Measurement of Respiratory Rate Using Peizoelectric sensor

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ABSTRACT- *Respiratory rate is an essential parameter in the clinical monitoring of hospital patients. It can be measured in various ways, such as by recording chest movements, breathing flow or heart rate variations. Current sensor technology allows the development of new kinds of convenient and portable respiratory rate recorders, including smart shirts, which enable more efficient healthcare processes in hospitals. Nowadays Rs232 compatible system suffers from following problem like short distance, speed and availability. In our project we implement USB based Respiratory Rate Monitoring so it will overcome the above said problems. This project carried out respiratory rate measurements using a respiratory sensor. An 8 bit analog to digital converter is used for converting the analog data into digital. The digitized data is then transferred to the PC using USB. Application software is provided .To monitors the real time trend of the respiratory parameter. Provision is also given for saving the data for further analysis and investigation.*

Keywords- **Peizoelectric sensor, Respiratory rate, ADC, USB**

1. INTRODUCTION

Breathing takes oxygen in and carbon dioxide out of the body. Aerobic organisms require oxygen to create energy via respiration, in the form of the metabolism of energy-rich molecules such as glucose. The medical term for normal relaxed breathing is eupnea. Breathing is only part of the processes of delivering oxygen to where it is needed in the body and removing carbon dioxide waste. The process of gas exchange occurs in the alveoli by passive diffusion of gases between the alveolar gas and the blood passing by in the lung capillaries. Once in the blood the heart powers the flow of dissolved gases around the body in the circulation.[1-2].As well as carbon dioxide, breathing also results in loss of water from the body. Exhaled air has a relative humidity of 100% because of water diffusing across the moist surface of breathing passages and alveoli[3-5].

Mechanics

In mammals, breathing in, or inhaling, is usually an active movement, with the contraction of the diaphragm muscle. This is known as negative pressure breathing. Normally, the diaphragm's relaxed position recoiled (decreasing the thoracic volume) whereas in the contracted position it is pulled downwards (increasing the thoracic volume)[6-7]. This process works in conjunction with the intercostal muscles connected to the rib cage. Contraction of these muscles lifts the rib cage, thus aiding in increasing the thoracic volume. Relaxation of the diaphragm compresses the lungs, effectively decreasing their volume while increasing the pressure inside them. The intercostal muscles simultaneously relax, further decreasing the volume of the lungs. With a pathway to the mouth or nose clear, this increased pressure forces air out of the lungs. Conversely, contraction of the diaphragm increases the volume of the (partially empty) lungs, decreasing the pressure inside, which creates a partial vacuum. Environmental air then follows its pressure gradient down to fill the lungs.In amphibians, the process used is positive pressure breathing. Muscles lower the floor of the oral cavity, enlarging it and drawing in air through the nostrils (which uses the same mechanics - pressure, volume, and diffusion - as a mammalian lung). With the nostrils and mouth closed, the floor of the oral cavity is forced up, which forces air down the trachea into the lungs[8].At rest, breathing out, or exhaling, is a combination of passive and active processes powered by the elastic recoil of the alveoli, similar to a deflating balloon, and the contraction of the muscular body wall. The following organs are used in respiration: the mouth; the nose and nostrils; the pharynx; the larynx; the trachea; the bronchi and bronchioles; the lungs; the diaphragm; and the terminal branches of the respiratory tree, such as the alveoli.

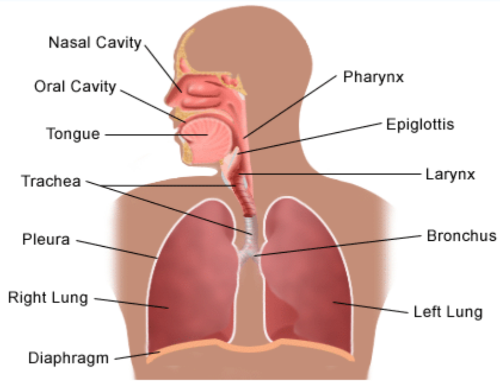


Fig 1. PIEZOELECTRIC SENSOR

Piezoelectric sensors are used to sense movement or vibrations in many applications. A piezoelectric sensor comprises a piezoelectric crystal which is typically mechanically coupled to an object which produces a mechanical movement. In piezoelectric materials, an applied electric field results in elongations or contractions of the material. Piezoceramic actuators are therefore able to convert electric energy directly into mechanical energy and offer several advantages, such as high actuating resolution, high actuating power and very short response times, while their size is small. Piezoelectric sensors for converting slight vibrations and stress of objects under measurement into electric signals with the piezoelectric effect of their materials find applications in various fields. Piezoelectric sensors are used as transducers because a potential difference is generated when the sensor is subject to a pressure change. A detection system is electrically coupled to the piezoelectric sensor and senses, for example, that a vehicle has passed over the sensor.

