

Respiratory Function Checking Device

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Abstract: As one of lifestyle-related diseases, COPD has been drawing attention. Since there is no pain and no feel COPD is difficult to be detected at an early stage. In this project, a cheap and easy operation Respiratory Function Checking (RFC) Tester is designed for personal use and the accuracy is as high as the spirometer used in hospitals. The tester is consisted of a microphone for measuring the breathing out and a smart-phone for recording the breath sound and calculating the parameters related to lung function. The structure is very simple but the accuracy is so-so high compering the spirometer used in hospitals.

1. Background and Purpose

Chronic Obstructive Pulmonary Disease (COPD) is a disease that causes inflammation in bronchial and alveolar cells by inhaling cigarette smoke or atmospheric contamination(Fig.1). When it occurs, patient will feel breathlessness even with a little exercise or moving the body. In the worst case, it becomes dyspnea etc. In addition, COPD is easy to make person becoming depression, causing metabolic syndrome, angina pectoris and osteoporosis and so on. This disease is a mild symptoms and suffers long-term continuous cough and mild breathing, so it is difficult to detect early, it has often become severe at the stage of consultation. It is thought that because the spirometer (Fig.2) required for COPD examination is not in the immediate vicinity and the respiratory function test cannot be performed easily as a cause of delay in discovery. There are several products that have already been commercialized, but the measurement result is not so ideal and the pulmonary function parameters obtained are not sufficient for diagnosing COPD. Therefore, we attempted to develop a device that can easily perform breathing function test at each household.

2. Concept and Idea

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The concept of the product is a Respiratory Function Checking Tester with simple structure, easy operation, used as a health-care checking device at each house. This tester consists a microphone for measuring the breathing out and a smart-phone for recording the breath sound and calculating the parameters related to lung function (Fig.3). Since the sensor part is only the microphone and the vibrating diaphragm, its structure becomes very simple. Further almost smart-phones have equipped the audio chip so that one just inserts the microphone sensor wire into the earphone jack of the smart-phone it will work. The lung function parameters calculation and results display can be done easily by an application software. The application software was also developed available for demonstration.

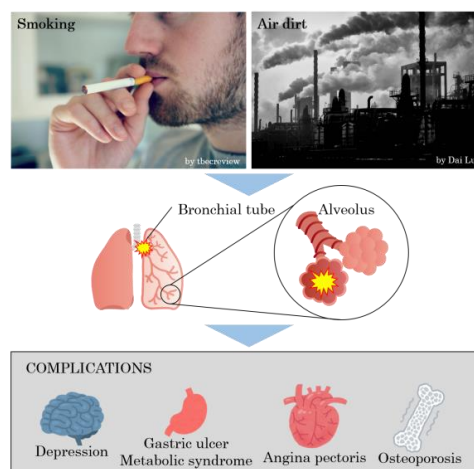


Fig.1 Causes of COPD and its complications.

3. Design and Functions

Since the microphone will capture the unexpected surrounding sounds a single frequency vibrating diaphragm is introduced in order to remove the unexpected surrounding sound. The designed prototype is shown in Fig.4. The microphone in the tester be easily connected to smart-phone through its earphone jack. For recording the data and calculating the pulmonary function parameters, the application software working on Android OS has been developed (Fig.5). There are several important respiratory function parameters: FVC, the Forced Virial Capacity, the ration of Forced Expiratory Volume in one second (FEV*1.0) and FVC in%. These parameters are usually obtained from the flow volume curve. In this study the breath sound data was converted estimably to the flow volume curve and (Virial Capacity) is supposed to be similar to.



Fig.2 Used in hospitals.

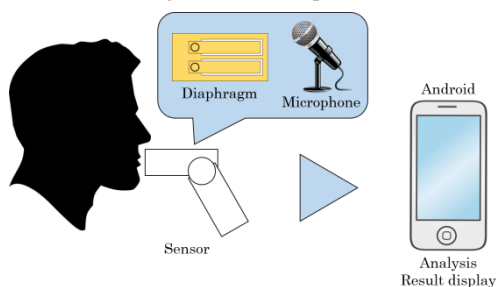


Fig.3 Concept of RFC Tester.

Now explain how to use this device:

- (1) turn on the smartphone and wait a moment breathe in as hard as you can;
- (2) push "Record" button, at same time breathe out, after breathing out completely push "Save" button to save the data;
- (3) Go to the result screen to check your

result. If your pulmonary function parameters are and it means your lung is in health condition, otherwise you are recommended to go hospital and take a close pulmonary examination.

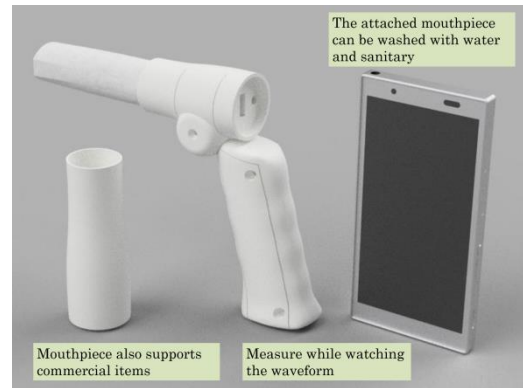


Fig.4 Respiratory function checking tester.

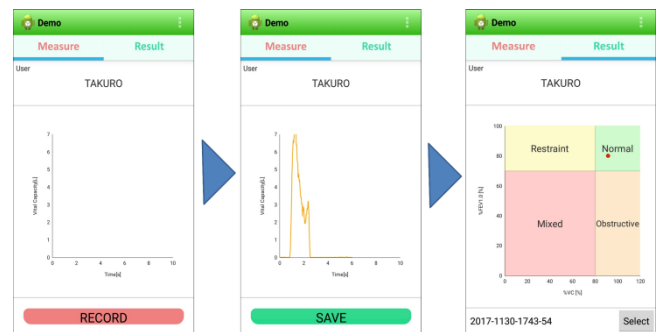


Fig.5 Smart-phone application software.

4. Problems and Future Work

In order to sale this prototype RFC Tester in the market, there are still many research works should be done:

- (1) Parameters calculation algorithm improvement: to get as high accuracy as the Spirometer.
- (2) Smartphone application modification: to make it friendlier to the users.
- (3) Appearance design of device: to make customers want to buy.

5. Reference

Chest Corporation >> Product introduction >> Spirometer >> Electronic spirometer HI-801
<http://www.chest-mi.co.jp/product/hi-801>.