P. A. COLLEGE OF ENGINEERING

(Affiliated to Visvesvaraya Technological University & Recognized by AICTE)

Near Mangalore University, MANGALURU – 574153, KARNATAKA

A MINI-PROJECT REPORT

ON

"Distance Sensor GP2Y0A21YK0F"

Submitted in partial fulfilment of the requirements for

the degree of bachelor of engineering in

Computer Science & Engineering

for the course

Sensors and Signal Conditioning

of

6th Semester.

Submitted By

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CERTIFICATE

This is to certify that the Mini-project report work entitled **“Distance sensor GP2Y0A21YK0F”** is a bonafide work carried out by, **Mr. Mohideen Nazim,** bearing register number **4PA19CS062** in partial fulfilment of CIE for **Sensors and Signal Conditioning** (18EC652) in Department of Computer Science and Engineering of the Visvesvaraya Technological University, Belagavi during the year 2021 – 2022.

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CHAPTER 1

INTRODUCTION

1.1 General Description

GP2Y0A21YK0F is a distance measuring sensor unit, composed of an integrated combination of PSD (position sensitive detector) , IRED (infrared emitting diode) and signal processing circuit. The variety of the reflectivity of the object, the environmental temperature and the operating duration are not influenced easily to the distance detection because of adopting the triangulation method. This device outputs the voltage corresponding to the detection distance. So this sensor can also be used as a proximity sensor.

Fig 1.1 Sharp GP2Y0A21YK

The Sharp distance sensors are a popular choice for many projects that require accurate distance measurements. This IR sensor is more economical than sonar rangefinders, yet it provides much better performance than other IR alternatives. Interfacing to most microcontrollers is straightforward: the single analog output can be connected to an analog-to-digital converter for taking distance measurements, or the output can be connected to a comparator for threshold detection. The detection range of this version is approximately 10 cm to 80 cm (4″ to 32″).

CHAPTER 2

TECHNICAL SPECIFICATIONS

2.1 Functional Description

The GP2Y0A21 uses a 3-pin JST PH connector that works with our 3-pin JST PH cables for Sharp distance sensors. These cables have 3-pin JST connectors on one end and are available with pre-crimped male pins, pre-crimped female pins, and with unterminated wires on the other end. It is also possible to solder three wires to the sensor where the connector pins are mounted. When looking at the back, the three connections from left to right are power, ground, and the output signal

The connector power supply pins and an analogue output voltage pin (Vo). Output voltage can be read by microcontroller ADC. Figure 1 shows pin layout for the sensor. Obstacle distance can be calculated from output voltage using following equation:

$$Distance\ (mm) = 10 \times \left(\frac{147737}{Output\ voltage\ (mV) \times 10} \right)^{1.2134}$$

IR distance sensors output an analog signal, which changes depending on the distance between the sensor and an object. You can see that the output voltage of the SHARP GP2Y0A21YK0F ranges from 2.3 V when an object is 10 cm away to 0.4 V when an object is 80 cm away. The graph also shows why the usable detection range starts at 10 cm. Notice that the output voltage of an object that is 2 cm away is the same as the output voltage for an object that is 28 cm away. The usable detection range, therefore, starts after the peak at roughly 10 cm or 2.3 V.

2.2 Key Parameters

Function	Min	Nom	Max
Input Voltage	4.5VDC	5V	7VDC
Output Voltage	-0.3VDC	—	VIN + 0.3VDC
Sensing Range	10cm	—	80cm
Current	—	30mA	40mA
Operating Temperature	-10°C	—	60°C
Storage Temperature	-40°C	—	70°C
The frequency of updates/cycle	—	25 Hz/40 ms	—
Analog output noise	—	< 200 mV	—

