Smart Pillow

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Abstract—Sleep is a vital, often neglected, component of every person’s overall health and wellbeing. Sleep is important because it enables the body to repair and be fit and ready for another day. Lack of sleep can affect overall health and makes prone to serious medical conditions, such as obesity, heart disease, high blood pressure and diabetes.

In order to overcome this problem, an idea of a smart pillow that is sensitive to snoring was developed. This pillow will help in falling asleep by allowing you to listen to music through the pillow and letting you choose music from your favourite sources. You can set a sleep timer in the app so that the music will stop automatically. Also, it helps in analysing sleep and optimally wakes up. This pillow links to a Smartphone app, so that one can see their sleep data, including snore score.

Smart pillow relies upon vibration to indicate to the sleeper when he snores while sleeping. The pillow has a touch sensor so that the system is enabled automatically when the person places his/her head on pillow and is idle when he raises his head up. When it analyses a snoring sound, it will turn on a vibration motor so that the sleeper wakes up. When a sleeper changes their sleeping position, they are more likely to settle into a different position that will prevent snoring. It uses a 3-axis gyroscope to detect your motion throughout the night and provide data on the quality of your sleep. It can generate binaural waves to make you fall asleep easily.

Keywords—Gyroscope, Binaural waves, Obesity.

I. INTRODUCTION

Sleep, a resting state within which our body is not active and therefore the mind is insensible. Sleep is that the act of slumbering. At now, our body systems can refresh themselves. English lexicon outlined sleep as a state of body and mind that relapse for many hours nightly, the eyes closed, the body muscles relaxed, and the nervous system is idle.

Sleep deficiency can cause the increasing of the risk of heart unwellness, high blood pressure and stroke. moreover, it conjointly helps to maintain the balance of hormones within the body. Lack of sleep causes the increasing of hormone level and also the leptin level can decrease. In fact, this explains the link between inadequate sleep and avoirdupois. Besides, sleep conjointly supports growth and developments. If our body concerned in deep sleep state of affairs, it'll trigger our body to unharness the growth-promoting hormones that may boost the muscle mass and facilitate to repair the cells and tissues in the body.

To maintain a healthy body and have a healthy life, human needs enough sleep. Sleep is a part of human’s life and it involves in human’s daily routine because for adults, they need to sleep at least 7 hours to 9 hours per day (National Sleep Foundation, 2015). Hence, around one-third of our time is used to sleep. Sleeping helps in resting human’s brain. But, the quality of sleep varies with everyone. By monitoring the physiological parameters during sleeping, the quality of sleep can be determined. Therefore, the quality of sleep of humans plays an important role in monitoring their physiological parameters. Hence, a specially designed Low-Cost Smart Pillow is needed to provide the second option to users and let user more understand and monitor his/her sleeping quality and improve it.
Internet of things, IoT, is an important part of the new generation of information technology, have developed rapidly both in theory and practice since proposed and derived many applications such as smart home, intelligent environmental monitoring. Things not only liberated a lot of manpower, but also achieved a standardized, automated management.

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. So many researchers have worked on implementing the smart pillow for the future. Some of the researcher’s work that helped us while working on this project have been shared below.

Sensor pillow system for monitoring respiration and body movement in sleep has been developed. The aim of this research is to develop “Sensor Pillow System” to measure the physical parameters in sleep without constraint to human. The performance of the system has been shown experimentally with comparison to the count of video or image and the medical equipment with the number of respirations counted by the pillow system [1].

Real-time Auto Adjustable Smart Pillow System for Sleep Apnea Detection and Treatment. The goal of this research is to develop a real time and auto adjustable smart pillow system. The system is capable to notice sleep apnea in real time using a pulse oximeter to adjust the height and shape of the pillow in order mitigate sleep apnea [2].

Smart Pillow Intelligent system to comfort newborn infants using vibration and monitoring movement of the infants via wireless. This Intelligent pillow is a device that can make an active improvement even when parents are not around to their baby by providing comfort both to the child and the parents. Therefore, they designed this pillow to play heartbeat vibrations and measure PPG signals to comfort the baby [3].

Sensor Pillow and Bed Sheet System: Unconstrained Monitoring of Respiration Rate and Posture Movements During Sleep. The aim of this research is developed a low-cost sleep monitoring system for the patient based on polysomnography which will be convenient for patient deliver their need with healthcare personals and/or relatives [4].
A Smart Pillow for Health Sensing System Based on Temperature and Humidity Sensors. The smart pillow is developed to provide a relatively easy way to observe one’s sleep condition, employing temperature and humidity sensors by implanting them inside the pillow in strategic positions [5]. Smart Pillow Using Actuator Mechanism, Pressure Sensors, and Deep Learning-Based ASR. It aims to improve the existing smart pillow technology in terms of higher transformability and better human-pillow interactions which is bidirectional, thanks to the actuator mechanism, pressure sensors and ASR system [6].

Automated Smart Pillow for all Age Group. This research propose an IOT based system that is personal automated pillow that helps the person suffering from insomnia and also helps person suffering from sleep this system is connected to phone through internet and it has massager embedded in it as well as the speaker is there which will work when alarm is turned on [7]. An IoT-based smart pillow for sleep quality monitoring in AAL environments. The pillow is able to forward the gathered information to a server through a wireless router with a static NAT configuration. Subsequently, user and medical staff can obtain the information and determine their quality of sleep [8].

