Asthma Care Apps

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***Abstract*— A novel Asthma electronic prototype device and its application for the Android smartphone are proposed in this paper. The device can be used to by an asthma patient to track asthma symptoms, triggers, and medications on a daily basis. The patient data can then be automatically shared with his/her doctor and family via an online service. This device can be very useful, efficient and helpful for the suffering patient, since it provides he doctors with precise data anywhere in the world without the need of any intervention by physical therapist. This application will allow doctors to follow their patients passively for medical check. This electronic prototype device consists of a microcontroller with a flow meter detector and a Bluetooth transmitter circuit to send data to the android Smartphone. It may be suited for PC applications, such as windows, by Bluetooth connectivity. Asthma Care Apps can be directly downloaded from the PC to the Smartphone as well. This well designed device will minimize the frustration of teenagers caused by doctor visits, help them live a healthier and a less stressful life. Furthermore, doctors are less disturbed by their patients who may have misread the data. The main objective of this work is to develop a telemedicine system which can manage asthma data for patients in childhood without the need of frequent visits at health care centers. This system includes the development of a multi-functional device that can solve the problem of daily patient's monitoring. A graphical interface will be added to make it more user friendly for patients of all ages without the need of any external help.**

Keywords -- Asthma Care, Smartphone Applications, PEF, Peak Flow Meter, Bluetooth, Amplifier, High Pass Filter.

I. INTRODUCTION

Smart Mobile Phones are the most accessible form of technology globally and offer a highly convenient system for self monitoring coupled with instantaneous feedback, and thus potentially engaging the patient in the monitoring and management of their asthma [4]. According to some researches, patients of all ages are participated in a study which clearly verified the effectiveness of the mobile use for tracking the asthma [5-6].

Mobile apps are opening new ways for technology to improve people's health [1] without adversely affecting the all-important doctor-patient relationship. Many health professionals support the virtual delivery of healthcare services to assist patients with daily management of chronic conditions. According to the World Health Organization (WHO), an estimated 300 million people suffer from asthma worldwide [2]. Children are mostly affected by this chronic disease. This disease is a public health problem in both rich and poor countries.

The majority of asthma patients use a device (mechanical or digital) many times per day to manage their disease [3]. The main problem that patients (young and old) find with using these devices is that they always need an assistant. In addition, doctors are contacted many times per day by their patents because they are reading data incorrectly. These problems are solved by Asthma Care Apps and the prototype described in this paper.

Asthma Care Apps is an electronic device with a smart phone application designed to help people cope with asthma. It transforms the written asthma action plan into an interactive application allowing users to recognize and respond to their asthma symptoms regardless of their location. The concept of the asthma care apps is explained in section II. In section III, the hardware of the proposed prototype is described. Results are shown in section IV followed by a brief conclusion in section V.

II. ASTHMA CARE APPS

Figure 1 shows the proposed system for the Asthma Care Application (ACA). This system is mainly composed of two components and an internet service. The two components are the flow meter and microcontroller-based control circuit; the internet service is Bluetooth. This system is used to establish an interactive medium between patients and doctors in a way to make patients feel they are managing their disease in a simple and effective way. The patient's breath test is read and recorded using a simple prototype device and then sent to the appropriate doctor.

Fig. 1. Asthma Care Apps Proposed System

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The Smartphone is used to collect and process the patient measured data received from the flow meter sensor via a Bluetooth wireless connection in order to come up with the actual asthma level of the patient. Moreover, an application of the asthma care is created and installed on the Smartphone with a simple user friendly interface. It contributes to manage the saved measured data in the Smartphone memory and send them to doctor's monitoring system via a Wi-Fi Internet connection. The application has the ability to display in real time the current measured data of the air flow when the patient blows through the flow meter. This would make the patient feels comfortable in coping with his disease.

Since Asthma Apps Care is a user friendly device that does not require complex software/hardware skills, it can be accessed instantly and easily for daily use.

A. The Peak Flow Meter

The Peak Flow Meter, also known as peak expiratory flow (PEF), measures the maximum level of a forced expiratory air flow rate parameter, It is an electro-mechanical device used for the measurement of the asthma level of the patient; it requires a careful handling to ensure that the patient level of asthma is precisely measured. It is a portable, easy-to-use device that measures how well your lungs are working. As for asthma patients, their doctors may recommend that they have to use a peak flow meter to help track their asthma systems. Moreover, it can be used by both children and adults.

