Burglar Detection and Alarm System

Course:
CpE 366 – Introduction to Hardware Description Language

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ABSTRACT

This project is a hardware-based Object Detection Alert System using a PIR motion sensor and FPGA development board. The system detects motion through infrared radiation and triggers an audible buzzer as an alert mechanism. Designed for basic intrusion detection or automation purposes, the system uses an Altera Cyclone II FPGA for processing and a buck converter for voltage regulation. It aims to provide a fast-response alert mechanism suitable for security or smart monitoring systems.

1. INTRODUCTION

1.1 Background

Object detection is critical in security, automation, and smart environments. This project explores how FPGA-based control systems can be utilized for real-time motion detection using a PIR sensor.

1.2 Objective

To develop a motion-based object detection system using a PIR sensor and FPGA, and to trigger an audible alert through a buzzer when motion is detected.

1.3 Problem Statement

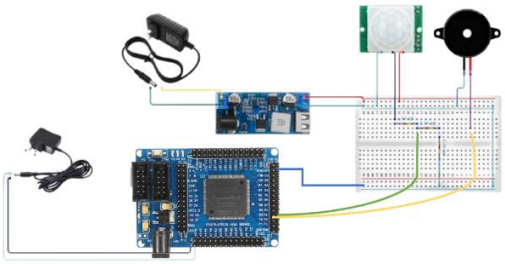
Conventional microcontrollers are widely used for simple detection systems. This project attempts to explore the capabilities of FPGAs in handling such tasks in a more hardware-parallel way, enhancing speed and accuracy.

2. COMPONENTS AND MATERIALS

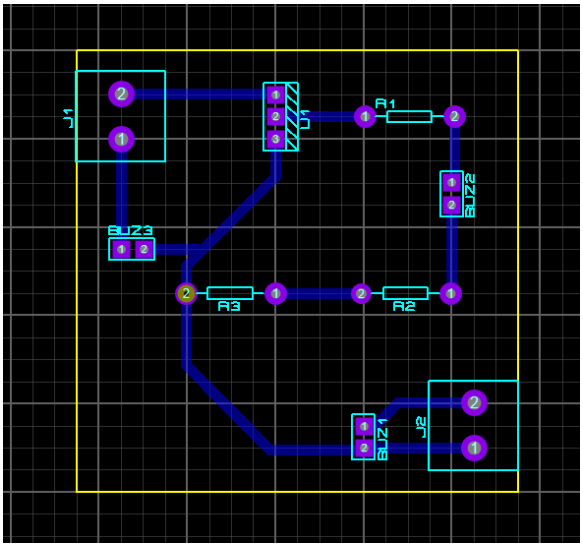
Component	Quantity	Description
FPGA Development Board	1	Altera Cyclone II EP4CE6E22C8N, acts as the brain of the system
DC Power Adapter	2	Provides power to the FPGA and buck converter
Buck Converter	1	Steps down voltage (e.g., from 12V to 5V or 3.3V)
Breadboard	1	For connecting and prototyping components
PIR Motion Sensor	1	Detects motion by sensing infrared radiation
Piezo Buzzer	1	Emits sound when motion is detected
Male-to-Male Jumper Wires	Several	Connect components across the breadboard and to the FPGA board

3. SYSTEM DESIGN

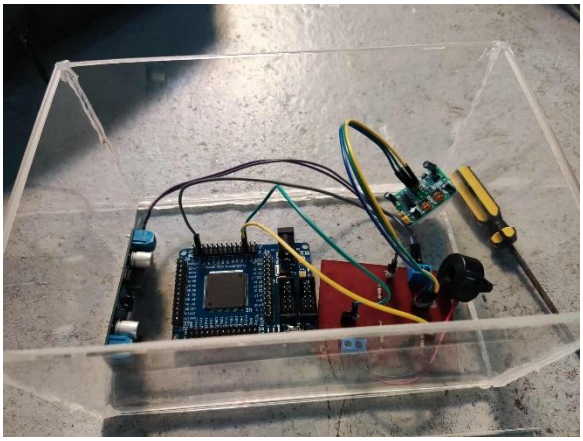
3.1 Actual Circuit Diagram:



3.2 PCB Circuit Diagram:



3.3 Actual Prototype



4. WORKING PRINCIPLE

The PIR sensor monitors for changes in infrared radiation, such as those caused by human movement. When motion is detected, the sensor sends a HIGH signal to the FPGA. The FPGA then processes this input and generates a corresponding control signal to activate the buzzer. As a result, the buzzer emits a sound to alert users of the detected motion.

5. FPGA CODE OVERVIEW

```
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;
use IEEE.STD_LOGIC_ARITH.ALL;
use IEEE.STD_LOGIC_UNSIGNED.ALL;
entity pir_buzzer is
    Port (
        clk        : in  STD_LOGIC;      -- 50
MHz clock
        pir_in     : in  STD_LOGIC;      --
PIR sensor input (3.3V safe)
        buzzer_out : out STD_LOGIC       --
Active low buzzer output
    );
end pir_buzzer;
architecture Behavioral of pir_buzzer is
    constant MAX_COUNT : INTEGER := 250000000;
-- 5 seconds at 50 MHz
    signal counter     : INTEGER range 0 to
MAX_COUNT := 0;
    signal buzzer_en   : STD_LOGIC := '0';
begin
    process(clk)
    begin
        if rising_edge(clk) then
            if pir_in = '1' and buzzer_en =
'0' then
                buzzer_en <= '1';    -- start
buzzer timer
                counter <= 0;
            elsif buzzer_en = '1' then
                if counter < MAX_COUNT then
                    counter <= counter + 1;
                else
                    buzzer_en <= '0'; -- turn
buzzer off after 5 seconds
                end if;
            end if;
        end if;
    end process;
    -- Active low buzzer output
    buzzer_out <=  buzzer_en;
end Behavioral;
```

6. TESTING AND RESULTS

6.1 Procedures

To operate the system, begin by powering it using the DC adapters. In its idle state, the PIR sensor continuously monitors the surroundings for any motion. When motion is detected—such as a hand wave or someone walking by—the sensor triggers a response. This causes the buzzer to activate, providing an audible alert that motion has been detected.

6.2 Observations

Test Condition	Motion Detected	Buzzer Activated
No motion	No	No
Hand wave (2m away)	Yes	Yes

Continuous motion	Yes	Continuous alert

6.3 Results

The system consistently detected motion and triggered alerts accurately in all tested scenarios.

7. CONCLUSION

The project successfully demonstrates a motion detection alert system using a PIR sensor and an FPGA board. The system is reliable for real-time response and can be expanded for use in home automation or security systems. Future work could include adding a GSM module for remote alerts or integrating multiple sensors for broader coverage.

8. References

- PIR Sensor Datasheet
- FPGA Cyclone II Documentation
- FPGA4student Verilog examples
- Buck converter working principle: www.electronics-tutorials.ws

9. SUPPLEMENTS

9.1 Appendices

- **Appendix A**: FPGA Board Pinout Diagram
- **Appendix B**: PIR Sensor Timing Diagram
- **Appendix C**: Breadboard Layout Picture
- **Appendix D**: Photos of Physical Setup

9.2 Pin Planner of the Project

Node Name	Direction	Location
Buzzer_out	Output	PIN_44
Clk	Input	PIN_17
Pir_in	Input	PIN_45