Table 2.1 Parameter Specification

CHAPTER 3

DESIGN

3.1 Pin Configuration

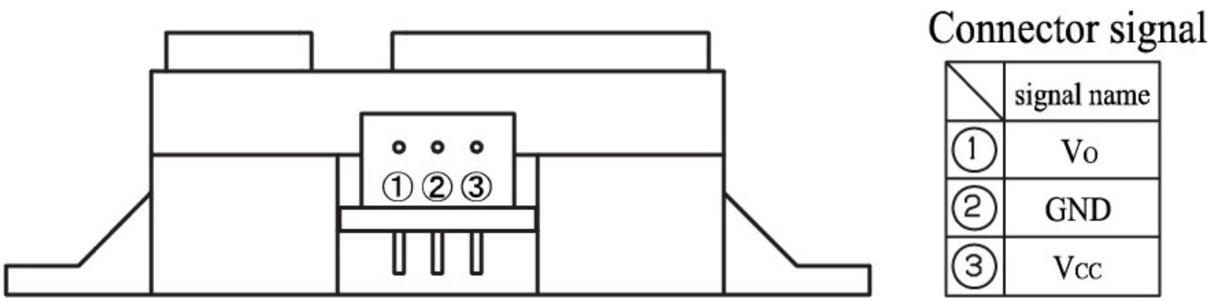

Fig 3.1 Pin Diagram

Pin No.	Name	Function
1	V_0	Output Voltage
2	GND	Ground
3	Vcc	Input voltage

Table 3.1 Pin Configuration

The GP2Y0A21 uses a 3-pin JST PH connector that works with our 3-pin JST PH cables for Sharp distance sensors (not included), as shown in the upper picture on the right. These cables have 3-pin JST connectors on one end and are available with pre-crimped male pins, pre-crimped female pins, and with unterminated wires on the other end

