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An Improved Design and Construction of a Portable Heartrate Monitor for Adults at Risk of Getting Heart Attacks in Uganda.

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Abstract*: In the fight to improve healthcare in Uganda, there has been a big challenge in investing in preventive measures and a lot of funds have been injected into dealing with the diseases as they surface. It is on record that most Ugandans aged 40 and above have a 50% chance of experiencing a heart attack in their lifetime. Little or no information is available for the general public about the importance of monitoring their health on a regular basis to prevent diseases that can be detected early before serious damage is done. In this paper, an improved user-friendly heart rate monitoring device has been designed and implemented to help in the detection of the signs of a likely occurrence of a heart attack.*

Keywords— Heart attack, monitoring, death, patient, heart rate

1. INTRODUCTION

Heart attack is one of the major killers in all parts of the world, especially in developing countries. In the data published by WHO in 2020, coronary heart disease deaths in Uganda reached 4.23% of total deaths, while 12 million people die throughout the world, and this accounts for 21% of deaths worldwide [1]. In Uganda, over 25 patients are admitted per month with heart attacks at Mulago National Referral Heart Institute, of which 10% are experiencing it for the first time. Survey data collected from 101 patients revealed that 62 were female, while 39 were male aged between 37 and 75 years. Out of the 25 admitted monthly, three lost their lives due to this [2]. An interview with the director at the Uganda Heart Institute revealed that of the 20 patients admitted in the emergency department, two were experiencing heart attacks. The patients that were quit were given a plan for revisits in the outpatient department to measure heart rate, blood pressure, check the heart rhythm, and electrical activity for a specified period of time so as to monitor their advancement and avoid future attacks [3]. Monitoring someone's heart status is rarely implemented because of people's attitude towards the process. In addition, the existing monitoring devices are expensive to buy and are mostly accessed at health centers, which comes at a high price for each examination [4]. This can be a financial burden to the elderly, especially those in rural areas, as they would need regular visits to these centers [5]. Most patients in low-income countries don't have access to smart phones, hence the application would not be effective enough. Biomarkers are not readily available in SSA, making it difficult to make diagnostic equipment. Doctors can easily play the role of sensitization of the already diagnosed patients. However, we identified that heart rate monitors available on the market are very expensive because the materials used for making them are rare [6]. In this paper, designing a low-cost device to measure and monitor the heart rate of adults diagnosed with heart attacks and individuals at risk of developing heart attacks is done, minimizing mortality due to ineffective patient monitoring and late diagnosis in Uganda.

2. Methodology

Design and construction

The design of the device utilizes a micro controller unit and two power sources. The output of this sub system is dependent on the power voltage of the micro controller of choice. All the other components on the circuit design draw power from the micro controller unit except the signal preconditioning circuit. The signals are to be acquired non-invasively using heart beat sensor.

