# STRESS LEVEL PREDICTION SYSTEM INTERFACED WITH IOT

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***Abstract:*** *Stress care industry has perpetually been on the forefront in the adoption and utilization of information and communication technologies (ICT) for the efficient Stress care administration and treatment. Recent developments in ICT and the emergence of Internet of Things (IOT) have opened up new avenues for research and exploration in the all fields including medical and Stress care industry. Hospitals have started using the cell instruments for communication intent and for this intent internet of things (IOT) has been used and fused with Wi-Fi sensor node reminiscent of small sensor nodes. The usage of a cellular agent in Stress care procedure underneath Wi-Fi community environment gives a chance to explore improved services for patients and staffs reminiscent of medical professionals and nurses given that of its mobility. In this paper novel method to utilize it IOT within the field of scientific and crafty wellness care are presented. The majority of the survey exist about the different Stresscare approaches used in the IOT, similar to, wireless well-being monitoring, U-Stresscare, E-Stresscare, Age-friendly Stress care techniques. This paper describes and proposes a complete monitoring existence cycle and effective Stresscare monitoring system designed by using the IOT. The experimental results in this paper show the robust output against various medical emergencies. In this system to get the veracious evaluation results, supervising and weighing the health status of patient and to increase the power of IOT, the combination of microcontroller with sensors is presented.*

**Keywords— Stress Analysis; Heart Rate (HR); Respiration; Temperature;**

## 1. INTRODUCTION

In the modern life, stress has become more and more prevalent. Even though it can lead to serious physical and psychological issues, its sources are difficult to identify. The human environments including worksite, home or society can induce stress on an individual to some extent. There are many ways that our body can react to stress; these reactions are mainly classified to either physiological reactions which includes the 'fight or flight' response by the Autonomous nervous system (ANS) of our body or behavioral reactions which includes defensive behavior, dysfunctional and expressive behavior [1].

The stress can be mainly classified into two categories: Acute stress and Chronic stress. Acute stress is the response of the body to a stressor for very shorter period and after that the body will attain the equilibrium. Chronic stress is the one which pertains for a longer period and can produce harmful effects on our body. Stress has a vital role in almost all diseases which includes diabetes, hypertension, migraine headaches, cardiovascular diseases, mental health problems, liver cirrhosis, cancer etc [1]. Understanding the stress levels of the patients such as cancer patients and cardio patients can play a vital role in their recovery, as chronic stress can activate the cancer cells and also cause progressive growth of tumor cells in cancer patients [2][3], while in cardio patients it increase the chance of having a high blood pressure which is not desirable for them. So, it is very important to understand the stress status of a person much before the stress starts to cause some adverse effects on our body.

The main motivation behind this work is to develop a continuous stress monitoring system and thereby reduce the adverse effects of stress on mental health as well as physical health of a person. The physiological parameters such as Heart rate (HR), Temperature and Pulse are taken into consideration. IOT platform 'ThingSpeak' is utilized in this work. ThingSpeak needs an authenticated account for the data reception and its storage. So, the user has to create an account and a channel to which the data from microcontroller will be received. MATLAB analytics on data can be done via two MATLAB applications, 'MATLAB Analysis' and 'MATLAB Visualization'. In this proposed work, the data sent from the microcontroller is received on this channel and later MATLAB analysis is performed, hence enabling continuous monitoring of stress.

## 2. LITERATURE SURVEY

This section reviews the related work done on the assessment of stress, its classification and its application in the study of various medical conditions. Various physiological parameters including Galvanic Skin Response (GSR), Heart rate (HR), Respiratory rate (BPM), Blood pressure (BP) etc. can be used to evaluate the stress response of a person.

Basel Khikia et al. developed a wristband for dementia patients, consisting of GSR sensor, light sensors and accelerometer, to effectively classify "Stressed" or "Not stressed" events. They performed analysis on patients while staff making observation on their behavioral patterns. From experiment, they found that the sensor data analysis and the staff observation correlate well and they showed that different scenarios are being served by different stress level thresholds.

