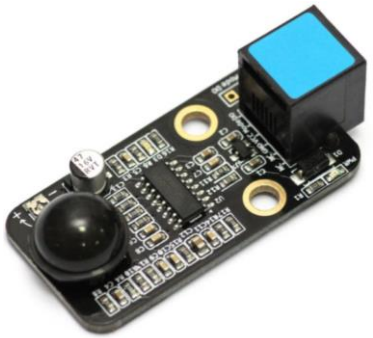
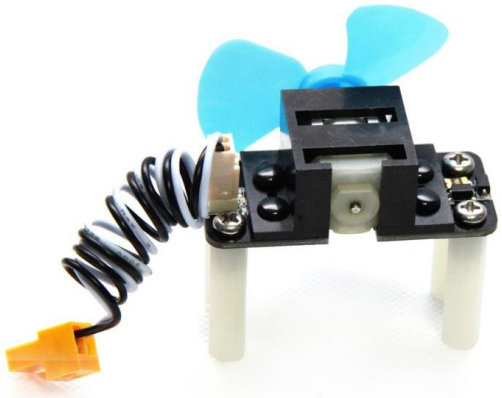
Human Inputting Devices for DC Motor Control

Class 2: Semiconductor Input Devices





July 25, 2017

Don Wilcher

DesignNews
CEC CONTINUING EDUCATION CENTER

Presented by:
Digi-Key ELECTRONICS
ROHDE&SCHWARZ

Semiconductor Input Devices

Agenda

- Semiconductor Sensor Basics
- The inner workings of a PIR Sensor
- The inner workings of an Ultrasonic Sensor
- Hands-On Project: A Smart Fan

Semiconductor Sensor Basics

- Often referred to as transducers.
- Semiconductor Sensors provide a link in integrating industrial control systems.
- They convert mechanical, magnetic, thermal, electrical, optical, and chemical variations into electrical voltage, and current signals.
- They have no moving parts.

Semiconductor Sensor Basics…

- They're replacing electromechanical transducers because of
  - a) fast detection switching speeds
  - b) increase operating life.
- Semiconductor Sensors are at the center of Industry 4.0 (Industrial Internet of Things).
  - a) Data Analytics and Machine Learning
  - b) Predictive Maintenance

Semiconductor Sensor Basics…

Examples:

Semiconductor Sensors

Hall Effect Sensor

Accelerometer

Proximity Sensor (IR Optical)

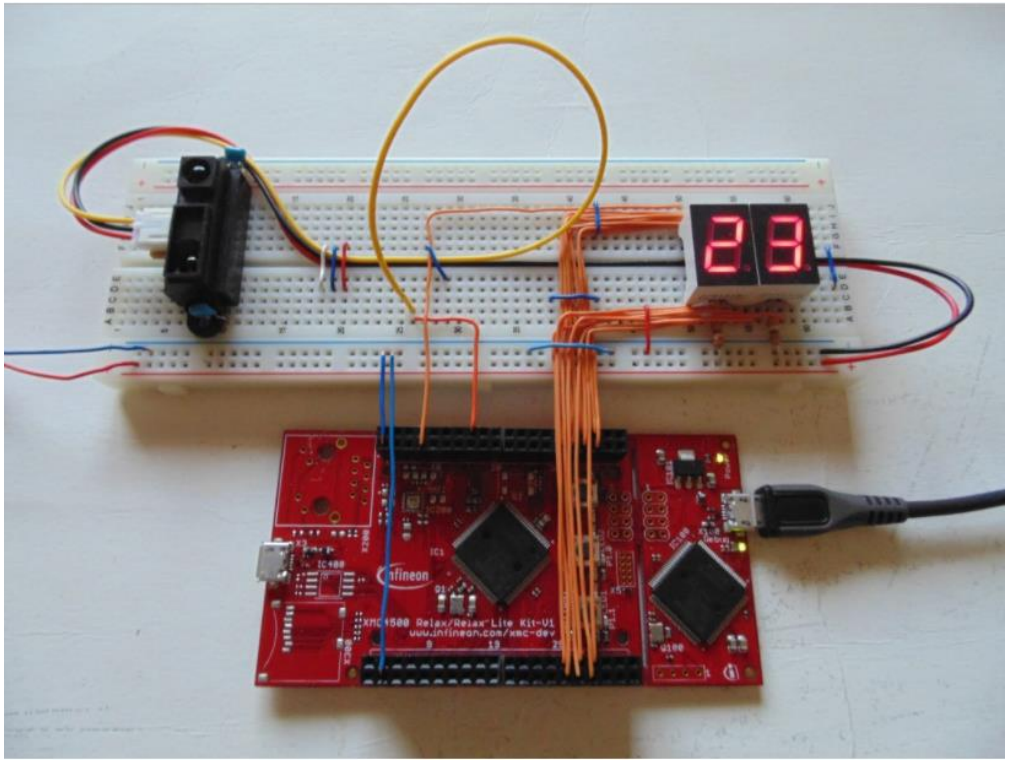
Light Sensor(Photo-transistor)

Ultrasonic Sensors

Semiconductor Sensor Basics…

Example Project:

Distance Sensor with 2 Digit LED Display.



Source:
http://usgroup.eu/activities/infineon/dave3-tutorials/proximity-sensor/

Semiconductor Sensor Basics…

Example Project:

A Simple and Cheap Dark-Detecting LED Circuit

Source:

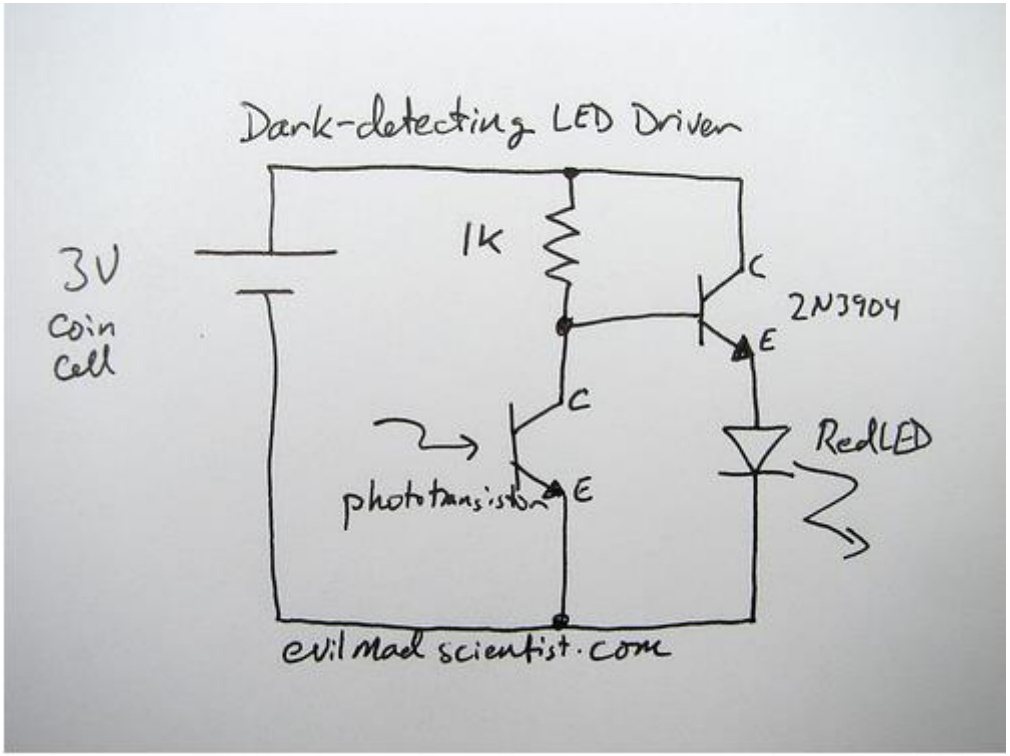
http://www.evilmadscientist.com/2007/a-simple-and-cheap-dark-detecting-led-circuit/

