

WSN Based Wheeze Detection Systems for Diagnosing Disease like Asthma: A Survey

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Abstract

The potential of computer science of integrating various other branches of science with the technology of computer machine has changed the various trends in human being's life by providing the health as service too. With the development of new technology of cloud computing which have the ability to provide the software on rent allowed the cheaper medium of services to the customer. In this paper, we will make a survey of the various wheezes detection system that have been used for detecting the chronic disease like asthma. We will also make a comparative study at the end of the paper.

Keywords: *Cloud computing, WSN, biomedical, Wheezes, Asthma.*

1. Introduction

“Cloud” computing has been receiving much attention as an alternative to both specialized grids and to owning and managing one’s own servers [1]. Therefore, IT industries are looking forward to the cloud computing for taking the advantages into their own side. Typically to settle an IT company or biomedical laboratory needs huge amount of infrastructure, ground, software to hardware requirements and scalability provision and many other things which could cost in the millions. By eliminating these drawbacks the cloud computing has become the backbone of every IT industry with a few period of time. Locally-hosted machines are also increasingly used to share data and applications in collaborative research, e.g., in the Biomedical Informatics Research Network (BIRN) and the Cancer Biomedical Informatics Grid (caBIG), both funded by the National Institutes of Health (NIH) [1].

Although cloud computing is capable to get integrated with almost every branch of science. Biomedical with cloud became a new hub or research in providing the health as a service. In many countries, the increasing longevity and declining fertility rates have contributed to aging populations and thus increased medical needs [2]. The typical method of getting the health care from the doctor is to visit the hospital, which needs an individual either to get leave from his working office if he/she is working or to travel miles from the rural area to reach the hospitals which are located in the urban areas to get their health being diagnosed by various doctors. Although the method was quite helpful earlier, but due to busy schedules of life and high life standard, people are not able to go to hospital for daily checkup purpose. So biomedical with cloud computing provided this facility of online health care by introducing various health care models for diagnosing and real time monitoring the various diseases through various body sensors to collect the data which are further sent to the respective doctor through various wireless sensor devices.

Cloud computing allows the doctors to provide a good health facilities to the patients who are not able to visit hospital on regular notes and also in the rural areas where doctors are not able to visit. In this route various new technologies and new concepts have been developed, such as wearable medical devices, Body Area Networks (BANs), pervasive

wireless broadband communications. Cloud computing can inherit various advanced mobile healthcare services that benefit both patients and health professionals. Specially, they enable the development of a system to perform remote real-time collection, dissemination and analysis of medical data for the purpose of managing chronic conditions and detecting health emergencies [4].

“A new system of distributed computing tools” known as biomedical engineers envision have been developed that collect legal medical data about patients and stores it on a secured network which gives a quick delivery and efficient care to patients. In order to obtain such benefits, the target population has to be monitored 24 hours a day, and a Wireless Body Sensor Network (WBSN) is deployed [5].

1.1 Asthma Disease

Researchers after so much research proposed that if the healthcare is made online through cloud computing, it can change the way patients use to be treated earlier as the patient don't need to visit the hospitals for the general checkups by sitting in bulk of lines of patients and waiting for his turn to come to see a doctor for diagnosing the chronic illness such as asthma. Asthma is a chronic respiratory disease which may start from the very childhood, although it is a non-communicable disease. While the causes of asthma are not fully understood, the symptoms of the disease result from a chronic inflammation of the lung airways that causes the episodic periods of wheezing, chest tightness, shortness of breath and coughing [7].

Asthma's adverse effect is according to the symptoms that a patient suffers. Although asthma can be classified into four stages on the basis of symptoms:

1. *Intermittent*: Patient suffers very less cough and wheezing for at least two times a week and at sleep time less than two times in a month.
2. *Mild Persistence*: Patient gets an asthma attack at least once in a week. Shortening of breath, heavy cough, wheezing, chest tightness occurs.
3. *Moderate Persistence*: The big air passageway of the lungs is affected by this, heavy coughing and wheezing in time slots.
4. *Severe Persistence*: Continuous slotted sessions occur for 24 hours a day for several days, persistent cough and wheeze.

