REVIEW ON DESIGN, ANALYSIS AND IMPLEMENTATION OF SPIROMETER

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ABSTRACT

Pulmonary diseases are major causes of ill-health throughout the world. Pulmonary infection such as acute bronchitis and pneumonia are common. The diagnosis of these diseases is facilitated by pulmonary parameter analysis using spirometer which has many limitations such that analog or mechanical devices does not have that accuracy and provision to store the data for further investigation. In electronic spirometer we cannot get inspiratory parameters. The quantitative measurement and permanent record of the diagnosed diseases is difficult. The computerized methods for recording and analysis of the respiratory parameters may overcome some of limitations of conventional Spirometry. An analysis of inspiratory parameters may quantify the changes in different respiratory conditions in various diseases. The use of modern digital signal processing technique may lead deep insight to get related diagnostic information.
Spirometer needs forceful exhalation and inspiration. For accurate measurement there should be minimum resistance to the exhaled or to be inspired air by the transducer. Hence the designing must involve aerodynamic study of the sensor.

Keyword: - *Pulmonary, Spiromete, Transducer, and Aerodynamic*

1. INTRODUCTION

Spirometry is a simple and widely used lung function test. A spirometry is a test that measures airflow when we breath and that can show possible abnormalities in the airways and lung tissue. When a spirometry test is performed, the subject breathes through a mechanical or electronic airflow sensor called a spirometer.[1]

The sensor has to be aerodynamically designed such that no air resistance is due to sensors inner wall and internal structure and the total amount of air should directly fall on propeller of turbine. As the spirometer is used to estimate lung volume and vital capacity. It is essential to utilize complete exalt air and inhalation without an obstruction.[2]

Transducer selection for spirometer: For detecting air flow, transducer used was fan with parallel axis of rotation with air flow; USB port was used for power source. The previous transducer is shown in below Fig.1

In BMI lab at MGMCET, Mumbai hardware less Spirometer was developed by using cold drink bottle and fan was developed by Mr. Bipin Mokal (2012). [2]

Fig -1: Previous Parallel axis transducer design

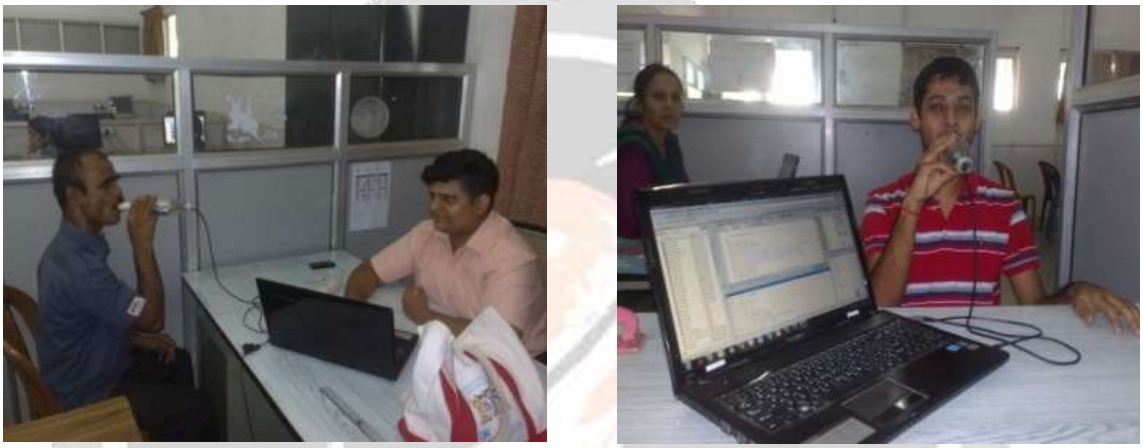

Fig -2: Respiration parameter analyser developed by Mr. B D Mokal [2]