Semiconductor Sensor Basics…

Example Project:

A Simple and Cheap Dark-Detecting LED Circuit…

Circuit Schematic Diagram



Source:

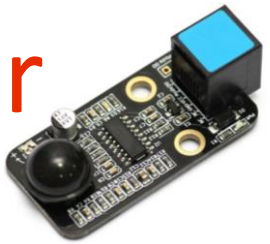
http://www.evilmadscientist.com/2007/a-simple-and-cheap-dark-detecting-led-circuit/

Question 1

Semiconductor sensors are often referred to as _____.

a) Control devices
b) Detection devices
c) Transducers
d) None of the above

The inner workings of a PIR sensor

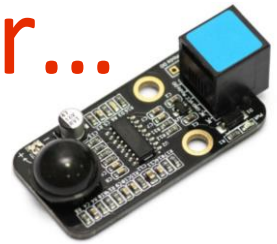


- **PIR sensors allow you**
  a) to sense motion.
  b) to detect whether a human has moved in or out of the sensor's range.
- **PIR sensors**
  a) are small.
  b) are inexpensive.
  c) are low-power.
  d) are easy to use.
  e) and don't wear out.

Source:

https://cdn-learn.adafruit.com/downloads/pdf/pir-passive-infrared-proximity-motion-sensor.pdf

The inner workings of a PIR sensor…

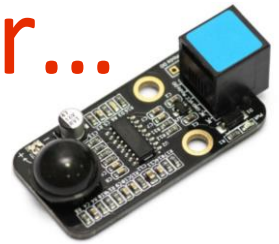


They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

Source:

https://cdn-learn.adafruit.com/downloads/pdf/pir-passive-infrared-proximity-motion-sensor.pdf

The inner workings of a PIR sensor…



What is Pyroelectricity?

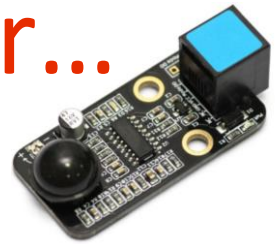
- Certain types of crystals are naturally electrically polarized.
- They contain a large electric field.
- Can be seen as one side of a triangle where each corner can be represented in three energy states:

