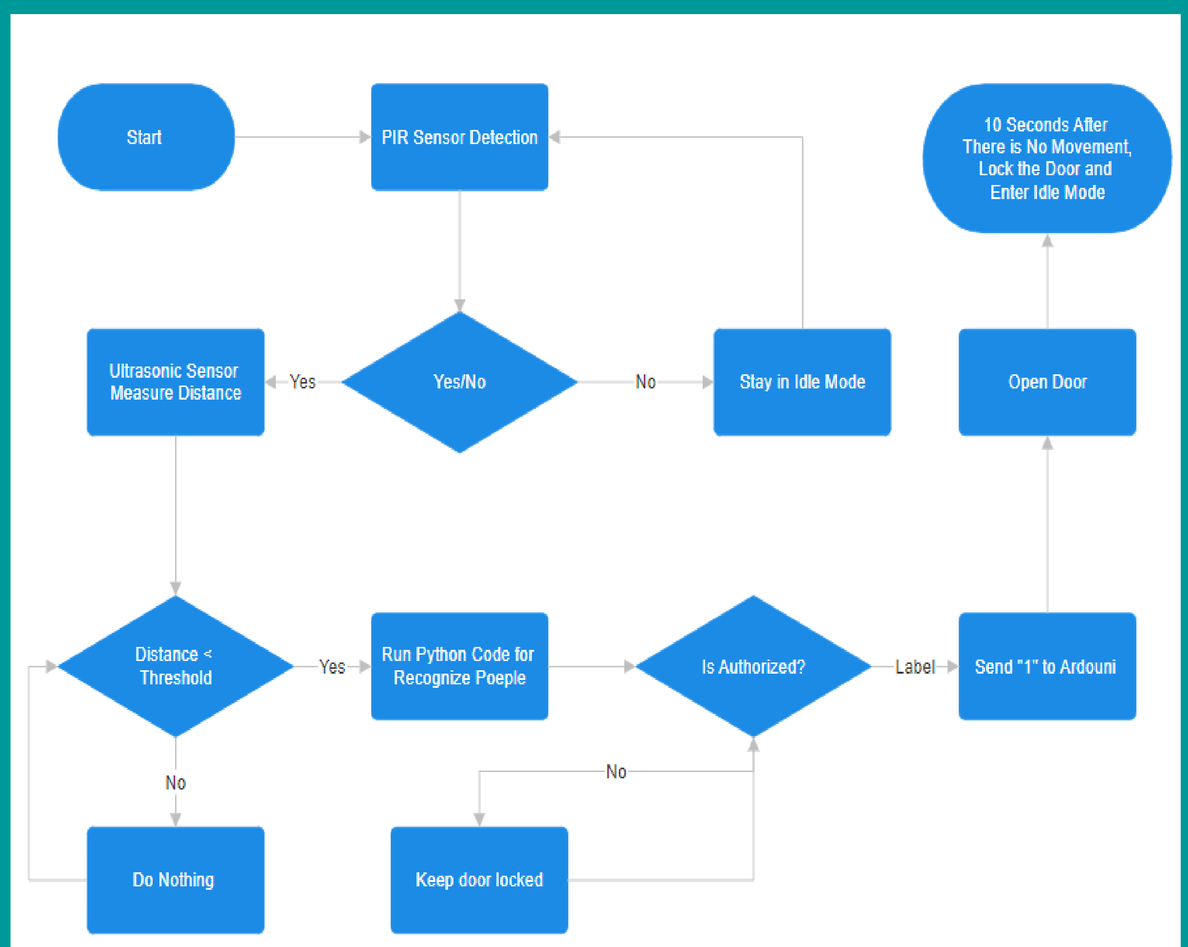
Received Results:
•**Motion Detection:** The PIR sensor effectively detected motion, triggering the system as expected.
•**Distance Measurement:** The ultrasonic sensor provided accurate and consistent distance readings, allowing the system to confirm the presence of a visitor.
•**Recognition Accuracy:** The Python script accurately identified authorized individuals, granting access only when appropriate.
•**System Reliability:** The integration of sensors and actuators performed reliably, with the servo motor responding correctly to the recognition results.

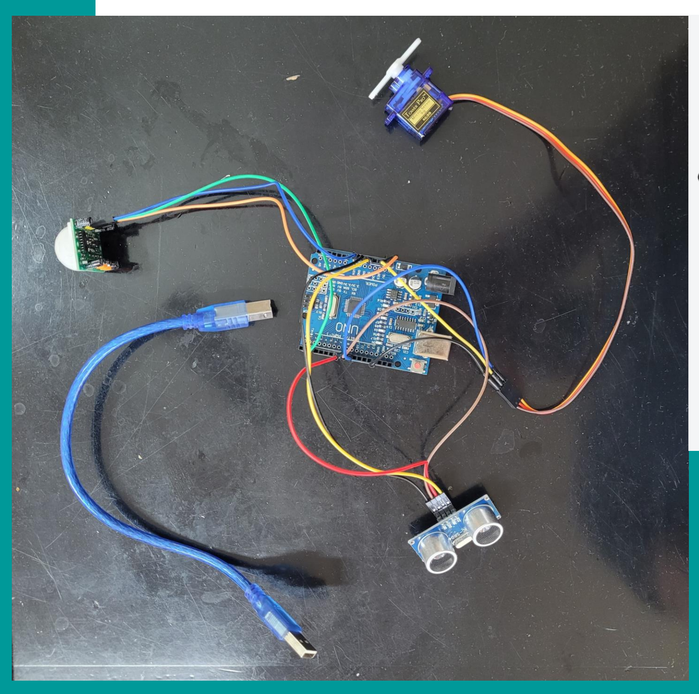
Comparison to Defined Targets:
The project achieved its initial goals of creating a functional, secure entrance system that integrates sensor data with machine learning for identity verification. The system operated as intended, meeting all the defined targets set at the beginning of the project.

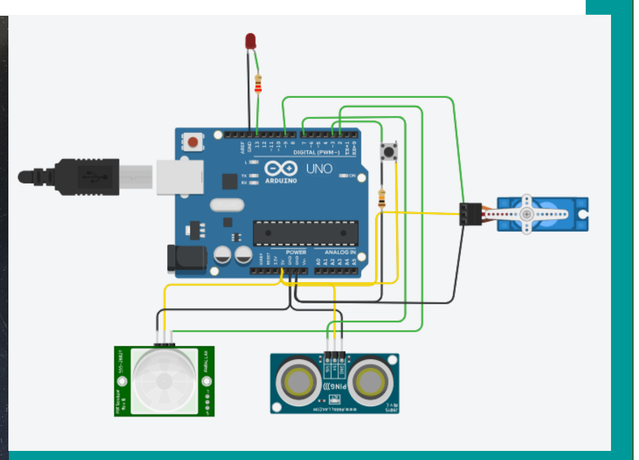
Discussions:

Vision for Further Development:
•**Improved Sensors:** Replacing the current sensors with more reliable, high-precision alternatives could reduce false readings and improve overall system accuracy.
•**Onboard Processing:** Upgrading to a more powerful microcontroller or embedded system, such as a Raspberry Pi, could allow the Python-based recognition code to run directly on the device, eliminating the need for a separate PC.
•**Wireless Communication:** Implementing wireless communication (e.g., Wi-Fi or Bluetooth) would increase flexibility, allowing the system to interact with a broader range of smart home devices and cloud services.
•**Expanded Recognition Capabilities:** Integrating advanced machine learning models and additional sensors (e.g., voice recognition, fingerprint scanning) could improve recognition accuracy and security in various environmental conditions.

Algorithm Flowchart:







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