Detection of Asthma and Diabetes from Patient Breath

J. Vijaya Lakshmi [1], S. Lakshmi Priya [2], S. Preethi[3] and A. Divya [4]

[1,2,3]Final Year Students, Department of Biomedical Engineering, Alpha College of Engineering, Chennai, Tamil Nadu, India.
[4]Assistant Professor, Department of Biomedical Engineering, Alpha College of Engineering, Chennai, Tamil Nadu, India.

Abstract—*The main purpose is to identify the diseases of people by using the breath Analysis. Breath analysis is an easier, more accurate and viable method in providing clinical care for the disease. It is a less time & low cost technique to indicate the disease. Human breath analysis offers a non- invasive and rapid method for detecting various volatile organic compounds that are indicators for different diseases. Each disease has a specific biomarker to identify the disease such as nitrous oxide for asthma, acetone for diabetes, ammonia for renal disease, sulphides for liver disease, etc.. Here, the exhalation of Breath is collected & it is detected using gas sensor. This defines the level of gas, indicates the type of disease and help the individual to monitor their disease with cheap and simple device.*

Keywords **- breath analysis, biomarker, gas, acetone, nitrous oxide, asthma, diabetes.**

Abbreviations **– VOC(Volatile Organic Compounds), BGL(Blood Glucose Level), LCD(Liquid Crystal Display), IoMT(Internet of Medidcal Things), NO(Nitrous Oxide).**

1.INTRODUCTION

The Asthma and Diabetes are the most common disease found in the old age people. Breath analysis is a non-invasive, pain free and cheap technique. Breath is the collection of highly complicated molecular matrix, the composition of nitrogen, carbon dioxide, oxygen, and water have very high percentage, which is present in our breath. Some volatile compounds are the indicators of diseases in the human. Exhaled breath analysis is a method in medicine for gaining information on the clinical state of an individual by monitoring the components present in the exhaled breath. Identification and quantification of potential disease biomarkers can be seen as the driving force for the analysis of exhaled breath .Patient with asthma have increase the level of nitric oxide in their breath, patient with renal diseases have ammonia, patient with liver diseases have sulphides in their breath, patient with diabetes have acetone in their breath, patient with cirrhosis diseases have aliphatic acid, patient with kidney failure have dimethyl amine and trimethyl amine in their breath and patient with lung cancer have substances like aldehydes, alkanes and derivatives of benzene in their breath. The breath odour exhaled from human body in the form of volatile organic compounds which can be detect and analyse by many methods like Gas chromatography and many other method for volatile organic compounds detection.

Diabetes can be described as a group of metabolic diseases where the blood-glucose level in the body is higher than the normal prescribed parameter. When a person suffers from diabetes, it is seen that their body is either unable to secrete enough insulin or their body is not able to use the insulin produced by the liver. This causes sugar to build-up in the blood thus leading to diabetes[4]. Investigations show that urine, sweat, saliva, tears and breath contain traces of glucose in them, and these traces vary with the levels of glucose in the blood. Therefore, these human serums have recently gained recognition as feasible alternatives to using blood for glucose measurement. Extensive research conducted in this area concludes that human breath is a good alternative to monitor and diagnose glucose levels as acetone in the breath has shown a good correlation to BGL. It is seen that in the human breath, there are numbers of chemical compounds that relate to different diseases Traces of acetone in the breath are used for the detection of diabetes.

Asthma is one of the most prevalent and costly chronic conditions[9]. It is one of the complicated state of respiratory disease which is harmful and risk in many of the people life. It cannot be cured but it can be prevented when it is treated before using the nebulizer at times. A condition in which a person's airways become inflamed, narrow and swell and produce extra mucus, which makes it difficult to breath. A common lung disorder in which inflammation causes the bronchi to swell and narrow the airways, creating breathing difficulties that may range from mild to life-threatening. In the breath analysis gas is the specific biomarker to detect each and every disease as mentioned before. Nitrous oxide is the biomarker for the Asthma.

1.1 NEED OF THE PROJECT

(1)This project is used to identify the most common disease like asthma and diabetes by patients breath. (2) It is a non-invasive, cheap and a effective method. (3) It can also easily intimate the doctor in emergency situation. It overcomes the disadvantages in available device.

1.2 OBJECTIVE

To analyse the exhalation of gas from breath. To correlate different gases with diseases,

1.Nitrous oxide – Asthma

2.Acetone – Diabetes

2. MATERIALS AND METHODS

The detection of asthma and diabetes is mainly based on the sensor which is being used. The block diagram clearly shows how the device works.

