Motion Detector Using Pir Sensor

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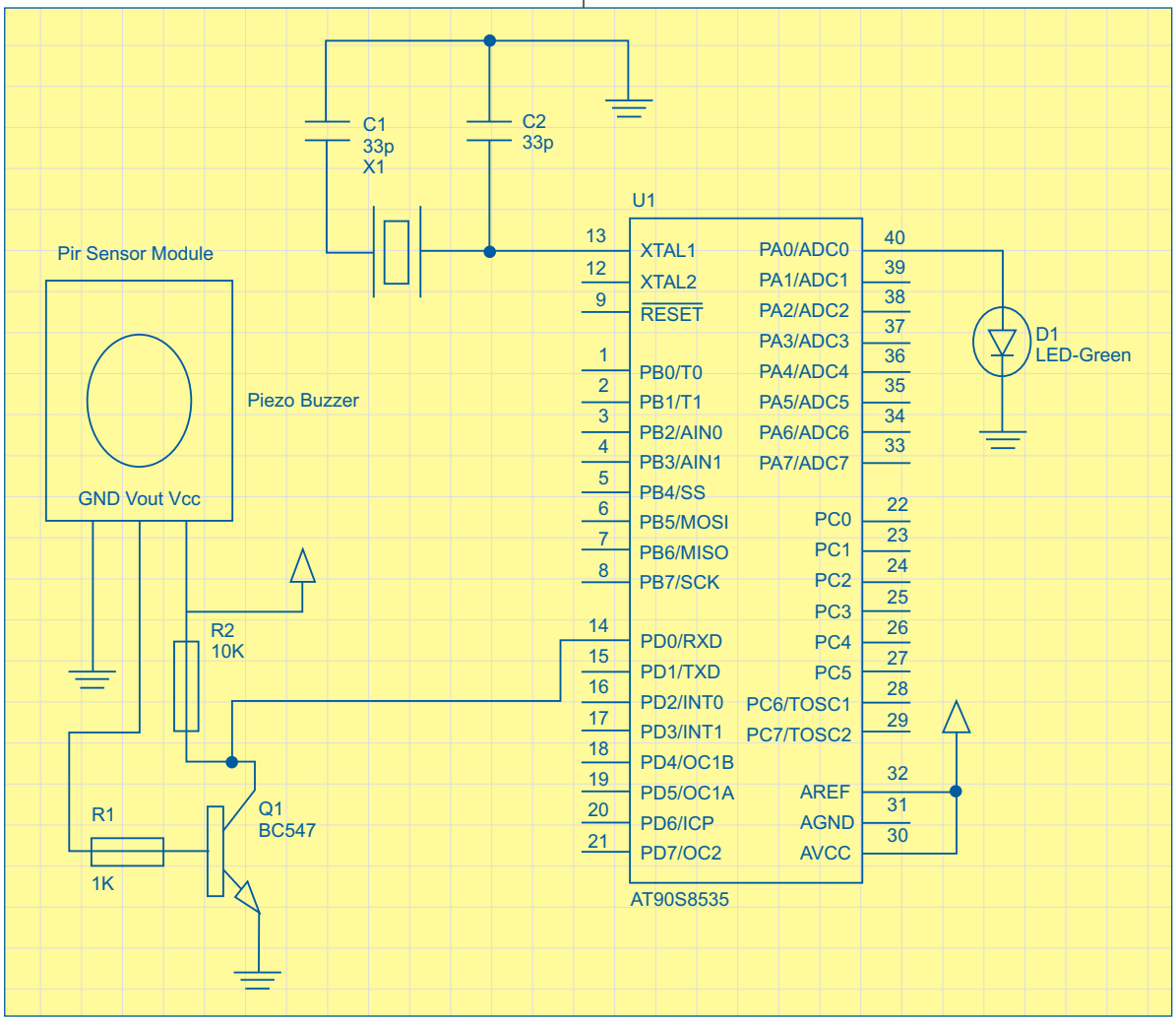
Infrared is the invisible radiation lies between the Visible and Microwave portions of the electromagnetic spectrum. The term Infra means below the ability to detect visually and the term Red means colour of the light with low energy level. The Near infrared is close to the red portion of visible light and the Far infrared is close to the microwave region. Far infrared is thermal and we feel it as heat by the temperature sensors in our skin. Short and Near infrared rays cannot be detected since these are invisible as well as cool. Active infrared rays are produced from semiconductor sources but natural objects like animals including human beings emit infrared rays from the body heat. Humans at normal body temperature emits Infrared rays at the wavelength of 10 microns.PIR Sensors are used in surveillance systems to detect moving persons in protected areas.PIR stands for Passive Infra-Red (PIR) sensor. There are many vendors that manufacture the PIR sensor modules and almost all