Seoane, Fernando, et al. focused on developing a wearable device for combatants to evaluate the physical, emotional and mental stress experienced during a combat [4]. They partitioned their project into two phases and successfully completed the first phase in this paper. First phase focused on to identify the best biomedical parameter to analyses the stress and the second phase to develop a sensorized wearable system for the measurement and analysis of the biomedical parameter to obtain different stress levels experienced by the combat. From the result of first phase they successfully found out the best bio-signal to assess the mental state of a person is ECG because vital parameters such as heart rate and respiratory rate can be obtained from ECG, which is highly automated by sympathetic nervous system. They set their future focus on developing a wearable system measuring and analyzing ECG for the detection of various types of stress.

Physiological sensing based stress analysis during assessment was studied by conducting an evaluation study on the performance of GSR with respect to stressful events [5]. For evaluation, the students, equipped with GSR and SPO2 sensors, are provided with multiple choice questions of different complexity levels. From the study, they found a strong correlation between GSR measurement and stress aroused due to complex questions.

Various other physiological parameters like Blood pressure, Heart rate variability (HRV) are also being used along with GSR for stress monitoring. Blood pressure reading along with GSR reading can classify the stress levels into mentally, physically or normal states [6]. Blood pressure and GSR readings can predict the acute hypotensive episodes in patients in intensive care units and emergency rooms [7]. HRV data along with GSR readings can be used to evaluate cardiac responses [8].

## 3. ARCHITECTURE OVERVIEW

*A. Physiological Parameters*

Several physiological parameters like Heart rate, Respiratory rate, Temperature rate can be used to monitor the activity of Sympathetic Nervous System. In this proposed model, the physiological parameters such as  and Heart rate are considered since it can be easily monitored with a wearable system and are found to be highly linked to the sympathetic nervous system.

1) Heart Rate: Heart is a muscular organ that performs a vital role in our body. It pumps the blood for our body functions and acts as a circulatory pump. The functioning of the heart is mediated by the autonomous nervous system of our body. Whenever a person experiences a 'fight or flight' situation, our body needs more oxygen for the energy build up. Blood is a connective tissue which carries the oxygen for our body. So whenever there is a need for more oxygen, the autonomous nervous of our body triggers the heart to pump more blood to the artery which carries oxygenated blood to the body parts, as a

result the heart rate increases. Heart rate is the number of times the heart pumps blood to the artery in a unit time. Hence, we can say that, Heart rate is directly linked to the Autonomous Nervous System of our body. The heart rate obtained from a PPG sensor.

2) Respiratory Rate: The respiratory rate is the rate at which breathing occurs. This is usually measured in breaths per minute. The respiratory rate in humans is measured by counting the number of breaths for one minute through counting how many times the chest rises. A breath rate sensor can be used for monitoring patients. Respiration rates may increase with fever, illness, or other medical conditions. The normal respiration rate for an adult at rest is 12 to 20 breaths per minute. A respiration rate under 12 or over 25 breaths per minute while resting is considered abnormal. Among the conditions that can change a normal respiratory rate are asthma, anxiety, pneumonia, congestive heart failure, and lung disease, use of narcotics or drug overdose.

3) Temperature Rate: The average body temperature is 98.6º Fahrenheit, but normal temperature for a healthy person can range between 97.8º to 99.1º Fahrenheit or slightly higher. Body temperature is measured using a thermometer inserted into the mouth, anus, or placed under the armpit. Body temperature can also be measured by a special thermometer inserted into the ear canal. Any temperature that is higher than a person's average body temperature is considered a fever. A drop in body temperature below 95º Fahrenheit is defined as hypothermia. Keep in mind that temperature can vary due to factors other than illness or infection. Stress, dehydration, exercise, being in a hot or cold environment, drinking a hot or cold beverage and thyroid disorders can influence body temperature. Because older adults do not control body temperature as well as younger adults, older adults may be ill without ever displaying signs of a fever.

*B. Experimental setup and Stimulus presentation*

An experimental setup was done for this research study for which an isolated room was selected so as to provide a quiet environment for the subject. The experiment was conducted on ten healthy subjects who possessed a normal vision. Each subject was explained about the methodology and scope of this experiment and a written consent for their participation in this research study was yielded. Also, before performing the experiment a survey on personal details were also conducted. A video compilation of calm and stressful scenes with a total duration of half an hour was used as stress inducing stimulus in the experiment. Visual scenes were arranged in a way that first video is a short animation movie and the readings taken during this period are discarded, since this period is meant to make the subject get acquainted with the experiment setup. The following scene is a calm video so as to make the subject calm, hence yielding a baseline threshold period. The baseline threshold is computed with the readings taken during this period. Each calm video is followed by a stress inducing scene which has a duration of approximately 10 minutes, which is again followed by another calm video with duration of approximately 5 minutes. By this way, the chance of overlapping of emotional response is avoided in this study.

