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The Scheme of Stress Detecting Tools by Using HIR333, GSR and DS18B20 Sensors Based On Microcontroller Atmega 8

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Abstract. A human stress detector has been designed with the physiological parameters of stress. Stress is a common respond to the demands of the body. There is a necessity for self adjustment, thus it causes disturbance in body's equilibrium. Nowadays, stress is not only experienced by the elders, but also young people. Stress also affects the condition of the body. When someone is stressed, the body will hold integrated reactions against the stressors. These reactions include the increasing heart rate, fast breathing, and cold sweating. The detector works on the condition of the body by using a GSR sensor to determine the conductivity of the skin, HIR333 to detect changes in heart and body temperature DS18B20, which then compared with the specified parameters.

Keyword: GSR, HIR333, DS18B20, stress, stress parameter.

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1 Introduction

The rapid growth of technology and economy has brought changes to human life. Those changes require human to always compete in life. This situation has gradually caused boredom and pressure, which often lead to stress. The cause behind stress is the difficulty in adjusting oneself to changes.

From many researches regarding stress both in psychological and medical disciplines, stress is always found as a negative contribution towards health [1-2]. This research proves that stress increases the potential of disease infection and the decline in immune system. Another negative impact is the inconvenient feeling when stress is failed to be managed. Thus, the ability to manage stress or stress management skills is highly necessary.

The signs of stress on human include the physical reactions, such as the increased heart rate and cold hand. Stress is the common reaction towards the demand of the body. Those demands are

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the requirement to self adjustment which in the process, body balance will experience some disturbance.

It is highly suggested to have early detection on stress so the serious treatment can be determined to minimize or stop the stress syndromes [3]. When syndromes are not treated early, they will cause some physical illness such as dizziness, pain, insomnia, or worse, heart attack, stroke, cancer, ulcer, Rheumatoid Arthritis and other diseases.

This problem has then become the reason behind the making of this tool. This tool is expected to guide people in recognizing stress since the early stage to avoid the impacts on their physical health. This tool is created with the combination of electronic, medical and psychological disciplines, where its measurement standard is similar to the psychological measurement scale.

2 Methods and Scheme

Stress begins with the alarm reaction towards threats which is seen from the automatic body responds, for examples the increased heart rate followed by the rejection towards stressors (stress trigger), which eventually reach the exhaustion if someone is not capable to survive. Body will form integrated reactions to face a stressor. The cortisol hormone will coordinate whole system in the body (heart, lungs, blood circulation, metabolism and immune system) to react towards the stressor.

That is why when someone is stressed, the heart rate will suddenly increase, respiration is faster and body will activate immune system on the skin, bone marrow and lymph nodes to be on guard. The blood flow will also be reduced and transferred to other priority organs. It will causes skin produces cold sweat and hand temperature decreases. These changes on the body will be caught by the sensor according to the level of the stress.

2.1 Heart Rate Sensor

The heart rate detecting sensor used the infrared type HIR333 as the transmitter and photodiode as the receiver [4]. Despite having a long wavelength, the infrared light is not able to penetrate the materials which cannot pass the visible light [5-6]. Thus, the infrared light still possesses the similar characteristics as the visible light.

Photodiode is the diode which reverse flow changes when it receives radiation. The work principle of photodiode is when given a reverse bias, a small current will flow through the diode, which temperature and intensity are dependent to the light on the depletion layer.

2.2 GSR (Galvanic Skin Response) Sensor

GSR is a sensor capable of sensing and measuring the conductivity level of skin [7-8], which differ based on the skin moisture or the salinity contained in sweat on the skin. The interesting thing that draws attention is that basically the sweat glands is influenced by the sympathetic

nerve, hence the change of someone's emotional level will affect the sweat gland in secreting sweats on skin surface. This will eventually affects the skin conductivity level.

