A mobile app that helps asthmatic patients monitor air quality in real time

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A mobile app that helps asthmatic patients monitor air quality in real time

by

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Abstract
Asthma is a chronic disease that cannot be cured. Every attack of asthma is a physical and mental destruction to patients, bringing pain and economic burden to patients, and seriously affecting the quality of life and happiness index of patients. But the vast majority of asthma cases can be completely controlled with appropriate treatment and intervention. Investigations at home and abroad have found that the self-health management level of asthma patients is still at a relatively low level, and more than half of asthma patients are in a state of out-of-control.

Currently, there is no online software that can effectively help people with allergies such as asthma check the ambient air quality and keep track of changes in the air quality. So of asthma patients need a simple and convenient mobile phone software to use, which can through to the reality and the existing network, more quickly and accurately provide people with more air quality information, makes the asthma patients can pass on these information collection, to respond to their surrounding environment, to avoid detrimental to their own conditions of the environment, so as to ease the development of the disease.

Based on the above analysis, an application that is connected with the air quality sensor network of the world's major cities need to be designed. By taking advantage of the advantages of sensors everywhere in the city, it can detect the surrounding environment and provide the effective air quality information obtained to the users more quickly and accurately. To help asthmatic patients monitor changes in their surroundings in real time, and using AR technology feature could allow people to monitor local air quality through real-time image processing. Thus, the incidence of respiratory diseases caused by changes in the air environment can be reduced.

Keywords
Asthma, Air Quality, Real-time Monitoring, AR Technology, Application
Introduction
Asthma is a common chronic respiratory disease that affects about 300 million people worldwide and is increasing at a rate of 20 to 50 percent every 10 years. Risk factors for asthma include host factors and environmental factors. Improper control can affect daily work and life, lead to a decline in the quality of life, and have a negative impact on economic burden and family life. Severe acute episodes can be fatal if left untreated. But its symptoms can be controlled by proper treatment plans, lifestyle and air quality improvement, taking necessary precautions and a lot of self-management.

Asthma is closely related to air quality. Therefore, it is of great significance to design an application that can monitor air quality in real time. Air quality detection is the detection of carbon monoxide, sulfur dioxide, ozone, suspended particulate matter and other substances in the air. The quality of air quality reflects the concentration of pollutants in the air. Air pollution is a complex phenomenon, and the concentration of air pollutants in a specific time and place is affected by many factors. Include the exhaust gas of vehicle, ship, aircraft, industrial enterprise production discharge to wait among them. Urban development density, landform and meteorology are also important factors affecting air quality.

Application can help asthmatic patients fight asthma with Internet big data. By detecting allergens in the air, it can provide a safe living environment for asthmatic patients and keep them healthy. In combination with AR technology, we can protect people with asthma and reduce the likelihood of asthma attacks. Help asthmatic patients control their symptoms and improve their quality of life.

Main body text

Section I: Context

The key to effective daily control of asthma attacks is to prevent them before they happen. A few major changes in the life may ward off the triggers that make asthma worse. In terms of external weather environment, paying attention to weather changes has a very important effect on asthma symptoms. It's also a good way to record the temperature, wind speed, barometric pressure and humidity on the day of an asthma attack. Mobile applications are expected to improve the self-management behavior of asthmatics, helping users keep track of changes in their surroundings and air quality in real time to prevent asthma. Asthma is a common disease of the respiratory system. Unlike other types of medical applications, asthma patients require long-term attention, not quick treatment, and no attention after recovery. Therefore, application with real-time monitoring technology is indispensable for asthmatic patients. It's like a 24-hour personal health steward. The real-time monitoring function of the application on the environment and air quality can effectively help asthmatic patients understand the changes in the surrounding environment and take corresponding preventive measures. Patients can simply understand the changes of the surrounding environment and air quality through the use of mobile phones. The application will also provide some academic theoretical methods to guide asthma patients to better protect themselves or improve the surrounding environment and air quality, so as to continuously improve their living environment according to the change degree of the environment and air quality and reduce the incidence of asthma.

Section II: Methods

Air quality sensors are ubiquitous in cities. This application will connect the data of these air sensors through the network big, so that people can obtain air quality information in more real time and more accurately, and respond to the surrounding environment better.

AQI is an authoritative and recognized air quality indicator in environmental monitoring. Air Quality Index (AQI) is a nonlinear, dimensionless index that can quantitatively describe air quality. The higher the value, the higher the grade and category, and the darker the color, the more serious the air pollution is and the greater the harm to human health.
According to Daily AQI Color, Values of Index, and Description of Air Quality, we can intuitively understand the corresponding Levels of Concern. Values of Index is 0-50 and the color is Green, meaning “Good”, air quality is considered satisfactory, and air pollution poses little or no risk. For color yellow, values of index is 51 to 100, air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution. For 101 to 150, “Unhealthy for Sensitive Groups”, orange color, means members of sensitive groups may experience health effects. The general public is not likely to be affected. For 151 to 200, “Unhealthy”, red, everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects. For “Very Unhealthy”, 201 to 300, purple, health warnings of emery conditions. The entire population is more likely to be affected. For 301 and higher, “Hazardous”, maroon, health alert: everyone may experience more serious health effects.