2. MATERIALS AND METHODS

Piezoelectric sensors have proven to be versatile tools for the measurement of various processes. They are used for quality assurance, process control and for research and development in many different industries. The rise of piezoelectric technology is directly related to a set of inherent advantages. The high modulus of elasticity of many piezoelectric materials is comparable to that of many metals and goes up to 105 N/m². Even though piezoelectric sensors are electromechanical systems that react on compression, the sensing elements show almost zero deflection. This is the reason why piezoelectric sensors are so rugged, have an extremely high natural frequency and an excellent linearity over a wide amplitude range. Additionally, piezoelectric technology is insensitive to electromagnetic fields and radiation, enabling measurements under harsh conditions. Some materials used (especially gallium phosphate [2] or tourmaline) have an extreme stability over temperature enabling sensors to have a working range of up to 1000°C.Measurement of respiratory rate is shown in figure 2

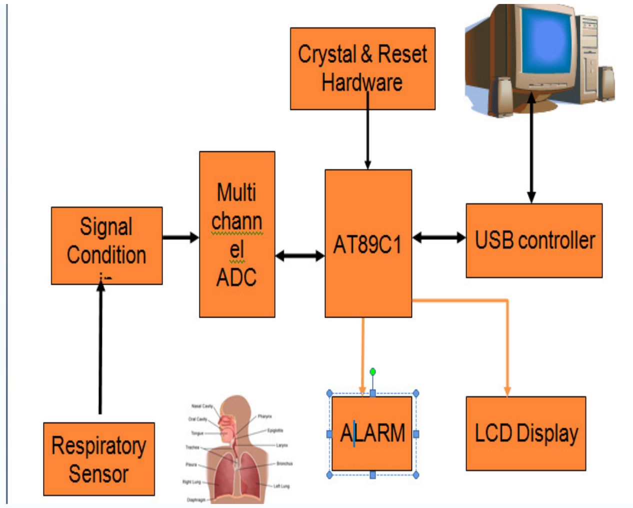


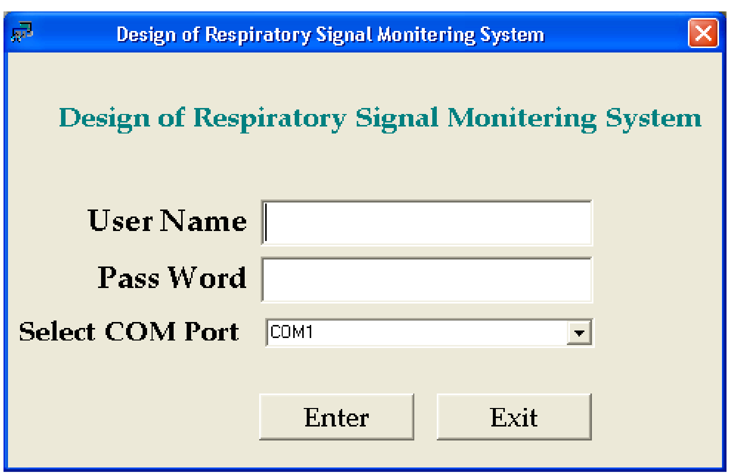
Figure 2. Block diagram of respiratory rate measurement

The aim of this project is to implementation USB based respiratory monitoring system using piezoelectric sensor. An appropriate embedded hardware for generating biological signals are developed by using AT89C51 and it is interfaced to PC through RS323.Application software for designing the specific waveforms and device drive for the hardware is developed.

- Embedded Processor : AT89C52
- PC Interface : USB
- Sensor : Respiratory sensor
- ADC : ADC0804
- Embedded Firmware : Embedded 'C' - Kiel IDE.

2. RESULTS &DISSCUSSION

The measurement of respiratory rate is measured in following procedure. The sensor is placed in patient chest due to patient respiration the sensor will convert the mechanical signal into electrical signal.