1.2 Cloud Computing Models

The cloud system consists of three service models based on the resource utilization, i.e. SaaS, PaaS and IaaS [14]. Various cloud computing models that provide the facility to the user as required are discussed below.

- *SAAS (Software as a service)*: In this the users are handed rights for using the software as per requirement. Users are supplied with the software's on rent and are permitted to wage only for what they use.
- *IAAS (Infrastructure as a service)*: The hardware demand restriction has been ruled out by IAAS model. IAAS offers the users with an infrastructure in which user can practice, any software without any restriction of the system configuration. For this role the marketers have established many physical and virtual machines to conduct over this job.
- *PAAS (Platform as a service)*: To run the application on the cloud there must be an surroundings where this service must run. Therefore the marketers cater the platform where the operating system, web server, programming language execution environment is provided.
- *SEECAAS (Security as a service)*: Users while using clouds can put their unauthorized data eg. Bank account, credit card id, passwords on the cloud so that it cannot be accessed by anyone. SEECAAS model offers a security level model for shelter of the user data.

2. Various Wheezes Detection Systems

The new way of providing health care is the electronic health service which allows the patient to get his/her health cared without visiting the doctors at the hospital. Particularly, we have focused on the disease of asthma in this paper therefore underneath are various wheezes detection systems that have been used for diagnosing the chronic disease like asthma.

2.1 Wireless Body Sensor Network for The Prevention and Management of Asthma: In [7] an open source platform application based on wireless body sensor network have been developed called DexterNet. Author has focused on asthma disease particularly in childhood. The architecture of the application consists of three layers. Top layer is the body sensor layer (BSL) that integrates child's activity monitoring process, earth location, and level of air pollution. The second layer is the personal network layer (PNL) in which a wireless wearable device is worn by the child that summarizes the sensed data, and provides informative feedback. Wireless communication is then taken place through the mobile devices with the third layer called as global network layer (GNL). The last layer consists of servers which facilitate with four type of useful data services: a clinical module that endorses the healthcare management of asthma sheaths, a personal health module that endorses case-by-case prevention of asthma attacks, a community module that endorses partake sensing, and a health research module that endorses the assembling sensor data for exploring into the risk divisors tied in with asthma. The Author has illustrated the potential of the system to pretend as a panoptic approach to manage asthma cases and preclude asthma attacks.

2.2 Wireless Sensor Networks In The Monitoring Of Asthma: Asthma is one of the biggest rising diseases now days that do not deal with age so it comes to any age group of people. Growing popularity increments the concern of personal disease administration, commercial expense and workload, on the both sides i.e. patient's side and healthcare system side. In [8] author has firstly presented the medical background of asthma and then talked about the Pathology and symptoms later. Then the author had lighted some of the drawbacks of the existing asthma management systems by showing the important disease management techniques in the traditional way. A revaluation on glide paths to asthma tele-monitoring is done. Author then analyzed the effectiveness of peak flowmetry and has used low power wireless sensor networks (WSN) which are paired with smartphone technologies in his novel asthma management tool. The major objective of the author was to keep the disease in a controlled manner with less effort required, lesser cost and evaluating patient's status objectively. WSN-s ensign of both asthma initiations in the surroundings, and continuous supervising of physiological subroutines, in picky respiratory function are looked back. Sensing modalities for acquiring respiratory function are presented. Signal accomplishment requirements and signal swearing out of respiratory sounds are surveyed. The rivet is put on low-power uninterrupted wheezes spotting techniques. At the end, the research gainsays for further studies are keyed out. Since the author has used the technique of wireless sensor network, the system becomes more convenient and reliable to use without settling of complex wired architecture. Sensors help us to sense the required data correctly for to make correct decisions for diagnosing disease.