3.2 Block Diagram

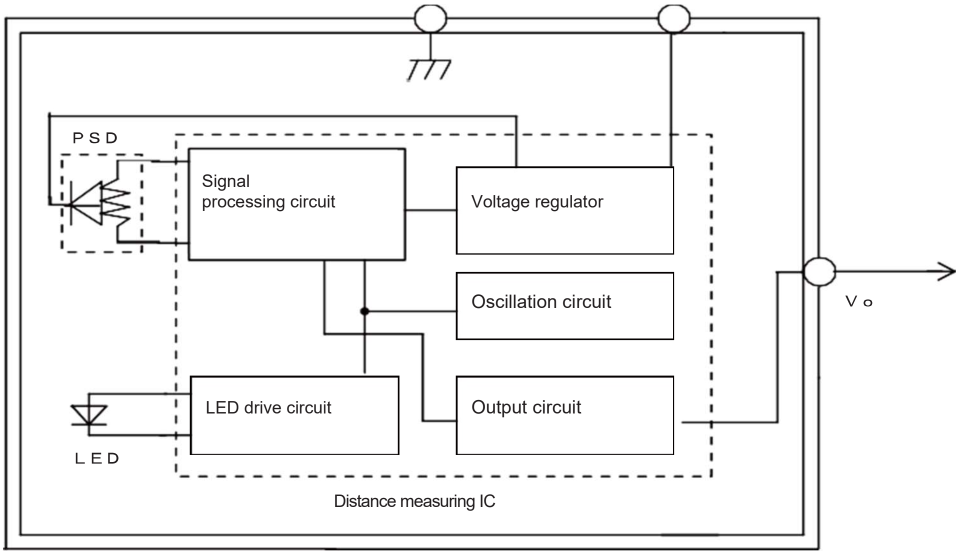

Fig. 3.2

3.3 Outline Dimensions

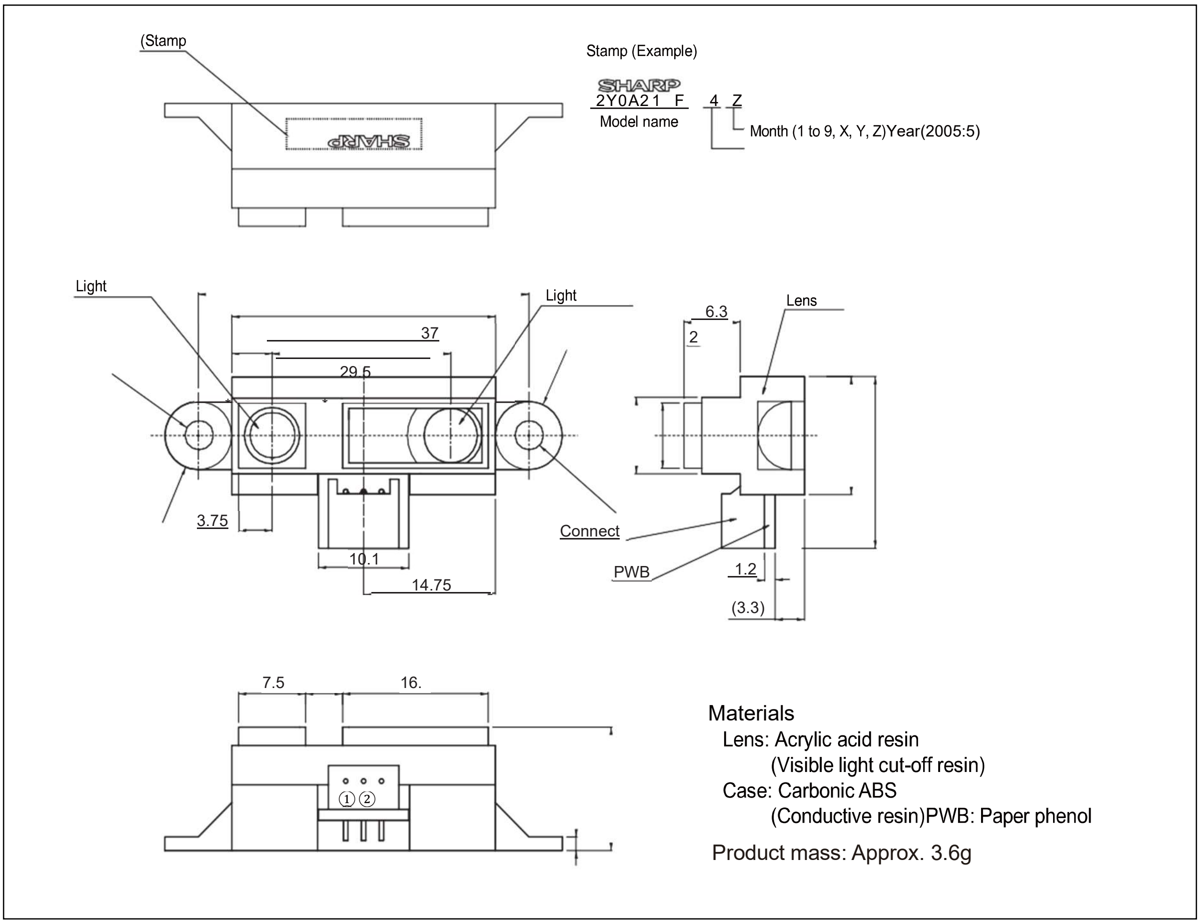

Fig. 3.3

CHAPTER 4

WORKING OF THE PROJECT

4.1 Working of the sensor

An IR distance sensor uses a beam of infrared light to reflect off an object to measure its distance. The distance is calculated using triangulation of the beam of light. The sensor consists of an IR LED and a light detector or PSD (Position Sensing Device). When the beam of light gets reflected by an object, the reflected beam will reach the light detector and an 'optical spot' will form on the PSD.

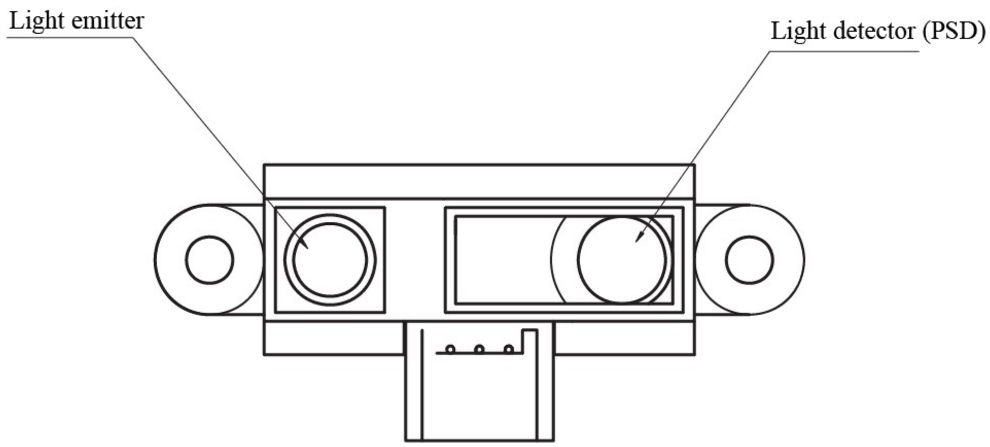

Fig 4.1.1

When the position of the object changes, the angle of the reflected beam and the position of the spot on the PSD changes as well. See point A and point B in the image below.

