

# Dust Sensor

SIRIWARDENA S.J.

*Department of Electrical and Electronic  
Engineering  
University of Peradeniya  
Srilanka  
[e19377@eng.pdn.ac.lk](mailto:e19377@eng.pdn.ac.lk)*

MAHANAMA M.G.S.U.

*Department of Electrical and Electronic  
Engineering  
University of Peradeniya  
Srilanka  
[e19233@eng.pdn.ac.lk](mailto:e19233@eng.pdn.ac.lk)*

SERASINGHE K.T.M.L.S.

*Department of Electrical and Electronic  
Engineering  
University of Peradeniya  
Srilanka  
[e19367@eng.pdn.ac.lk](mailto:e19367@eng.pdn.ac.lk)*

## I. INTRODUCTION

In present times, air quality is reduced steeply due to many reasons. Environmental dust is a major factor in reducing air quality. Combined particles of cigarette, fabric, broom and bunk etc. can be collectively referred to as environmental dust. To overcome the negative effect of dust on the environment, dust sensors can play a big role. Sensing dust can be advantageous in operating and maintaining fresh air systems. The main objective of this dust sensor is to sense the dust by a sensor module with a voltage output to detect changes in light amount to determine the state of the environment. The main aspects to reckon is the accuracy, Hysteresis, range, and response time. In addition, it should be lightweight, compact, and should be easy to install.

## II. LITERATURE REVIEW

There are lots of dust sensors that are developed for specific industries. For all these sensors the most used technology is optical technology. Mostly Optical measuring technology is used for a very long time in the industry. On the other hand, once the design is functional, incremental improvements can be done to meet new customer requirements. The available sensors are given below,

### A. GP2Y1010AU0F Compact Optical Dust Sensor

GP2Y1010AU0F is specially designed for residents and small factories. The dust sensor works by using laser scattering technology. The sensor can operate at the temperature range of -10°C to 65°C. and supply voltage range of 0.3V to +7V. GP2Y1010AU0F Compact Optical Dust Sensor provides highly accurate readings about dust concentration in the air.[1]



Fig. 1. GP2Y1010AU0F Sensor [1]

### B. PMS7003 Digital Universal Particle Concentration Sensor

PMS7003 is a kind of digital and universal particle concentration sensor, which can be used to obtain the number of suspended particles in the air. This is specially designed for residents and small factories. This sensor works by using laser scattering technology. The sensor can operate at the temperature range of -10°C to 60°C and supply voltage range of 4.5V to 5.5V.[2]



Fig. 2. PMS7003 Sensor [2]

### C. PM3006S Outdoor Laser Particle Sensor Module

The outdoor particulate sensor PM3006S uses laser scattering technology and is based on a linear light source. It is intended to measure the number of various particle sizes per unit volume and can simultaneously produce particle mass concentrations of PM1.0, PM2.5, PM10, and TSP in g/m<sup>3</sup>. This is accomplished using a mathematical method and scientific calibration. Built-in Cubic auto particle recognition technology allows for precise detection of ambient air quality from various dust sources.

The sensor can operate at temperature range of -30°C to 70°C and supply voltage 5V±0.1V [3]



Fig. 3. PM3006S Sensor[3]

### D. Nova PM Sensor SDS011

this is an optical dust sensor. in this type of sensor, An infrared emitting diode and a phototransistor are diagonally positioned close to the air intake within the optical dust sensor to enable it to detect the dust in the air. the scattered light sensed by the infrared emitting diode is transformed into a signal by a phototransistor and amplified by an amplifier circuit to detect the particle concentration. The size of the dust particles affects how much light is dispersed. this sensor can detect the particle concentration between 0.3 to 10µm in the air. typically works with 5V DC voltage and with a maximum of 100mA current.[4]



Fig. 4. SDS011 Sensor[4]

### E. ZH03B LASER DUST SENSOR MODULE

The ZH03B Laser Dust Sensor Module is a typical small-sized sensor that detects airborne dust particles using the laser scattering principle. It has high selectivity and stability. With UART output and analog output, it is simple to use. this works with 5V DC voltage and <120mA current and has response time of <45s. working humidity range is 0-80% RH

and the working temperature is -10 to 50 Celsius degrees. It is extensively utilized in portable instruments, air quality monitoring apparatus, air conditioners, ventilation systems, and smart home apparatus.[5]



Fig. 5. ZH03B Sensor[5]

### F. BAM 1020 Particulate Monitor

The BAM 1020 Particulate Monitor uses Beta Ray Attenuation. It is intended to measure the number of various particle sizes per unit volume and can simultaneously produce particle mass concentrations. The sensor can operate at the temperature range of 0°C to 50°C. This sensor provides highly accurate readings about dust concentration in the air.[6]