*C. System Architecture*

The system design of the proposed prototype consists of three modules, a mask over mouth for respiratory rate, a finger over PPG sensor for heart rate and another finger touches the temperature sensor for temperature rate.Fig.1, shows the system architecture of the proposed work. The system consists of three main elements and ThingSpeak serving as Open IOT platform with MATLAB analytics. The three main elements are sensing elements, Microcontroller and Communication element. Various physiological parameters are sensed by the sensing elements and it is fed to the microcontroller. The microcontroller will perform the signal processing methods like filtering and sampling, prior to its transmission to the webpage, as the data from sensing elements will be raw data. The communication elements enable the transmission of the data from microcontroller to the Open IOT platform. The open IOT platform provides the provision to perform online computation on the received data. For accessing data a user account has to read the fields of the channel where the data sent from microcontroller are stored.

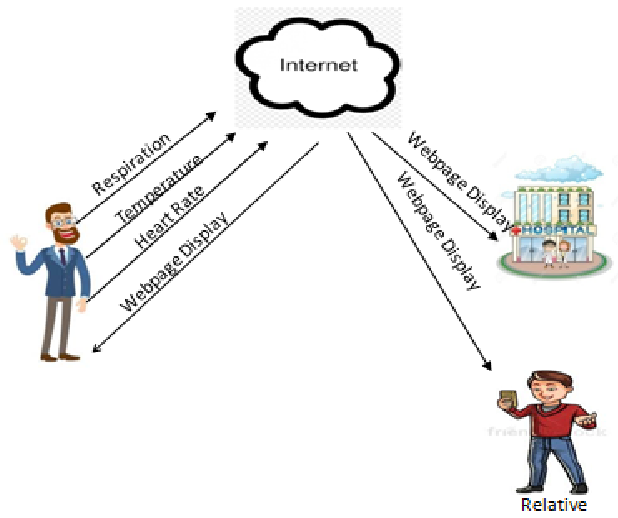


Fig.1 System architecture

The interfacing of the sensors with these channels is achieved by a microcontroller and a Wi-Fi module which enables a TCP connection for the data transmission. Once the connection is setup, the data from the sensors are sent to this cloud platform, where they get stored and later an analysis is performed on.

## 4. IMPLEMENTATION DETAILS

The proposed system is a combination of hardware and software elements performing two main functionalities such as data collection and transmission by two modules and data reception and analysis by ThingSpeak.

*A. Hardware Details*

The hardware elements consist of three modules such as smart band module and chest strap module for the measurement of respective physiological parameters from the two measurement sites. The software elements consist of Arduino software for data collection and preprocessing of raw data and MATLAB software for the data analysis in ThingSpeak. Fig.2, depicts the block diagram of the proposed work. Mask can be worn over the mouth and it consists of a Breath sensor, a finger over PPG sensor and another finger touches the temperature sensor, Arduino microcontroller, Voltage regulator and an ESP8266 Wi-Fi module. All sensors collect the respective data and fed this data to Arduino Microcontroller. The received data is then sent to ThingSpeak Webpage by establishing a TCP connection with the help of ESP8266 Wi-Fi module. The ESP8266 Wi-Fi module makes use of AT commands for the communication with ThingSpeak server. The ESP8266 Wi-Fi Module works only on 3.3v, so the 5v power from the Arduino is regulated to 3.3v using a voltage regulator. The Arduino Power supply supplies a 5v power to the Arduino Microcontroller using a battery.

