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Asthma inhaling and analyzing device interfering with application software

Saravanaraja Nikesh [1], Balasubramanian Mithra [2]

[1] UG - Biomedical Engineering, Bannari Amman Institute of Technology, Erode, Tamil Nādu

[2] UG - Biomedical Engineering, Bannari Amman Institute of Technology, Erode, Tamil Nādu

Abstract: This paper deals in representation of the severityof asthma using the measured content of nitric oxide in the exhaled breath through hardware and software perspective. An innovative design is madeup for the scope of simplicity, mass implementation and fabrication. The design is predominantly in the scope of clustering specific nano sensors at needful time based on varying environmental conditions for trial-and-errormethods. This paper aims to understand the severity of asthma based on various internal factorssuch as mutation, hypoxemia and external factors such as smoking, pollution, climatic change. As forthe software perspective, we here apply the conceptof telemedicine into the system software designed, along with presence or absence of asthma. We here- monitor, analyze and store the data collected for implementing an algorithm of our own and to give feedback about the condition of the subjects to the healthcare professionals through the app designed. The designed software acts as a path of communication between the doctors and the patients.

Keywords: Nano sensory circuit, dual actuator, asthma diagnosing inhaler, exhaling proboscis, asthma application software.

1. INTRODUCTION

The current COVID Situation is still astray in the surrounding. Hospitals are not safe for non-covid patients even with the present pretext ofvaccination. In India, Asthma is increasing at ahigher rate due to poor environmental conditions and hereditary. Even with the introduction of electric vehicles for a greener environment, it may take decades to bring it out for full practice. The climatic change by global warming too has a very important effect in respiratory diseases like Asthma.

The current system of diagnosing is much riskier in hospitals due to the strains of novel coronavirus. This is potentially leading to the spread of virus and will have a greater advantage of mutation of the virus in the environment. In addition, the temperature checks are not enough to check upon the people who come to the hospital. The inhaler which we made is used for both diagnosing and therapeutic purposes. In which we aim to measure the severity of asthma by non-invasive means through exhaled breath and to know the ratio of user to usage of inhaler as the excessive usage of inhaler can lead to further more respiratory causes. It is a diagnostic equipment which is economically designed for the specific addition of a number of sensors and for the improvement of end results.This device is a rechargeable system which is designed to have a larger life span of a product and to improve the ratio of result to exhaled breath.

Figure 1. Indicates the asthmatic condition

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2. EXPERIMENTAL METHODS OR METHODOLOGY

2.1) Hardware Design

The inhaler is designed and prototyped to bring about social-innovation. Here, we use a cluster of sensors to sense the severity of asthma throughexhaled breath by monitoring, collecting, intersourcing the collected data through IOT, machine learning, AI. This device is effective even based on environmental factors for analysing a patient but limited to extreme abnormalities. The design of product is modelled through Autodesk Fusion 360. The design has two sections in which asection is used for the diagnosis of subject and the other one is used as normal inhaler for the purpose of medication where a special jet nebulizingmechanism applied. To begin with therapeutic side,we have a drug peddler to push the medicine insidea canister which can varies in different sizes to the dual step actuator which is placed instead of the conventional actuator, so that it can easily control the to and fro motion of medicine to the nozzle part. The drug flow conveyor stores the medicine which is leaked through to and fro motion of the device and a main part in assisting the dual step actuator in controlling its motion. The other sectionof the device is the main diagnosing part where the data are collected, stored and manipulated in the website and gets updated in the app designed for other medical purposes. In this part, the machine learning comes in to existence in training and testing the data collected in the diagnosing part. The diagnosing part has a rechargeable battery holder in which the battery placed serves as the power source for the inhaler. A power unit is specifically designed of transistors to ensure thesafety of sensors and microcontroller. The nanonitric oxide sensors are combined with a solitary sensor, so that we ensure safe passage of data to thewebsite. The Arduino nano microcontroller mentioned is connected to a light emitting diode (LED) in order to specify the output of the exhaled breath i.e., severity level of asthma. A small C-typeUSB cable point is available to recharge the batteryin the inhaler. Colour indication system and buzz system is programmed in the device to indicate the severity of the asthma. The red light and three buzzers indicate that subject is under a serious stage where immediate hospitalization is needed.

