IoT Based Stress Detection and Monitoring using GSR Body Temperature and Heart Rate

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Abstract— Stress is a part of every individuals life. Stress maybe psychological, physical or both. Stress needs to be controlled monitored and eliminated. Stress affects the way a person thinks behaves and may even affect the way a person solves his problems. Stress is triggered by something called as stressors. Stressors can be classified as external stressors or internal stressors. Internal stressors are nothing but illnesses or menopause and example of external stressor is excessive work load. In order to manage stress it is important to monitor the stress levels. Hence to monitor stress levels we have formulated an idea to detect stress levels of an individual by monitoring the Galvanic Skin Response of the person, the person's body temperature, and his or her respiration rate.

Key words: IoT, GSR Body Temperature, Heart Rate, Stress Detection and Monitoring

I. INTRODUCTION

Stress is a part of every individual's life. Stress affects us in many ways directly or indirectly. It is necessary to have proper knowledge and take necessary measures to reduce the effects of stress. Our prototype will help an individual to detect any stressful event and will alert the user. Any individual maybe undergoing stressful conditions knowingly and unknowingly and this may affect an individual's health. Stress may harm the person's heart or even cause abnormalities in a person's respiration rate. Our prototype will measure a person's respiration rate, heart rate and skin conductance and body temperature and will alert the user of any stressful conditions.

Stress is a pervasive part of the modern fast-paced life. Additionally, there is a growing body of scientific research indicating that the elevated, semi-permanent stress levels many of us face are leading to a variety of health problems. By some, stress is being considered an epidemic. Stress is primarily a physical response. When stressed, the body thinks it is under attack and switches to 'fight or flight' mode, releasing a complex mix of hormones and chemicals such as adrenaline, cortisol and norepinephrine to prepare the body for physical action. This causes a number of reactions, from blood being diverted to muscles to shutting down unnecessary bodily functions such as digestion. Through the release of hormones such as adrenaline, cortisol and norepinephrine, the caveman gained a rush of energy, which prepared him to either fight the tiger or run away. That heart pounding, fast breathing sensation is the adrenaline; as well as a boost of energy, it enables us to focus our attention so we can quickly respond to the situation. In the modern world, the 'fight or flight' mode can still help us survive dangerous situations, such as reacting swiftly to a person running in front of our car by slamming on the brakes. The challenge is when our body goes into a state of stress in inappropriate situations. When blood flow is going only to the most important muscles needed to fight or flee, brain function is minimized. This can lead to an inability to 'think straight'; a state that is a great hindrance in both our work and home lives. If we are kept in a state of stress for long periods, it can be detrimental to our health

How it affects us - One of the difficulties with stress is that people experience stress in different ways. This contributes to stress manifesting itself differently. So it would be wrong to over generalize when giving advice on how to identify stress in others. However, what we can say is that because stress has negative effects, it will usually manifest itself one way or another. Stress targets the weakest part of our physiology or character; if you are prone to headaches or eczema, this will flare up. If you have low levels of patience or tolerance for others, this will be the first area to present under times of stress. Stress isn't avoidable but it is manageable. A key action in order to minimize risk is to identify stress-related problems as early as possible, so that action can be taken before serious stress-related illness occurs. There will be changes in the stressed person**.** These changes may be emotional, physical or behavioral, or a combination of all three. So, the key thing is to look out for negative changes of any kind. Bear in mind that the negative changes are also likely to have knock-on effects e.g. reduced performance at work. Of course, we all experience 'bad days', so we are really talking about situations where people display these negative changes for a period of time (e.g. 5 days in a row).Prolonged stress undoubtedly makes people ill. It is now known to contribute to heart disease, hypertension and high blood pressure, it affects the immune system, is linked to strokes, IBS (Irritable Bowel Syndrome), ulcers, diabetes, muscle and joint pain, miscarriage, allergies, alopecia and even premature tooth loss.

Stress management refers to the wide spectrum of techniques and psychotherapies aimed at controlling a person's levels of stress, especially chronic stress, usually for the purpose of improving everyday functioning. Stress produces numerous physical and mental symptoms which vary according to each individual's situational factors. These can include physical health decline as well as depression. The process of stress management is named as one of the keys to a happy and successful life in modern society. Although life provides numerous demands that can prove difficult to handle, stress management provides a number of ways to manage anxiety and maintain overall well-being. Despite stress often being thought of as a subjective experience, levels of stress are readily measurable. It may seem like there's nothing you can do about stress. The bills won't stop coming, there will never be more hours in the day, and your work and family responsibilities will always be demanding. But you have a lot more control than you might think. In fact, the simple realization that you're in control of your life is the foundation of managing stress. Stress management is all about taking charge: of your lifestyle, thoughts, emotions, and the way you deal with problems. No matter how stressful your life seems, there are

steps you can take to relieve the pressure and regain control. If you're living with high levels of stress, you're putting your entire well-being at risk. Stress wreaks havoc on your emotional equilibrium, as well as your physical health. It narrows your ability to think clearly, function effectively, and enjoy life. Effective stress management, on the other hand, helps you break the hold stress has on your life, so you can be happier, healthier, and more productive. The ultimate goal is a balanced life, with time for work, relationships, relaxation, and fun—and the resilience to hold up under pressure and meet challenges head on. But stress management is not one-size-fits-all. That's why it's important to experiment and find out in which ways you can manage stress. What if we could quickly detect and ameliorate stressful conditions continuously throughout the day? An electronic stress detection system could enable just that. We will present a prototype of a stress detection system that uses heart rate, respiration rate, and skin conductance to detect stress as well as monitor the stress levels of the patient

