

Easy Respire Device-Smart Asthma Management using IoT

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Abstract: Asthma is one of the widespread chronic diseases. Rising prevalence increases the burden of personal disease management, financial expenditures and workload, both on sides of patients and healthcare systems. According to the World Health Organization asthma is a serious public health problem with over 100 million sufferer's worldwide. Outcomes for patients with chronic respiratory diseases remain poor despite the development of novel therapies. In part, this reflects the fact that adherence to therapy is low and clinicians lack accurate methods to assess this issue. Digital technologies hold promise to overcome these barriers to care. For example, algorithmic analysis of large amounts of information collected on health status and treatment use, along with other disease relevant information such as environmental data, can be used to help guide personalized interventions that may have a positive health impact, such as establishing habitual and correct inhaler use. This paper presents an Internet of Things (IoT) based wearable device integrated with low-cost sensors and consumer graded devices along with a cellular mobile network for continuous monitoring and management of asthma patients.

Key words: *Internet of things (IoT), Arduino, Thingspeak, Telegram bot, Smart asthma management*

1. INTRODUCTION:

Asthma is a chronic lung disease that cannot be cured, but its symptoms and acute exacerbations (often called acute asthma attacks) can be controlled. There are various situations that can be a stimuli for asthma symptoms. Thus, it is difficult to protect patients from an uncontrollable environment. Over the last 20 years, the global burden of asthma has increased by almost 30%, as more than 235 million people-most of them children-cope with the breathlessness and wheezing characteristic of the disease. In particular, cases have spiked in metropolitan cities of India like Delhi, where pollution is reported to sometimes be deadly.

Asthma treatment focuses on improving overall lung function, reducing daily symptoms and preventing acute asthma attacks. Each patient has a personalized treatment and disease self-management plan designed to reduce daily symptoms, maintain optimal lung function, and allow for participation in daily life activities, while limiting the number of acute asthma attacks. It is very difficult to predict an acute asthma attack since it often occurs suddenly (i.e., within minutes) with little warning. Predicting the severity level of an asthma attack is even harder because it depends on multiple factors including the person's disease characteristics and severity, how well the disease is managed with medications, and the asthma attack trigger.. Recent success of the wearable systems that consume very little power for "sensing" tracking of environment and health

data for monitoring and managing chronic respiratory illness have led to the development of an Artificial Intelligence algorithm to perform adaptive learning for personalized prediction and treatment plans.

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. 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. 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.

Easy respire device is a sensor integrated device designed to help people cope with asthma. It senses the asthma triggering attributes using various sensors and notifies the patient to use the inhaler using telegram notifications. It transforms sensor data into an interactive application allowing users to recognize and respond to their asthma symptoms regardless of their location. These sensor data are stored on an open source cloud platform called thingspeak, which can be used by the doctor to personalize asthma patient treatment based on the data available. Many AI algorithms can be further applied to detect the severity of asthma in a patient.

2. LITERATURE SURVEY:

Wudan et al.[1] talks about better management of asthma using various wearable devices monitoring a patient,smart and connected inhalers through an app, the biologics behind the drug delivery of the inhaler and how to improve aerosol drug delivery into the lungs.

Utkarshani Jaimini et al.[2] evaluates how one of the leading reasons for pediatric admissions to children's hospitals is asthma . She also examines the examples of correlations in the data which can be useful in asthma management like the medication (Albuterol) taken by a patient possibly decreased the exhaled nitric oxide and patient's activity limitation is possibly related to high pollen activity on the same day Martin S.Holmes et al.[3] studied the need for patients' adherence to their asthma medication regime. Manually listening to recordings of inhaler use is a tedious and time consuming process and thus an algorithm which can automatically and accurately carry out this task would be of great value. This study employs a recording device attached to a commonly used dry powder inhaler to record the

acoustic signals of patients taking their prescribed medication.