For people with chronic diseases, physical and psychological stress can be high, and overwork (aggressive or prolonged physical labor, intense competitive sports); Mental factors (mood swings can be a trigger. Worrying, sadness, overexcitement, even laughter) are all possible triggers for an asthma attack. Therefore, in the application of color matching, this application also improved according to the color system of AQI, reducing the purity of the overall color, making the color softer and more lively, giving people a relaxed, natural and positive feeling.
In the design process of the application, AQI icon also be designed. First of all, small clouds were selected as the design prototype to represent air quality, and personified facial expressions were added, so that users could intuitively and affectionately see the meaning represented by each icon when it appeared. According to the quality of the air, expressions representing the surrounding air quality are displayed, such as smiling, expressionless, sad, wearing a mask, disinfectant mask and gas mask. Meanwhile, the color of the whole icon is also one-to-one corresponding to the color of AQI. In this way, asthma patients are constantly familiar with the AQI situation represented by different colors and icons from multiple aspects, so as to effectively and intuitively pay attention to the changes in air quality and environmental severity. In this way, the user's memory burden can be reduced and the logic of the whole app can be strengthened.

Through expert interviews, user interviews and questionnaire surveys, the status quo of health management of asthma patients was fully investigated, and the influence of changes in air quality on the incidence of asthma patients was understood.

To clarify the dependence of asthma patients on high quality air quality and find the influence index of poor air quality on asthma patients.

To maximize the range of environmental monitoring of air quality that people with asthma need to know in their daily lives. Combined with the analysis of each age group, the following four contents are summarized:
1. Real-time monitoring of indoor and outdoor air quality is needed in daily life.
2. Real-time monitoring of air quality during travel
3. Find out about air quality in other areas when traveling or going abroad
4. Trip data recording and air quality analysis

Although color and mascot expression can be intuitive to see the change of the surrounding environment and air quality, and a healthy environment and air quality range values, but in the environment and air quality monitoring data provided to users at the same time, also want to consider further the meaning of the data in patients with asthma. If just provide users with these numbers, that does not have any practical meaning. While providing real-time data to users, the application helps users improve and enhance their ability to monitor the air quality of the surrounding environment, so that they can live in a more comfortable environment. The ability to prevent, control, and provide self-awareness and management of acute attacks is especially important for patients with asthma. Application can update relevant knowledge content in a timely manner to provide patients with more asthma related knowledge. Users can not only conduct intuitive data detection, but also improve their own understanding and control ability of air quality.

Given the nature of asthma, which requires significant attention in terms of prevention, it is necessary to know what kind of weather causes asthma attacks to help prevent the onset of asthma symptoms. For example, people with asthma should stay indoors because cold air can cause bronchial spasms or bring in pollen. Diet, asthma patients should eat more light, easy to digest, low protein, rich in vitamin A, vitamin C, calcium food. Do not smoke, do not drink alcohol, smoking as a stimulant, may directly trigger asthma. In the attack of bronchial asthma, due to shortness of breath, sweating and other easy to form sputum blocking small bronchus, so should drink more water. Psychologically, keeping a good attitude can prevent asthma from getting worse. These knowledge points can be learned by asthmatic patients using the application.

Section III: Results

The real-time monitoring application is called AirCare, and based on previous research, it has four functions:
The first major feature is real-time monitoring of indoor and outdoor environments. This part mainly divided into two parts, the first part is the indoor real-time monitoring, the user can on the home page intuitive by numerical and the change of different colors, see the indoor environment, contains the AQI value, scope of AQI is located at the moment, suggested that health value and the current state of the health value of indoor environment, the date and location of the present time, the basic weather conditions, etc. It will also provide a knowledgeable explanation of AQI to users who are new to or unfamiliar with the AQI value. Let the user further familiar with and understand the specific meaning of each color and icon. In addition to the basic situation that users see, AirCare will also integrate virtual world information into a real world environment and interact with it use AR technology. For example, in AirCare, users can click the photo button on the right top conner to enter the corresponding interface and monitor the surrounding air quality in real time by taking a picture in real time. In the interface at this moment, the specific AQI value and corresponding AQI icon will appear in the real time camera lens. Users can intuitively understand the surrounding air quality and health range. In the process of real-time monitoring, users can also take photos and record them at any time, which will contain the basic information such as the time, location and AQI value of the air quality. Users can save the pictures to the album for recording or directly send them to their friends or doctors for communication. Users can enter the details page by clicking on the basic information of the home page. In the details page, the user can further understand the value of each air quality index, and according to the change of each value, AirCare will also provide professional explanation and advice on how to effectively increase or decrease these indicators, so that the user can improve the environment and air quality at the home by themselves.
In the home page, user can click the "scan" button in the upper right corner to monitor the surrounding environment.