2.3 Temperature Sensor DS18B20

The temperature sensor DS18B20 has digital version in small size, and the access method is by 1 wire serial [9-10]. This sensor saves microcontroller pin port, because 1 microcontroller pin port can be used to communicate with some other devices. This sensor performs high accuracy level, which is 0.5°C on temperature range of -10°C up to +85C.

a. Possesses a unique 64-bit serial code
b. Operates without external power supply
c. Power supply 3 – 5.5V. Obtained from data current
d. Temperature measurement from -55^{o}C - +125^{o}C
e. ADC 9 bit resolution
f. Conversion time max to750 ms

2.4 HIR333 Infrared Sensor Circuit

The infrared sensor functions to detect the heart rate through the blood flow in the hand. There are two main blocks in this circuit: heart sensor circuit and the amplifier circuit [11].

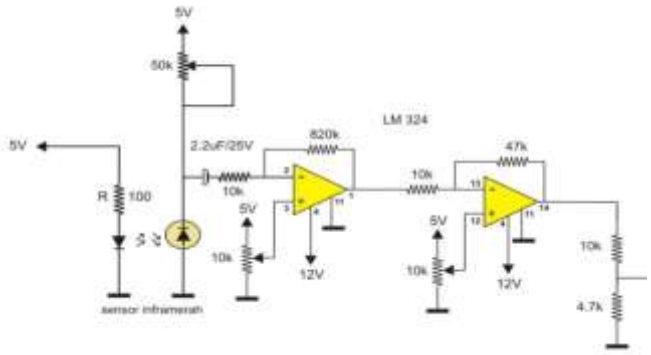

Figure 1. Heart Rate Detector Circuit

On the first op-amp, the amplifier is set to produce the 82 times reinforcement. The second op-amp is set to produce 4.7 times reinforcement. Total reinforcement is 385.4 times. Photodiode drained 10 mV upon receiving radiation from the infrared. Based on the circuit above, the output voltage from photodiode can be calculated with this equation:

$$V_{Out} = G_{total} \times V_{in} = 385.4 \times 10mV = 3.854\, Volt \quad (1)$$

On the circuit above, there is a voltage divider circuit. The divider circuit can be calculated with this following equation:

$$V_{out} = \left(\frac{R_2}{R_1 + R_2}\right) V_{in}$$

$$= \left(\frac{4{,}7K}{10K + 4.7K}\right) 3{,}854\ Volt$$

$$= 1.23\ Volt \quad (2)$$

2.5 GSR Sensor Circuit

GSR sensor made of cloth and electrode slab were placed on 2 fingers on left hand: middle finger and pointer [12-13].

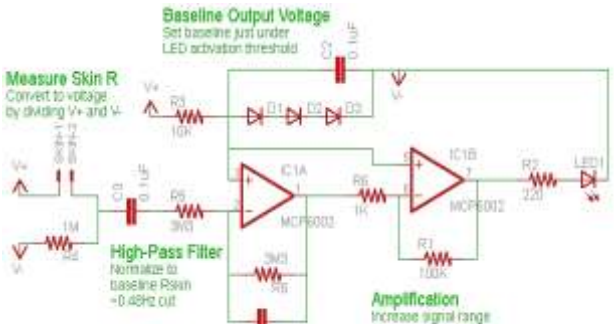

Figure 2. GSR Circuit

Human skin is a fine electric conductor. When the weak electric was sent to skin, the change on skin conduction can be measured. The variables measured are skin resistance or reciprocal, skin conductance.

According to Ohm's law, resistance skin I is equal to voltage (V) is applied between two electrodes on skin, divided with the current through skin (I). The law is stated as follows:

$$R = \frac{V}{I} \quad (3)$$

2.6 DS18B20 Sensor

Sensor was controlled by microcontroller only at 1 bit, showing the efficient use of port [14-17].