A yellow light and two buzzers indicate that the subject is in a semi normal state, where an appointment with doctor is required on the next day, green light and a buzz indicate that the patient is in a normal state, where the patient can follow his regular schedule. A conventional GSM Module is placed to send or receive messages about the subject to their peers even in a remote area, where the data transmission is unavailable about the patient's health status.

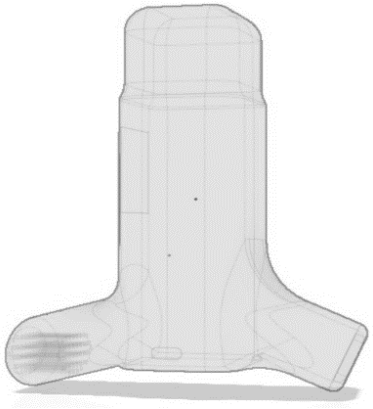

Fig 2. Illustrates the design of the AsthmaInhaler.

An alarm system is placed in case the patient takestoo much or low of the medicine, which is also sentas an automatic message to the registered mobile number. The angle of inclination between the dual actuator and drug bearing canister is designed to a certain degree. The remaining dose of the inhaler isrepresented digitally in the LED, which is connected to a level controller in the drug canister and the charge available of the inhaler for diagnosis is displayed. The materials such as poly-butyl terephthalate and poly-ethyl terephthalate are used, as it is a considerable material for 3D printing. It is also of high strength and durability.

2.2) Block Diagram

The block diagram tells us how the system actually works as a combination of hardware and software. The input (exhaled breath) passed on to the nano-sensory circuit through the filtered mouthpiece and the sensory senses the amount of nitric oxide in the exhaled breath and passes the digital information (as binary) to the microcontroller where the ADC Converter convertsinto a feed of analog data and it is transmitted to the application developed digitally and to the led output digitally. The microcontroller isprogrammed in such a way that after diagnosing it to give a text message to the peer of the subject andthen update the diagnosed value to the physician. Ifthe result is an emergency case, then the physician's hospital is alerted through a phone call and the peer or family members are altered to both message and phone call and emergency appointment booked by app itself.

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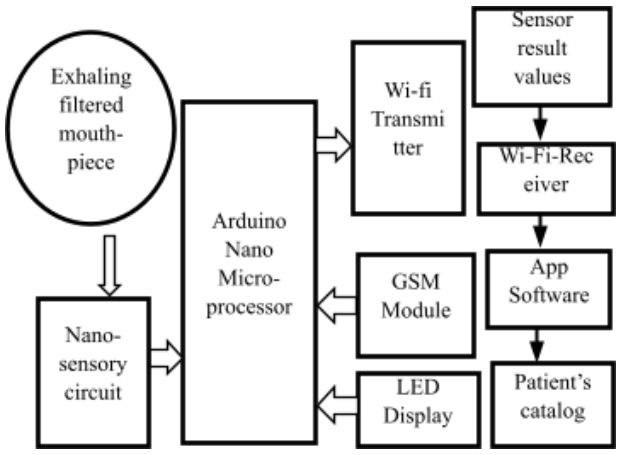

Fig 3. Shows the working block diagram.