Peak Flow Meter is an active device and should only have one button (The Power Button). The additional functionality added to this Flow Meter is Bluetooth connectivity, as shown in figure 2; which will make easy to connect smart cell phones.

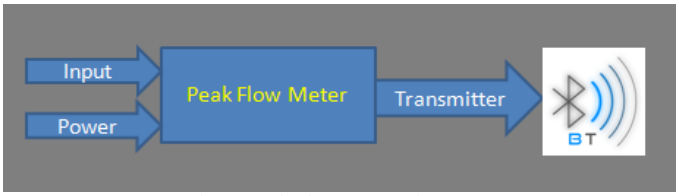


Fig. 2. Peak Flow Meter Diagram

B. Asthma Care Apps for Android

Asthma Care Apps is an intelligent asthma application software which combines together everything you need to manage the patient's asthma, and may also help to prevent and/or control asthma attacks [7-8]. This application can set reminders for medicine and measurements, record symptoms and triggers, track, share and review multiple accounts online with the patient's doctor. In addition it can share vital information with healthcare providers and family members. In this application, the cell phone will automatically connect to the Peak Flow Meter system and will display the current measurement result; history of the measured values will be emailed to the doctor [5]. The asthma care application logo is shown in figure 3.

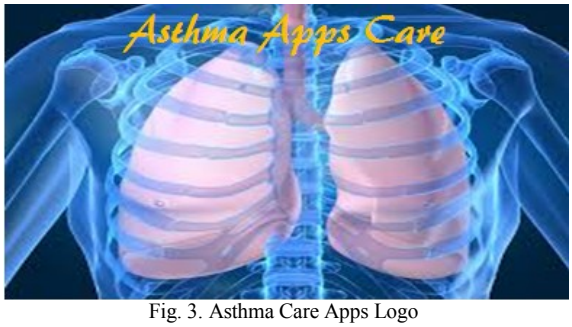


Fig. 3. Asthma Care Apps Logo

The application will fulfill the following requirements

- The application is easy to install
- The application is easy to use
- The application is efficient in terms of processing
- The application is durable and up-to-date

A digital system is used to calculate the level of asthma. This can be shown via a graph displaying of the early stage of the asthma and the state the patient. As shown in Figure 4, three zones of measurement are commonly used to interpret Peak Flow Rates. These three zones are Good, Caution and Medical Alert. In general, a normal peak flow rate can vary as much as 20 percent from the normal value described by Equations 1 (for Men) and Equation 2 (for women) [9].

Man:

$$ln(PEF)=0.544\ ln(age) - 0.015\ age - 74.7/ht + 5.48 \quad \textbf{(Eq. 1)}$$

Woman

$$ln(PEF)=0.376\ ln(age) - 0.012\ age - 58.8/ht + 5.63 \quad \textbf{(Eq. 2)}$$

where ln(x) is the natural logarithm of *x*, age is in years and *ht* is height (cm) of the patient.

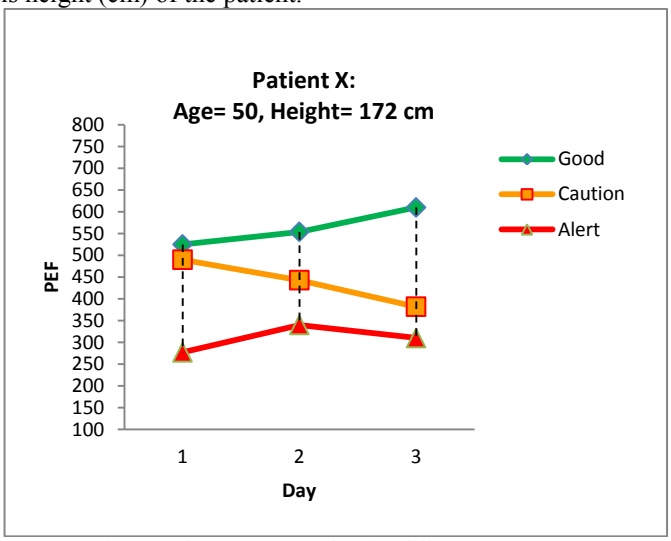


Fig. 4. Asthma Care Apps showing daily measurements

-*Good Zone:* 80 to 100 percent of the measured value over the normal value calculated by the equation 1 or 2. The reading value in this zone means that the asthma of the patient is practically in good control [1].