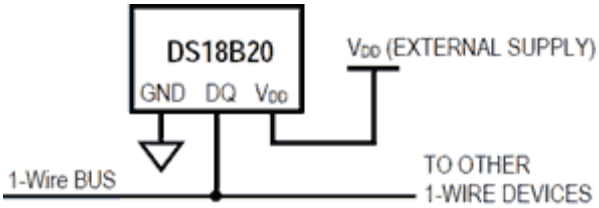

Figure 3. DS18B20 Sensor Circuit

2.7 TOOLS SCHEME: Block Diagram

This block diagram is created to learn and understand easier the work method and function of the stress detector:

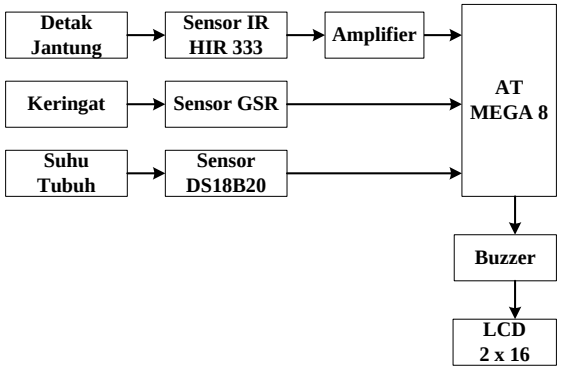

Figure 4. The Block Diagram of the Circuit

3 Result and Discussion

The overall result of the scheme is seen in this following figure:

Figure 5. Stress Detector

Table 1. The stress condition and parameter on human

Condition	Parameter		
	HR (bpm)	GSR (Siemens)	Temperature
Normal	60-90	<4	>35
Mild Stress	90-100		33-35
Severe Stress	>100	>6	<33

3.1 Overall Tool Test

The overall tool test was conducted by stringing up all the compulsory components in minimum system ATMega 8, GSR sensor, DS18B20 temperature sensor, and Heart Rate sensor which then programmed with C language by using CV-AVR 3.08 [12,18].

There were several conditions happened to this tool after the test. The available indications are normal, mild stress and heavy stress. So when the GSR is at 6 and HR is at 92 bpm, the indication is mild stress. But on this tool, one parameter is not enough. GSR, HT and temperature data must be compared because our palms will sweat along with the changing emotional condition.

Table 2. The Result Data of Heart Rate, GSR and DS18B20

No	Name	Heart Rate (bpm)	GSR (Siemens)	DS18B20 (^{o}C)	Result
1	Teguhta S	85	6	35.25	Normal
2	Putri S.	82	5	34.12	Mild Stress
3	Daniel	92	2	36.3	Normal
4	Desi Rahmanda	82	4	34.87	Mild Stress
5	Hari Saragih	78	3	35.27	Normal
6	Sarvita Simaibang	76	4	35.73	Normal
7	Edo Putra	80	1	35.22	Normal
8	Yuni Sinaga	75	2	35.89	Normal
9	Jhon Victor	96	5	35.02	Mild Stress
10	Citra Damanik	81	6	34.08	Mild Stress

When heart rate sensor was not installed to the hand, the output voltage was 0. But when it was installed, the voltage was changing according to the heart beat. When heart pumped the blood to the whole body, the blood volume in left hand's pointer finger increased, causing the light intensity on photodiode decreased and the output voltage turns bigger. This indicated that heart beat can be detected by sensor.

The external light disturbance also disrupts photodiode from obtaining the light from infrared. On the other hand, it is also influenced by the finger thickness. The thicker the finger, the smaller the intensity that photodiode can obtain [19-20]. If the hand position is not exactly between photodiode and infrared, the work method will not be in precision.

4 Conclusion

1. The photodiode sensor and infrared HIR333 (heart rate) are able to detect blood vein in human fingers with the error rate of 3.305%.
2. The temperature measurement with DS18B20 sensor performs a very good accuracy rate of 98.59%.
3. The stress detector tool can only be used if object is static and fulfill the inclusion and exclusion criteria.

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