a)kinetic

b) electrical

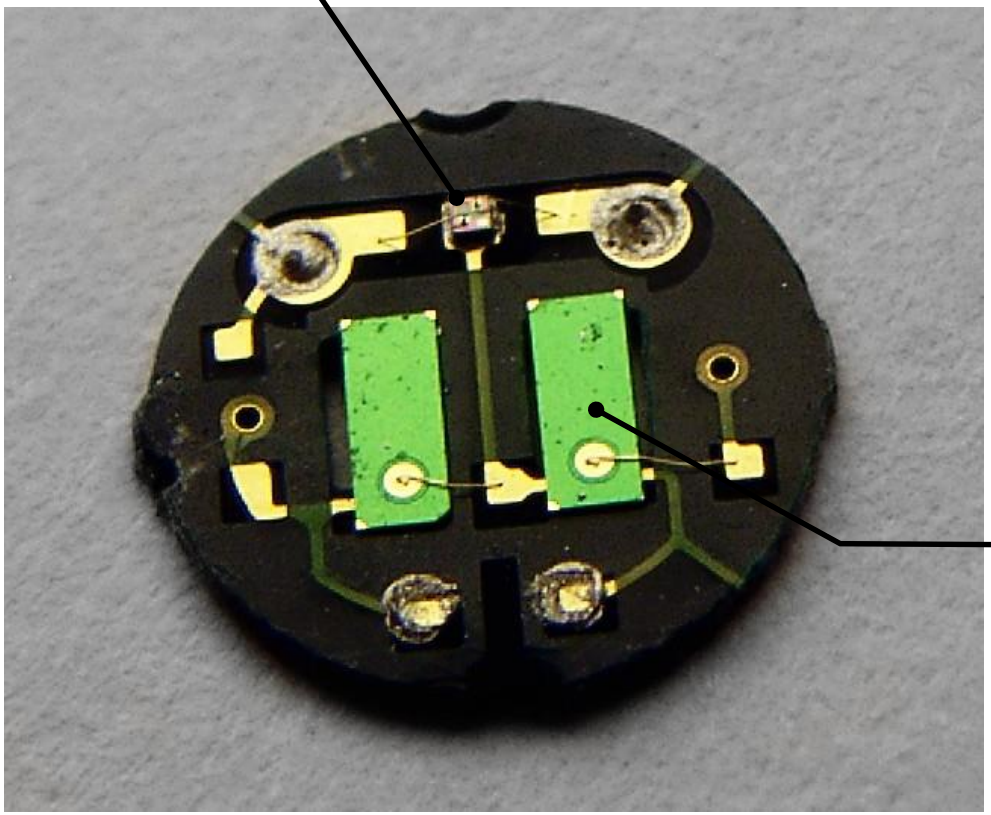
c) thermal

The inner workings of a PIR sensor…



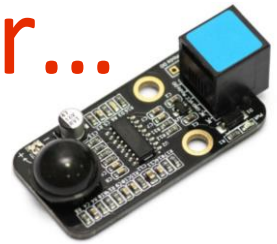
Polarized Pyroelectric crystal

Pyroelectric sensor: major parts



Metal film electrode, typical

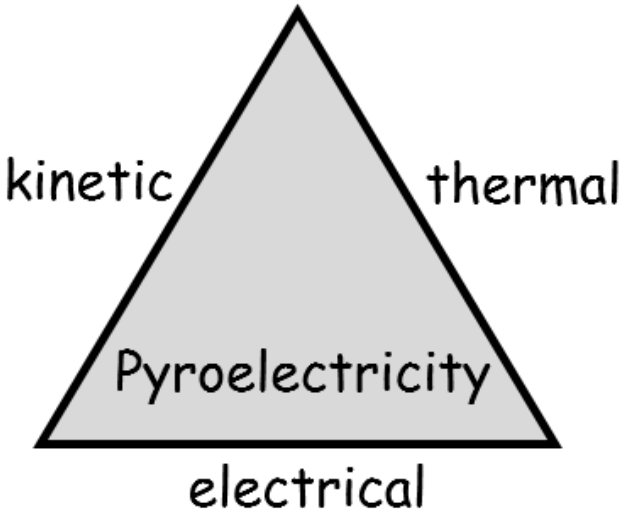
The inner workings of a PIR sensor…



Visualizing Piezoelectricity as a triangle

Piezoelectric effect = electrical + kinetic ⟶ no heat

Pyroelectricity = electrical + thermal ⟶ no kinetic energy



Question 2

In slide 8, what type of transistor driver is used to switch the LED on or off?

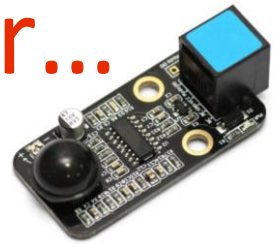
a) Low side driver

b) High side driver

c) Darlington

d) None of the above

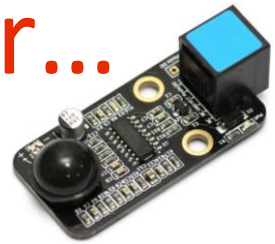
The inner workings of a PIR sensor…

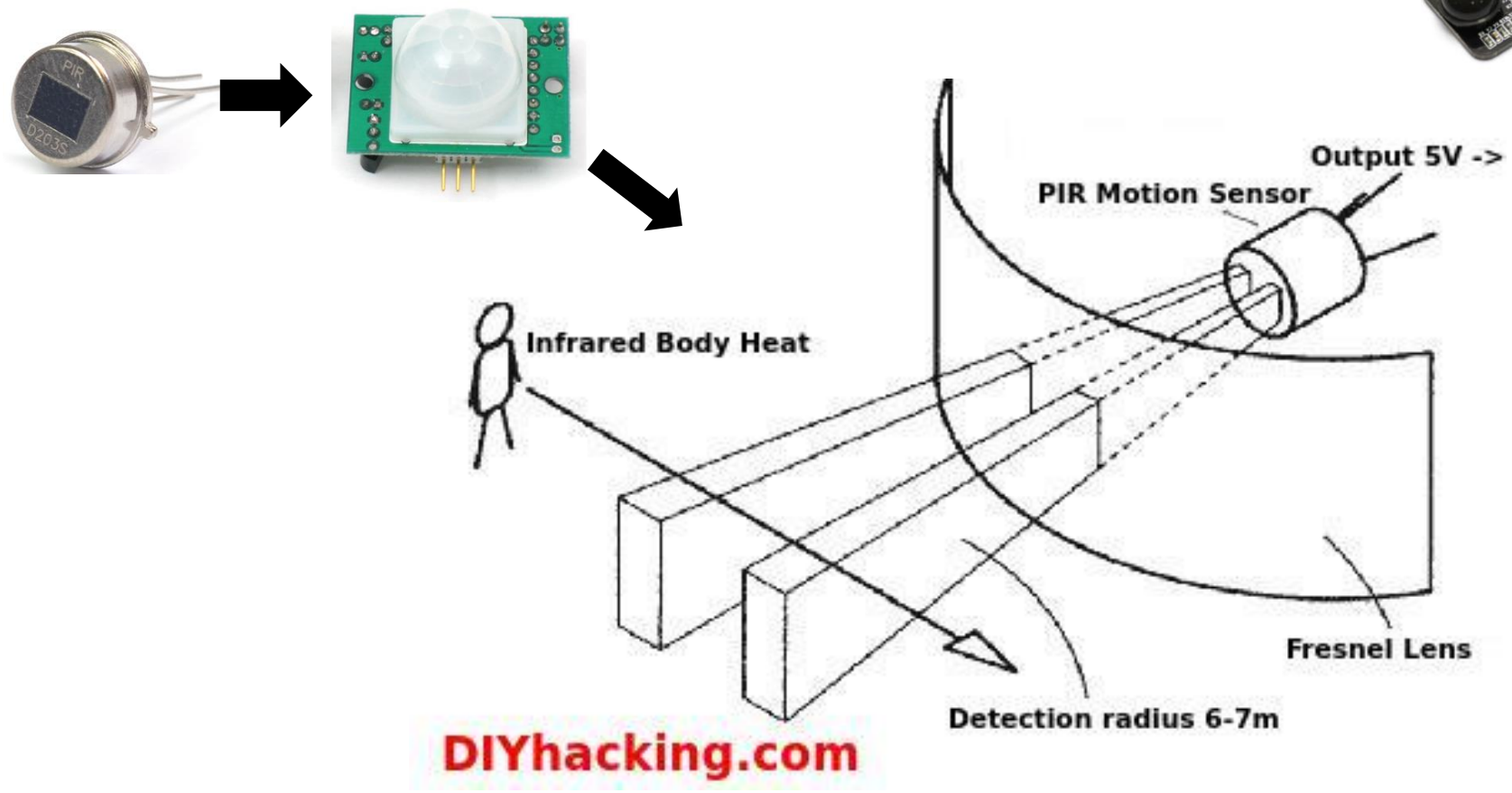


- **Sensor is split into two halves.**
  a) Looking to detect motion change.
  b) Not concern about average IR levels.
- **The two sensor halves are wired**
  a) to cancel detection motion change
  b) to swing the output signal high or low

based on more or less IR radiation detected.

