

TECHNOLOGICAL WORLD



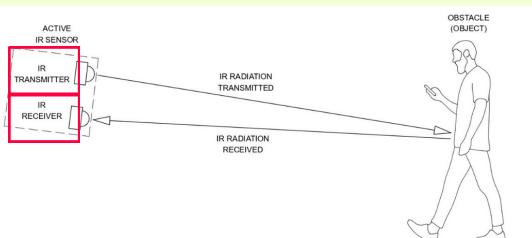
3.007 DTP II

Problem Statement:

What is the maximum range of detection of the Arduino Infrared (IR) Sensor for objects of varying surface areas?

Physics Concepts

The way IR sensors work in general is that they consist of an emitter and a receiver. The emitter emits infrared (IR) radiation towards a region, while the receiver detects the reflected IR radiation reflected/re-emitted from the initially emitted IR radiation by objects to determine the presence of an object in the IR sensor's view. The IR sensor feedbacks the that an object is being detected by flashing a second LED light. (The first LED light represents whether the IR sensor is being turned on or off)



The Arduino IR sensor allows the user to modify the intensity of the IR radiation being emitted by adjusting the **trimpot**, which in turn changes the range of detection of the Arduino IR sensor.

This is governed by the Inverse Square Law:

$$I = \frac{P}{4\pi r^2}$$

where:

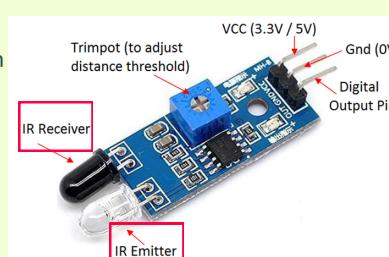
I is the intensity of the physical quantity
 r is the distance (radius) from the source

P is the power of the radiation source

Since intensity threshold (I) that indicates that an object is 'detected' is constant, when intensity of the emitted IR radiation increase, the intensity of the re-emitted IR radiation of the object increases (P).

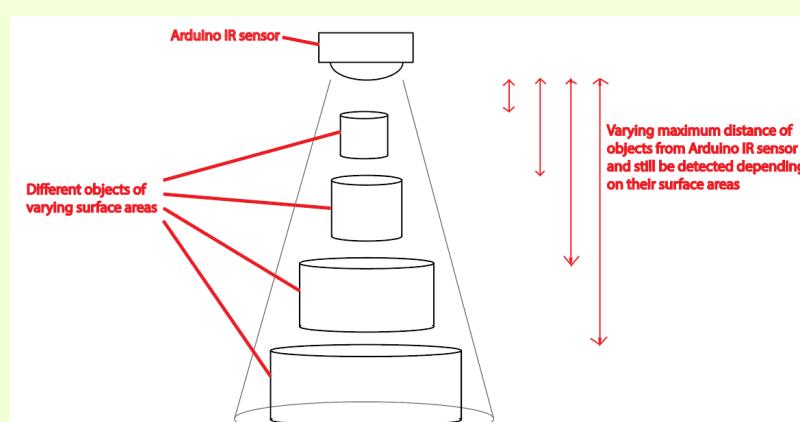
Hence, according to the Inverse Square formula, when intensity threshold (I) is constant and re-emitted IR radiation of the object increases (P), the distance (radius) (r) from the source (object) that can be detected by the Arduino IR sensor increases.

However, another factor that affects how far an object can be detected is its surface area, which is not answered by the Inverse Square Law. Hence, we will do the following experiment to help us find the relationship between the surface area of an object, and the maximum distance from the Arduino IR sensor where it can still be detected.



Experiment

To answer this question, we will test for objects of different surface areas, what is the maximum distance each of them can be placed away from the IR sensor and still be detected.



Assumptions

- Assume intensity of the emitted IR radiation by the Arduino IR sensor is set to maximum and is constant through all experiment measurements.
- Assume the material and geometry of the objects used are the same.
- Assume the surface area of the objects are of the shape of a circle.

Experimental Data

Radius (cm)	Surface area (cm²)	Maximum distance of object from Arduino IR sensor to be detected			
		Reading 1 (cm)	Reading 2 (cm)	Reading 3 (cm)	Average reading (cm)
1	2π	3.8	3.9	4	3.9
2	8π	6.5	6.4	6.6	6.5
3	18π	7.4	7.5	7.6	7.5
4	32π	8.5	8.7	8.6	8.7
5	50π	10	9.8	9.9	9.9
6	72π	11	10.9	10.8	10.9

Radius represents the radius of the circular object

Surface area represents the surface area of the circular object

Limitations

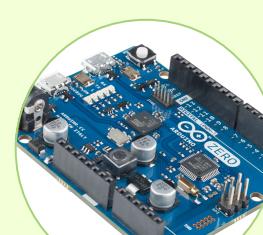
- The Arduino IR sensor can only detect the presence of an object in its range of detection, but not the exact distance of where the object is from the Arduino IR sensor
- The Arduino IR sensor cannot detect how many objects is in its range of detection.
- Different objects of different shapes, material and colour might have a different maximum range of detection (largest distance (radius)) and angle deviating from the axis of the IR sensor)

Functional Diagram



Arduino IR Sensor

Sense at a position using re-emitted IR radiation from objects to determine if there is someone/something there in the lift



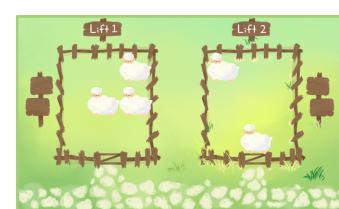
Arduino

Acts as the microprocessor to process the received signal by the Arduino IR sensor.



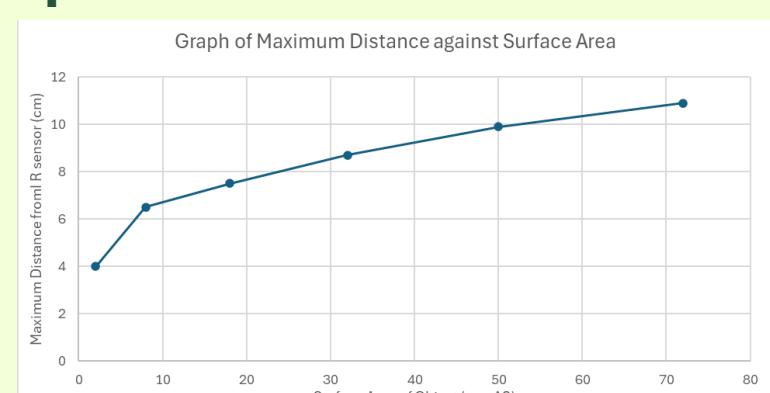
Display screen

Displays the informative display at the lift lobby, which shows the occupancy status of the lift (by showing at which areas of the lift is occupied).



Results of Experiment

From the experimental data we have collected, we can observe a relationship where as surface area increases, the rate of increase in maximum distance decreases, as the graph tends to a straight line.



Improvements

This experiment can be expanded and tested for objects of different materials, as the IR radiation reflectivity property of different materials affects the maximum distance of detection of the Arduino IR sensor for that particular object. This way, the maximum distance of detection can be found for various objects of different shapes and materials.