Smart Pillow:Sleep Apnea Monitoring and Minimization Device

Sleep Apnea is a mutual disorder of sleep caused by obstructing airflow due to collapse of the soft tissue surrounding the upper airway of mouth or throat, and normal breathing would start again with a loud snort or choking sound. A traditional identification process of Sleep Apnea is polysomnography, which can only be accompanied in sleep centre with specific announcements, thus it is costly and problematic. In addition, it is utilized for understanding the conditions, without treatment work. Supplementary detecting techniques are Electrocardiogram (ECG), Pulse Oximeter, microphone or taking a video.

In this paper, we propose and implement IoT based real time auto adjustable smart pillow system, we targeted only obstructive Sleep Apnea, initially it detects the attack and adjust the pillow accordingly if patient does not recover due to high Apnea attack it produces an alarm, so that the person lying beside the patient would awake to cater the situation and doctor would also be notified through IoT. Likened with current analysis or usage devices, the pillow is comfortable, non-invasive, inexpensive and portable, which can be used at home or during travelling.

Sleep Apnea is a communal syndrome of sleep caused by obstructing airflow due to collapse of the soft tissue surrounding the upper airway of mouth or throat. Person who have Sleep Apnea stop breathing repeatedly while sleep, even in some cases, it happens hundreds of times. This means the brain and the rest of the body may not get enough oxygen. In the world, the overall ratio of sleep Apnea is about 2% to 4% (about 200 million Sleep Apnea patient all over the world) and about 80% of people don't know that they have Sleep Apnea.

In order to facilitate patients, the proposed solution is comfortable, non-invasive, portable and less expensive. Besides these facilities, the product detects and treats Sleep Apnea and also establishes the communication between the patient and the doctor easier. The pillow consists of different sensors mainly pulse oximeter, gyro and accelerometer, from which the oxygen level of body, chest movement and alignment of a body will be detected and transmitted to the main processing unit. Pillow will receive signals from the sensors and detects whether Apnea event occurred or not, if Apnea event occurred then it will transmit the signal to the MCU i.e. microcontroller used to adjust the air bladder in the pillow and at the same time main processing unit send its data to IoT database via WLAN, both doctor and patient have their excess to see report on regular bases.

Sleep Apnea attack can be identified in real-time by measuring oxygen saturation and desaturation in the blood, heart rate and body position of a patient by using the pulse oximeter and gyro+accelerometer sensors respectively. The data of these sensors are transmitted wirelessly to main processing unit (controller) which detects Sleep Apnea event. If apnea event occurred then the main processing unit will transmit the adjustment command using adjustment algorithm based on the position of a patient. The pillow consists of six air packets, which inflate or deflate the air through air pump according to which the shape and height of the pillow can be adjusted automatically to minimize the Sleep Apnea attack. In contrast, after the adjustment of the pillow, the sensors monitors continuously the oxygen level of the blood, heart rate, chest movement and body position of a patient to appraise the efficiency of the pillow and to meet appropriate adjustment scheme. To adjust the pillow, a real-time Sleep Apnea detection and classification algorithm is proposed.

If the duration of Sleep Apnea exceeds above a certain level, the chances of heart attack may increase. To avoid this, the controller sends command to produce an alarm in order to alert the patient's partner and also send the message through a mobile application, which is connected to the system via a Bluetooth device, meanwhile controller also transmits the data to the server, which is accessible to the doctor and the patient. All these components are wirelessly connected, to make patient's sleep comfortable.

Many different performances, experiments and tests have been left for the further work (i.e. the testing with real data are very time taking tasks, requiring even many days to complete a single attempt). Future work includes closer analysis of specific mechanisms, curiosity or new proposals to try different methods. This paper has been mainly focused on the new technique for the detection and treatment of sleep Apnea and the IoT has also been introduced. The following are the ideas which could be worked on: 1. It would be exciting to consider the use of actuator instead of air bags, as actuators are good enough for feedback control and it is easy to determine accurate position from it. 2. A sensor would also be placed near nose to detect the air flow, either patient is inhaling/exhaling or not.