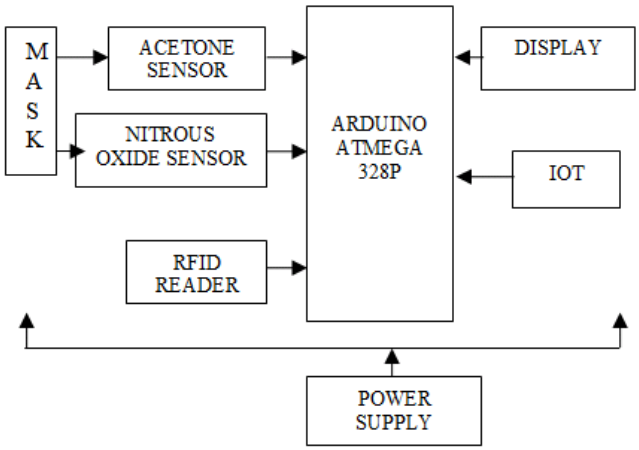

Figure:1 Block Diagram of detection of Asthma and Detection using Patient Breath Analysis

A. *Arduino Atmega328P*

The Arduino used in our project is used for the hardware and software connectivity. It is based on the Atmega328P microcontroller in the device with 14 digital pins, 8 analog pins, 2 reset pins and 6 power pins which is interfaced with MPU6050 sensor. It is basically used for multiple I/O interfaces.. It is used in real time biometrics and robotic applications. We use it for the real time prediction and also for the sensing value conversion along with the embedded C language.

B. *RFID Reader*

A Radio Frequency Identification Reader (RFID reader) is a device used to gather information from an RFID tag. It is used here to capture the patient details when the breath is being given as a input for the sensor. It contains the details of the patient like name, age, address, phone number, etc.., which is to be programmed in the device.

C. *Sensor*

Acetone gas sensor and Nitrous oxide sensor are used as a biomarker for the Diabetes and Asthma respectively. The sensor plays a major role to take the input as a breath. it detects the biomarker with the prescribed level which is to be measured to know the level of gas in the breath. The sensor output values can be get by means of both analog and digital.

D. *Mask*

The mask is inbuilt with acetone and nitrous oxide sensor for the detection of the gas in the breath. The Mask helps to avoid some of the atmospheric gases to avoid the error level.

E. *IoT Module*

IoT is the machine to machine communication as it is used in the medical field it is called as IoMT. By using it, on time prediction is possible and information is delivered to the doctor or the care taker who is looking towards the patient. It saves money as well as the time for the people.

F. *Data Analysis*

The gas in the breath is analyzed along with their level in the normal human and diseased human. For the normal people the range of the gas is minimum and for the diseased case it reaches the beyond level to confirm the severity of the disease.

G. *Range*

Each biomarker specifies each disease with a particular gas. Our breath is a mixture of different gases with a composition. When the gas exceeds the normal level it is considered as diseased level and goes on indicates the severity.

Acetone Range[4],[9],

Normal level = 0.2-0.7ppm

Diseased level= 1.7-3.7

Nitrous Oxide Range[5][11],

Normal Level = 20 -25 ppb

Diseased Level = above 25ppb

2.1 METHODS

Now the techniques used in the medical field is invasive, pain full and costly. When a new evolution of non-invasive, pain free and cheap technique is introduced, it will be highly helpful for the people. At first the mask is placed in the patient nose and mouth and breath is collected for 20 to 30 seconds. Sensor placed in the mask mouthpiece sense the type of the gas and denotes the level by using the Arduino and it is displayed in the LCD (Liquid Crystal Display). Here we use IoT for the on time prediction and by using the IoT web page it is easy to see the details of the patient who all undergone the treatment. As blood test is mostly considered for the detecting the disease, this breath analysis is highly helpful and needed technique for our generation. The results are predicted then and there itself. It is a efficient and valuable technique.

3. RESULTS AND DISSCUSSION

As the below flowchart explains the condition of the normal and abnormal state of the disease. It indicates the range as mention in the methods and methodology. According to the studies, it is seen that patients who have diabetes have body cells that are unable to absorb the glucose in blood. In such cases, when the liver breaks down fat for energy, there occurs an abnormal increase in ketone bodies in the patient's blood. Acetone is one of the three kinds of ketone bodies, which are volatile, and the body exhales the acetone thus formed. Therefore, higher concentration of acetone is found in the exhaled air of a diabetic patient.[4] In the same way, the main objective of this technique to interpret the accuracy with which using simple parameters to identify the asthma among the general population along with the diabetes.[5] In asthma, the fraction of exhaled nitric oxide (NO) is increased and the use of noninvasive monitoring in asthma as well as in other respiratory diseases The Nitrous Oxide is normally related as a biomarker for lung disease and especially for Asthma[14].