The inner workings of a PIR sensor…

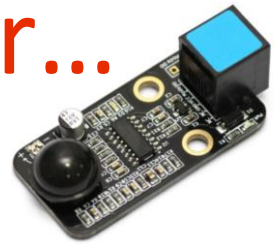




Source:

https://diyhacking.com/pir-motion-sensor-automate-home/

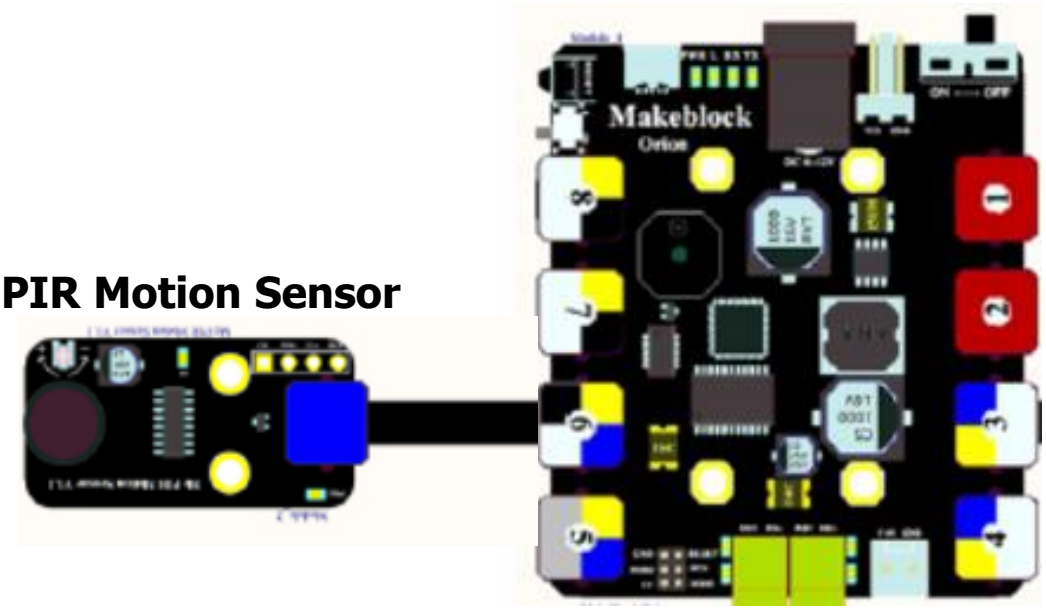
The inner workings of a PIR sensor…



Testing a Me PIR Motion Sensor:

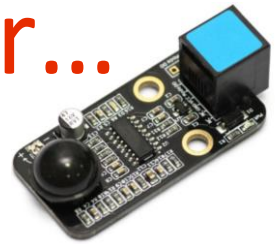
Me Orion

Me PIR Motion Sensor



Source:
http://www.makeblock.com/me-pir-motion-sensor

The inner workings of a PIR sensor…

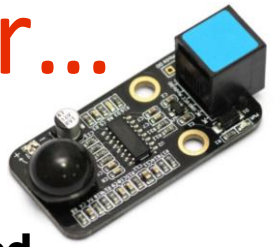


Me Orion- Me PIR Motion Sensor Test Code

```
#include "MeOrion.h"
#include <Wire.h>
#include <SoftwareSerial.h>

MePIRMotionSensor myPIRSensor(PORT_6);

void setup( )
{
  Serial.begin(9600);
}



void loop() {
 Serial.print("PIR Motion values=");
 Serial.println(myPIRSensor.isHumanDetected());
 delay(100);

}
```

Source:
http://www.makeblock.com/me-pir-motion-sensor

The inner workings of a PIR sensor…



Me Orion- Me PIR Motion Sensor in operation. The value = 1, object detected.

COM4

```
PIR Motion values=1
PIR Motion values=1
PIR Motion values=0
PIR Motion values=0
PIR Motion values=0
PIR Motion values=1
PIR Motion values=1
PIR Motion values=1
PIR Motion values=1
PIR Motion values=0
PIR Motion values=0
PIR Motion values=0
PIR Motion values=0
PIR Motion values=1
PIR Motion values=1
PIR Motion values=1
PIR Motion values=1
PIR Motion values=1
PIR Motion values=1
PIR Motion values=1
PIR Motion values=1
PIR Motion values=0
PIR Motion values=0
```

Serial Monitor Output

The inner workings of an Ultrasonic Sensor

An ultrasonic sensor

- is a solid state sensor that can detect the presence of an object by:

  a) emitting and receiving high frequency sound waves.

- high frequency sound waves are typically in the 200KHz range.
- can be used to monitor the level in a tank.

Source:

Electrical Motor Controls for Integrated Systems, 5th ed, G.J. Rockis, G.A. Mazur

The inner workings of an Ultrasonic Sensor…

An ultrasonic sensor

- can provide an analog voltage or digital output voltage(switched output).
- can be used to monitor the level in a tank.
- can detect metallic and non-metallic objects.
- can detect solid and liquid targets at a distance of up to approximately 1m (3.3’).
- can detect other objects that easily reflect sound waves.

Source:

Electrical Motor Controls for Integrated Systems, 5th ed, G.J. Rockis, G.A. Mazur

The inner workings of an Ultrasonic Sensor…

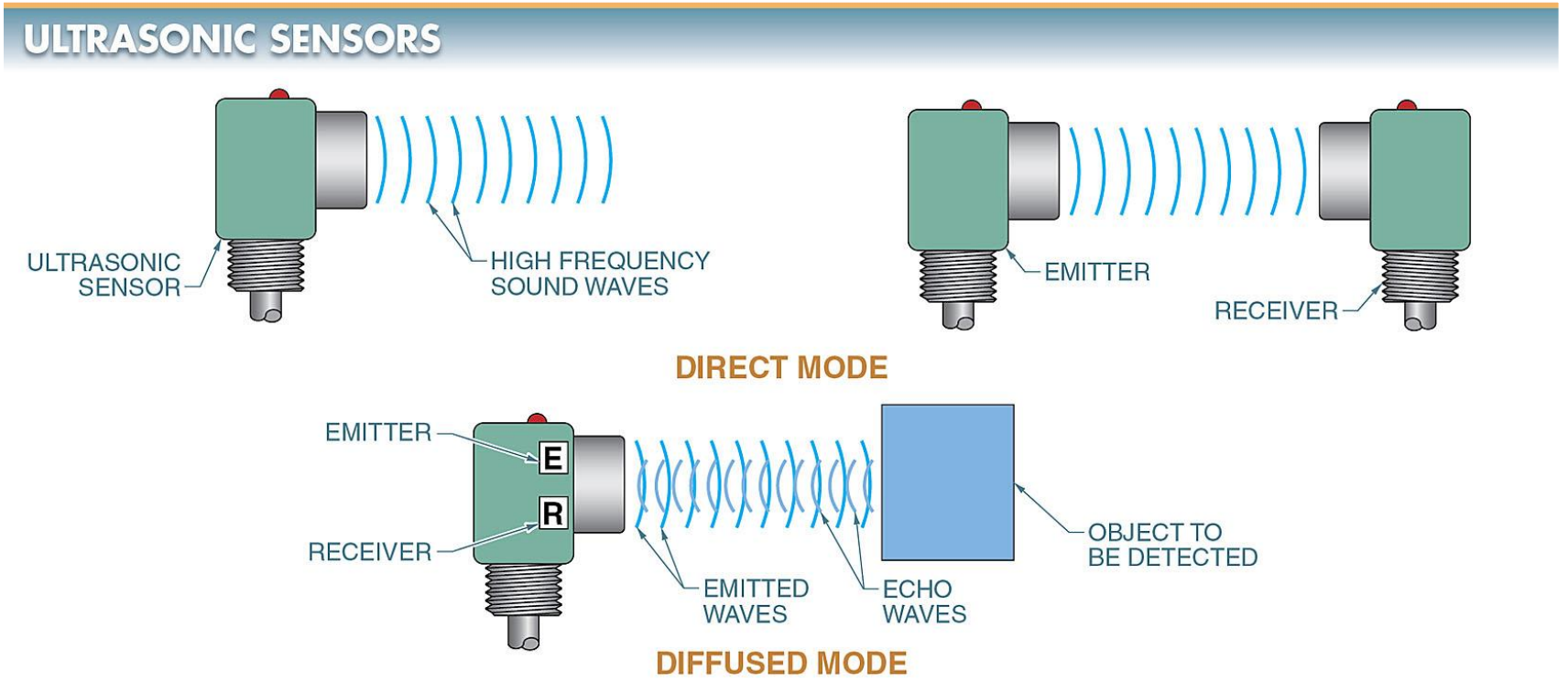
An ultrasonic sensor has two basic operating modes:

- Direct - operates like a direct scan photoelectric sensor.
- Diffused – operates like a scan diffused photoelectric sensor.

Source:

Electrical Motor Controls for Integrated Systems, 5th ed, G.J. Rockis, G.A. Mazur

The inner workings of an Ultrasonic Sensor…



Source:

Electrical Motor Controls for Integrated Systems, 5th ed, G.J. Rockis, G.A. Mazur

Question 3

In a PIR Motion Sensor, the sensor is split in____.

a) 4 parts

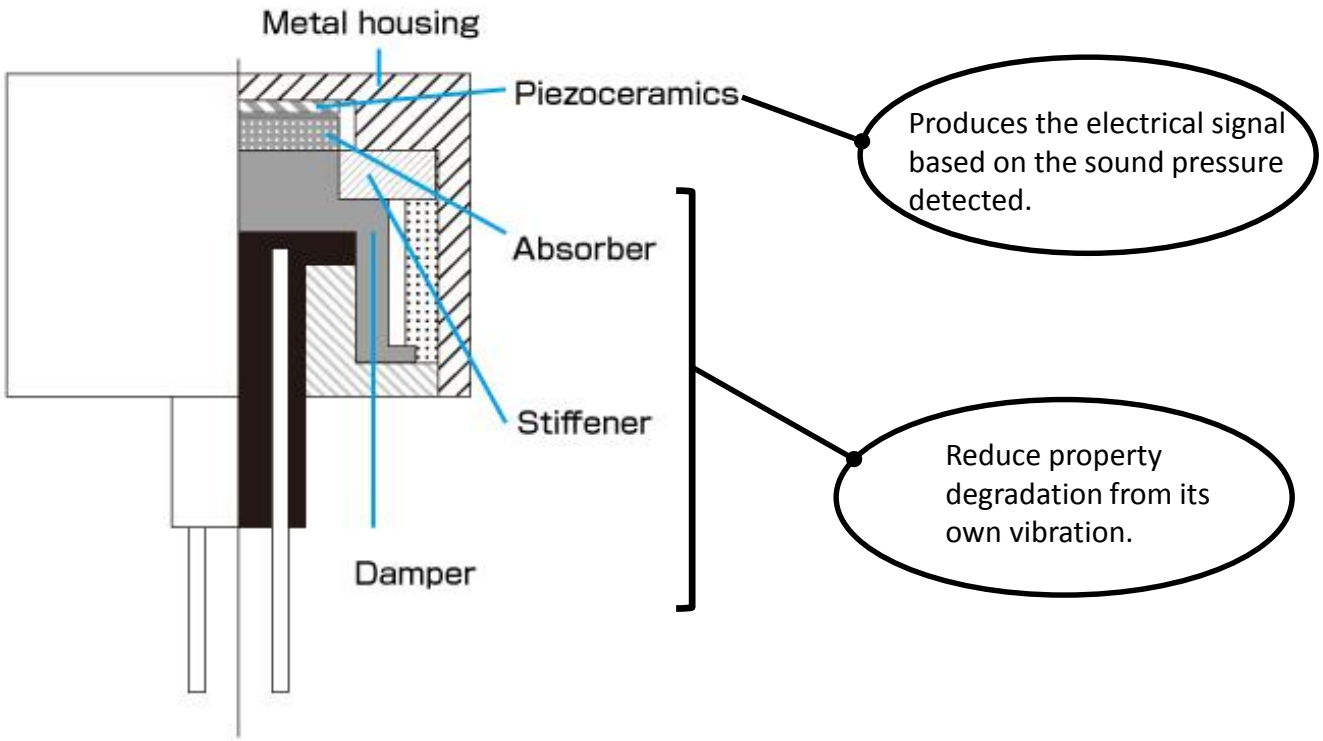
b) 3 parts

c) 2 halves

d) None of the above

The inner workings of an Ultrasonic Sensor…

Inside ultrasonic sensing element:



Source:

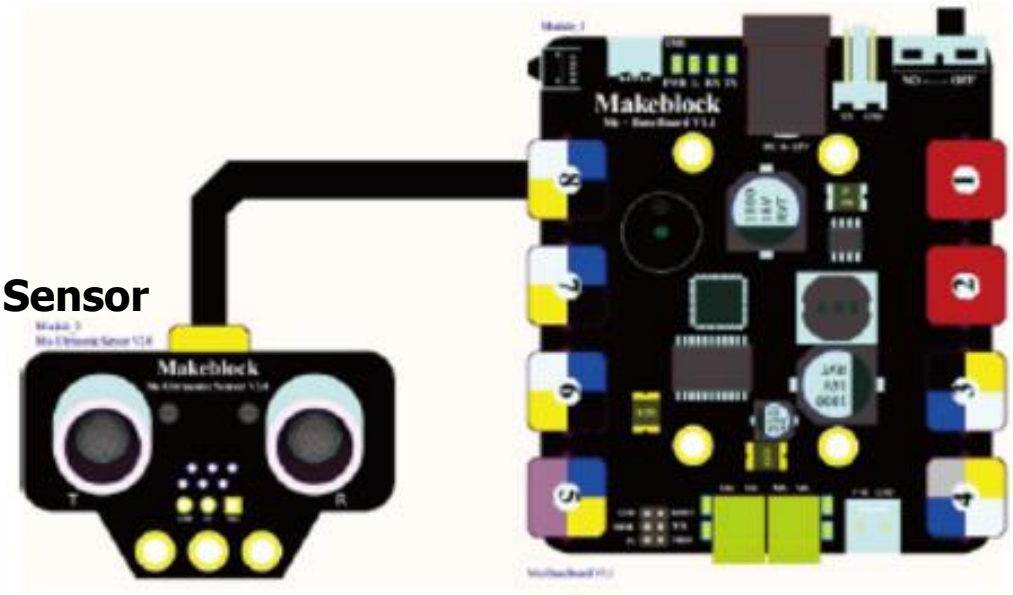
http://www.murata.com/about/newsroom/techmag/metamorphosis17/productsmarket/ultrasonic