-*Caution Zone:* 50 to 80 percent of the measured value over the normal value calculated by the equation 1 or 2. The reading value in this zone means that the asthma of the patient can get better or worse depending on the patient activities, or the patient is in need of some medications [1].
-*Medical Alert Zone:* When the ratio of the measured value to the normal value calculated is less than 50 percent, the peak flow rate indicates a Medical Alert. In this zone, an immediate action should be taken. The patient must take his/her rescue medications right away and must contact his/her doctor or any nearby health center [1].

In each case, the application will help the patient to take the required step at each zone.

III. HARDWARE SYSTEM IMPLEMENTATION OF THE PROPOSED SYSTEM

The block diagram of the proposed (ACA) system is shown in figure 5. It is mainly composed of two devices, the flow meter and a hardware PCB. The main device is the flow meter connected to a control circuit. The control circuit is composed of a high pass filter, signal amplifier, stabilizer named as Trigger, microcontroller and Bluetooth device. In order to use the device without the Smart Phone, a digital screen can be provided to give the patient the ability to test himself or herself.

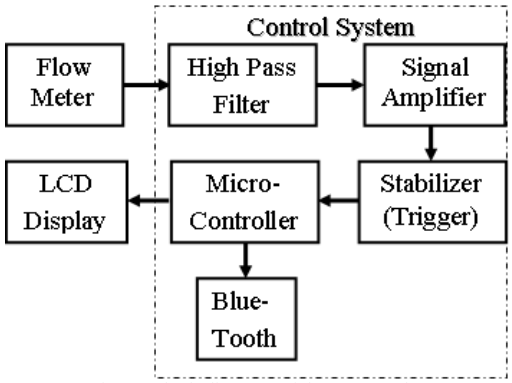


Fig. 5. Block diagram of the proposed ACA

The Peak Flow Meter of Asthma Care Apps is powered by a 9-Voly battery, which accommodates the need of the hardware system such as microcontroller and Bluetooth transmission. This component is a necessity to make Peak Flow Meter of Asthma Care Apps not only unique in terms, but also special.

Looking inside the Asthma Care Apps system hardware in Figure 6, the microcontroller is the central unit. It's operated with a clock of 4MHz to supply enough data to its connected components and also receive accurate data instantaneously. The flow meter plays an essential role by supplying the data (analog signal) to the microcontroller after signal filtering, signal amplification and stabilizing with precision as done in standard Peak Flow Meter and in Digital Peak Flow Meter.

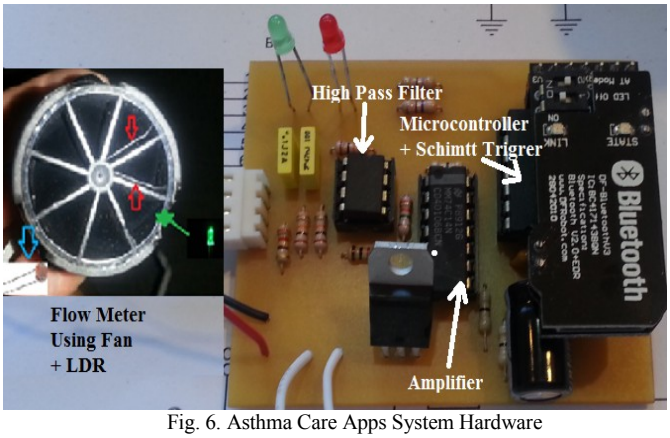


Fig. 6. Asthma Care Apps System Hardware

The flow meter is calibrated using a flow meter calibration device as shown in figure 7.

