A Review on Novel Design of Routine Digital Spirometer Flow Sensors
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Abstract—Spirometer measures the amount of volume and flow rate of air that is inhaled & exhaled. Spirometer is a noninvasive diagnostic instrument. This paper represents the comparison of three different spirometer sensor designs. 1st design of spirometer sensor is made up with using Infra-Red Transmitter – Receiver. 2nd design is made up by using LED (Light Emitting Diode) – LDR (Light dependent resistor) pair as visible light Transmitter – Receiver. 3rd design uses differential pressure sensor which senses difference in air flow pressure.

Key words: Spirometer Flow Sensors, LED-LDR PAIR

I. INTRODUCTION

These sensors are made to design the digital spirometer with PC interface. Spirometry takes measurements of the quantity of air inhaled & exhaled by the lungs during a certain period of time to determine the pulmonary capacity. The spirometry test includes parameters like MEF (Maximum Expiratory Flow), FEV1 (Forced Expiratory Volume in 1 sec.), FVC (Forced Vital Capacity), Forced Expiratory flow at 25% (FEF25%). The spirometer is the ideal instrument for pulmonary the function test that allow the analysis, determination and monitoring of lung diseases like COPD (Chronic Obstructive Pulmonary Disease), asthma, respiratory bronchitis etc.

The sensor made up of Infra-Red transmitter-receiver gives output in terms of square pulses. These square pulses count can be converted in to air flow rate and volume. The sensor design using LED-LDR pair gives pulses which then be counted and can be calculated to measure flow rate and volume of air. Differential pressure based spirometer sensor measure the pressure differences between inlet and outlet pressure port. This sensor outputs in terms of voltage which is proportional to pressure difference ranges from -7 KPa to +7 KPa.

II. SENSOR DESIGN

A. Flow Sensor Using Infra-Red Transmitter Receiver

Infra-Red transmitter-receiver pair is made using 555 timer, Infra-Red LED, & TSOP38 Infra-Red receiver. Everybody in this world emits IR rays. Here TSOP1738 IR detector is used because very rare natural body emit IR rays of 38 KHz.TSOP1738 is 3 pin IC having Vcc, GND & output. It uses 5 volt power supply & its output can be directly connected to microcontroller or microprocessor. The PCM (Pulse Code Modulation) frequency of TSOP1738 is 38 KHz, so for that I have to design an astable multivibrator of 38 KHz using 555 Timer IC.

B. Flow Sensor Using LED-LDR Pair:

This type of sensor is designed using visible LED & LDR. LDR is a light dependent resistor which gives change in resistance when exposed to light. Resistance of LDR decreases with increase in light intensity. The dark resistance (resistance of LDR in darkness) is in the range of few mega ohms. The spectral response of LDR depends on the wavelength of visible spectrum. LDR gives high response having wavelength ranges 530 nm to 560 nm. Green visible light have wavelength range of 495nm to 570 nm which cover the highest spectral response range of LDR hence it would be better to use green visible light LED.

1) Block Diagram:
Visible LED is driven by 5 volt power supply and it is a green light LED. LDR is also driven by 5V power supply. Inside LDR circuit, LDR is connected to a transistor which is working as a switching devise. Transistor switching is depends on light falls on LDR or LDR is in darkness. When fan of rotating wheel is in between LED & LDR, LDR is in darkness & at that time transistor is in OFF condition. The output of transistor is given to DSO.

C. Flow Sensor using Differential Pressure Sensor:

For the design of this flow sensor integrated differential pressure sensor MPXV7007DP [2] of Freescale is used. It measures differences in pressure (-7 KPa to +7 KPa) & gives output in terms of voltage (0 to 5V) which is equivalent to the pressure difference. 

1) Block Diagram:

This flow sensor consists of one hollow tube having capillary type resistor between inlet & outlet of air flow. Pressure at port P1 is higher than the Pressure at port P2 which is created by the resistance between inlet & outlet & is measured by the integrated differential pressure sensor.

III. RESULTS & DISCUSSION

Fig. 3: Block Diagram of Flow Sensor using Differential Pressure Sensor

In the fig. 3.1, the output graph of IR flow sensor is shown. The yellow color pulses is IR transmitter pulses & green color pulses is output of monostable multivibrator for full exhalation. There are about 8-10 pulses.

Fig. 4: Output of Flow Sensor using IR light

In the fig. 3.2, the pulses for a complete one exhalation.

Fig. 5: Output of Flow Sensor using LED - LDR

The graph showed in fig. 3.2 is the pulses for a complete one exhalation.

Fig 6: Output of Flow Sensor using Differential Pressure Sensor

In the fig. 3.3 the negative & positive peak are for inhalation & exhalation respectively.

IV. CONCLUSION

The IR based flow sensor has one biggest advantage is that it is not affected by ambient light but has one drawback is that it gives too much less count pulses (8 to 10) for a complete one revolution which is very less for further calculation.

The LED – LDR based flow sensor solve the problem faced by IR based flow sensor that it has more count pulses which ranges 80 to 90 pulses per one exhalation which is better for further signal processing. But this sensor is too much sensitive to ambient light so as to be placed in darkness & also it is difficult to calibrate.

The differential pressure type pressure sensor works on different principle than other two sensors. It measures pressure difference between two ports and gives voltage out equivalent to pressure difference. One biggest advantage is that it is internally calibrated & also has temperature compensation over 0ºC to 85ºC.

REFERENCES

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