User can get the real-time surrounding environment situation by taking photos.

Environmental changes are visually represented by color and position changes.

Users can click the download button to save the photos locally.

Users have multiple ways to upload the photo to other software.

When user click the cancel button, it will automatically return to the main screen.

In the home page, user can click the big number to check the environment details.

Here shows the details about the indoor environment. Also prompt the user what can be improved.

App provides tips for reducing NO2, as well as some extended reading.
The second part is the outdoor monitoring record. The same as the indoor monitoring, this part will directly show the outdoor real-time environmental changes, such as the normal range, time, date and basic weather conditions. In addition, there are detail pages, which will record the numerical changes of each allergen in depth. Also through the way of historical records, a week, a day or even an hour of the external environment changes to record. It is convenient for users to observe the general trend of environment and weather changes. In addition, in the history record, users can also select the value change of an allergen that more interested in.

User Flow 2 - Home Screen (Outdoor Details)

As an asthmatic who needs to go outside, users can learn about outdoor air quality as soon as possible and be prepared when they go outside.

In the home page, user can click the big number to check the environment details.

User can get the pollen data and pollutants.

User can get pollen data forecast and air quality forecast.

User can get the advice for health and data history.
The second main function is to work out the best driving route according to the user’s destination and surrounding environment. Combined with the basic features of the map, users can choose the form of riding, taking a bus and walking. In the “Local Air Quality” screen will display AQI situation of destination, the time needed for each path to the destination route and methods within the scope of the change of the environment, the map will be through the corresponding color of the cover to show the environment, and recommend the best route, the user can also make reasonable choice according to oneself circumstance. So when asthma patients go to travel, they do not have to worry about sudden changes in the surrounding environment.

User Flow 3 - Local Air Quality

As an outdoors asthmatic, the user can find a route with the best air quality, thereby reducing the risk of asthma attacks.
The third main function is to browse the air quality of the country, for asthma patients who want to travel or go aboard, it will help them to reasonably specify the tourist site and plan the route. In the interface, users can see the map of the whole world and the environmental changes of each region. They can also select the overall environmental situation of the country they want to see by selecting the region. Users can also zoom in and out to see changes in the environment for specific cities and regions. By selecting the environmental AQI values of different regions on the map, the specific location and local time can be understood in detail. Users can also select their own acceptable AQI range by selecting the AQI range at the bottom of the screen.

**User Flow 4 - Global Air Quality**

As an asthma sufferer who wants to travel abroad, users can keep track of air quality in other countries, choose the best travel route and take preventive measures.
User can click "Global Air Quality" part from home page.

In the "Global Air Quality" part, user can choose the place they want to check the AQI.

Users can swipe the filter to choose the country they are interested.

When user click the place they are interested, it shows the details.

Users can also adjust the AQI range to see air quality around the world.

Users can also adjust the AQI range to see air quality around the world.

User can change the country shows order.

User can move the map page to find the place they are interested.

User can move the map page to find the place they are interested.
The fourth function is to record and analyze the air quality environment of places or routes frequently visited by asthmatic users. AirCare uses a history of a patient's location to select frequent or desired places to visit and monitor changes in air quality in real time. Users can also select a place to set it by themselves, and the application will track the air quality by itself, send real-time air quality report to the user, and remind the user when the air quality is not ideal. Asthma patients can grasp the first-hand information in a timely manner, better planning their own itinerary or travel routes.

For asthmatic patients, it is urgent to have an application that can monitor the surrounding air quality in real time, just like having a real-time medical butler at the side. This is an application for asthmatic patients. Asthma patients should use Internet big data to fight asthma. In the context of mobile health care, a data platform and related health management system with professional monitoring and timely feedback are designed to facilitate patients with high and severe incidence to timely know about their own bodies and environmental changes, and facilitate medical treatment, daily care and other information. Let asthma patients monitor the surrounding air quality at any time and feel free to travel whenever they want.