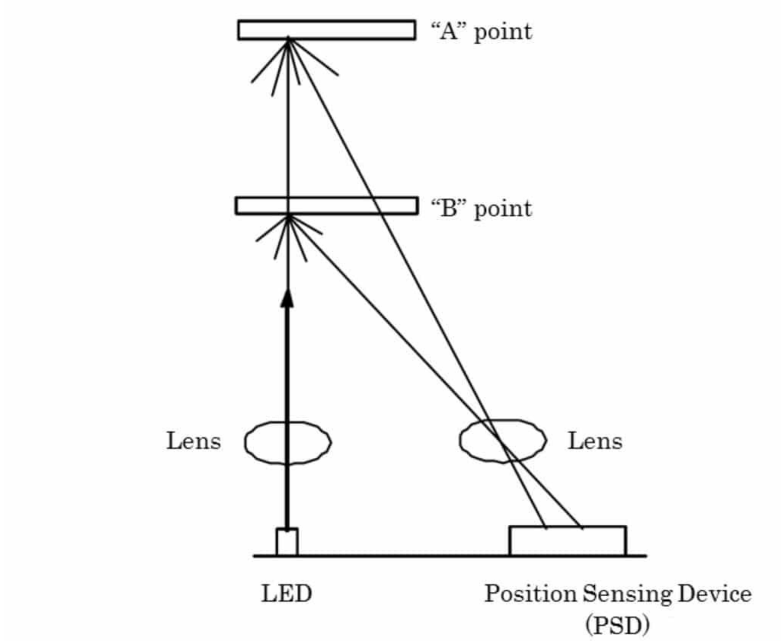

Fig 4.1.2

Note the change in the angle of the reflected beam and the position of the ‘optical spot’ on the PSD.

The sensor has a built-in signal processing circuit. This circuit processes the position of the optical spot on the PSD to determine the position (distance) of the reflective object. It outputs an analog signal which depends on the position of the object in front of the sensor.

4.2 Linearizing the output

The relationship between the sensor’s output voltage and the inverse of the measured distance is approximately linear over the sensor’s usable range. The GP2Y0A21YK datasheet (374k pdf) contains a plot of analog output voltage as a function of the inverse of distance to a reflective object. You can use this plot to convert the sensor output voltage to an approximate distance by constructing a best-fit line that relates the inverse of the output voltage (V) to distance (cm). In its simplest form, the linearizing equation can be that the distance to the reflective object is approximately equal to a constant scale factor (~27 V*cm) divided by the sensor’s output voltage. Adding a constant distance offset and modifying the scale factor can improve the fit of this line.

