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Title of Thesis **DESIGN AND DEVELOPMENT OF COMPUTER BASED BIOPHYSICAL MODEL FOR DIAGNOSING PULMONARY EDEMA**

Abstract

In the area of clinical diagnosis a physician always depends on the technology, instrumentation and engineering principles to be surer about their opinion. In present scenario diagnostics, health treatments and critical care is solely depending upon advance technology based systems and equipments. It is also necessary to point out that clinical diagnostics prefers to rely on non-invasive methods. Some disease requires diagnosis in early stages, rapid and continuous monitoring, and one such disease i.e. Pulmonary Edema is considered in this work. The objective of this research is to save and help mankind by collaborating the two essentials, medicine and technology to develop new tools for the development of healthcare and monitoring systems. This work is focused to design a computer based, fast and reliable system which should be able to diagnose Pulmonary Edema quickly and quantitatively.

The need of clinical measurements incorporating diagnosis to prognosis is emphasized and the importance of non-invasive measurements in clinical applications is discussed. Brief descriptions on the survey of literature for the diagnosis of pulmonary edema with and without involving computer based systems are highlighted in the introductory chapter. A little light is also thrown on the software LabVIEW. In second chapter two important aspects of the disease 'Pulmonary Edema' are unfolded. The first is physiological aspect in which the physiology of the involved organ especially lungs in terms of the focused disease is discussed. Definition causes and symptoms of Pulmonary Edema are explained. Various types of Pulmonary Edema are also described briefly. In the second aspect the electrical impedance analysis of Pulmonary Edema is described. Secondly principle of electrical impedance technique and measurement of impedance of thorax are taken up. In preceding section the transthoracic electrical impedance is predicted by using empirical relations based on anthropometric dimensions of thoracic area. The predicted values of transthoracic electrical impedances are compared with the previously reported data to validate the current technique and software approach using LabVIEW. The reported approach is more accurate than the existing methods hence can be used as a routine clinical tool furthermore the amount of fluid accumulation i. e fluid volume can also be closely approximated. The developed LabVIEW software based program is able to detect and diagnose pulmonary edema by quantifying the thoracic fluid volume accurately. The amount of edema is difficult to estimate. Clinical examination, chest radiography, and blood gases have proven to be of limited significance in quantifying pulmonary edema. Previous attempt lacked an absolute quantification of the disease and looked only at the presence of the disease. A simple expression is being extracted from a pre defined curve and the obtained relation is able to predict the quantity of fluid present inside the lungs for diagnosis of Pulmonary Edema and monitoring. Moreover the utilized technique is purely non-invasive and able to predict the severity of the disease.

A Microprocessor Based System (MBS) for non-invasive measurement of Pulmonary Edema is also analyzed and tested to diagnose High Altitude Pulmonary Edema. Twenty subject's data collected at All India Institute of Medical Sciences (AIIMS), New Delhi is used for the system validation. The MBS is able to detect Pulmonary Edema quantitatively in the patients and normal subjects. At the same time it also provides the value of measure and predicted transthoracic electrical impedance. It is observed that the difference in measured and predicted impedance is more for patients. The difference is leading to higher amount of fluid quantities in patients and hence validates the presence of HAPE.

Model based approach is also incorporated in this thesis. A simple cylindrical model is drawn and the main aim of the reported simplified modeling for volumetric estimation of Pulmonary Edema is to educate and prove that the volumes are greatly responsive to the act of breathes i.e. the inspiration and expiration states and hence can be adopted for diagnosis of several diseases. This model based approach shows the extent of its sensitivity in terms of volumetric variations even in the state of inspiration and expiration itself. An observable difference is found in the values of thoracic impedances and thoracic volumes at the state of full inspiration and at resting or expiration state. Remarkable differences in thoracic volumes are computed with the act of breathe just by using anthropometry. The variations in thoracic volumes are quite obvious even for the normal subjects.

Finally intelligent, fast and non invasive systems for diagnosis of Pulmonary Edema and other thoracic impedance investigations for various related diseases are proposed. The proposed systems facilitates the development of a system or device which could be extremely portable and clinically adoptable for smart and expert diagnosis, if practices. It is essential to highlight that this technique is non-invasive or non-destructive. Any invasive method can only be performed in a clinical environment. That's why the development of the designed model may lead to a device which may become conventional and can be commercialized. The proposed online model is based on LabVIEW environment. In addition it may also employ a data acquisition card. With the aid of suitable signal processing and hardware optimizations the instrument might become a truly portable and non-invasive pulmonary monitoring system. The research work is further extended for two more systems that has been studied, analyzed and proposed in the thesis. The first is; DAQ based online computer based model for diagnosis of Pulmonary Edema and the other is a DAQ-Based volt-amperometric transthoracic impedance measurement system.

The proposed model may lead to a hardware which would be adequate for clinical diagnosis and monitoring patients. Several results obtained for a number of volunteers further evidence the feasibility of the proposed system in monitoring the breath activity of a patient or normal subject and also in extrapolating the relevant diagnostic parameters. With the aid of suitable signal processing and hardware optimizations the software model may be converted to a hardware system and in future work it might become a portable, non-invasive and computerized diagnostic instrument.