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***Research paper***

# An Android & IoT based Health Care and Personal Monitoring Device

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**Abstract**

The paper signifies the test to monitor the condition of diabetic patient's breath which involves non invasive medical treatment or test which does not involve cutting of the body or not penetrating any instruments which are harmful. This one is identified as quick and user friendly technique which diagnosis the diabetic ketoacidosis [DKA]. Basically DKA is preventable complication type 1 diabetic mellitus. Usually diabetic are required to undergo the urinary and blood glucose test to monitor the diabetic condition. So these methods are expensive, inconvenient and harmful. Keeping these things in mind recently a new technique has been involved in terms which is making use of breath acetone that has been considered as a new ketone indicator which is non painful convenient and it reflects the level of ketone in the body .In this research we are providing a method to monitor the ketone level by using the measurement of breath. We are mainly focusing on easy handheld way for health care on monitoring the diabetic level with using the breath. We are using Internet of Things (IoT) system to provide the facility to the patients for diagnosis and self monitoring component which sense the breath ketone and help us to see the reading for further diabetic treatment

***Keywords:*** *Personal monitoring system, acetone, ketone, exhale breath, IoT and sensors.*

## 1. Introduction

Nowadays the health care system involves the major health problem faced by most of the people in worldwide among them diabetic mellitus I is in common. Diabetics are one of the severe diseases which makes person weak and suspect able to many other power. This can be diagnosed by measuring the ketone level in body basically which involves two level test which are blood glucose test and urinary test so this test are valid only if a patient is involved in some activates to maintain his blood sugar level. Finding the measurement of blood glucose or blood ketone level in bed ridden patient is insignificant for such issues we providing a healthcare monitoring process for diabetic patients which involves the measurement of breath which is non invasive and personal monitoring .This particular test not only involves the measurement of blood sugar level but also detects lung cancer, obesity, asthma attacks which are diagnosed via breath. In this method it involves the development of hardware connection with the known IoT system. This IoT facility of the patient for self diagnosis and monitoring .Many portals and applications which are associated with IoT that is helpful for patients that are helpful for the patients to improve their diabetic care.

"Internet of Things" represents system of mechanical and digital machines, interrelated computing devices, objects, people or animals that are provided with ability to transfer data over a network and unique identifiers without human to computer or human to human interaction. IoT is one of the rising new concepts which are creating new resolution for medical field and many more. This intelligent data identification can be done through mobile application and websites which can function in heterogeneous connectivity environment as well.

Arability of IoT is in large quantity in healthcare devices. IoT mainly deals with patients numerous commitments and stratification which helps in interacting and counseling with doctors on button click and data can be derived very easily and effectively.

## 2. Existing System: Manual Diabetic Testing

At Present blood test is carried out to diagnose diabetes. Various diabetes symptoms such as increased thirst, excessive urination and tiredness are observed in many people with type1 and type2 diabetes. Some people show slow healing of wounds and persistent infections. It is also possible that many people with type 2 diabetes do not show any symptoms of diabetes at all. Blood samples are collected from a vein for blood test and sent to a pathology laboratory. The different tests may be:

- a fasting sugar (glucose) test – Patient should be fasting for at least eight hours, like as drinking and eating overnight
- A glucose test randomly taken during the day without fix time slots.
- An oral glucose tolerance test (OGTT) – In OGTT patient who is fasting or fasted drinks a drink with sugary content undergo blood test done 1 and then 2 hours later.

The patient require to drink and eat adequate (mostly 150 grams a day) of carbohydrates contents (starch rich foods) for continuous 3 days before taking glucose tolerance test. At Present, the Diabetes tests for glucose rely on blood or urine glucose levels to diagnose the disease. This is described in Table 1.