2.3 Asthma Attack Monitoring and Diagnosis: In late tenner's, childhood asthma has turned more far-flung and thus become a universal concern. The diagnosis of childhood asthma depends extremely on the doctor's knowledge and the symptoms explained by the child, which sometimes tough to understand. Many a times the symptoms might misguide in the diagnosis of asthma. In [9] author has proposed a

method to diagnose and classify asthma in children. The proposed method is grounded on using cough sound to excerpt characteristics that aid in asthma diagnosis. Addition to this author has proposed a hardware system for asthma attack monitoring. The proposed system was carried out and performed by a self-developed computer program written in MATLAB using many cough sound samples of asthmatic and non-asthmatic children. The main aim of the author was to develop an easy and simple scenario for asthma detection for people who don't prefer complex architectures.

2.4 Digital Analysis Methods of Wheezes in Asthma:The schemes of e-health are potent tools in the medical sphere. The main advantage of those schemes is slimming down the necessity of hospital care and the number of death rates. Advanced e-health schemes can command successfully such diseases as cardiac, diabetic or pulmonary diseases. So in [10] author has reviewed all wheeze breath detection algorithms in asthma monitoring techniques. After reading and analyzing the entire digital wheezes detection algorithms author has presented the new solution of the wheezes detection system as well. Author not only surveyed but made a review of all the existing digital wheeze detection algorithms, this made the approach of the author to be powerful enough as author has tried to eliminate the drawbacks of all the existing wheeze detection algorithms by introducing its new solution for wheeze detection which according to author have a lot advantages compared to the existing techniques that the author has covered in his paper.

2.5 A Fuzzy Rule-Based Expert System for Diagnosing Asthma:In [11] a fuzzy rule-based expert system has been developed for diagnosing asthma at starting stages. From a high level pool the knowledge deputation of this system has been taken which is based on patients' perception. The system is organized into two different structures called Type A and Type B. Symptoms, allergic rhinitis, genetic factors, symptom hyper-responsiveness, medical factors and environmental factors are the 6 modules which form Type A structure. Symptoms, allergic rhinitis, genetic factors, and response to short-term drug use, bronchodilator tests, challenge tests, PEF tests and exhaled nitric oxide are the 8 modules that forms Type B structure. Defuzzification is done with the concluding result of every system to provide the opinion on possibility of asthma disease in patients. Since the design of the system is made for every type physician ,either general physician or experienced asthma physicians or for the patients too through the mechanism of authorization and authentication process.

2.6 The Development Of A Rule-Based Asthma System:Asthma being a common disease becomes very harmful if not put into consideration. A continuous monitoring of asthmatic patients must be done according to their body conditions, especially their respiration behavior and the environmental conditions they breathe in. So In [12] author proposes a development of a rule-based asthma system. The patients are given various suggestions on the possibilities of occurring an asthma attack, according to the patient's current body conditions and the encompassing environment. The system works by asking the patients some simple questions to which the patient needs to answer which allows the system to sympathize patients present health condition and the kind of environmental conditions they are living in. Suggestions would be then generated by the system which will help in avoiding the asthma attack to occur. Interviewing various concerned doctors and online medical data resource allows, to build useful database for this algorithm and facilitated the author to build a rule-based algorithm based on gathered data. Patient's self-health management becomes quite easy with this system, leading to a healthy and asthma-free lifestyle. This Rule based system made patients more aware how to live a life if a person suffering from asthma by allowing us to follow simple rules and a little change to daily routines.

2.7 Wheeze Detection Based On Time-Frequency Analysis of Breath Sounds: In [13] author has gone through various abnormal hint sounds called wheezes occurring in patients with obstructive pulmonary diseases. The major objective of the authors' research was to build an automatic proficiency for wheeze diagnose system and supervising it using spectral analysis apparatus. The Author has used time-frequency wheeze detector (TF-WD) for recording wheezes from 13 patients with diagnosed asthma, chronic obstructive pulmonary disease and pneumonia as a tester for his system. Also the efficiency of TF-WD was evaluated using 337 breath sounds and then making a comparison between TF-WD's findings and clinical auscultation findings carried out by two experts. The TF-WD was also examined by deliberately putting some unreal noise. The efficiency and high noise lustiness of the TF-WD was absolved by the experiments and testing results made at the end of the paper. The approach of the author is counted to be very powerful with the introduction of the TF-WD which eliminates the timeindependence of wheezes that maylead to false diagnosis of the disease like asthma and the medical prescription by the doctor after detection of the disease.

