IoMT based Approaches for Automatic Stress Detection and Control

IFIP IOT ifip
2nd IFIP International IoT Conference
Tampa, Florida, USA
October 31st – November 1st, 2019

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Reduced energy levels Sleep issues

A state of emotional or mental strain, experienced due to internal or external circumstances is referred to as psychological stress. Under this stress, the human body releases complex hormones and chemicals such as adrenaline, cortisol, etc.

A prolonged exposure to stress may increase the risk for obesity, metabolic and cardiovascular diseases, diabetes, polycystic ovarian syndrome, as well as cancer.

(1) 75% doctor visits due to stress related disorders in USA
(2) $300 billion expenditure on stress-induced disorders each year in USA

Spire Stone - Breath

Thync's - Ultraso Vibeund Muse - EEG

Numerous applications exist that allow users to log meals, monitor total calorie intake, log sleep timings, log physical workouts and overall nutritional value. However, most of these require users to manually log this information. Both, over-reporting and under-reporting has been identified as problems with user-entered data, stimulating research to automate this.

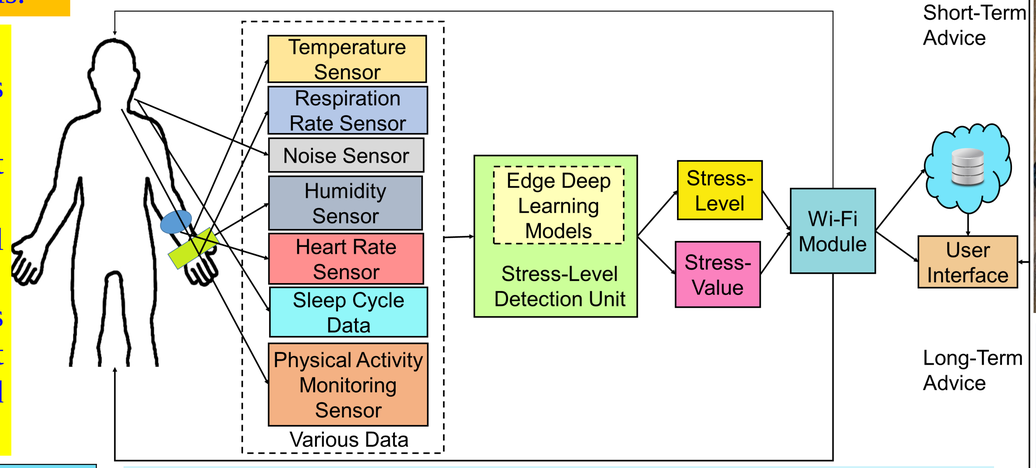
Issues of existing solutions: detection accuracy, don't account multiple stressors for more effective stress level analysis, no unified detection and management, lack fully automation features.

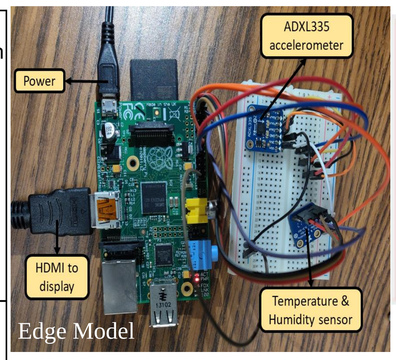
Value Proposition
(1) Allow automated stress monitoring of the soldiers by a wearable, and
(2) Notify the doctors on the battle readiness of the soldiers.
For example, based on stress level of soldiers, next physical activities and meal can be advise. A soldier can be advised to take rest before resuming deployment again.

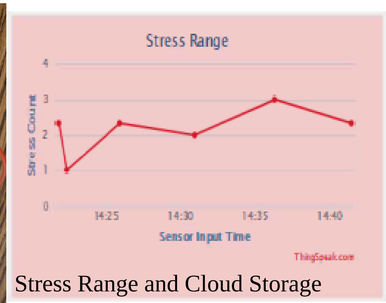
Novel Features:
(1) Smartwatches and fitness trackers tack on stress-related features as part of a variety of monitoring activities around a wrist.
(2) Targeted wearables for stress tracking: smart jewelry to head-worn devices.