**Table 1:** Diabetics diagnosis ranges

| BLOOD CONTENT | LEVEL | OCCASIONS |
|---|---|---|
| Fasting Sugar | >7 mmol/L | 2 |

| | | |
|---|---|---|
| Glucose | >11 mmol/L | 2<br>(2hrs after sugary drink) |
| HbA1c | >6.5% | 2 |

From the Table 1, it is clear that diagnosis of Diabetes is positive when:

- The fasting sugar level is greater than 7mmol/L (on 2 separate instances)
- The glucose tolerance test is greater than 11mmol/L, when test is taken 2 hours after the consumption of sugary drink (on 2 separate instances)
- The HbA1c level is greater than 6.5% (on 2 separate instances)

Alternative blood test to diagnose diabetes is the HbA1c test. This test measures the hemoglobin percentage of molecules (the molecules responsible for red color of red blood cells) in the blood that has a sugar molecule attached to them. Only blood glucose meter and finger prick techniques are used to diagnosis of diabetes, or by urine glucose test. Even if a doctor may take a blood test with a finger prick technique in the clinic room, it is compulsory to send blood test sent to pathology to confirm the diagnosis. Formerly, blood and urinary ketone detections have been widely used for diagnosis of diabetic ketoacidosis (DKA).but both methods have been considered inconvenient, painful and invasive.

## 3. Methodology

As shown in fig.1. proposed methodology aims to provide a convenient monitoring of human-breath test to check the condition of diabetic patient. This is an alternative method, which diagnosis the diabetic ketoacidisosis which is a very quick and easier technique. The HRV [Heart Rate Variability] is used to measure the variation of time interval between the consecutive heart beat. For the experimentation purpose, person's breath and heartbeat rate are considered. Proposed system is categorized into the following steps:

(1) Breath and Pulse data sensing using sensors
(2) Calculating Acetone and Heart rate
(3) Uploading Patient data to server
(4) Access and Utilize data by Patient
(5) Access and Utilize data by Doctor. Below figure represents flow chart of the methodology.

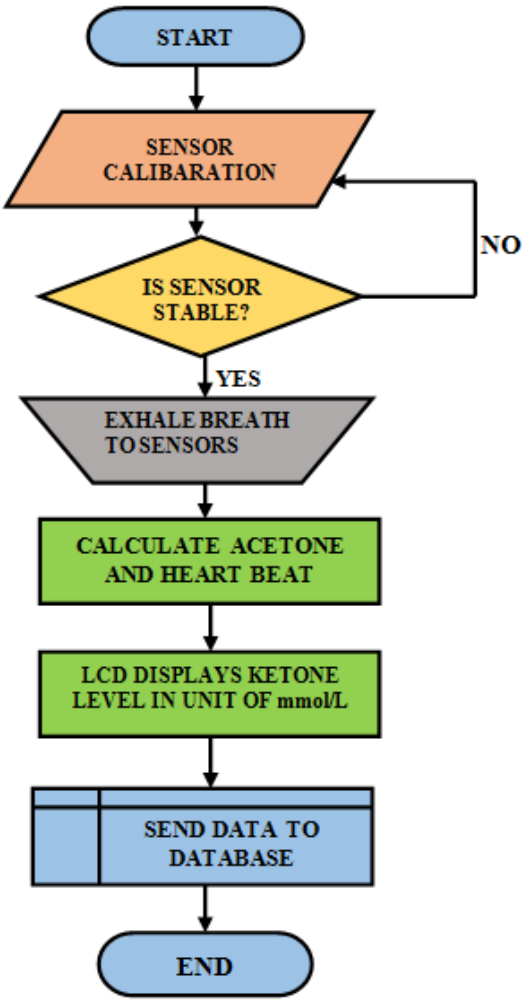


**Fig. 1:** Flowchart of proposed system

**(1) Breath and Pulse Data Sensing Using Sensors**

The collection of raw data from sensors for humidity, temperature, acetone and pulse by providing breath and skin contact to sensors is referred as Breath and Pulse data sensing using sensors. Sensors are mainly divided into two sets. 1. Sensors to collect data from breath 2. Sensors to collect heartbeat from skin contact. Figaro 822 tgs and DTH22 sensors are used to collect Ketone level, humidity and temperature respectively. SEN-11574 pulse monitoring sensor is used to collect pulse data. User exhale breath to mouth piece and attach pulse monitoring sensor to finger or hand. Sensors collect data such as ketone reading, humidity and temperature from breath and heartbeat pulses from pulse sensor. The data collected from sensor is raw and in format as per the sensors datasheet. This collected raw data from sensors is used to calculate actual concentration of acetone in breath and heart beat rate of the patient.