2.3) Technology Incorporated

i) Severity detection and circuit implementation:

The exhaled nitric oxide is sensed by the array of sensors which will be designed in the quick field software and the microcontroller connections are initially tested in Multisim software. A PCB Modelis created and the sensory values are transferred to the software designed through the methodology of IOT and the data collected are tested and trained by Artificial Intelligence (AI). This enables the easy transmission of data and good communication between the physician and the patient.

ii) Algorithms used for testing and training:

It is planned to use certain algorithms for testing and classifying the medical data, from which we can come to a certain conclusion about the status ofthe subject. These algorithms also help us in using the raw data collected into the data actually needed without any noise or error.

iii) Gradient Boosting Algorithm:

This algorithm is applied in our dataset, as it is used to reduce the bias error in the raw dataset collected from the subject. It is also used to predict the categorial type of variable which is notpredicted in the usual set of algorithms. It alsohelps in improving the accuracy using as the value can be predicted using two different estimators.This reduces the traffic in tree algorithms, so that the data overfit the algorithms applied, quickly andeasily.

iv) Random Forest:

This is a supervised technique which is used for both classification and regression of the data and it also reduces the overfitting of data in an easy manner. The importance is much given to the inputfeatures, which are obtained from the subject which is a very important factor used in the analysis of the exhaled breath. This is mainly used in analysing the medical history of the patient and predicting the values from it, so it is a valuable asset to use this algorithm.

2.4) Software Approach

The application is designed in android studio usingthe programming languages of Java and Python. Some algorithms like random forest and gradient boosting algorithms are added up for the purpose of training the data and to remove some mean errorin the datasets obtained.

The IOT is used to transferthe data from hardware to software. The raw data taken first is made into a clean data set for the purpose of classifying, analysing and predicting thedata. The application also acts as an interface for communication between doctor and the patient. The application is also used for emergency appointment booking and the normal bookings in hospitals. The slots available for each booking is also specified, where the doctor can set a limit of appointment. The factors of smoker, active smokerand past smoker are extended in the application designed.

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3. RESULTS AND DISCUSSION

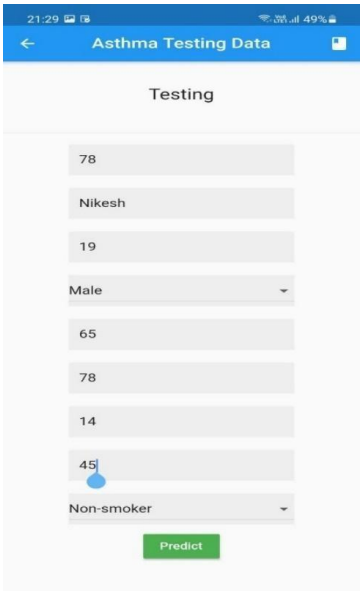

Fig. 4.1 Shows the real- time values that the patient got from the designed hardware

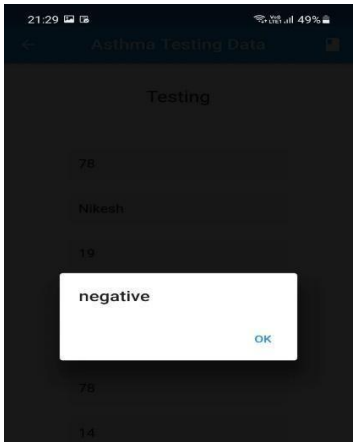

Fig. 4.2 Shows the prediction result of the absence of asthma (negative).

Fig. 4.3. Shows the history of prediction resultsof asthma in doctor's ID.

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CONCLUSION

The infected result shows the presence of asthma and the negative result shows the absence of asthma. In the current work, we measure the content of nitric oxide. This explains the piece of information about the inflammation factor in lungs,which in turn expresses the concern of asthma in the human system. Not only this measurement is used in analysing, but also the environmental factors surrounding the subject is analysed and the social habits of him are also integrated in the algorithm for accurate prediction. The application developed is completely safe and improves better monitoring of the subject and has an ease in appointment system. The hardware design will be well calibrated to the sensors and have a good battery backup. The primary design and the complete software development are available. The next phase includes updating the application and to test the sensitivity of nano sensors and solitaring it.

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