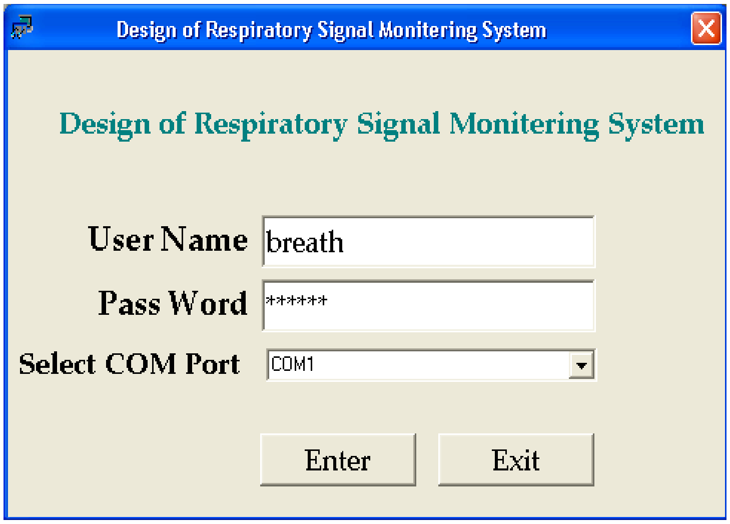


Fig 3. shows the patient details

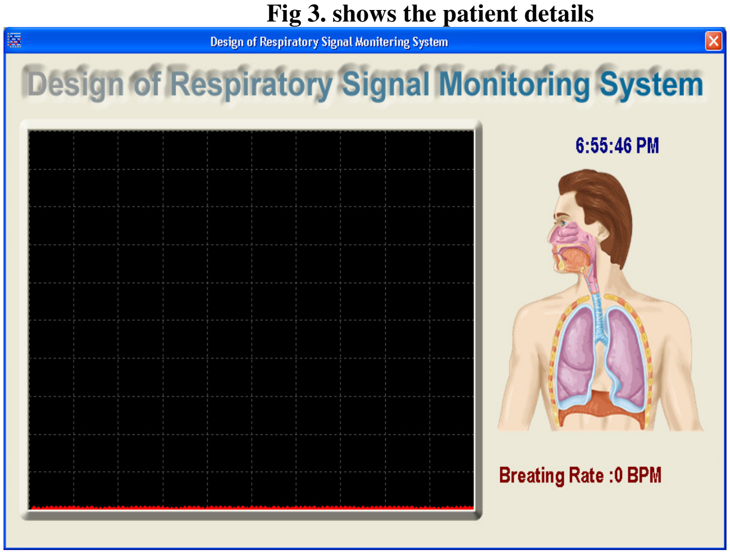


Fig 4. Breathing measuring software.

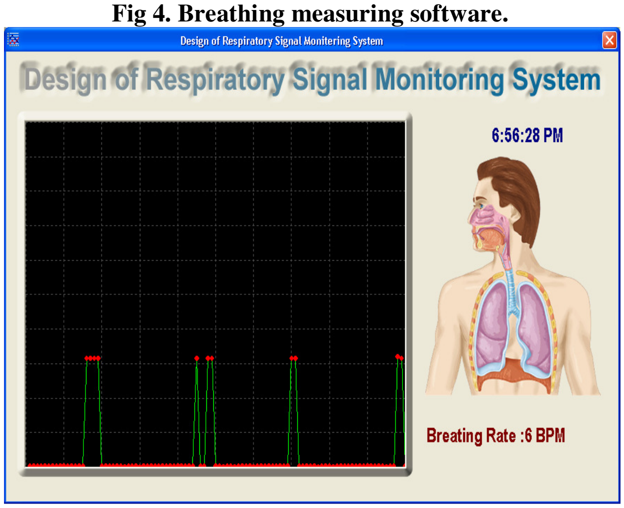


Fig 5. Respiratory rate valueusing peizoelectric sensor.

3. CONCLUSION

The design and implementation USB based respiratory signal monitoring system Project has been very successful in proving that measuring the respiratory rate of the patient accurately. Our large degree of accomplishment shows that a project of this sort can be completed to the given specification. The proposed model is simple and easy to handle for measurement of respiratory rate for patient. The respiratory rate values were obtained at equal intervals and displayed in the monitor .The system was achieved using USB cable, thus increasing the scope of the project.USB method proved to be very useful, easy and very compatible with any personal computer, thus can be used universally.

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