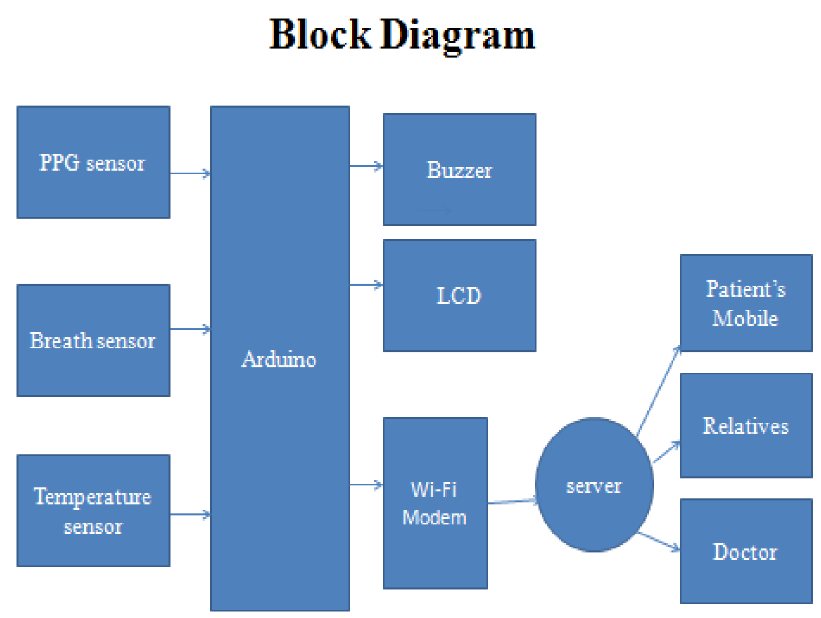


Fig.2 Block diagram of the proposed work

*B. Software Details*

The software elements consist of Arduino IDE software for data collection and transmission and ThingSpeak IoT platform with MATLAB Analytics for data reception and analysis.

1) Arduino IDE: Arduino IDE is open source software available for programming an Arduino board. It runs on any operating system such as Windows, Linux or MAC OS X. The data collection is performed using an “analogRead” function which enables the Arduino board to read an analog input pin to which the sensor is connected. Another section of program enables the TCP communication of Arduino board to Thingspeak IOT platform with the help of the AT commands of ESP8266 Wi-Fi module in the program.

2) Thingspeak IOT platform with MATLAB analytics: The ThingSpeak webpage serving as online open IoT platform have channels and fields to receive the incoming data. The platform provides MATLAB applications and Time control

Applications. MATLAB analysis on the data is performed using MATLAB application in the IoT platform. The time interval for performing the MATLAB analysis on the received data can be set using the Time Control application in the platform. Upon setting a time interval, the Timing Control application triggers the MATLAB software program to run and produce output using the received data as input variable. The data from ThingSpeak Channel is transferred to MATLAB analysis through 'ThingSpeakread' function. The reception of data using this function is followed by certain pre-processing techniques.

## 5. RESULT ANALYSIS

The study was focused on to identify the relationship of the physiological parameters such as Heart rate, Respiration rate and Temperature rate with stress induced on a person and thereby utilizing it for the analysis of stress experienced by a subject. The proposed system is tested for its functionality of stress analysis. The physiological parameters such as Heart rate, Respiration rate and Heart rate reading are obtained in the ThingSpeak platform. The incoming data to ThingSpeak Platform is received in the fields enabled in a channel for the reception of the data. Here, a stress analysis channel is created in the ThingSpeak platform, in that Fig.3 represents the Pulse rate, Fig.4 represents the Temperature rate and Fig.5 represents the Respiration rate. The data collected in these figures can be viewed by an authorized user using a Laptop or a Smartphone.

In this section, the analysis of the data obtained from a subject is explained.

