Design and Implementation of IoT based Stress Detection and Monitoring

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***Abstract*—Stress affects individuals in many ways which are known and unknown. A person undergoing stress is affected both physically and mentally. Stress is caused by stressors. These stressors can be internal or external stressors. Example of external stressors are work load, fights with family members and many more. Internal stressors can be classified as stress due to sickness such as menopause. Stress levels increase beyond a certain level may even lead to fatal diseases. Hence it is important to manage stress levels. To monitor these stress levels we have formulated a device which will monitor the heart rate, the galvanic skin response and the body temperature of the person.**

Index Terms—IoT, Sensors

I. INTRODUCTION

Stress is a part of every individual's life. A person big or small is greatly affected by stress. Even school going children are exposed to small levels of stress. However patients suffering from heart diseases or people who cannot work under stressful conditions need to monitor their stress levels and maintain a stress free environment. Stress is the body's natural defence against predators and danger. It flushes the body with hormones to prepare systems to evade or confront danger. This is known as the "fight-or-flight" mechanism. When we are faced with a challenge, part of our response is physical. The body activates resources to protect us by preparing us either to stay and fight or to get away as fast as possible. The body produces larger quantities of the chemicals cortisol, adrenaline, and noradrenaline. These trigger an increased heart rate, heightened muscle preparedness, sweating, and alertness. All these factors improve the ability to respond to a hazardous or challenging situation. Factors of the environment that trigger this reaction are called stressors. Examples include noises, aggressive behaviour, a speeding car, scary moments in movies, or even going out on a first date. The more stressors we experience, the more stressed we tend to feel. Stress slows normal bodily functions, such as the digestive and immune systems. All resources can then be concentrated on rapid breathing, blood flow, alertness, and muscle use. The body changes in the following ways during stress, blood pressure and pulse rate rise, breathing is faster, the digestive system slows down, immune activity decreases, the muscles become tense, and a heightened state of alertness prevents sleep. How we react to a difficult situation will affect how stress affects us and our health. A person who feels they do not have enough resources to cope will be more likely to have a stronger reaction, and one that can trigger health problems. Stressors affect individuals in different ways. Some experiences that are generally considered positive can lead to stress, such as having a baby, going on a trip, moving to a nicer house, and being promoted. This is because they often involve a major change, extra effort, new responsibilities, and a need for adaptation. They are also steps into the unknown. The person wonders if they will cope. A persistently negative response to challenges can have a detrimental effect on health and happiness. However, being aware of how you react to stressors can help reduce the negative feelings and effects of stress, and to manage it more effectively. Acute stress is a type of stress which is short-term and is the most common way that stress occurs. Acute stress is often caused by thinking about the pressures of events that have recently occurred, or upcoming demands in the near future. For example, if you have recently been involved in an argument that has caused upset or have an upcoming deadline, you may feel stress about these triggers. However, the stress will be reduced or removed once these are resolved. It does not cause the same amount of damage as long-term, chronic stress. Short-term effects include tension headaches and an upset stomach, as well as a moderate amount of distress. However, repeated instances of acute stress over a long period can become chronic and harmful. Episodic acute stress affects people who frequently experience acute stress, or whose lives present frequent triggers of stress, have episodic acute stress. A person with too many commitments and poor organization can find themselves displaying episodic stress symptoms. These include a tendency to be irritable and tense, and this irritability can affect relationships. Individuals that worry too much on a constant basis can also find themselves facing this type of stress. This type of stress can also lead to high blood pressure and disease. Chronic stress is the most harmful type of stress and grinds away over a long period. Ongoing poverty, a dysfunctional family, or an unhappy marriage can cause chronic stress. It occurs when a person never sees an escape from the cause of stress and stops seeking solutions. Sometimes, it can be caused by a traumatic experience early in life. Chronic stress can continue unnoticed, as people can become used to it, unlike acute stress that is new and often has an immediate solution. It can become part of an individual's personality, making them constantly prone to the effects of stress regardless of the scenarios they come up against. People with chronic stress are likely to have a final breakdown that can lead to suicide, violent actions, heart attacks, and strokes.

The system uses three main sensors

a. SEN01400P
b. LM35
c. XD58C

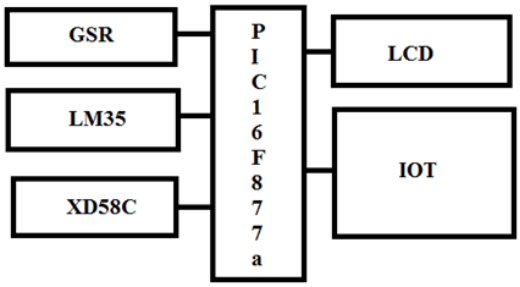

Fig. 1. Block Diagram

II. Sensor Description

1) SEN01400P:

This sensor is called as the Galvanic Skin Response (GSR) sensor. This sensor is used to measure the skin impedance of an individual. During stressful conditions the person starts perspiring. The more the stressful event the more will be the perspiration rate. Our prototype uses GSR as one of the factors to determine any stressful event. The Galvanic Skin Response (GSR), also named Electro dermal Activity (EDA) and Skin Conductance (SC), is the measure of the continuous variations in the electrical characteristics of the skin, i.e. for instance the conductance, caused by the variation of the human body sweating. The traditional theory of the GSR analysis is based on the assumption that skin resistance varies with the state of sweat glands in the skin. Human body sweating is regulated by the Autonomic Nervous System (ANS). In particular, if the sympathetic branch (SNS) of the autonomic nervous system is highly aroused, then sweat gland activity also increases, which in turn increases skin conductance, and vice versa. In this way, skin conductance can be a measure of the human Sympathetic Nervous System responses. Such system is directly involved in the emotional behavioural regulation in the humans. Additional studies highlighted the relationship between GSR signal and some mental states, such as stress, drowsiness and engagement. The GSR signal is very easy to record: in general just two electrodes put at the second and third finger of one hand are necessary. The variation of a low-voltage applied current between the two electrodes is used as measure of the EDA. Recently, new commercial healthcare devices more and more wearable and fancy (bracelets, watches) have been developed, thus such measure is usable in each research activity in the neuroscience domain also in no-laboratory settings.

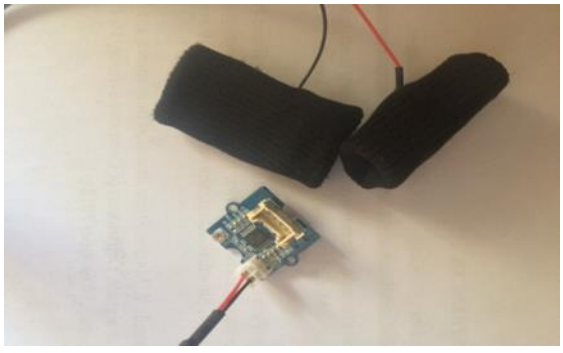

Fig. 2. Block Diagram

2) LM35:

Body temperature as well as surrounding temperature of an individual is an important factor in determining if the stressful event is an actual stressful event which causes perspiration or is an external environmental factor which causes the individual to perspire. The LM35 temperature sensor used will help in determining the surrounding temperature. If the surrounding temperature of an individual is within normal range and yet the person is perspiring a lot then the event causing such perspiration can be considered as a stressful event. However in summers when the external temperature is high it is natural that the individual will perspire more than normal. Thus the use of the temperature sensor is important. The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35-series devices are precision integrated-circuit temperature sensors, with an output voltage linearly proportional 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 temperature-sensing element is comprised of a delta-V BE architecture.

Fig. 3. LM35 Sensor

3) XD58C:

Heart rate monitoring is another important factor in determining stressful conditions. Along with the perspiration rate the heart rate of the individual also changes during stressful events. This sudden increase in heart rate of the individual indicates that the person is undergoing some stressful conditions. The XD58C sensor will help us in determining the stressful conditions. 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.

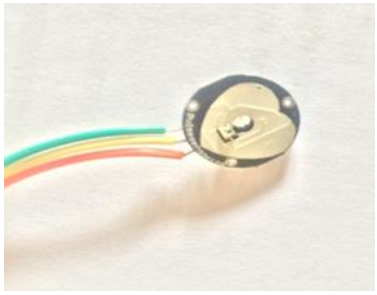

Fig. 4. XD58C Sensor

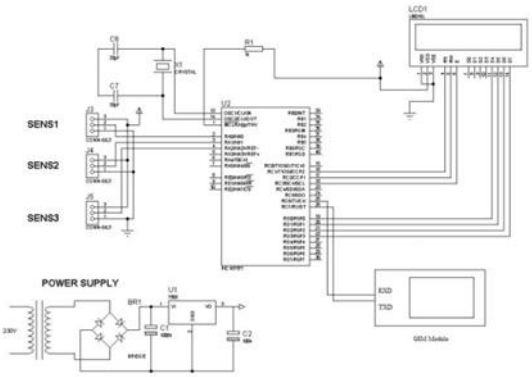

Fig. 5. Circuit diagram

III. Ideology

Our device will monitor the person's skin impedance using the GSR sensor, the person's heart rate using the XD58C sensor and the body temperature using the LM35 sensor. These three aspects will help in determining if the person is undergoing any stressful condition or not. For example if the person is undergoing tremendous work load, this will cause the persons heart beat to drop below the average heartbeat, this anomaly will be detected by XD58C sensor. In another case where a heart patient starts perspiring a lot. This is an indication that the person is going through a stressful condition. The GSR sensor will detect this anomaly and will indicate this to the user. This will help the person to avoid that stressful condition and will educate the person to avoid such similar conditions.

IV. Conclusion

Thus it can be concluded that our device will help monitoring the stress levels of an individual and will help the individual avoid stressful conditions. The device can also be used for the purpose of hospital management where the three aspects GSR, heart rate and body temperature can be continuously monitored. The use of IoT provides the flexibility of ease of access. The person or a doctor can easily access a person records and easily monitor the persons stress levels.

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