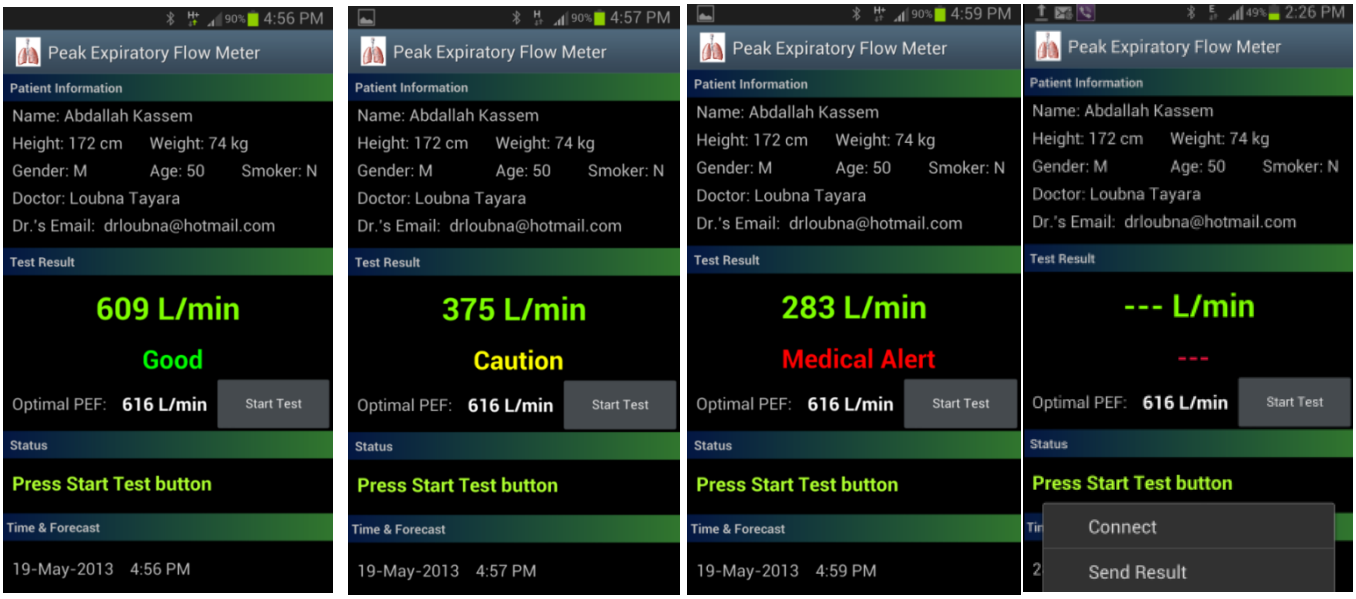

Fig. 7. A Flow Meter Calibration Device

IV. SPECIFICATIONS AND PRIMARY RESULTS

In order to demonstrate the efficiency of the proposed ACA system, patient personal information such as: name, age, gender, height, and weight, should be entered on the smart phone. In addition, the doctor's name and email address are also entered before the device can turn on.

When the prototype device is on, the microcontroller waits an interval of time to load its program and the searches a Smartphone's Bluetooth module previously paired to establish a wireless connection. While the connection is successful with the smart phone, the patient should press a start test on his/her smart phone and blows air on the flow meter sensor. In case the patient did not blow air in 5 seconds, the system will ask again to start testing. The patient blows three times and the maximum blow is taken by the system. A green LED is on when the system and the smart phone are connected and ready to use. In addition a red LED is used when the system is in progress.

The Smartphone collects the measurement data received which is the peak flow from the flow meter via a Bluetooth. Data are processed to produce the asthma level of the patient by an application program using Android operating system as shown in figure 8. Date and time are then recorded. Moreover, the patient can send the saved data to a selected doctor for medical advice. The sent information are shown in figure 9, where the last column indicates the asthma level to help the doctor compare the measurement values with the predicted values according to equations 1 and 2. This can help both patient and doctor to cooperate without disturbing each other.



(a) (b) (c) (d)

Fig. 8. Asthma level produces by ACA system, (a) Good zone, (b) Caution zone , (c) Medical Alert zone, (d) Connecting to the Bluetooth and sending rsults to the selected doctor

Dear Dr. Lobna Tayara,
The following are my last PEF measurements.
Name: Abdallah Kassem Age: 50 Gender: M
Height: 172 cm Weight: 74 kg Smoker: No

Date	Time	Measured (l/min)	Optimal (l/min)	Level
16-04-13	7:00	609	616	Good
16-04-13	10:00	375	616	Caution
16-04-13	15:00	283	616	Alert
17-04-13	7:10	365	616	Caution
17-04-13	11:20	390	616	Caution
17-04-13	15:34	300	616	Alert

Please give me your feedback,
Regards,
Abdallah

Fig. 9. Patient Information sent to doctor

V. CONCLUSION

The Asthma Care Application system (hardware and software) is described in this paper. This is a low-cost and easy-to-use electronic monitoring device for medical application. The results obtained, using an Android application interface on smart phone, compared favorably to the expected (theoretical) results. The tests showed a very good reproducibility and were in agreement with the pneumotachograph. Therefore, they seem to be adequate both for screening and monitoring. However, further studies are needed to assess long-term reproducibility, usability, and improvement of respiratory care.

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