Breath analysis has great potential for disease detection, therapeutic monitoring, determination of the phenotype of enzyme activity for personalized medicine, detection of pulmonary or gastric bacterial infection. Monitoring of exhaled breath is one of the most noninvasive screening techniques for early diagnosis; however, this method is limited by insufficient accuracy, as many VOCs are present in the exhaled breath at very low concentrations (ppb level)

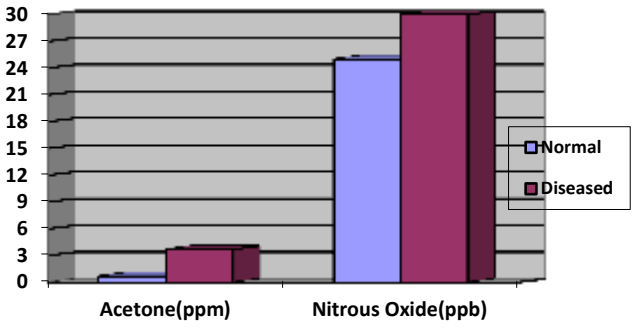

Figure 2: The range of Diabetes and Asthma

4. CONCLUSION

The Acetone level and Nitrous Oxide level in the breath denotes the level and severity of the disease which can be previously determined. This is non-invasive, cheap and pain free technique to detect the disease. As the technology developing day by day, new inventions are evolving around us. In the Medical Field, the detection of disease using the breath will be highly helpful for the people. This is more useful for the old aged people as they have both the disease which is easy to interpret their disease. Hence, we thought our technique will be easy, cheap, non-invasive and helpful to everyone.

4.1 FUTURE SCOPE

In Future it can be done for other diseases. When it developed for various diseases using the biomarkers then all the diagnostic techniques will be non-invasive, cheap and pain free. Because breath analysis is a valuable technique which is highly helpful for our generations. Common diseases can be find out, and it can be join together to test and detect the disease.

REFERENCES

[1] Survey of Artificial Electronic Nose to Detect the
[2] Diseases of Human Parveen Khan, Dr. Surendra Kumar Yadav, INTERNATIONAL JOURNAL FOR RESEARCH IN AP PLIED SCIENCE AND ENGINEERING TECHNOLOGY 2014
[3] IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS, VOL. 19, NO. 4, JULY 2015
[4] Predicting Asthma-Related Emergency Department Visits Using Big Data Sudha Ram, Member, IEEE, Wenli Zhang, Max Williams, and Yolande Pengetnze
[5] Methods of NO detection in exhaled Breath, S M Cristescu1, J Mandon1, F J M Harren1, P Meril□ainen2 and M H□gman2,3, J. Breath Res. **7** (2013) 017104
[6] Non – invasive technique using breath analysis for detection and classification of diabetes S. Lekha, M. Suchetra, International Journal of Engineering and Technology.
[7] F. Martinez, "Recognizing early asthma," Allergy, vol. 54, no. s49, pp. 24–28, 1999.
[8] P. F. Adams and M. A. Marano, "Current estimates from the national health interview survey, 1994.," Vital Health Stat 10, Data from the National Health Survey, no. 193 Pt 1, p. 1, 1995.
[9] Analysis of Exhaled Breath for Disease Detection Anton Amann,1,2,∗ Wolfram Miekisch,3 Jochen Schubert,3 Bogusław Buszewski,4 Tomasz Ligor,4 Tadeusz Jezierski,5 Joachim Pleil,6 and Terence Risby7,2014.
[10] C. M. Ionescu, "The human respiratory system," in The Human Respiratory System, pp. 13–22, Springer, 2013.
[11] Big Data and mHealth Drive Asthma Self-Management Quan Do, MS and Son Tran, PhD Kris Robinson, PhD School of Nursing 2015 International Conference on Computational Science and Computational Intelligence.
[12] A Sub-ppm Acetone Gas Sensor for Diabetes Detection Using 10 nm Thick Ultrathin InN FETs Kun-Wei Kao 1, Ming-Che Hsu 2, Yuh-Hwa Chang 1, Shangjr Gwo 3 Sensors 2012.