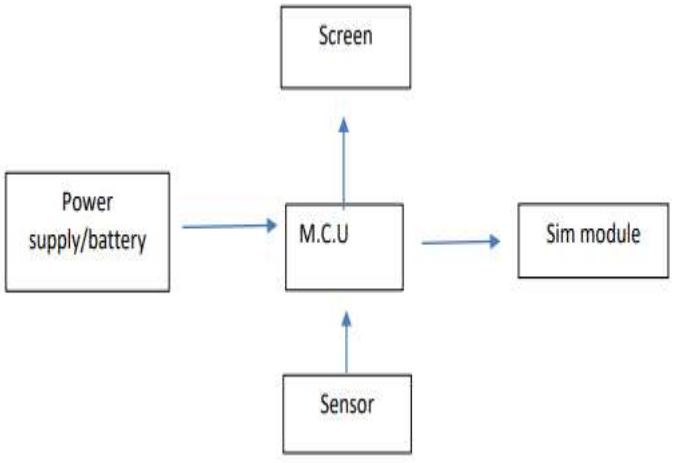

Figure 1: Block diagram of the design

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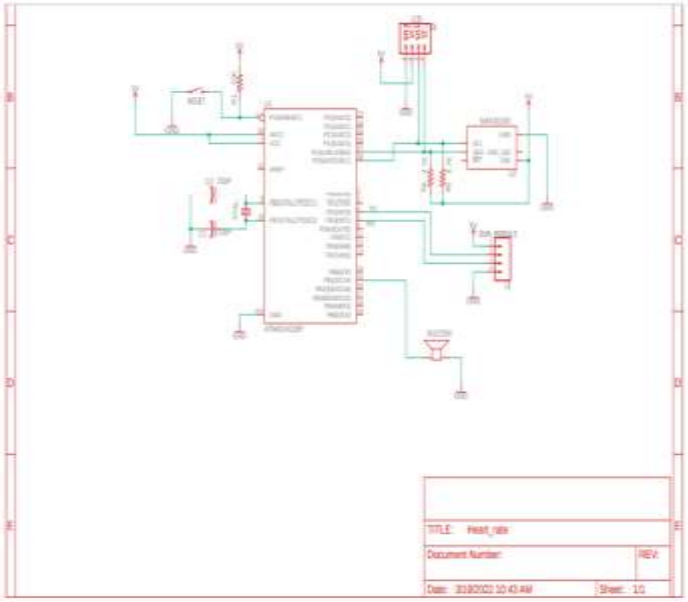

Figure 2: Circuit Diagram of the prototype

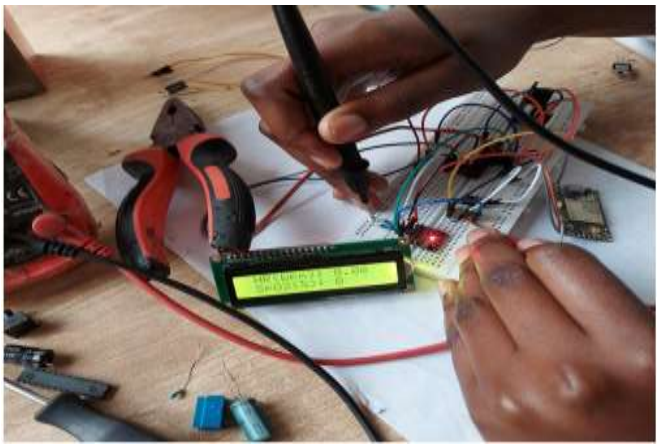

Figure 3: Testing the voltage follow in the completed circuit

The heartbeat sensor forms the photoplethysmographic sensor. When the fingertip is placed over the sensor, the volumetric pulsing of the blood volume inside the fingertip due to heart beat varies the intensity of the reflected beam, and this variation in intensity is according to the heart beat. When more light falls on the photo transistor it conducts more, its collector current increases and so its collector voltage decreases. When less light falls on the photo transistor, it conducts less, its collector current decreases, and so its collector voltage decreases. This variation in the collector voltage will be proportional to the heart rate. This voltage variation is so feeble that additional signal conditioning stages are necessary to convert it into a microcontroller-recognizable form.

3. Operation of the prototype

A 5V power supply powers the microcontroller, sensor, LEDs, and SIM card module. The buzzer is activated through the microcontroller. On pressing the start button, the heart rate sensor emits red light at 950nm and is received sensed by an infra-red receiver as it passes through the blood in the fingertip. This creates a voltage signal of 5 mV and it's received by the SCL pin on the microcontroller, which amplifies it and processes it. The processed signal is output through the SDA pin, which is attached to the LCD screen to display the results. The buzzer is grounded and receives a signal of around 3 mV through pin 15 of the microcontroller unit. The SIMCARD module sends and receives information through pins 4 (Tx) and 5 (rx) respectively. To use the device, the user must ensure that the power bank or 5V adapter is firmly connected, evidenced by the red LED lighting. The device is then turned on by flicking the switch to the ON position. The screen will then display the name of the device, and after it will display "initializing" as it prepares you for the next menu. It will then prompt you to press the start button. As you do that, your finger must be firmly fixed onto the sensor (Max30100). On pressing the start button, the device will load for some seconds and display the results on the screen, which are heart rate in beats per minute and oxygen saturation in percentage. The results are later sent to a phone number for either the doctor or health worker.

4. Conclusion

Cardiovascular diseases continue to claim thousands of lives on a daily basis, regardless of whether they are in developed or non-developed countries globally. The current gaps in monitoring of patients diagnosed with the disease, more so in the less developed countries, are alarming and, therefore, it is necessary to improve the current methods used. The heart rate monitor brings the heart rate monitoring service closer to the patient and also bridges the gap between the patient and his/her physician. This saves the patient the burden of traveling to a health facility to have the heart rate monitored, which can help prevent future heart attacks.

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