1.1 Respiration Indices

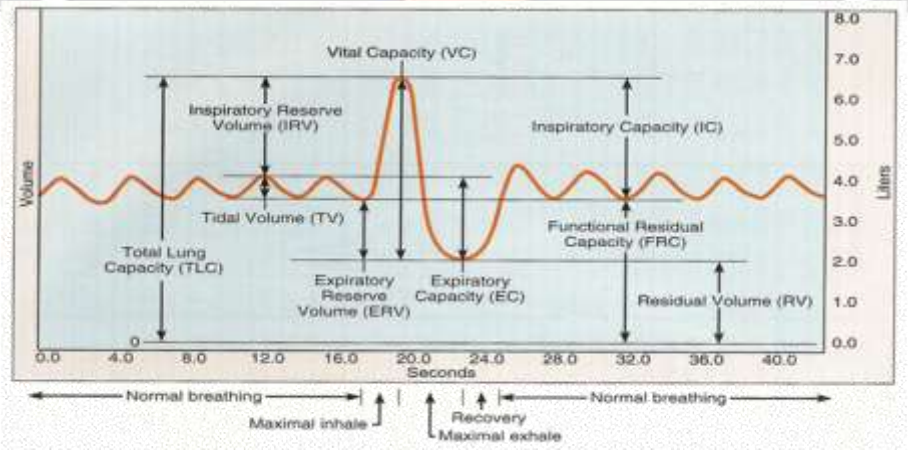

Fig -3: Respiration Indices Diagram [2]

- **Total Lung Capacity =** Inspiratory Reserve Volume (IRV) + Tidal Volume (TV) + Expiratory Reserve Volume (ERV) + Residual Volume (RV)
- **Vital Capacity =** Inspiratory Reserve Volume (IRV) + Tidal Volume (TV) + Expiratory Reserve Volume (ERV)
- **Inspiratory Capacity =** Inspiratory Reserve Volume (IRV) + Tidal Volume (TV)
- **Functional Residual Capacity =** Expiratory Reserve Volume (ERV) + Residual Volume (RV)

1.2 Patient Preparation

- Comfortable, loose clothing
- Avoid eating a substantial meal within 2 hours of testing
- Avoid vigorous exercise within 30 minutes of testing.

1.3 Type Of Spirometer

Spirometry is one of the primary Pulmonary Function Tests (PFT) used to check the health of the lungs and respiratory passageways. When a spirometry test is performed, the subject breathes through a **mechanical** or **electronic** airflow sensor called a spirometer.

- Incentive or Theraptic spirometer
  1. Volume type
  2. Flow type
- Diagnostic spirometer

2. RESEARCH METHODOLOGY

Earlier project was designed as a prototype to prove the concept of measurement lung volume capacity by using air turbine. But the project was made using available recourses and no mechanical design was done concerning aerodynamic study. Hence we are design the project by considering aerodynamic and proper mechanical design to improve the accuracy and usability of the project. Further it can be used as a complete medical equipment – Hardware less spirometer to meet patient comfort and useful for accurate diagnosis.

To overcome the said problems, the computerized mechanical designed can be made and analyze by using different design and analysis software's. After final analysis the computerized 3-d print of design model can be obtain and implement to complete the innovative product.

2.1 Design

In spirometer as shown in Fig. 1.1, the respiration signal is picked up from subject's mouth with nose clip applied on the nose. This signal is fed to the computer for conditioning. After analyzing the signal the report is generated and fed to printer for printing. [2]