Fig. 6. BAM 1020 Sensor[6]

## III. METHODS

### A. Using Scattered Light

The air enters through the air inlet where a light source (Infrared emitting diode) illuminates the particles and the scattered light is transformed into a signal by a phototransistor. These signals are amplified by the amplifier circuit and then processed to get the particle concentration. The intensity of the scattered light depends on the dust particles. More the dust particles in the air, the greater will be the intensity of light. Output voltage at the VOUT pin of the sensor changes according to the intensity of scattered light.[7]

Based on the scattering principle of light, the working principle of the dust particle sensor was developed. The air enters through the air inlet where a light source (Infrared

emitting diode) illuminates the particles, and they scatter light when exposed to light. At the same time, they absorb some of the energy of the light that hits them. When a parallel beam of monochromatic light enters the field of the particle being measured, it will be affected by the scattering and absorption around the particle, and the light intensity will be weakened. Two different ways can be used to measure the output.[8]

1. Measuring the non-reflected light

If the dust concentration is at a low level, this method would be much better since non-reflected light intensity is high.

2. Measuring the reflected light

If the dust concentration is at a high level, reflected light intensity would be high. This method is better.

In this way, the relative attenuation rate of the incident light passing through the concentration field to be measured can be obtained. The relative attenuation rate can reflect the relative concentration of dust in the area to be measured almost linearly. According to the algorithm and calibration method, the dust concentration can be obtained by counting the real-time particle number concentration.

The structure consists of the following parts, its inner diagonal Settings have an infrared light-emitting diode and the phototransistor, infrared light-emitting diodes, and phototransistor optical axis intersection, when the airflow through the intersection area of the optical axis intersects with dust, dust reflected infrared light, phototransistor can detect the reflected/non-reflected light, the dirt in the air even can detect very small particles, such as tobacco smoke, receiving sensors detect the reflected light intensity, the reflected light intensity is proportional to the dust concentration, the output signal, according to the output signal intensity of dust concentration, through the output of different pulse width modulation signal to distinguish. [8]

The proposed design is given below,

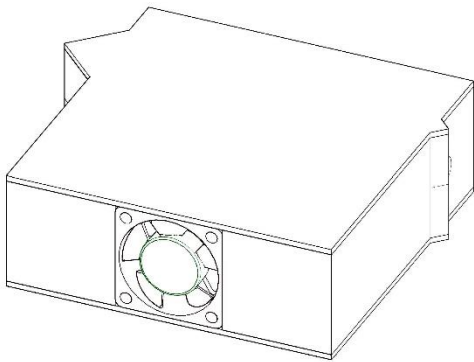


Fig. 7. Appearance Of The Proposed Design

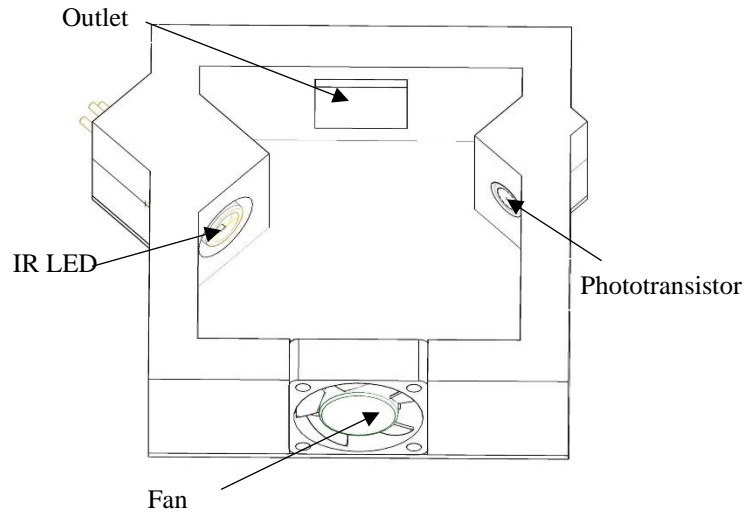


Fig. 8. Inside Of The Proposed Design



Fig. 9. Proposed Design (3D Rendered)

