



College of Electrical and Mechanical Engineering

Department of Software Engineering

Embedded System (SWE4102)

Group assignment

Title: Vehicle Theft Detection System

Group – 4

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Abstract

This project contains Arduino Microcontroller to process and initiate signals and Motion sensor to detect any objects in a specified range. It uses a simple approach to show how we can integrate microcontrollers with other components and apply them to real life problems.

Introduction

Traditional car security systems are expensive or complex to fit and hence out of reach for most users. This project provides a cheap, simple-to-implement car theft alarm system using an Arduino Uno microcontroller and a PIR motion detection sensor to detect movement within close range.

The system is designed to demonstrate how simple parts of an embedded system can be integrated to develop a functioning security system. The system provides instant feedback in the form serial output upon detecting motion close to the vehicle, alerting the user to a potential threat.

This project not only addresses a real-world problem but also enhances real-world embedded programming, sensor incorporation, and circuit design skills. It is a foundational prototype that can be enhanced with different ways.

1. System Overview

1.2 System Architecture

The architecture of the vehicle theft detection system is based on a simple and efficient sensor-microcontroller-output design. The system comprises two main hardware components: the Arduino Uno and a PIR motion sensor, which work together to detect motion near the vehicle and trigger an alert.

1. **Input Stage (Motion detection):** When an object moves within its defined detection range, it outputs HIGH signal.
2. **Processing Unit (Arduino Uno):** Arduino receives signal from the sensor processes it and executes a ore defined response.
3. **Output Stage (Alert Mechanism):** LED signal and state alert messages on the ArduinoIDE.

1.3 Operational Flow

Sequence of operations performed

1. **System Initialization:** The Arduino Uno is powered on and initializes the PIR sensor.
2. **Continuous Monitoring:** The PIR sensor continuously checks for motion by detecting changes in infrared radiation within its field of view.
3. **Motion Detection:** When motion is detected, the PIR sensor sends a HIGH signal to the Arduino.
4. **Event Handling:** The Arduino receives the signal and performs a predefined action, logging the event via serial monitor.
5. **Loop and Reset:** The system waits briefly, then resets to continue monitoring for motion

1.4 Features

- **Real-time Motion Detection:** continuous monitoring of the systems environment using a PIR motion sensor.
- **Silent Operation:** the system doesn't consist of buzzer or alarm which provides a discreet way of detecting motion.

- Serial Feedback: when a motion is detected the system indicates by printing message to the Arduion IDE Serial Monitor.
- Low Power and Cost: the microprocessor and sensor we used are highly energy-efficient and affordable.

2. Component Description

This section outlines the hardware components used in the system and their roles in implementing the vehicle theft detection functionality.

2.1 Arduino Uno

The Arduino Uno is the central processing unit of the system. It is a microcontroller board based on the ATmega328P and is responsible for reading sensor inputs and executing control logic.

Key Features:

- 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs
- 16 MHz ceramic resonator
- a USB connection
- a power jac
- an ICSP header and a reset button. (Jacob Hylén, 2025)

Role in Project:

Arduino Uno reads motion signals from the PIR sensor and triggers appropriate responses by logging events via the serial monitor. It serves as the main controller that processes inputs in real-time.

2.2 PIR Motion Sensor (HC-SR505)

HC-SR505 Mini PIR Motion Sensor is based on infrared technology and it can automatic control by itself with high sensitivity and high reliability. Because of the minimum size and low-power operation mode, it widely used in various of automatic electronic equipment, especially battery-powered automatic products.

Role in Project:

The PIR sensor continuously monitors the area near the vehicle. When it detects motion, it outputs a HIGH signal to the Arduino.

2.3 Male-female Jumper Cable

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering.

Male-female jumper cables are electrical wires with male connectors on one end and female connectors on the other. Male ends have a pin protruding and can plug into things, while female ends do not and are used to plug things into.

Role in Project:

Jumper cables are used to connect the PIR sensor to the Arduino Uno's digital input pins, ensuring stable and easy wiring for testing and development.