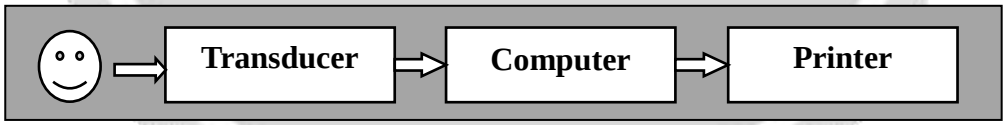

Fig -4: Block diagram of spirometer

2.2 Electronic Circuit For Transducer

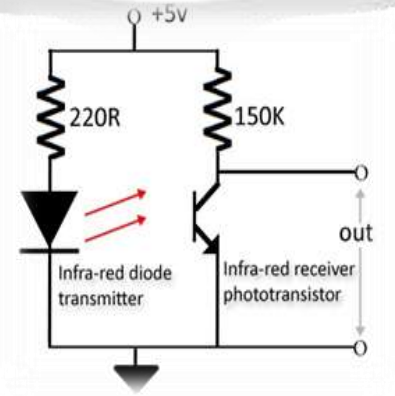

Fig -5: Circuit diagram of sensor

The circuit above is based on using a matched Infra-red Diode Transmitter/Receiver pair. We have taken an optocoupler and separated the two halves of it to be used as transmitter and receiver these are placed on either side of the fan blades. Hence when blade rotates it cuts the infra-red beam falling on the receiver causes digital output.

2.3 Proposed Design

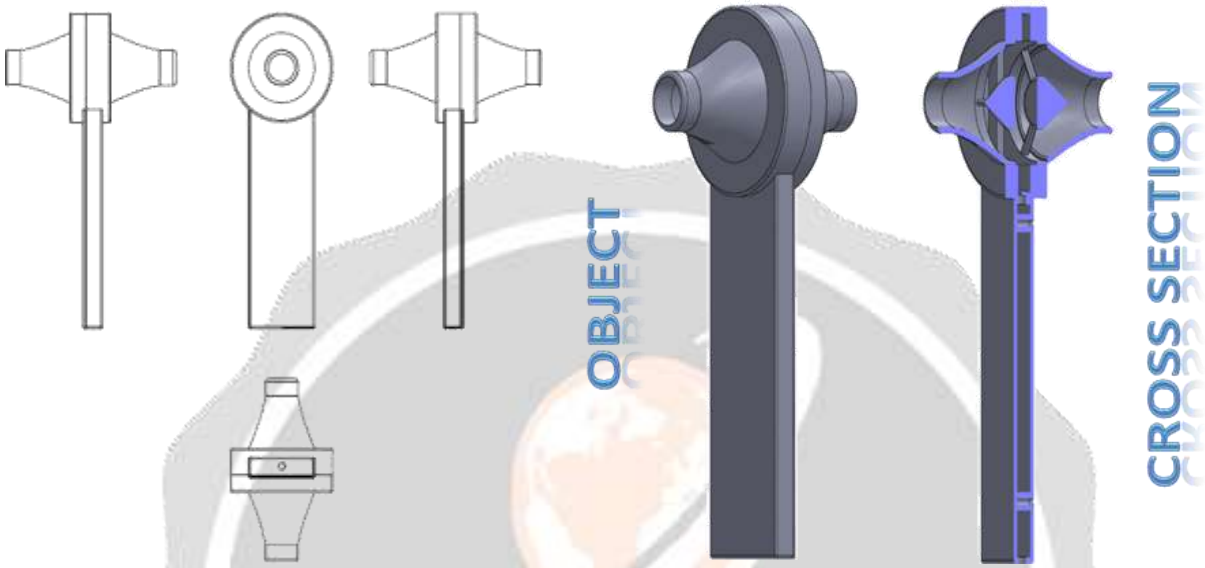

Fig -6: Assembly drawing

3. CONCLUSIONS

The previous transducer developed is having some drawbacks which reduces accuracy as there is flat surface in the middle of fan causing resistance to air inhaled and exhaled. It is difficult to hold the transducer in hand as there is not grip on the transducer. Cables in the output of transducer cause additional obstacle to air causing inaccuracy in the result.

To overcome the said problems, the computerized mechanical designed can be made and analyze by using different design and analysis software's. After final analysis the computerized 3-d print of design model can be obtain and implement to complete the innovative product.

All these issues can be overcome with redesigning the transducer considering mechanical, aerodynamic and maneuverability to make the equipment user friendly and patient supporting.

4. REFERENCES

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