The inner workings of an Ultrasonic Sensor…

Testing a Me Ultrasonic Sensor:

Me Orion

Me Ultrasonic Sensor



Source:

http://learn.makeblock.com/en/me-ultrasonic-sensor/

The inner workings of an Ultrasonic Sensor…

Me Orion- Ultrasonic Sensor Test Code

```
#include "MeOrion.h"
#include <Wire.h>
#include <SoftwareSerial.h>

MeUltrasonicSensor ultraSensor(PORT_8);
void setup() {

 Serial.begin(9600);
}

void loop() {
 Serial.print("Distance :");
 Serial.print(ultraSensor.distanceCm());
 Serial.println(" cm");
 delay(100);
}
```

Source:

http://learn.makeblock.com/en/me-ultrasonic-sensor/

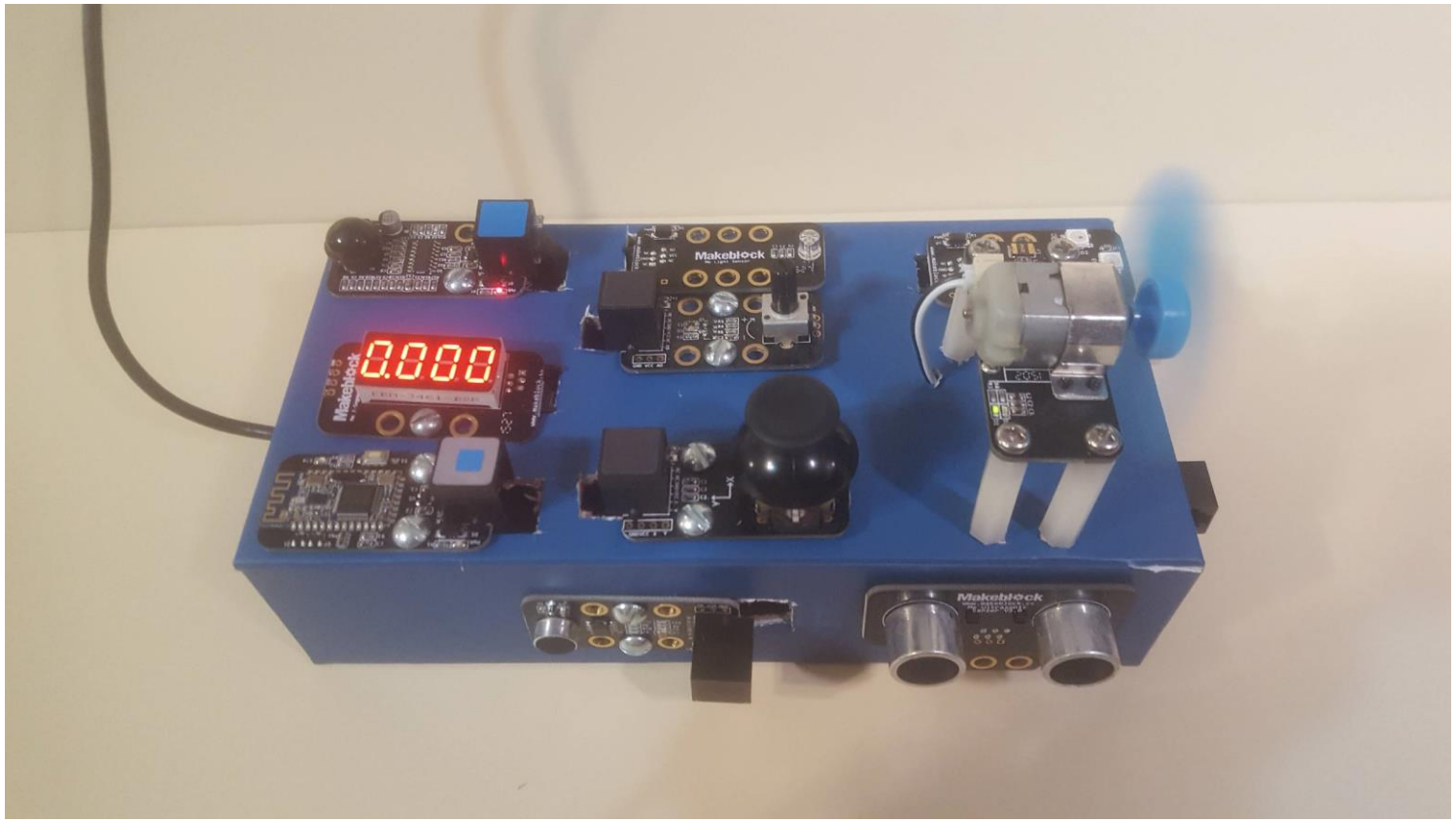
The inner workings of an Ultrasonic Sensor…

COM4

```
Distance :16.53 cm
Distance :30.17 cm
Distance :31.98 cm
Distance :31.48 cm
Distance :32.81 cm
Distance :94.60 cm
Distance :31.47 cm
Distance :34.74 cm
Distance :101.47 cm
Distance :26.71 cm
Distance :19.00 cm
Distance :15.72 cm
Distance :14.83 cm
Distance :9.24 cm
Distance :143.29 cm
```

Serial Monitor Output

Hands-On Project: Smart Fan



Hands-On Project: Smart Fan

Project Objectives:

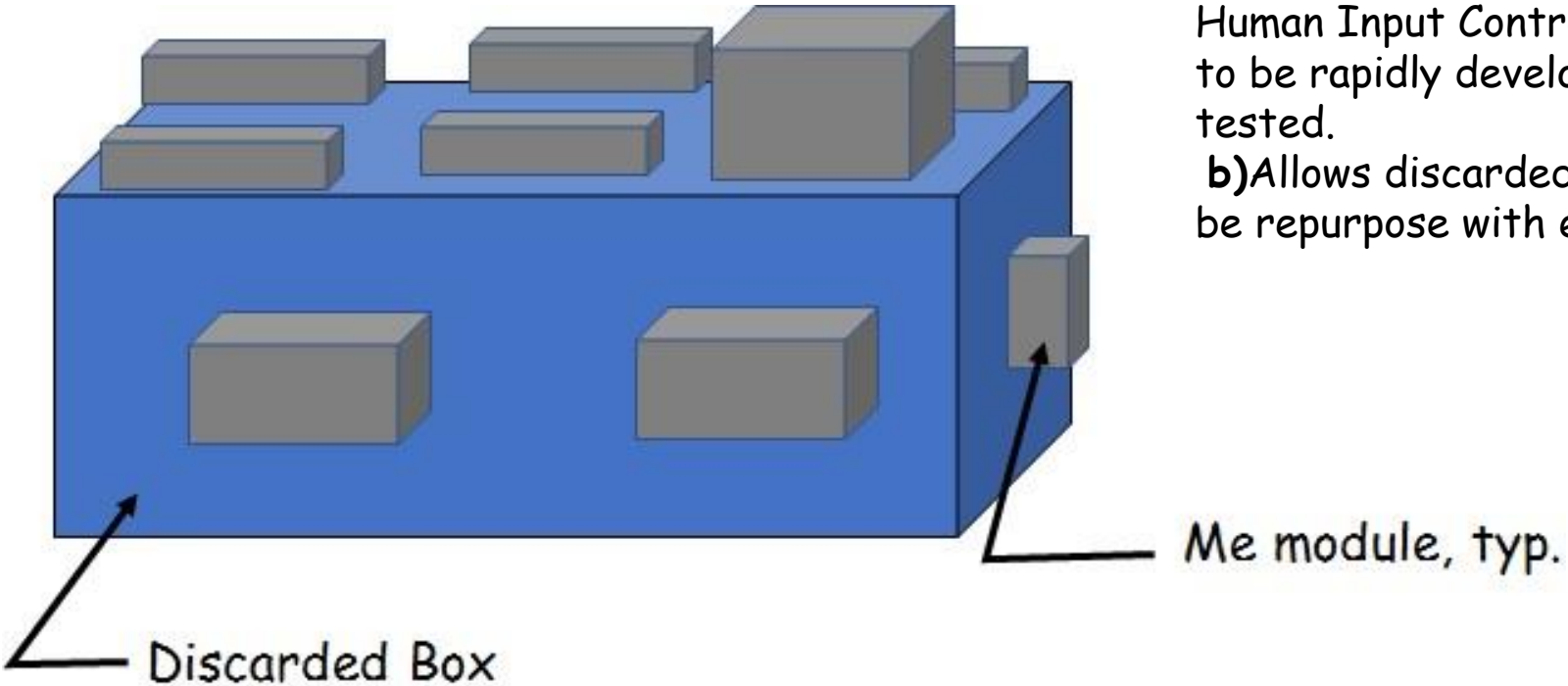
a) Build a prototyping technology trainer for testing Human Inputting Devices concepts.

b) Design a safety feature where placing your hand in front of a sensor will turn off a fan.

c) Prototype semiconductor input controls that perform Design Feature b.

Hands-On Project: Smart Fan…

Human Inputting Device Technology Box: Concept Drawing



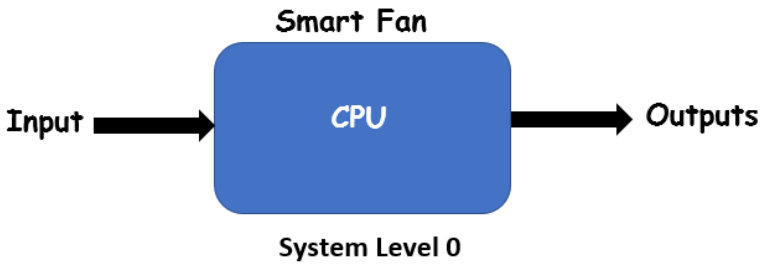
The BIG IDEAs:

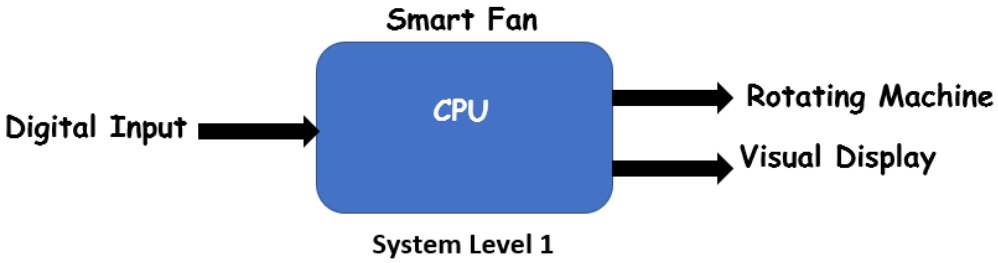
a) Technology Box allows Human Input Control Designs to be rapidly developed and tested.

b) Allows discarded items to be repurpose with electronics.

Hands-On Project: Smart Fan

Smart Fan: System Block Diagram Designs For Safety Feature





Question 4

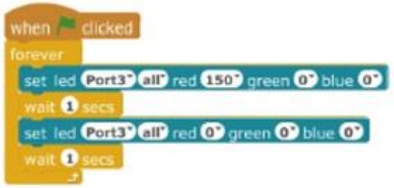
What System Level Block Diagram show the generic function of the Smart Fan?