of them are pretty much the same in function. They have a single output that goes high (or low, based on specification) when the motion is detected. Certain crystalline materials have the property to generate a surface electric charge when exposed to thermal infrared radiation. This phenomenon is known as pyroelectricity. The Passive Infra-Red (PIR) sensor module works on the same principle. The human body radiates heat in the form of infrared radiation which is maximum at about 9.4 um. The presence of human body creates a sudden change in the IR profile of the surrounding that is sensed by the pyroelectric sensor. PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, low cost ,easy to use ,don't wear out, , pretty rugged, have a wide lens range, and are easy to interface with. For that reason they are commonly found in appliances and gadgets used in homes or businesses.

The PIR sensor module has an instrumentation circuit on board that amplifies this signal to appropriate voltage level to indicate the detection of motion.The PIR sensor requires an initial stabilization time of about 10 to 60 seconds in order to function properly. During this time, the sensor gets familiar with the surrounding environment, and any motion in its field of view should be avoided. The PIR sensor has a typical range of 20 feet, and is designed to adjust to slowly changing conditions such as the gradual change in the thermal profile of the surrounding as the day passes. However, any sudden change in the profile (e.g. human body motion) is responded by the sensor. That's why the PIR sensor module should not be placed near a heater, AC outlet or anything that could create a rapid change in the surrounding environment.

In this project, a AVR 8535 microcontroller continuously monitors the output from the sensor module and turns a buzzer on when it goes active. The circuit diagram is quite simple. The sensor requires a 5V-9V supply.

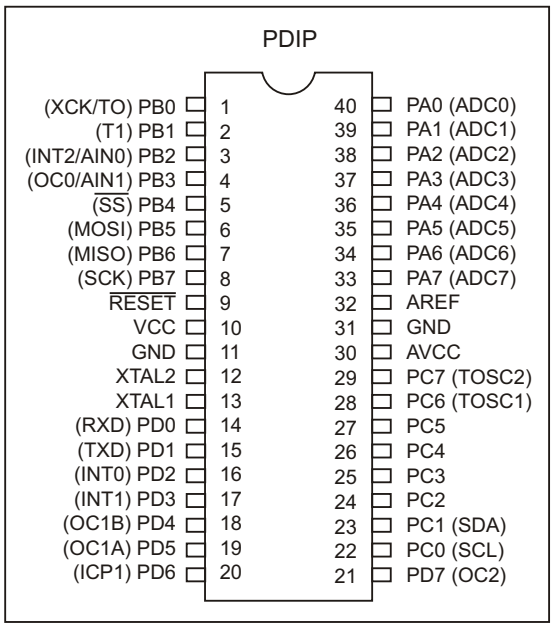
Working

The circuit diagram shows the connection of the PIR sensor to the AVR 8535 controller. The output of the PIR sensor module is monitored through PD0 of the AVR 8535. The microcontroller monitors the voltage at the collector of the transistor. During the normal condition, the transistor is cut off, and the collector output is at logic high (+5 V). Connect regulated DC power supply of 5 Volts to the positive power supply of sensor and connect another pin to Ground, Next the middle wire is output and connect the pin to directly to the microcontroller to send the motion detecting signal. After powering up leave it for 1-2 minutes before using the sensor for warming up. Now sensor is ready to use for connecting with microcontroller. The changes in the amount of infrared striking the element change the voltages generated, which are measured by an on-board amplifier. The device contains a special filter called a Fresnel lens, which focuses the infrared signals onto the element. As the ambient infrared signals change rapidly, the on-board amplifier trips the output in low signal to indicate about the motion. When the motion is sensed, the high output from the sensor module saturates the transistor and the voltage at the collector drops down to logic low. An LED is connected to the pin 0 of port A.It goes high whenever the sensor detects a person.

Component Used

ATmega 8535 Controller

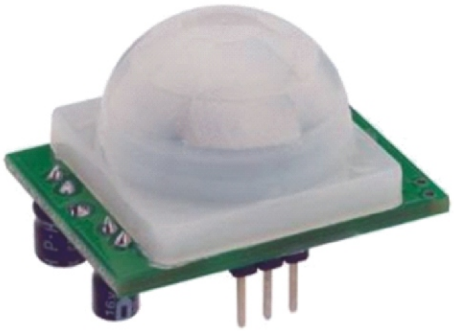
The ATmega8535 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing instructions in a single clock cycle, the ATmega8535 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption



versus processing speed. The ATmega8535 provides the following features: 8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes EEPROM, 512 bytes SRAM, 32 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART.