Rawinan Praditsangthong et al.[4] proposed an M-Learning System where the guideline for using inhaler based on the correct inhaler technique is presented as a video. The expected outcome is that patients can develop their skill on using an inhaler device correctly. As a consequence, patients will have a low risk for their lives.

Scott W.Burgess et al.[5] carried out an invitro evaluation of an asthma dosing device. This study examines the accuracy of different smart inhaler in various clinical and research settings. Smart inhalers with dosers were comparatively studied in a top bench experiment.

James Dieffenderfer et al.[6] evaluated Low Power Wearable Systems efficiency for Continuous Monitoring of Environment and Health for Chronic Respiratory Disease. They presented preliminary results that show the wearability and functionality of each of the discussed sensor subsystems and the resulting power consumption. The proof of concept is limited to the ability of each of the sensors to produce reasonable preliminary output in controlled environments.

Kaseem et al.[7] developed asthma care apps for better management of asthma patient. His work was to develop a telemedicine system which can manage asthma data for patients in childhood without the need of frequent visits at health care centers. The system included the development of a multi-functional device that can solve the problem of daily patient's monitoring.

3. REQUIREMENTS:

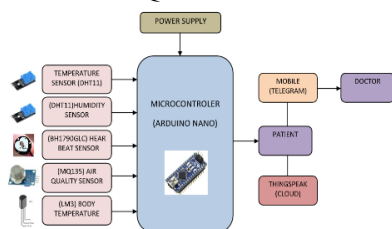


Fig 1-block diagram of requirements

3.1 Hardware requirements

3.1.1 Sensors selection criteria: It depends on the sensitivity: input parameter change required to produce a standardized output change, range: maximum and minimum values of parameters, precision and resolution. The other parameters to be considered during the selection of a sensor includes cost, size and power supply.

3.1.2 Interfacing of the sensors: The ports of the sensors were soldered to the ports of the microcontroller. The concept of interfacing sensors is giving input from sensors to microcontroller in which they can understand and act accordingly. Most of the sensors give output in analog form but the microcontroller needs input as digital so now comparators acts as interfacing sensors where they convert analog signals to digital signals. Microcontroller used: Arduino Nano. Inbuilt comparator: ATMEGA328P

3.1.3 Sensors used: 1. **Body temperature** : The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in C). This sensor is used to measure the body temperature of the patient.

2. The gas sensor: The gas sensor used is MQ-135, which detects asthma triggering pollutants like NH₃, NO_x, alcohol, Benzene, smoke, CO₂, etc.

3. The environmental temperature and humidity: DHT-11 is used to measure the surrounding temperature and humidity. NH₃, NO_x, alcohol, Benzene, smoke, CO₂, etc.

4. Heartbeat of the patient: The sensor used is BH1790GLC. It is used to measure heartbeat of the patient using infrared led and photo transistor.

5. Wifi-module: ESP8211 is used as a Wi-Fi module which is integrated with tcp/ip protocol. It is preprogrammed using AT commands set firmware. It gives the microcontroller access to the Wi-Fi network.

3.1.5. Microcontroller: A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on a single chip. Arduino nano is used as a microcontroller because it is small, flexible and compatible with the arduino software

3.2 SOFTWARE REQUIREMENTS:

3.2.1 Arduino application: The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards. Arduino is mainly used for writing, compiling and uploading the code in the Arduino device. It mainly contains two basic parts: editor and compiler where former is used for writing the code and later is used for compiling and uploading the code into the given Arduino compatible boards.

3.2.2 Thingspeak: ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates and quit. It is an IoT analytics platform service that allows you to aggregate, visualize, and analyze live data streams. ThingSpeak allows you to connect and save sensor data in the cloud and develop IoT applications. Once you send data to ThingSpeak from your devices, you can create instant visualizations of live data without having to write any code.

3.2.3 Telegram Bot: Bots are simply Telegram accounts operated by software – not people – and they'll often have AI features. They can do anything – teach, play, search, broadcast, remind, connect, integrate with other services, or even pass commands to the Internet of Things. In our case we'll pass commands to Arduino regarding threshold values of asthma attributes. we have to create a bot based on Telegram that uses an ESP8266 to control peripherals.