We propose the following research:
Explore machine learning methods for automatic stress monitoring on edge level devices by
(1) Analyzing body temperature, rate of motion and sweat during physical activity [1,3].
(2) Analyzing the sleeping patterns and physiological changes during sleep [2].
(3) Advising various short-term and long-term solutions for stress control by taking in the effects of different stressors' in the order of their relevance, effect and accuracy to account.

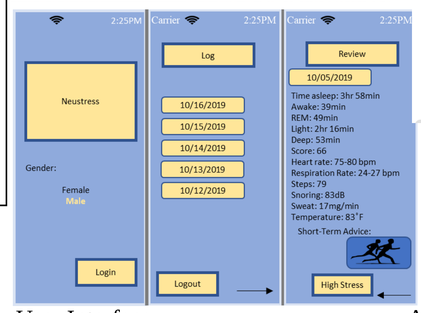
Physical exercise, yoga, meditation- heavy breathing, specific music, shower, Massage appointment, Nap, pet time..



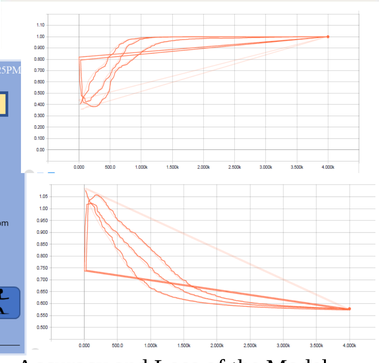




Stress Range and Cloud Storage



User Interface



Accuracy and Loss of the Model

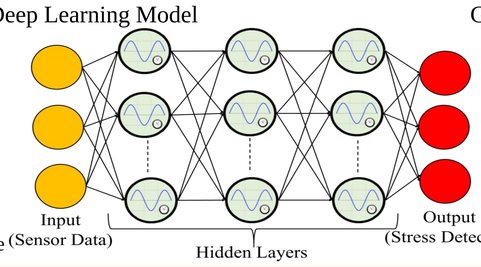
In the Notification Bar: Generate workout plan, meal plan, sleep schedule, display stress relief paintings, play music in the background, suggest videos to play, quick 2 min breathe exercise, display positive and inspirational quotes, nearby therapy dog's location, automatic slide show of photos from gallery.

Analyses

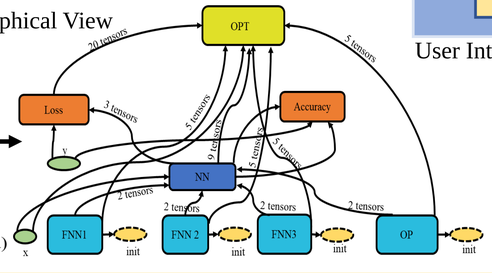
* SR (dB)	RR (bpm)	HR (bpm)	A (steps /min)	H (mg/ min)	T ℉	Stress State	
50-80	17-22	54-64	50-75	9-11.9	98-100	Low (L)	ML
80-89	23-25	65-70	75-100	12-15	90-97	Med (M)	MH
90+	25+	70+	101-120	15-20	80-90	High (H)	H

* SR- Snoring Range, RR- Respiration Rate, HR- Heart Rate, A- Accelerometer, H- Humidity, T- Temperature

Deep Learning Model



Graphical View



Using deep learning models on the edge provides an easy way of acknowledging the variations. Providing the user interface through mobile application helps users to calm themselves using control mechanisms.

[1] L. Rachakonda, S. P. Mohanty, E. Kougianos, K. Karunakaran, and M. Ganapathiraju, "Smart-Pillow: An IoT based Device for Stress Detection Considering Sleeping Habits", in *Proc. 4th IEEE International Sympo. Smart Electronic Systems*, 2018, pp. 161--166.
[2] L. Rachakonda, P. Sundaravadivel, S. P. Mohanty, E. Kougianos, and M. Ganapathiraju, "A Smart Sensor in the IoMT for Stress Level Detection", in *Proceedings of the 4th IEEE International Symposium on Smart Electronic Systems (iSES)*, 2018, pp. 141--145.
[3] L. Rachakonda, S. P. Mohanty, E. Kougianos, and P. Sundaravadivel, "Stress-Lysis: A DNN-Integrated Edge Device for Stress Level Detection in the IoMT", *IEEE Transactions on Consumer Electronics (TCE)*, Volume 65, Issue 4, November 2019, pp. 474--483.