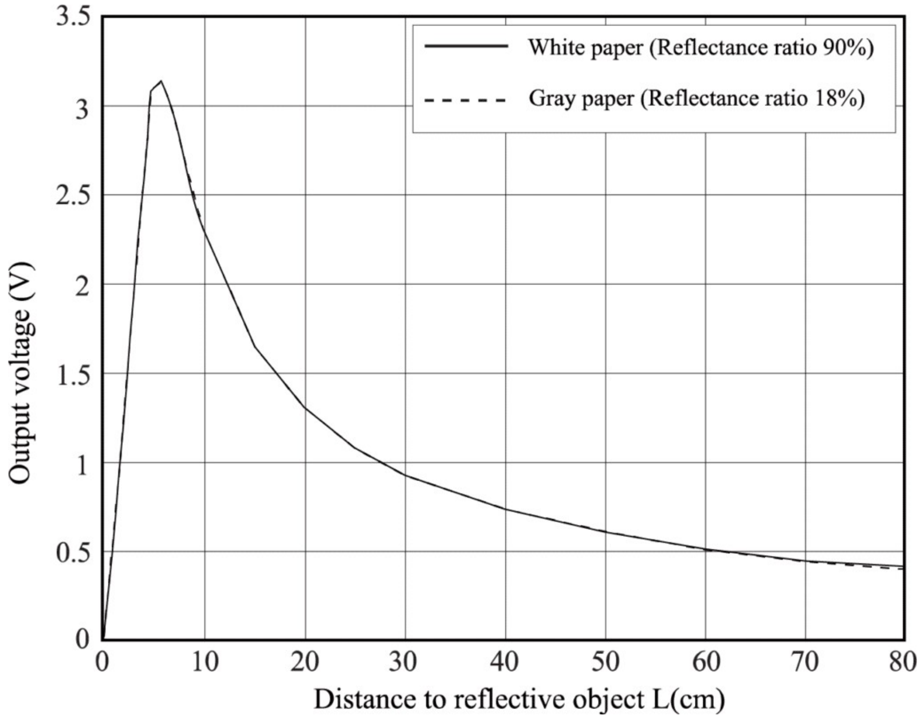

Fig 4.2

The graph also shows the drawback of these sensors, the response is non-linear. In other words, a big change in the output voltage does not always correspond to a big change in range. In order to determine the distance between the sensor and an object, you need to find a function that converts the output voltage into a range value.