**(2) Calculating Acetone and Heart Rate**

In this step input is taken from step (1). The raw values received from sensors are used to calculate concentration of acetone in breath. The sensor to analyze breath is connected to analog pin 0. Sensor read 3 values at interval of 5 ms from analog pin of sensor.
gasValue1 = analog Read (0);
Delay (5);
gasValue2 = analog Read (0);
Delay (5);
gasValue3 = analog Read (0);
In order to determine concentration of acetone gas two parameters; temperature and humidity are included. Temperature and humidity values received from DHT22 sensor are used to calculate scaling factor as below.
Scaling Factor = (((current Temperature * -0.02573) +1.898) + ((current Humidity*-0.011) +0.3966))
This scaling factor is used to multiply with sensor values read to get acetone concentration. The value of the sensor which reads in the unit of PPM must be converted to mmol/l by taking the molar weight of acetone which is 58.08 because the ketone level is measured with unit of mmol/l, It is given by
PpmInmmol = ((PPM / 1000) / 58.08);
PpmInmmol = PpmInmmol * 1000;

**(3) Uploading Patient Data To Server**

Once concentration of Acetone and Heartbeat values are calculated, that data is updated to server. Hardware system uses Bluetooth technology to send calculated values of acetone and heartbeat to android application on patient's mobile device. Android application collects data sent by hardware system on trigger and uploads it to web server using device internet connection. Sensor readings are stored across the patient's user id in database. Users related to this patient can fetch new uploaded data based on request to web server.

**(4) Access and Utilize Data By Patient**

Android system is a multiuser system and both doctor and patient can use the system to access and utilize data from web server. When user logs in into the Android system as a Patient, user can perform following operations.
1. Access sensor readings
2. Access consulting doctors list
3. Send new consultation request to doctors
4. Access doctor details and prescriptions prescribed by selected doctor.
Patient can upload new readings of acetone and heart beat by using hardware system and android system as described in step (3). On successful login patient can see list of already consulting doctors and other doctors registered with the system. When patient clicks on doctor from the list, android system display complete profile of the doctor, acetone and heart beat reading for particular patient and prescriptions prescribed by particular doctor. Patient can send new consultation request to doctors from list of new doctors.