Section IV: Evaluation & Discussion

AirCare is a set of real-time air quality monitoring application. Including the country's air quality index rating, hot news, local news, air purification product recommendations, weather forecast, positioning, in addition to monitoring air quality, but also to provide weather information, health advice function, powerful function. Through the four aspects of indoor and outdoor air quality real-time monitoring, driving route planning, nationwide air quality browsing and historical record analysis, the incidence of asthma patients due to changes in air quality is well avoided. Among them, real-time display of the current indoor and outdoor air quality, ready for the user to go out; provide air pollution dynamic map, so that users can quickly grasp the movement of air pollution within the travel range; support domestic and foreign cities to seamlessly connect, provide real-time air quality index; according to the daily air quality and the physical condition of the user, provide suggestions for going out and protection; maintain daily/hourly AQI records for 7 days. It is a data platform and related health management system designed for professional monitoring, timely feedback, convenient for high-incidence and severe patients to know their own body and environmental changes in time, convenient for medical treatment, daily care and other information under the background of mobile health care.
Conclusions
With the development of society, smartphones have become a necessity of people's daily life, while the Internet is also setting off a profound change on a global scale that affects all levels of human beings with the power to change the world. In the Internet era, the medical industry also has a new direction of development.

In such networked times, an application for asthmatics, a smart application that lets asthmatics fight their asthma with Internet big data, is a promising tool for improving asthma monitoring and management. Self-management of asthma is essential to improve health, and changes in the surrounding environment and air quality are also the daily concerns of asthma patients. As an application for real-time monitoring of air quality environment, AirCare has practicability and reliability, and can be widely used in daily air quality monitoring of asthma patients.

In the commercial era with the continuous development of mobile phones, the application has become more and more humanized, bringing a lot of convenience to people's lives. The development of application has gradually become an important industry in the Internet, and has attracted attention from many aspects. As a new medium, mobile devices are welcomed by the public, while application is an extension of mobile devices. Air quality is related to the environment we live in and affects the incidence of asthma patients. Monitoring air quality can improve the quality of life of asthma patients and improve their happiness index. In the era of the popularity of mobile application, how to combine air quality monitoring with application is a topic of common concern for us.

References
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AirCare

A mobile real-time monitoring application helping asthma patients find out surrounding environments.

Designed by: Jiani Su
Audience

About 300 million people worldwide who suffer from asthma.

Also, other people who are concerned about indoor and outdoor air quality.
About Asthma

Asthma is a common chronic respiratory disease. The risk factors of asthma include both host factors and environmental factors. In patients with asthma, a severe acute attack can be fatal if left untreated. Poorly controlled asthma patients will affect daily work and daily life, leading to a decline in the quality of life, and bring economic burden and negative impact on family life.
Main Purpose

By detecting allergens in the surrounding indoor and outdoor environments, we can provide a safe living environment for asthma patients and keep them in a healthy state. Combined with AR technology, we can protect asthma patients and reduce the potential for asthma attacks.
Prompt

To reduce the impact of respiratory disease caused by allergens and pollution in the environment.
Problem

It is difficult to see real time information about allergy, pollution and other airborne elements.
Solution

An application connected to a network of air quality sensors located in major cities all over the world could provide people with accurate air quality information so they can react to their environment.

An additional AR feature could allow people to monitor their local air quality through real-time image processing.
AQI Icon

0 - 50 Good
51 - 100 Moderate
101 - 150 Unhealthy for sensitive groups
151 - 200 Unhealthy
201 - 300 Very Unhealthy
301 - 500 Hazardous
Home Screen

- Indoor and outdoor air quality
- Introduce AQI
Indoor Details

- AR technology
- Details of indoor air quality and provide solutions
Outdoor Details

- Pollen data
- Pollutants
- Pollen date forecast
- Air quality forecast
- Advice for health
- Data history

Image: Mobile app interface showing outdoor air quality and pollen data.
Local Air Quality

- Provide the best route for fresh air
Global Air Quality

- Pay attention to the changes of air quality in the world
- Regional air quality
Landing Page

- Reliable global data
- Monitored environment
- Reminder of air pollution
Research

- World Health Organization

indoor allergens (for example, house dust mites in bedding, carpets and stuffed furniture, pollution and pet dander)
outdoor allergens (such as pollens and moulds)
tobacco smoke
chemical irritants in the workplace
air pollution.
# Research

<table>
<thead>
<tr>
<th>Air Quality Index (AQI) Values</th>
<th>Levels of Health Concern</th>
<th>Colors</th>
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<tr>
<td>0 to 50</td>
<td>Good</td>
<td>Green</td>
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<tr>
<td>51 to 100</td>
<td>Moderate</td>
<td>Yellow</td>
</tr>
<tr>
<td>101 to 150</td>
<td>Unhealthy for Sensitive Groups</td>
<td>Orange</td>
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<td>151 to 200</td>
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<td>301 to 500</td>
<td>Hazardous</td>
<td>Maroon</td>
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</tbody>
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Change

Before

After
Conclusion

- Before exercise
- Go back home
- Travel
Thank You So Much