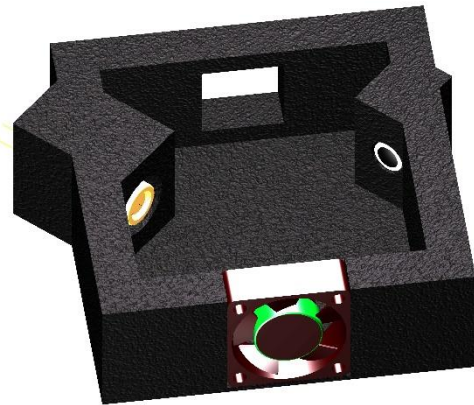


Fig. 10. Inside Of The Proposed Design (3D Rendered)

#### 1) Advantages

- Even very small particles can be detected.
- Low cost
- On-time dust concentration

#### 2) Disadvantages

- The dust has to enter the sensor

#### B. Using Beta Ray Attenuation

Measures pm 10 or pm 2.5 particles which are fine dust particles that are well proven to damage human health

At the roof of monitoring, an enclosure is the particulate size-selective inlet which captures particles which are smaller than pm 10. A large volume of air is pumped from a pump and smaller particles which are less than 10 microns in diameter are drawn gravimetrically onto a filter tape assembly. There, it separates the large coarse particulates and samples these smaller particulates that are smaller than pm 10. There will be measurements of beta attenuation at time intervals. More particulate matter settles on the tape during that time interval and fewer attenuation areas of the signal. The instrument is able to calculate the mass concentration of dust particles for that time interval.

#### 1) Advantages

- Compact size
- Simple to set up and minimal operator interaction
- Highly reliable data capture >95%

#### 2) Disadvantages

- Fairly expensive
- The radioactive source also limits the acceptance

## IV. SPECIFICATIONS

- Accuracy 0.1mg/m<sup>3</sup>

The main idea is to make the Dust sensor by using the Scattered Light method mentioned above in (A). This method was selected because of the simple structure and available resources. By using this sensor, it may be able to calculate the dust concentration in the air and the concentration of the various particle sizes that may be available in the air. Temperature and other environmental factors will also have to be considered.

## REFERENCES

- [1] pdf1.alldatasheet.com. (n.d.). GP2Y1010AU0F pdf, GP2Y1010AU0F Description, GP2Y1010AU0F Datasheet, GP2Y1010AU0F view :: ALLDATASHEET :: [online] Available at: <https://pdf1.alldatasheet.com/datasheet-pdf/view/412700/SHARP/GP2Y1010AU0F.html> [Accessed 8 Nov. 2022].
- [2] Digital universal particle concentration sensor PMS7003 series data manual. (2016). [online] Available at: [https://download.kamami.pl/p564008-PMS7003%20series%20data%20manua\\_English\\_V2.5.pdf](https://download.kamami.pl/p564008-PMS7003%20series%20data%20manua_English_V2.5.pdf).
- [3] en.gassensor.com.cn. (n.d.). Best Outdoor PM2.5 Dust Sensor - PM3006S | CubicSensors. [online] Available at: [https://en.gassensor.com.cn/ParticulateMatterSensor/info\\_itemid\\_241.html](https://en.gassensor.com.cn/ParticulateMatterSensor/info_itemid_241.html) [Accessed 8 Nov. 2022].
- [4] Laser PM2.5 Sensor specification Product model: SDS011 Version: V1.3. (2015). [online] Available at: <https://cdn-reichelt.de/documents/datenblatt/X200/SDS011-DATASHEET.pdf> [Accessed 10 Nov. 2022].
- [5] Laser Dust Module (Model: ZH03/ZH03A/ZH03B) Manual. (2016). [online] Available at: [https://www.winsen-sensor.com/d/files/air-quality/zh03-series-laser-dust-module-v2\\_0.pdf](https://www.winsen-sensor.com/d/files/air-quality/zh03-series-laser-dust-module-v2_0.pdf).
- [6] BAM 1020 Particulate Monitor Operation Manual -© BAM 1020 PARTICULATE MONITOR OPERATION MANUAL BAM 1020-9800 REV W. (n.d.). [online] Available at: <https://metone.com/wp-content/uploads/2019/05/BAM-1020-9800-Manual-Rev-W.pdf>.
- [7] Components101. (n.d.). Optical Dust Sensor - GP2Y1010AU0F. [online] Available at: <https://components101.com/sensors/optical-dust-sensor-pinout-features-applications-working-datasheet#:~:text=Optical%20Dust%20Sensor%20%2D%20Overview&text=As%20mentioned%20earlier%2C%20it%20works> [Accessed 10 Nov. 2022].
- [8] www.luftmy.net. (n.d.). The working principle of dust particle sensor is briefly introduced | PM2.5 sensor - LUFTMY. [online] Available at: <http://www.luftmy.net/sensor-news-273.html> [Accessed 10 Nov. 2022].