Table 1. Comparative Study of Various Wheezes Detection Systems

Wheezes Detection System	Description	Pros	Cons
Wireless Body Sensor Network for The Prevention and Management of Asthma	The Authorhas presented an application of an open source platform for wireless body sensor network called DexterNet for diagnosing of wheezes.	Very less user interaction needed to for tracking the activity and exposure it. Also the scenario is very cost effective.	No authentication and encryption is done at user's sensed data. Integration of mobile sensors in the system consists of an arguably bulky setup.
Wireless Sensor Networks In Monitoring Of Asthma	Author then analyzed the effectiveness of peakflow -metry and has used low power wireless sensor networks (WSN) which are paired with smart -phone technologies in his novel asthma management tool	Low-power continuous wheeze detection techniques are used which proves to be very energy saving architecture. Optimal design of a minimally intrusive body-worn wireless body sensor node is presented.	Although low power techniques are used, but node level and network level power management does not take place. No work on Background noise cancellation.
Asthma Attack Monitoring and Diagnosis: A Proposed System	The Author presents a system which diagnoses the asthma on the basis of cough sound to excerpt characteristics that aid in asthma diagnosis. Used MATLAB to implement it.	Cough sound analysis we performed enabled us to correctly classify about 85-90% of the sound cough records. Proposed hardware system can be used at homes to help parents monitor their asthmatic child.	Since the accuracy is not 100% percent therefore cannot be used in real time monitoring and diagnosing the disease. Settling up of architecture is costly.
Digital Analysis Methods of Wheezes in Asthma	Author has reviewed all wheeze breath detection algorithms in asthma monitoring techniques and presented a new wheezes detection algorithm.	Reviews all the digital analysis method of wheeze detection which allowed the author to build a powerful approach by overcoming the drawbacks of the entire reviewed algorithm.	Since the author has not used sensor technology therefore the system fails when the patient is at motion.
A Fuzzy Rule-Based Expert System for Diagnosing Asthma	Author has designed a fuzzy rule-based expert system to palliate for diagnosing asthma at initial stages	Verification and validations criteria are considered through -out a life-cycle. The system was developed by the participation of general physicians, experienced asthma physicians and asthmatic patients which made it more reliable.	To implement and develop fuzzy expert system explained by author is very costly and complex in nature which may sometime consists of various uncertainties.

The Development Of A Rule-Based Asthma System	Author proposes a rule-based algorithm which offers suggestions for patients who would like to know the probabilities of coming an asthma attack from the patient's present asthma status and the encompassing environment	Provide suggestions that help in avoiding the attack, or to hasten asthma recovery. Rule-based asthma system allows patient's self-management to lead a healthy, asthma-free lifestyle	Rule based system is based on the questions that are asked by the system therefore it only make suggestions, does not provide any real time diagnosing of asthma. It may bring false decision of being asthmatic.
Wheeze Detection Based On Time-Frequency Analysis Of Breath Sounds	Author built an automatic proficiency for wheeze detection and supervising using spectral analysis and a time-frequency wheeze detector (TF-WD) based on TF wheeze features was built.	TF-WD technique provides information about wheeze existence with low computational complexity; hence, it could be used as an objective, fast and noninvasive tool for monitoring and evaluating wheeze activity during breathing.	Since author covers the local-scale of the system therefore the TF-WD scheme needs to be applied to large-scale experiments for the justification and generalization of its efficient performance.

3. Conclusion

In this paper, we try to conclude all the wheeze detection system proposed by various numbers of authors and scientists which help in diagnosing the chronic disease of asthma. There were some authors who try to implement the detection system practically on their own through different tools and some author have just made a proposal for implementation. Various numbers of advantages and disadvantages we founded by making a comparative study of all the wheezes detection system that we try to conclude into a tabular form in the table 1 section for more easy and convenient understanding. Although many different aspects have been used to develop the systems, but there are various parameters that need to be considered in order to develop a useful and effective diagnosing system for asthma which somehow were missing in various proposed approaches covered in this paper.

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