Apnea detection system

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Abstract* - In this article was developed algorithm that can give an accurate result of having apnea, a disease that causes breathing st\op for short interval at night. Together with a device that consists of an accelerometer and a control mechanism, the algorithm makes it possible to diagnose apnea yourself at home.

Key words – data analysis, apnea, computer diagnostic, health, breathing.

I. Introduction

Apnea (Greek απνοια - lack of breathing) - full stop breathing during sleep that lasts at least 10 seconds. Growth of apnea can have serious consequences for human health and even threaten his life. For example, excessive daytime sleepiness can lead to automobile accidents, if a person falls asleep at the wheel. The problem of sleep is hidden, but common in nature. Almost anyone can be at risk stop breathing at night. Therefore, the study of this problem in the early stages can save lives. But a careful study requires a long time, at least one night in the hospital, which is quite difficult as the process of research and the ability to research all comers. Exactly for this computer program has been developed, which in the home can identify the main symptoms of sleep apnea - cessation of breathing. The program uses the accelerometer to determine respiratory arrest and device software development is attached to the patient's abdomen and monitors during sleep. The output of the device gives the result count of stops breathing and need access to a doctor.

The amplitude of the human respiratory close to sinusoidal dependence. The amplitude of respiration is almost night shift, but systematic decline amplitude even at 10% is an alarming sign and symptom of sleep apnea. The method of investigation is based on capturing changes in the position of the upper abdomen, which is due to breathing.

Accelerometer installed in the device delivers the input processing unit three values of body acceleration in units of G. The figure shows how these values are obtained. The values are normalized as follows:

$$X_n = X - G_e \qquad (1)$$

where X_n - Normalized value, G_e - Acceleration due to gravity of the Earth.

In general, we are interested in only the axis through which the change takes place and position of the device. Assume that this axis. Measurements will hold 20 times per second. The essence of the method is the study and processing in real time, and therefore used an additional feature, which is an indicator of changes in amplitude of respiration. This function has a direct correlation with input:

$$\Phi_i = (Z_i - \Phi_{i-1}) * \kappa_n \qquad (2)$$

Fig. 1. Referral axes

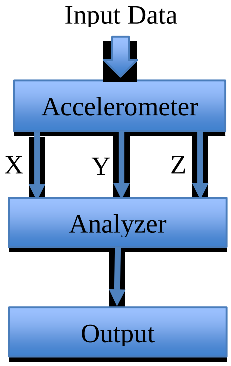

Fig. 2. System model

Where Φ_i - The function- indicator in the present time, Φ_{i-1} - The function-indicator in the last time, and κ_n - coefficient normalization of function-indicator.

This function plays a key role in identifying the fall in amplitude sinusoidal functions. Its dependency may be written:

$$\lim_{t\to\infty} \Phi(t) \to X(t) \qquad (3)$$

But in order to function indicator reflects the status of adequate amplitude, it is necessary to calibrate the initial values. This process can take up to 20 minutes. You can significantly shorten the time taken $\Phi_0 = Z_0$.

Then, the case of sleep apnea can be registered on receipt of values that satisfy the condition:

$$Z_i < \Phi_{i-1} \qquad (4)$$

As can be seen from the Eq. (3), the function is infinitely close to the input data and by Eq. (4) on the time interval $\Delta t \in [10{,}120]$ where $\Delta t = t_i - t_{(4)}$

where $t_{(4)}$ - The time at which Eq. (4) is true.

Therefore, sleep is recorded from 10 seconds to 120 seconds. The upper limit was chosen with health indicators. Along this time function indicator does not change its value until the input function does not violate the Eq. (4). In violation of Eq. (4) or at the end of the maximum time event, the algorithm continues to run in the same mode.

If you change the axis, data that can occur when turning to the side, the index Y be the input and the algorithm is executed starting from this option.

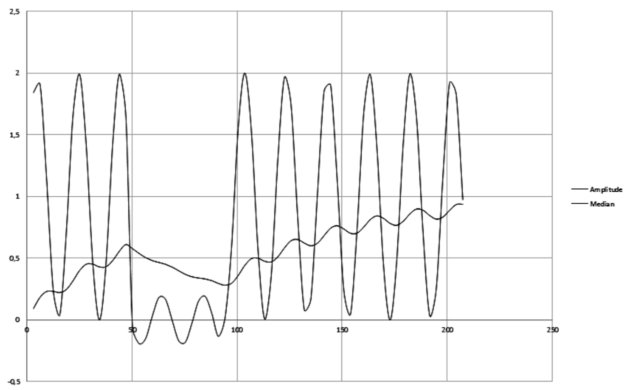

Fig. 3. Example of algorithm

Stop the algorithm executed by the morning or in the fixing of more than 10 stops breathing.

As can be seen from Fig. 3, the interval $t \in [0,50]$, median nigh to the mean amplitude. Based interval $t \in [50,100]$ amplitude decreases, but the median level and keeps dialed is greater than the amplitude in this interval. Based interval $t \in [100,200]$ amplitude begins to grow again and end stabilizes. Fig. 3 clearly shows sleep, which lasted 50 seconds.

The main problem is choose the optimal normalization coefficient κ_n. In case of this coefficient is too big (up to 0.5) function-indicator will not work correctly as can see from Fig. 4

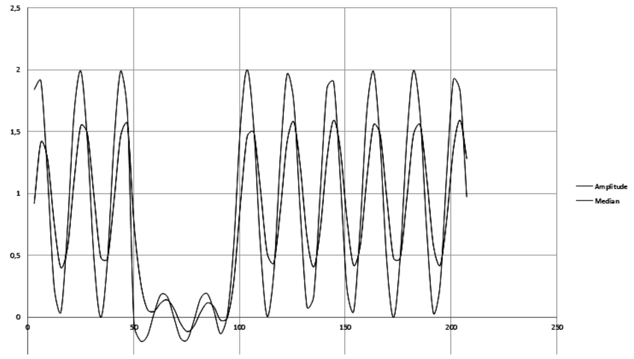

Fig. 4. Big normalization coefficient

However, if it will be too small (less than 0.001) function-indicator will grow so slow and time that need to stabilize it can reach up to 40 minutes. This is shown in Fig. 5.

II. Conclusion

Thus, the input of the device in action expected discharge outlets in hospitals and reduce the number of false hits. The project is in beta and develop further plan to expand functionality. In certain improvements device can awaken owner when notice endanger life. It is also planned to make some personal settings to the unit for your convenience.

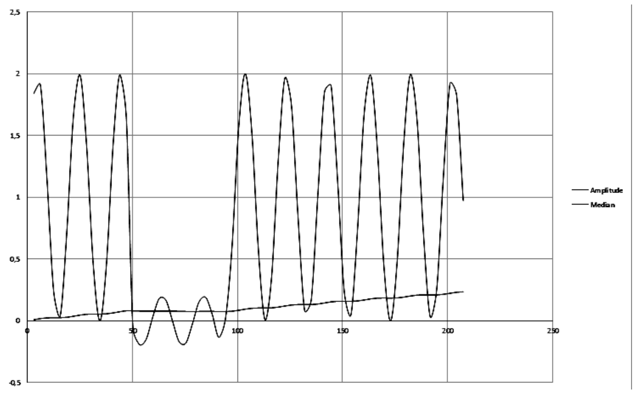

Fig. 5. Small normalization coefficient

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