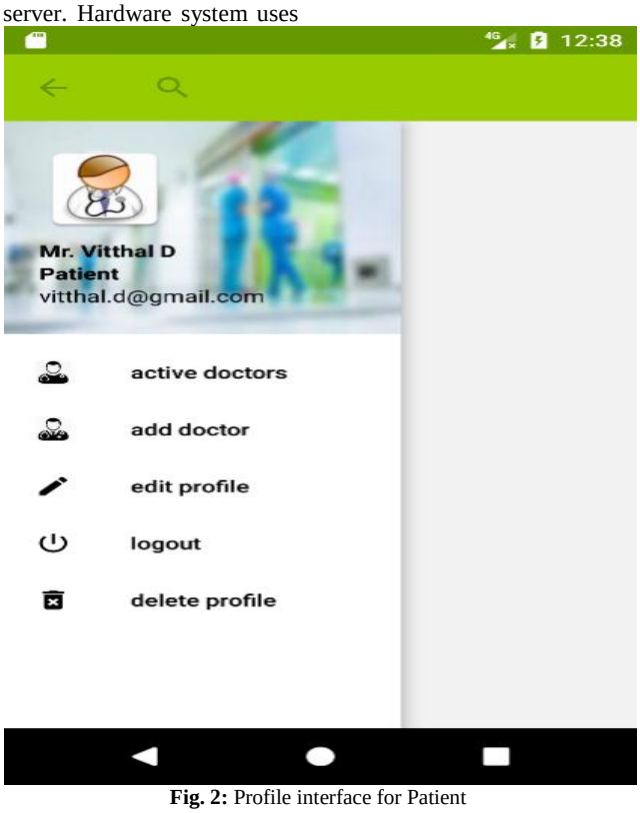


**Fig. 2:** Profile interface for Patient

**(5) Access and Utilize Data By Doctor**

When user logs in into Android system as Doctor, user can perform following operations. 1. Access sensor readings of patients 2. Access patient list 3. Accept/Reject new consultation request sent by patients. 4. Access patient details and upload new prescriptions for particular patients.When user logs in into system as Doctor, user can see list of already registered patients.

When Doctor Clicks on patient from list android system opens complete profile of patient, acetone and heartbeat readings for particular patient stored on web server and prescriptions already prescribed by doctor to particular patient. User can select a menu to display new consultation requests list. This menu will fetch new consultation requests for doctor from server.
As blood ketone levels (β-hydroxybutyrate) has good correlation with breath acetone levels, thus the patient's condition is determined by the range of the ketone level represented with unit of mmol/l.

**Table 2:** Range of Ketone Level condition

| Blood β-hydroxybutyrate (mmol/l) | Breath Acetone (ppmv) | Action to be taken |
|---|---|---|
| < 0.6 | < 3.0 | Normal – recheck every 1-2 hours if blood glucose >13.9 |

| | | |
|---|---|---|
| | | mmol/l |
| 0.6 – 1.5 | 3.0 – 7.0 | follow sick day rules, checking ketone and glucose levels every 1-2 hours Insulin required. |
| 1.5 – 3.0 | > 7.0 | DKA Risk– please seek urgent medical attention |

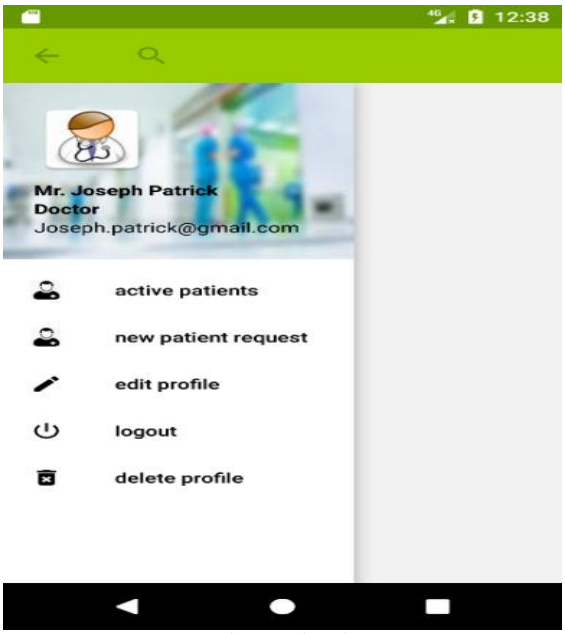


**Fig. 3:** Profile interface for Doctor

## 4. Conclusion

As it is realized through this paper and as per achieved results, it is clear that the acetone amount measurement that is present in patient's breath to calculate diabetic patient's ketone level is applicable as there is a good correlation between blood ketone level (β-hydroxybutyrate) and breath acetone levels. The real time acetone monitoring system for diabetes patients is able to use the functionality of Internet of Things (IoT) to provide the effective and remote access to calculated data. This will be helpful in remote and timely consultation for elderly patients over Internet without need of visiting clinic/doctor each time. The effective use of the personal diabetes and heart rate monitoring using web server database is described and demonstrated in this paper. The test results and outcome of testing shows that monitoring the ketone levels by measuring the acetone amount in breath is possible. The algorithm to calculate breath acetone can be improved to achieve better accuracy in system.

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