4.3 Timing Chart

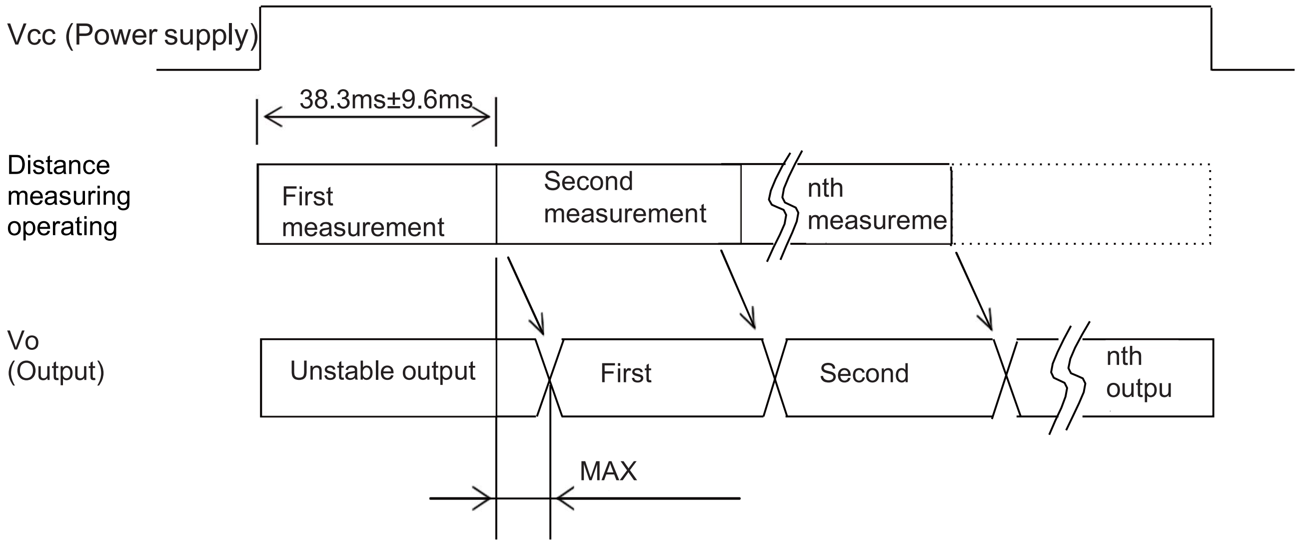

Fig 4.3

4.4 Distance Characteristics

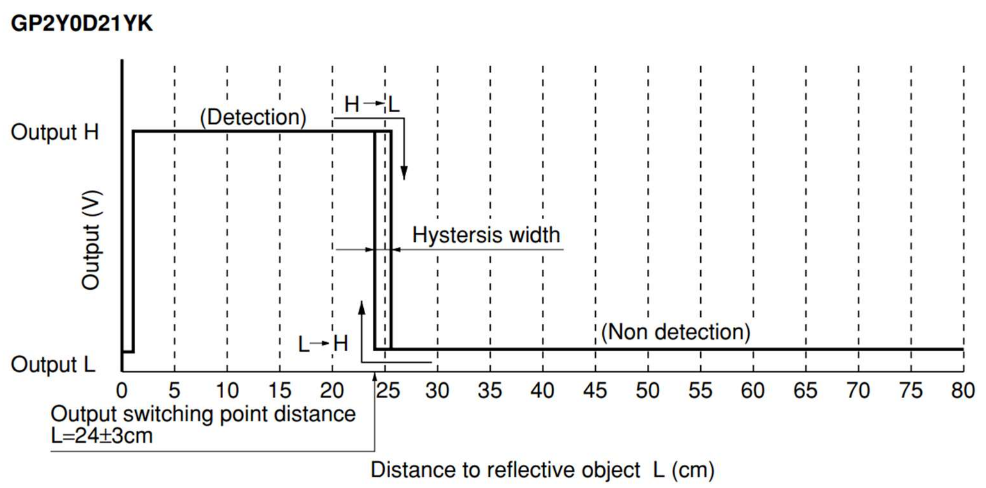

Fig 4.4

4.5 Distance sensor using GP2Y0A21YK

The Sharp proximity sensor can detect objects as close as 10 cm and as far away as 80 cm. It emits a pulse of infrared light and then detects the angle at which that light is reflected. The farther away an object is, the lower the output voltage. If the sensor receives no reflection, the output voltage of the sensor will be 0 V. If the object is 10 cm or closer, the output voltage will be equal to 5 V. (In this experiment, we are supplying 5V to the sensor.)

The sensor's output is connected to an Arduino analog input. The Arduino's analog-to-digital converter (ADC) then converts that value to a value between 0 and 1023. This value is then mapped to a value between 0 and 255, and that number is used to set the duty cycle of a pulse-width modulated output, which controls the brightness of the LED. The result is that the closer an object is to the proximity sensor, the brighter the LED will shine.