Pin Descriptions

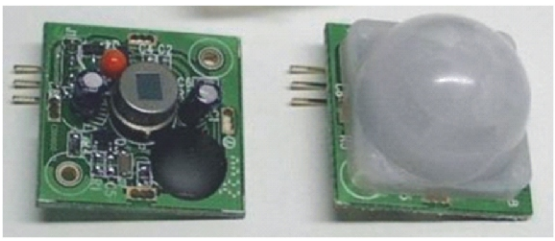
VCC Digital supply voltage.
GND Ground.
Port A (PA7..PA0) Port A serves as the analog inputs to the A/D Converter.Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used.Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.
Port B (PB7..PB0) Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.
Port C (PC7..PC0) Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.
Port D (PD7..PD0) Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.
RESET Reset input. A low level on this pin for longer



than the minimum pulse length will generate a reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a reset.
XTAL1 Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.
XTAL2 Output from the inverting Oscillator amplifier.
AVCC AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.
AREF AREF is the analog reference pin for the A/D Converter

PIR Sensor

The name PIR (Passive Infrared) is given to the sensor because it receives the infrared rays passively and do not emit any infrared ray. The PIR sensor is a solid state device made of ¼ inch pyroelectric material as a thin film. The pyroelectric material may be Gallium nitride(GaN), Cesium nitrate(CsNO3), Cobalt phthalocyanine, Lithium tantalite(LiTaO3) etc. They show both piezoelectric and pyroelectric properties. The sensor is made as part of the integrated circuit having 1 – 4 pixels of pyroelectric material. The paired pixels are connected to the inputs of a differential amplifier. The differential amplifier cancel each other the PIR measurements and the average temperature in the



field of view is removed from the electrical signal so that the IR energy on the sensor will not trigger the alarm. This prevents false triggering when exposed to flashes of light. The differential amplifier also minimizes the common mode interference from electric fields.

The PIR sensor is mounted on a PCB with other semiconductors. The complete assembly is mounted in a case with a Fresnel lens molded in front of it. Behind the lens, there is a small window through which infrared enters into the sensor. The window is covered with a transparent plastic which allows only IR rays to enter into the sensor and prevents visible light. The filtering window limits the IR rays to 8-14 micrometers similar to the IR rays from human body.

The circuit in the PIR sensor is connected to a relay and the sensor resets at power on and remains standby. If the amount of the IR in front of the sensor changes within a configured time, the circuit switches off the relay to trigger the alarm system.

When a person enters within the range of the Sensor, The Fresnel lens focus the IR energy into the sensor which had previously sensed the cooler area. This change in energy level makes the sensor warmer and makes a hot spot in it. When the person moves, the hot spot also moves which causes the electronic circuit to deactivate the relay. This activates the alarm system connected through the normally closed(NC) contacts of the relay.

Pin Definitions and Ratings

Fixing and focusing the PIR sensor is important to give maximum sensitivity and to prevent false alarms. Mounting the device on the wall at an angle of 45 degree and 2-3 meters height will give good results. The sensor may saturate if strong sunlight and head light from vehicles fall on the sensor. Such positions should be avoided.

Sensitivity

The PIR Sensor has a range of approximately 20 feet. This can vary with environmental conditions. The sensor is designed to adjust to slowly changing conditions that would happen normally as the day progresses and the environmental conditions change, but responds by making its output high when sudden changes occur, such as when there is motion.

Pin	Name	Function
-	GND	Connects to Ground or Vss
+	V+	Connects to Vdd (3.3V to 5V) @ ~100uA
OUT	Output	Connects to an I/O pin set to INPUT mode (or transistor/MOSFET)

The firmware is written in C and compiled using AVR-STUDIO 4.The hardware connections are simulated on the proteus.

```
#include<avr/io.h>
#include<util/delay.h>
void main()
{
        DDRA = 0x01;      //Led output
        DDRD = 0x00;      //sensor input
        PORTD= 0x01;      //pull up

        // Blink LED at Startup

        PORTA=0x01;
        _delay_ms(100);
        PORTA=0x00;

        PORTA=0x01;
        _delay_ms(100);
        PORTA=0x00;

        PORTA=0x01;
        _delay_ms(100);
        PORTA=0x00;


        _delay_ms(6000); //    delay for PIR module stabilization
                while(1)
        {
                if(PIND==0x01)  //MOTION DETECTED
                {
                        PORTA=0x01;    //LED ON
                        _delay_ms(1000);
                }
                else            //MOTION NOT DETECTED
                {
                        PORTA=0x00;    //LED OFF
                }
        }
}
```