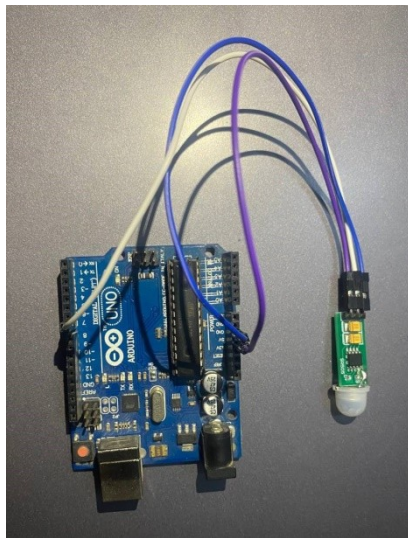
3. Circuit Design

Figure 1

3.1 Circuit Connection

PIR Sensor Pin	Jumper Color	Arduino Pin	Function
VCC	White	5V	Powers the sensor
GND	Blue	GND	Ground connection
OUT	Purple	Digital Pin 7	Motion signal input

The PIR sensor's 3-pin header is connected to the corresponding pins on the Arduino Uno using jumper cables. The white wire supplies 5V, the blue wire is connected to ground, and the purple wire carries the output signal to digital pin 7 on the Arduino.

The Arduino is powered via USB cable connected to laptop, which shares the power to the PIR sensor through 5V and GND pins.

3.2 Circuit Description

When the arduino is connected and the system is turned on , the sensor begins monitoring its surroundings.

If the sensor detects motions the sensors OUT pin goes HIGH. Then the Arduino reads the signal on pin 7 and processes it and prints message to the serial motor.

4. Software Design

The software for this vehicle theft detection system was written using the Arduino IDE. The program is responsible for monitoring the PIR motion sensor and reporting motion events through the Serial Monitor.

The sketch follows a simple logic: it continuously reads the digital output of the PIR sensor and prints a corresponding message based on whether motion is detected or not.

```

const int pirPin = 7; // Connected to HC-SR505 OUT pin

void setup() {
  Serial.begin(9600);
  pinMode(pirPin, INPUT);
}

void loop() {
  int sensorVal = digitalRead(pirPin);

  if (sensorVal == HIGH) {
    Serial.println("🔥 Motion Detected!");
  } else {
    Serial.println("✅ No Motion");
  }

  delay(1000);
}

```

The Arduino sketch begins by defining pin 7 as the input pin connected to the PIR motion sensor's output. In the `setup()` function, serial communication is initialized at a baud rate of 9600, and the PIR pin is configured as an input.

Within the continuously running `loop()`, the program reads the digital signal from the sensor. If motion is detected (i.e., the sensor outputs a HIGH signal), the Arduino prints "Motion Detected!" to the Serial Monitor. If no motion is detected (LOW signal), it prints "No Motion." A one-second delay is included between each reading to stabilize output and avoid excessive serial messages.

4.1 Flow Summary

1. System Setup

- Serial communication starts.
- Sensor pin is set as input.

2. Monitoring Loop

- The Arduino checks the PIR sensor output every second.
- If motion is detected, a motion alert is printed.
- If no motion is detected, a confirmation message is printed.

5. Working Principle

The vehicle theft detection system works based on motion sensing. The PIR motion sensor detects any object near the car in the specified range by monitoring changes in infrared radiation. When a motion is detected the sensor gives HIGH signal which is detected by the Arduino Uno. Then the signal is processed by the Arduino and triggers a predefined response by printing message on the serial monitor to indicate a potential motion has occurred.

The system runs continuously in a loop, monitoring the surroundings for suspicious activity and alerting when motion is detected. This helps in detecting unauthorized access attempts around the vehicle.

5.1 Limitation

- **Reset Delay:** The PIR sensor has a built-in delay of about 8 seconds after detecting motion. During this reset period, it cannot detect new movement, which limits its responsiveness in high-activity areas.
- **Limited Detection Range and Angle:** Detection is limited to a ~3 meter range and a narrow angle (~100°). Motion outside this field of view will not be detected.
- **Environmentally Sensitive:** The sensor's reliability may be affected by environmental conditions such as heat sources, light, and airflow, potentially leading to false positives or missed triggers.
- **Cannot Identify Specific Objects or People:** The system reacts to any motion, with no capability to distinguish between authorized and unauthorized individuals, or humans and animals.
- **No Event History or Storage:** Detected motion is not recorded or stored. Once the Arduino is disconnected, any detection data is lost.

6. Conclusion

This project best demonstrates an easy-to-use vehicle theft detection system based on a PIR motion sensor and an Arduino Uno. The system detects movement continuously and inform the user through a visual output through serial monitor. The simplicity of the design, low cost, and ease of installation make it an ideal solution for prototyping and learning applications of the Arduino microprocessor.

The project as a whole proves the capability of embedded systems in addressing real-world security problems with minimal hardware and straightforward programming.

7. Reference

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