a) Level 0

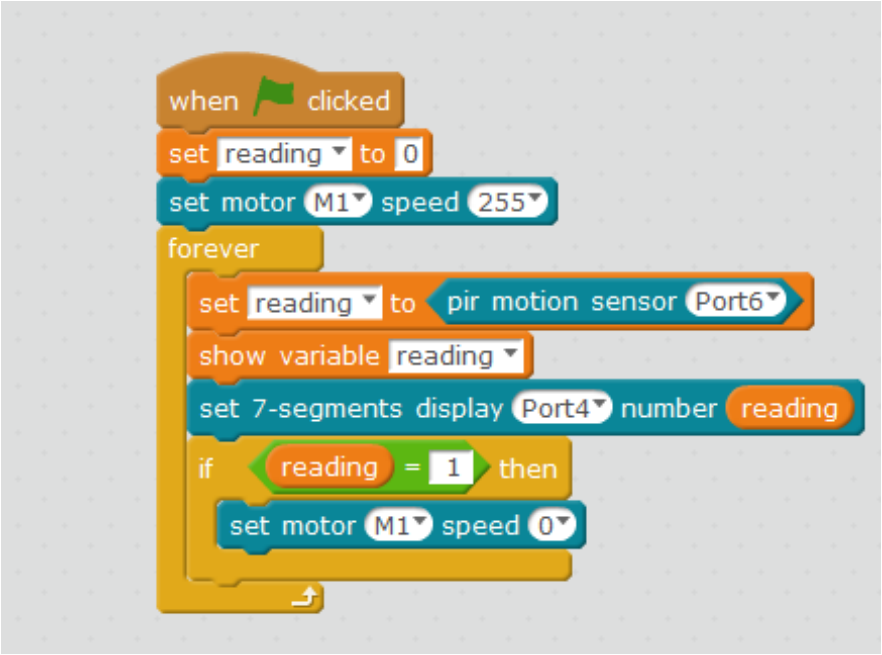
b) Level 1

c) Level 2

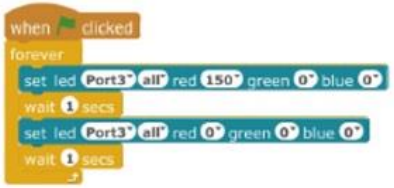
mBlock (VPL)Visual Programming Language…



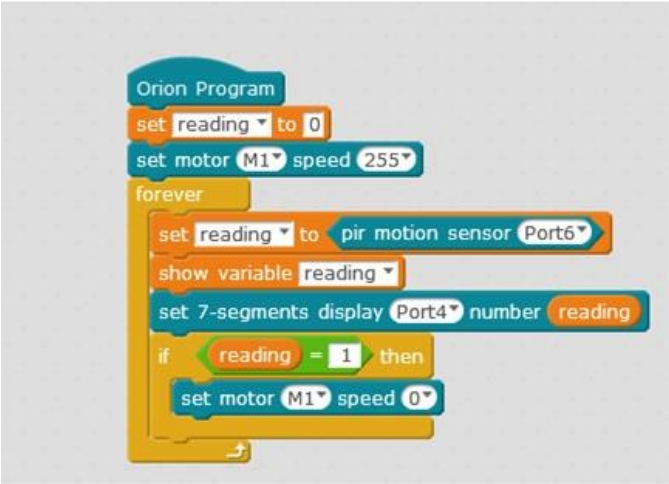
Project Code: **PIR Motion Controlled Smart Fan**



mBlock (VPL)Visual Programming Language with Arduino Code…

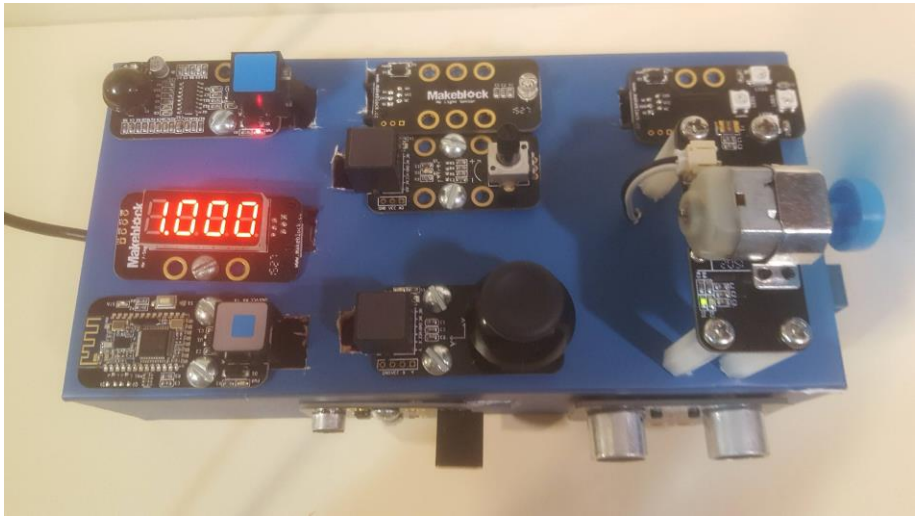


Project Code: PIR Motion Controlled Smart Fan

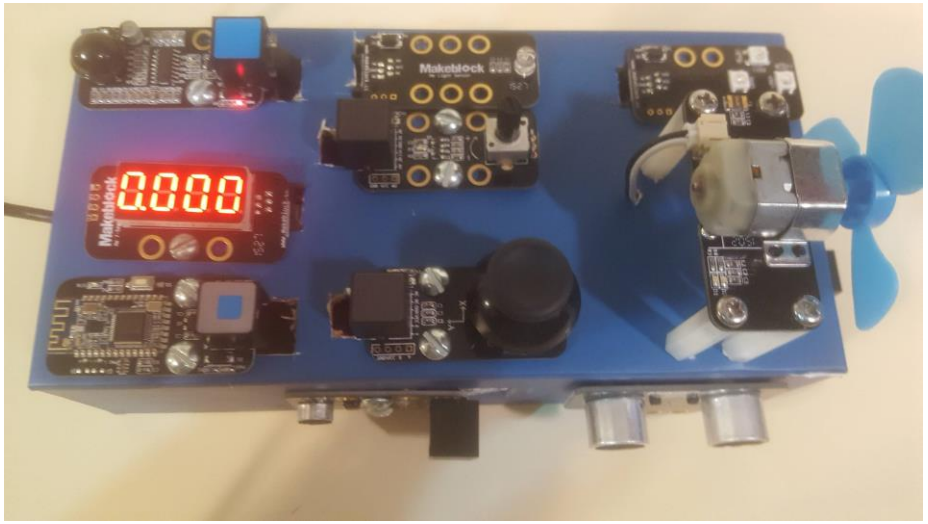



```
#include <Arduino.h>
#include <Wire.h>
#include <SoftwareSerial.h>

#include <MeOrion.h>

double angle_rad = PI/180.0;
double angle_deg = 180.0/PI;
double __var__98_111_111_108_32_114_101_97_100_105_110_103;
double reading;
MeDCMotor motor_9(9);
MePIRMotionSensor pir_6(6);
Me7SegmentDisplay seg7_4(4);

void setup(){
    __var__98_111_111_108_32_114_101_97_100_105_110_103 = 0;
    motor_9.run(255);
}

void loop(){
    reading = pir_6.isHumanDetected();
    seg7_4.display((float)reading);
    if(((reading)==( 1 ))){
        motor_9.run(0);
    }
    _loop();
}
```

Hands-On Project: Smart Fan



Fan Running, object detected.
PIR Motion Sensor value = Binary 1



Fan Stop Running.
PIR Motion Sensor value = Binary 0

Question 5

What logic function is being performed by the Smart Fan's safety feature?

a) The AND Gate

b) The OR Gate

c) The NOT Gate

d) None of the above