CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Adarsh S. Ambati

Project Number

J0801

Project Title

Low-Cost, Cloud-based, Contactless Vital Signs Monitor Using Photoplethysmographic Imaging & Infrared Sensing Techniques

Abstract

Objectives/Goals

To design and develop a low-cost, contact-free, continuous monitoring (CFCM) prototype using Raspberry Pi that detects and logs surface body temperature and heart-rate (HR). It should have the ability to provide remote monitoring and the ability to alert the guardian of any abnormalities detected.

Methods/Materials

Designed and built a prototype using Raspberry Pi, MLX90620, and Raspberry Pi camera to detect, transmit, and display real-time temperature and HR information on a mobile device. The temperature data and the video recording are uploaded to the Cloud. The algorithms running on the Cloud server process the IR thermal sensor data and video of the subject to extract temperature and HR data. Developed an app to display temperature array, still image, and HR on a mobile device after downloading relevant data from Pi webserver.

Temperature: MLX90620, infra-red sensor, reads the temperature profile of the subject. The app displays it as a 16X4 thermal map.

Heart-Rate: Measured by Photoplethysmographic technique. The algorithm processes the video feed by using OpenCV to locate the face and distinguish the forehead region. The dominant frequency of pixel intensity variation from the green channel of the video in the forehead region (which is a result of optical absorption changes caused by alterations in blood volume due to pumping of the heart) is extracted using Fast Fourier Transform (FFT) to determine the HR.

Results

A total of 496 tests were conducted with 62 participants, and 8 tests were performed on each participant. An oximeter and non-contact electronic thermometer were used to validate the results. For temperature, my prototype had a very high accuracy rate of 99% within the specified error margin. For HR, the accuracy of my prototype was 69% within an error margin of ±10 bpm.

Conclusions/Discussion

I concluded that primary reasons for errors are lighting conditions and participant#s motion. In good, natural light, the accuracy increased by 10% - 15%. In artificial light, any subtle flicker interfered because it becomes the most dominant frequency and decreases accuracy. My future plans are to improve HR detection accuracy by adding green ambient light and higher quality video compression format. I want to add night vision camera to work in low light to detect sleep apnea and bruxism. Triggering interventional actions is another enhancement I am looking into.

Summary Statement

At a total cost of $70, my prototype is a cost-effective solution for detecting, monitoring, continuously logging and alerting the guardian of any irregularities in vital signs without even touching the subject.

Help Received

Mrs. Chung & Mr. Takemoto reviewed my project and provided general guidance. Johan Sosa, a DIY science enthusiast, helped with Cloud integration.