Smart-Pillow: An IoT Based Device for Stress Detection considering Sleeping Habits. A system which helps in stressfulness of a person based on sleeping habits was proposed. Physiological parameters such as temperature, blood pressure, respiration rate, and heart rate tend to vary during the NREM (Non-Rapid Eye Movement) and REM (Rapid Eye Movement) stages of sleep. Non-physiological parameters such as the number of sleeping hours, the range of snoring, the sleeping position, and environmental conditions can also affect the quality of sleep [9].

Some of the drawbacks in proposed and existing smart pillow technologies are:

- Some researches provide design prototype for tests and demonstration purposes.
- There is an unrestrained respiration detecting system that observing a body movement and user respiration in sleep by using the camera. So, this system is not suitable for users who are worrying about an incursion of privacy.
- The proposed systems are not plug and play devices. Hence, they are difficult for daily usage purpose.
- Some designs do not monitor required parameters for analysis of sleep.
- The research is based on complex design without help of newly evolving technology.
- The sleep data is not conveniently available every time to the user.

The purpose of this project is to design a Smart Pillow using IOT for providing a good quality of sleep for the person or patient. The advances in information and communication technologies have led to the emergence of Internet of Things (IOT). In the modern health care environment, the usage of IOT technologies brings convenience of physicians and patients, since they are applied to various medical areas (such as real-time monitoring, patient information management, and healthcare management). The patient can be monitored and sophisticated by different parameters like touch identification-based music activation, Android mobile based alarm settings, gyro sensor-based sleeping analysis plotting in cloud using Thing speak, snoring detection using sound detection sensor etc.

This pillow will improve the sleep quality and quantity in multiple ways. The main features of this pillow are:

- Built in speakers to listen to your favourite music or the custom sounds.
- The app lets you check sleep data, set alarms, see your snore score.
- The pillows battery lasts for the whole week and charges via micro USB.
- The pillowcase can be removable and washable.
- It is not only smart but also super comfortable.
III. IMPLEMENTATION

The microcontroller used is Arduino and every input and output modules are interfaced to Arduino. To detect the presence of user, a touch sensor was used. Whenever the user lays on the pillow the output of the touch sensor becomes high and whole system will be activated. The Microphone or Sound sensor is used to get the audio signal from the user while sleeping. The sound level if is greater than the set value then it is recognised as snoring. This triggers the vibration motors to turn ON when the sound level is crossed the set value. The vibration motors are ON for a few seconds so that the user can adjust his sleeping position to minimize the snoring. The user can manually control the music system to ON/OFF the music while sleeping. The songs are loaded in Memory chip which is inserted into the MMC Driver. This is integrated to the Arduino which controls the music system. The user can set the alarm using blynk app in the mobile phone which requires a Bluetooth connection. User must set the time for the alarm to trigger. When the alarm is triggered both Music system and Vibration motors are turned ON to wake up the user from sleep. Whenever the user gets up, the touch sensor’s output becomes low which in turn shuts the system OFF.

IV. SYSTEM DESIGN

The input and output modules are connected to the Arduino pins as shown in schematic diagram. To make the system rigid modules and battery are glued to cardboard. Speakers are placed on both sides for stereo music system. To detect head position gyro sensor is placed on near the surface of pillow for free movement of gyroscope. Two vibration motors are placed on each side of cardboard to ensure even distribution of vibration to the user while sleeping.

The gyro sensor values are transmitted to Thing speak. A delay of 30sec is placed while retrieving values. The graph plotted is used for sleep pattern analysis, more the fluctuation in graph less is the sleep quality. Three batteries each of rating 4V 1Amp are connected in series producing a total of 12V 1 Amp rating. Audio Amplifier is connected to the speakers for adjusting the volume. Two switches are used, one for switching on the system and other for the music system. Bluetooth terminal app can be used to connect the Bluetooth module (HC-05) of the system for setting of alarm. For the convenience of user, a potentiometer is used to change the sensitivity of the microphone according to their snoring level.
V. RESULTS

“Smart Pillow” has been designed and implemented successfully. The features, Snore detection and reduction, music system, alarm system, sleep quality analysis, have been successfully implemented.

Raw data from gyroscope is used and normalization function to get normalized data. This data has been plotted in a 2d graph as shown below. X-axis mentions the time of data acquired and Y-axis mentions the value of particular axis of the gyroscope. A histogram of instability is also plotted for better understanding of sleep quality.

Severe fluctuations were observed in the below graphs from which we can conclude that sleep quality of the user is poor.

![Graph showing the axis of Gyroscope and the Instability of sleep during a certain period](image-url)
VI. CONCLUSION

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC with help of growing technology, the project has been successfully implemented. The “Smart Pillow” was successfully implemented with the resources available and further looking to integrate some more advanced features.

VII. FUTURE SCOPE

Our project “Smart pillow” is mainly intended to design an intelligent smart pillow system which is used to provide a good sleep and also monitors the analysis of patient sleeping quality. Further it can be integrated with some of the following features:

- By adding WebRTC it was possible to transmit audio and video in real time securely.
- By connecting raspberry pi3 processor, it has inbuilt Wi-Fi so no need to connect extra Wi-Fi module.
- This pillow can be modified with pressure pads to generate patterns of pressure which can massage head to relax the user.
- According to irregular sleep patterns of the user the pillow can insist to change the sleep pattern for healthy and efficient sleep.
- A dedicated app for the smart pillow can be developed with all the external analysis of data obtained from the pillow for detailed explanation of sleep patterns, quality of sleep and solutions to sleep problems.
- Further thermal heaters and cooling system with a secure circuit protection can be infused into the pillow to control the temperature and feel better.

REFERENCES

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