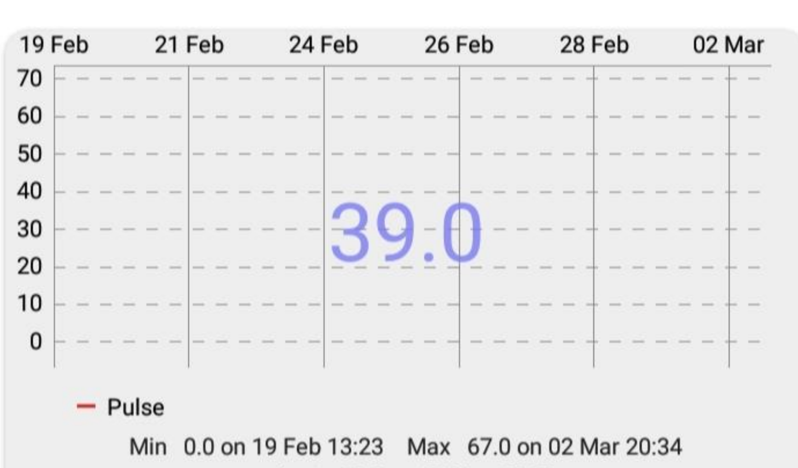


Fig.3 Pulse data obtained in the ThingSpeak channel

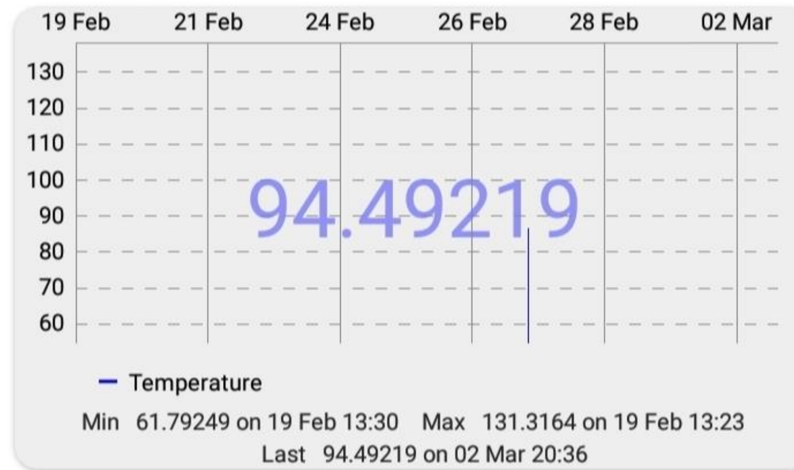


Fig.4 Temperature data obtained in the ThingSpeak channel

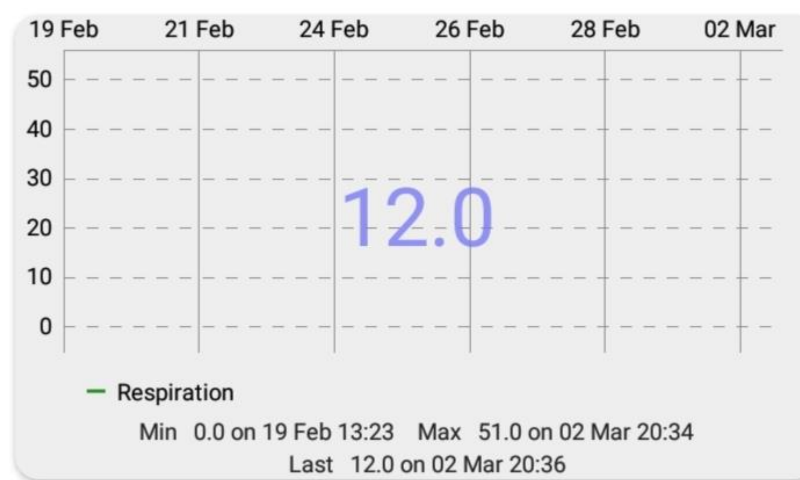


Fig.5 Respiration data obtained in the ThingSpeak channel


Fig.6 Stress data obtained in the ThingSpeak channel

The normal value of stress is between 0.2-0.3, the above and below this level is considered as stress.

Fig.6 represents the Stress level, Fig.7 represents the Sugar level, Fig.8 represents the Velocity level, Fig.9 represents the O2 level and Fig.10 represents the Co2 level.

Fig.7 Sugar data obtained in the ThingSpeak channel


Fig.8 Velocity data obtained in the ThingSpeak channel


Fig.9 O2 data obtained in the ThingSpeak channel


Fig.10 Co2 data obtained in the ThingSpeak channel

## 6. CONCLUSION

As health care administrations are essential piece of our society, computerizing these services reduces the weight on people and facilitates the measuring procedure. Additionally the easy of access of this system helps patients to rely on it. The goal of creating such a system is to decrease health mind costs by diminishing doctor office visits, hospitalizations, and demonstrative testing method. Many further upgrades can be made in the proposed system to improve it and make it effortlessly versatile, for example, including more propelled sensors. The system is expected to track and sense the ongoing information with the assistance of various sensors and help to enhance the nature of healthcare.

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