4. PROPOSED WORK:

An IOT based approach has been implemented to design a device to help monitor asthma patients. Easy Respire is one such device which uses various low cost sensors, telegram app for notifying the patients and the patient's data is made available on the cloud platform, Thingspeak for doctors to

further draw conclusions from the data available and personalize the treatment of an asthma patient.

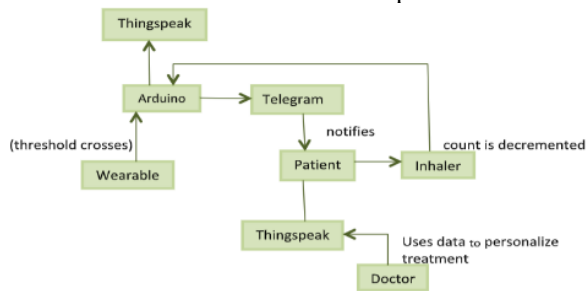


Fig 2-block diagram of working modules

4.1 Wearable device:

It consists of all sensors to measure the environmental conditions and health conditions of the patient. All the sensors are monitored using arduino software. Code is written in C programming language to control the programming of the sensors and to check the various threshold value for health condition of the patient.

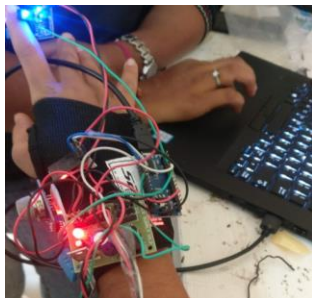


Fig 3-Wearable device

4.2 Inhaler Device:

This is used by asthma patients to inhale the drug during asthma attacks as well as during prescribed time. A Switch is implemented to this, which transforms the low availability of the drug to a notification on telegram reminding the patient to refill the device.



Fig 4- Inhaler Device

4.3 Telegram bot:

A channel is created using telegram bot which produces a Token. This Token is used and reprogrammed in arduino app to send notifications to the patient regarding the use of inhaler.



Fig 5- Telegram Bot

4.4 Cloud Storage:

The attributes sensed by the sensors are stored on thingspeak, which can be visualized using a graph. This data can be used by the doctor to study the trigger patterns of the patients and help them personalize the treatment. Further Algorithms can be applied to the data set to determine the severity of asthma in a patient.

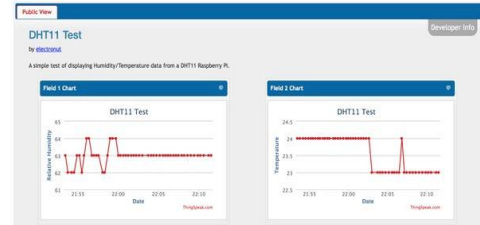


Fig 4- Thingspeak Graph Plotted For Various Attributes

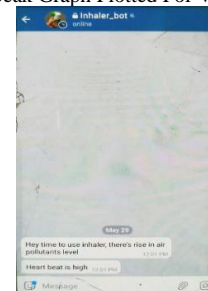


Fig 5- telegram notification

5. CONCLUSION:

Easy respire is one such system which focuses on improving the lifestyle of asthma prone patients. This paper portrayed our vision of how life can be improved for asthma sufferers through the development of a personalized smart asthma monitoring. The portrayal is based on the collected data samples and their analysis. We aim to make life easier for those who suffer from asthma by creating tailored feedback and personalized up-to-date asthma management plans using readily available data and Internet of things. Today, as an asthma sufferer, people carry around multiple medications, inhaler spacer and sensors and it is hard to keep track of everything. Our proposed architecture uses Telegram bot and cloud services to collect and aggregate the data relevant to the individual, analyze the data and provide timely and personalized feedback. In the near future, it could be used to apply different deep learning algorithms to classify different stages of asthma and the wearable device can be made wireless.

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