[13] Sensors for detecting pulmonary diseases from exhaled breath Dina Hashoul and Hossam Haick, Eur Respir Rev 2019;
[14] Sensors for detecting pulmonary diseases from exhaled breath, Dina Hashoul and Hossam Haick,2019
[15] L. Agertoft and S. Pedersen, "Effects of long-term treatment with an inhaled corticosteroid on growth and pulmonary function in asthmatic children," Respir Med, vol. 88, no. 5, pp. 373–381, 1994.
[16] J. FitzGerald, E. Bateman, L. Boulet, A. Cruz, T. Haahtela, M. Levy, P. O. Byrne, P. Paggiaro, S. Pedersen, M. Soto-Quiroz, et al., "Global strategy for asthma management and prevention. 2015," Global Initiative for Asthma, 2015.
[17] J. A. Castro-Rodr´ıguez, C. J. Holberg, A. L. Wright, and F. D. Martinez, "A clinical index to define risk of asthma in young children with recurrent wheezing," Am J Respir Crit Care Med, vol. 162, no. 4, pp. 1403–1406, 2000.
[18] R. Kurukulaaratchy, S. Matthews, S. Holgate, and S. Arshad, "Predicting persistent disease among children who wheeze during early life," Eur Resp J, vol. 22, no. 5, pp. 767–771, 2003.
[19] D. Caudri, A. Wijga, C. M. A. Schipper, M. Hoekstra, D. S. Postma, G. H. Koppelman, B. Brunekreef, H. A. Smit, and J. C. de Jongste, "Predicting the long-term prognosis of children with symptoms suggestive of asthma at preschool age," J Allergy Clin Immunol, vol. 124, no. 5, pp. 903–910, 2009.
[20] R. F. Machado, D. Laskowski, O. Deffenderfer, T. Burch, S. Zheng, P. J. Mazzone, T. Mekhail, C. Jennings, J. K. Stoller, J. Pyle, J. Duncan, R. A. Dweik and S. C. Erzurum, "Detection of lung cancer by sensor array analyses of exhaled breath," American Journal of Respiratory and critical care medicine, vol. 171, pp. 1286-1291, 2005.
[21] W. Busse, H. Boushey, C. Camargo, D. Evans, M. Foggs, S. Janson, et al., "Expert panel report Guidelines for the diagnosis and management of asthma," Washington, DC: US department of Health and Human Services, National Heart Lung and Blood Institute, pp. 1–417, 2007.
[22] A. Sheffer, J. Bousquet, W. Busse, T. Clark, R. Dahl, D. Evans, L. Fabbri, F. Hargreave, S. Holgate, H. Magnussen, et al., "International consensus report on diagnosis and treatment of asthma.," Eur Resp J, vol. 5, no. 5, pp. 601–641, 1992.
[23] F. Martinez, "Recognizing early asthma," Allergy, vol. 54, no. s49, pp. 24–28, 1999.
[24] P. F. Adams and M. A. Marano, "Current estimates from the national health interview survey, 1994.," Vital Health Stat 10, Data from the National Health Survey, no. 193 Pt 1, p. 1, 1995.
[25] C. M. Ionescu, "The human respiratory system," in The Human Respiratory System, pp. 1322, Springer, 2013.
[26] R. Kurukulaaratchy, S. Matthews, S. Holgate, and S. Arshad, "Predicting persistent disease among children who wheeze during early life," Eur Resp J, vol. 22, no. 5, pp. 767–771, 2003.
[27] D. Caudri, A. Wijga, C. M. A. Schipper, M. Hoekstra, D. S. Postma, G. H. Koppelman, B. Brunekreef, H. A. Smit, and J. C. de Jongste, "Predicting the long-term prognosis of children with symptoms suggestive of asthma at preschool age," J Allergy Clin Immunol, vol. 124, no. 5, pp. 903–910, 2009.
[28] M. Kaliner, J. H. Shelhamer, P. B. Davis, L. J. Smith, and J. C. Venter, "Autonomic nervous system abnormalities and allergy," Ann Intern Med, vol. 96, no. 3, pp. 349–357, 1982.

BIOGRAPHIES

Vijaya Lakshmi. J pursuing Biomedical Engineering in Alpha college of Engineering, Thirumazhisai.

Lakshmi Priya. S pursuing Biomedical Engineering in Alpha college of Engineering, Thirumazhisai.

Preethi. S pursuing Biomedical Engineering in Alpha college of Engineering, Thirumazhisai.

Mrs. Divya. A (Project Guide) Assistant Professor in Alpha College of Engineering, Thirumazhisai.