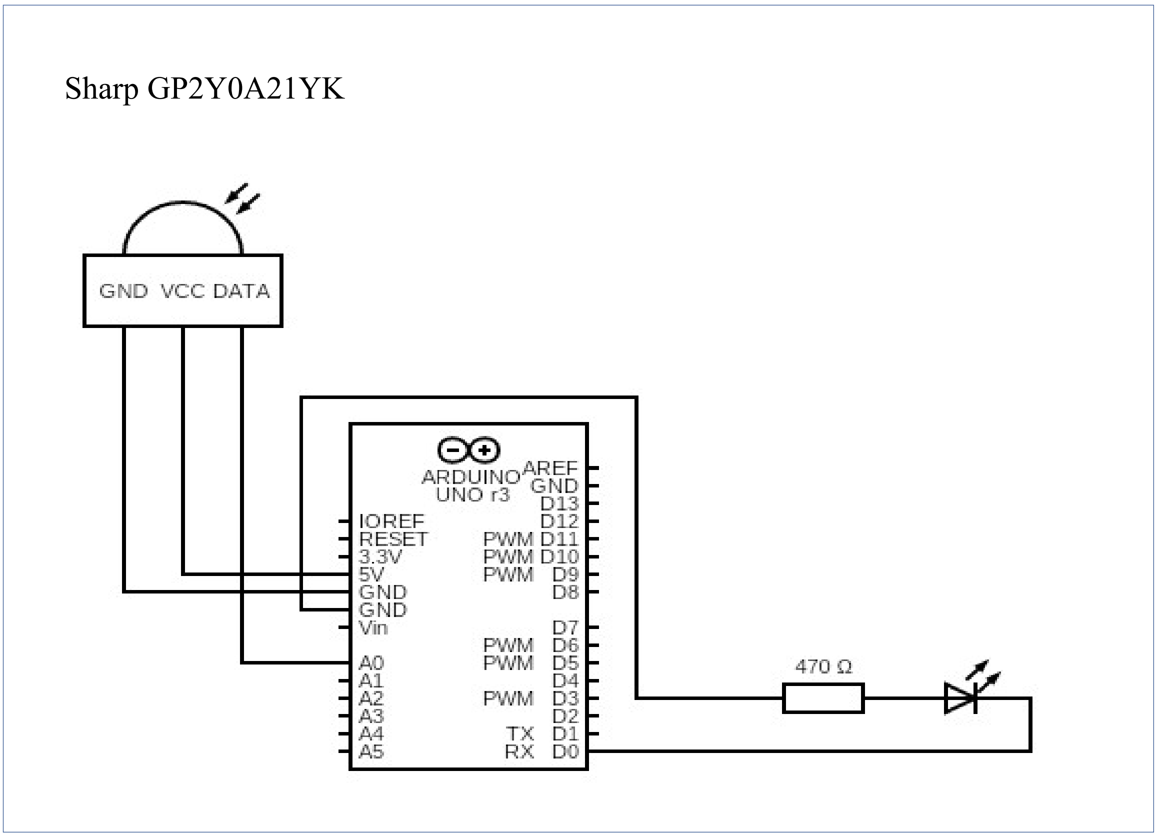

Fig 4.5.1 Circuit Diagram

4.6 Components Required

Hardware	Quantity
Arduino Mega2560	1
Sharp GP2Y0A21YK proximity sensor	1
LED	1
Jumper wires	5
470-ohm resistor	1
PCB Board	1

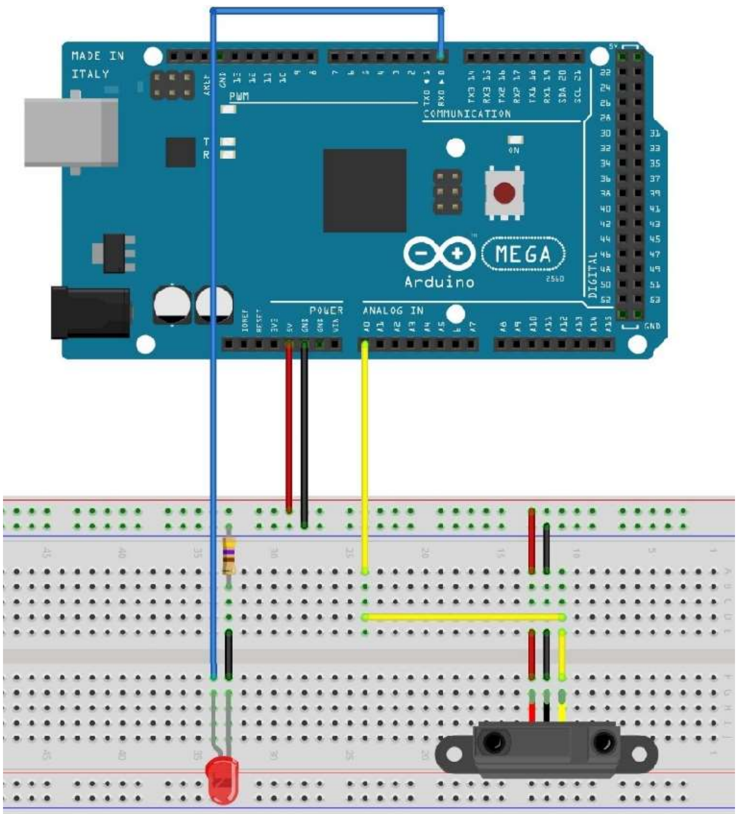

Fig 4.6.1 Component visualization

CHAPTER 5

IMPLEMENTATON

5.1 Typical Applications

(i) The devices in this publication are designed for use in general electronic equipment designs such as:

- Telecommunication equipment [terminal]
- Audio visual equipment
- Touch-less switch (Sanitary equipment, Control of illumination, etc.)
- Robot cleaners
- Sensor for energy saving (ATM, Copier, Vending machine)
- Amusement equipment (Robot, Arcade game machine.

(ii) Equipments that requires higher reliability such as:

Transportation control and safety equipment (i.e., aircraft, trains, automobiles, etc.)

- Traffic signals
- Gas leakage sensor breakers
- Alarm equipment
- Various safety devices, etc.

5.2 System compatibility

The GP2Y0A21YK has been designed for best possible fit into modern mobile consumer electronics devices. Besides the ultra-small footprint and very low power consumption, the GP2Y0A21YK has very wide ranges for V_{DD} and V_{DDIO} supply voltages.

CHAPTER 6

REFERENCES

1. The 2023-2028 **“World Outlook for Consumer Electronic Sensors”**
   -By Prof Philip M. Parker Ph.D.
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3. **Sensor Datasheets –** Sharp.com, alldatasheet.com/142549/SHARP/GP2Y0A21YK
4. **SHARP GP2Y0A21YK0F IR Distance Sensor with Arduino -Maker Guides**