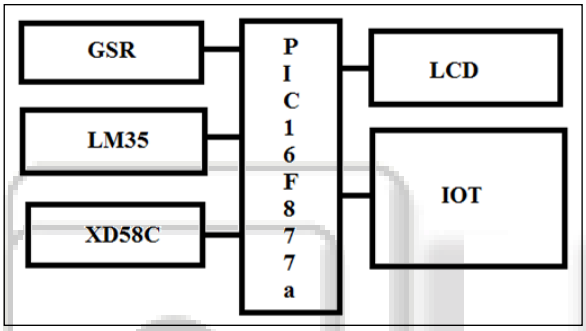

Fig. 1: Block Diagram of the system

The system will consist of a GSR sensor LM35 Temperature sensor XD58C heart rate sensor. These three sensors will measure the skin impedance, the body temperature and the heart rate of the individual. If the person is going through any stressful condition his heart rate or skin impedance changes which will be detected by these sensors and will be helpful in determining the stressful condition. The information obtained will be displayed online and also will be made available to the user in a mobile application. This information can be viewed by the person himself or even by a doctor. If a person suffering from any heart disease has to avoid any stressful conditions this module will help the individual. Doctors can use this module to monitor the stress levels of several individuals simultaneously.

II. SENSOR DESCRIPTION

1) SEN01400P - Galvanic skin response, also referred to as skin conductance (SC) or electro-dermal activity (EDA). EDA modulates the amount of sweat secretion from sweat glands. The amount of sweat glands varies across the human body, being highest in hand and foot regions (200–600 sweat glands per cm2). While sweat secretion plays a major role for thermoregulation and sensory discrimination, changes in skin conductance in hand and foot regions are also triggered quite impressively by emotional stimulation It is noteworthy to mention that both positive ("happy" or "joyful") and negative ("threatening" or "saddening") stimuli can result in an increase in arousal – and in an increase in skin conductance. Skin conductance is not under conscious control. Instead, it is modulated autonomously by sympathetic activity which drives human behavior, cognitive and emotional states on a subconscious level. Skin conductance therefore offers direct insights into autonomous emotional regulation. It can be used as alternative to self-reflective test procedures, or – even better – as additional source of insight to validate verbal self-reports or interviews of a respondent. Skin conductance is captured using skin electrodes which are easy to apply. Data is acquired with sampling rates between 1 – 10 Hz and is measured in units of micro-Siemens (μS). The time course of the signal is considered to be the result of two additive processes: a tonic base level driver, which fluctuates very slowly (seconds to minutes), and a faster-varying phasic component (fluctuating within seconds).Event-Related Skin Conductance Response (ER-SCR). Interestingly, changes in GSR can also be described within a longer time interval, e.g., while watching a video or movie. In that case, Non-Stimulus-locked Skin Conductance Responses (NS-SCR) characteristics are analyzed such as number of peaks and inter-peak latencies within a longer time window in order to characterize a respondent's emotional arousal. The synchronized acquisition of GSR with other sensors (such as optical heart rate, EEG or facial EMG) as well as video-based facial expression analysis opens completely new horizons towards multimodal experimental setups and cross-sensor analysis strategies which provide insights into the interaction of autonomous processes and higher cognitive-behavioral systems..

2) LM35 - Body temperature of an individual is an important factor which affects the galvanic skin response of the person. Suppose the person is travelling during summers, his or her perspiration rate will be comparatively high even though travelling is not a stressful condition. The external heat causes perspiration in the body and not a stressful condition. Whereas when a person is undergoing any stressful condition he or she starts perspiring and the skin impedance changes. This change will be measured by the Galvanic Skin Response sensor. But during such conditions the body temperature of the person will not increase but will remain constant. The LM35 sensor is used to determine if the stressful condition is actually a stressful condition which causes perspiration or is just an external surrounding factor which affects the perspiration rate. The LM35 series are precision integrated-circuit temperature devices with an output voltage linearlyproportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range. Lower cost is assured by

trimming and calibration at the wafer level. The low-output impedance, linear output, and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 μA from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 device is rated to operate over a −55°C to 150°C temperature range, while the LM35C device is rated for a −40°C to 110°C range (−10° with improved accuracy). The LM35-series devices are available packaged in hermetic TO transistor packages, while the LM35C, LM35CA, and LM35D devices are available in the plastic TO-92 transistor package. The LM35D device is available in an 8-lead surface-mount small-outline package and a plastic TO-220 package.

3) XD58C - Heart rate monitoring is an important factor in determining and monitoring stress. A persons heart rate should be 72 beats per minute but it is observed that if a person is undergoing a stressful condition his or her heartbeat increases. For example a person having tremendous work load will have his heart rate below average. This condition is called as Bradycardia where the persons heart rate is 60 beats per minute. This is a useful criteria to determine if a person is going a stressful event or not. We have used the XD58C sensor for measuring heart rate. Heart rate measurement along with Galvanic ski response and body temperature will be used to determine any stressful condition the person is going through. The heartbeat sensor is based on the principle of photo phlethysmography. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ (a vascular region). The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses. The basic heartbeat sensor consists of a light emitting diode and a detector like a light detecting resistor or a photodiode. The heart beat pulses causes a variation in the flow of blood to different regions of the body. When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate.

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