CE1: Digital Breath and Pulse Rate Meter

Introduction

CE 1.1 I will present my experience and achievements in this career episode on developing a digital breath and pulse rate meter. I did this project as part of my final year project during my degree in Biomedical Engineering studies at [redacted] I started this project from [redacted] which lasted for almost 40 weeks. I did this project in Karachi, Pakistan campus of my university. I had the opportunity of working alongside four other talented classmates under the supervision of my professor [redacted] They guided me through the project.

Background

CE 1.2 The aim of this project was to develop a device for assisting in monitoring heartbeats and breathing conditions. I developed this digital meter with microprocessor-based technology. I created a portable and user-friendly device capable of providing accurate measurements of breath and pulse rates for individuals. I build the technological gap in field of medical and helped in improved monitoring of these physiological parameters. The primary objectives of this project were:

a) To develop an instrument for monitoring breath rate and pulse rate.
b) To use ATMEL 89C51 microcontroller for designing.
c) To design a cost-effective, portable and easy to operate device for fulfilling the needs of both medical professionals and users monitoring their health.

CE 1.3 I worked in a team of five members under the supervision of [redacted] I was chosen to be the leader of my team. I coordinated the project and guided my teammates. I communicated regularly with them regarding the updates to ensure successful completion of this project. I proposed the idea of project, conducted research on the parameters involved in this project. I selected appropriate hardware components. I also designed the circuit and compiled the other related work in a final file format following the guidelines.

CE 1.4 The organizational structure of the project team can be represented through the following organogram:

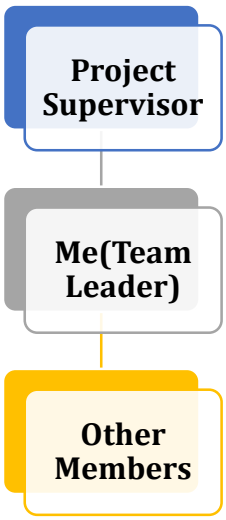

Figure 1: Organogram

In this structure, [redacted] served as project supervisors and provided valuable guidance to us. As the team leader, I was responsible for checking the project's progress and ensuring the completion of all tasks.

CE 1.5 I selected the idea of the project and prepared a proposal. As a student of biomedical, I knew the importance of gaining knowledge of physiological parameters of breath and pulse rates. I gained knowledge of the factors which affect these parameters. I understood the relationship between the rates of breath and pulse for designing this device and accurate results.

CE 1.6 After studying about the physiological parameters, I moved to hardware selection part of this project and designed decisions. I researched and identified the components for making this device which included; microcontrollers, op-amps, voltage regulators and sensors. I chose these components on the basis of their easy use and portability.

CE 1.7 After selecting the hardware components. I moved to designing of the circuity of this device. I created circuit diagram and assembled the hardware using Veroboard. I designed this circuit in a way to integrate the selected components accurately and effectively. I also displayed the readings of the breath and pulse rates.

CE 1.8 I lead and motivated my teammates, monitored their progress and updated the progress to the supervisors.

Personal Engineering Activity

CE 1.9 I applied my knowledge I gained through engineering in achieving the objectives of this project. I carried out research on physiological parameters including breath and pulse rates. I studied literature related to the topic, I analysed the data and understood about the factors which affect these parameters. I also applied my knowledge of biomedical engineering in interpreting these findings from research. I identified the key considerations of the design of this device. I started my research from pulse rate and shared my findings from this research with my teammates for their involvement in the project. I discovered that pulse rate changes on the basis of oxygen absorption and excretion of carbon dioxide. I learned that pulse rate of adults varies from 60 to 100 pulse/ min. I also learned about the factors which influence heart rate and also their importance of measuring it in assessing the function of heart, flow of blood and coverall health condition.

CE 1.10 Next, I research on rate of breath and shared my knowledge with my teammates to make sure they are active in every step. From this research I found that the rated of breath indicate the respiratory status and it is different for every age and gender. It is also measured in breaths/ min. I learned that the breath rate of children is faster compared to the adult and that women breathe more frequently. I studied about the factors that affect these rates. I also studied about the relation between pulse and breath rates and learned their direct correlation during any physical activity. I learned about the reasons behind the importance of their rate measurements and their benefits. I learned that users can get benefit by continuously measuring the pulse and breath rates with the help of a portable and easy to use device. This can help users in managing their stress levels by identifying the increased rates and taking actions in order to reduce them.

CE 1.11 After completing this research, I looked for the suitable hardware components required in this device. I analysed their specifications and discussed with my teammates. I successfully selected the sensors, op-amps, voltage regulators and other components. I used LmM324 IC which is a 14-pin op-amp having a voltage operating range of 3-32 volts. I also chose LM358 having same voltage range as LM324 and includes dual-op-amps. For voltage regulation I chose 7805 voltage regulator which delivers 5 volts of output. I chose AT89C51 microcontroller on the basis of number of input/output ports and ADC channels to meet the requirements of this project.

CE 1.12 I also emphasized on the power efficiency, and selected LCD module for that purpose. I chose 16x2 LCD module for my project. To amplify and improve signals I chose CD40106 Hex inverting Schmitt trigger which is a versatile chip with six individual triggers. For transistor I chose C94 which is a npn bipolar junction transistor. In the beginning of this project, I did experimentation for determining the suitable thermistor and its placement. I considered the minimal temperature variation linked with human respiration and chose a highly sensitive thermistor with the ability to detect subtlest changes. I did experiments using large thermistors but they were not effective in detecting breath and gave delayed responses. I chose 103 model thermistor as the optimal one.

CE 1.13 I also used a buzzer in my circuit design. I used SPO2 probe in my system for continuously monitoring patients. This probe helped in accurate assessment of saturation levels of oxygen in blood of patients by emitting red and IR light beams into the tissues. It also helped in measuring the transmitted light using a photodetector located opposite to the probe.

CE 1.14 I used my knowledge and expertise of electronics and microprocessor-based system in designing the circuitry for this device. I created a detailed circuit diagram and selected the components and integrated them following the electrical safety standards. I assembled these components on Veroboard and

connected each component. I also verified their functionality in the circuit. I also used my knowledge of analog and digital circuits for making the efficient circuit design.

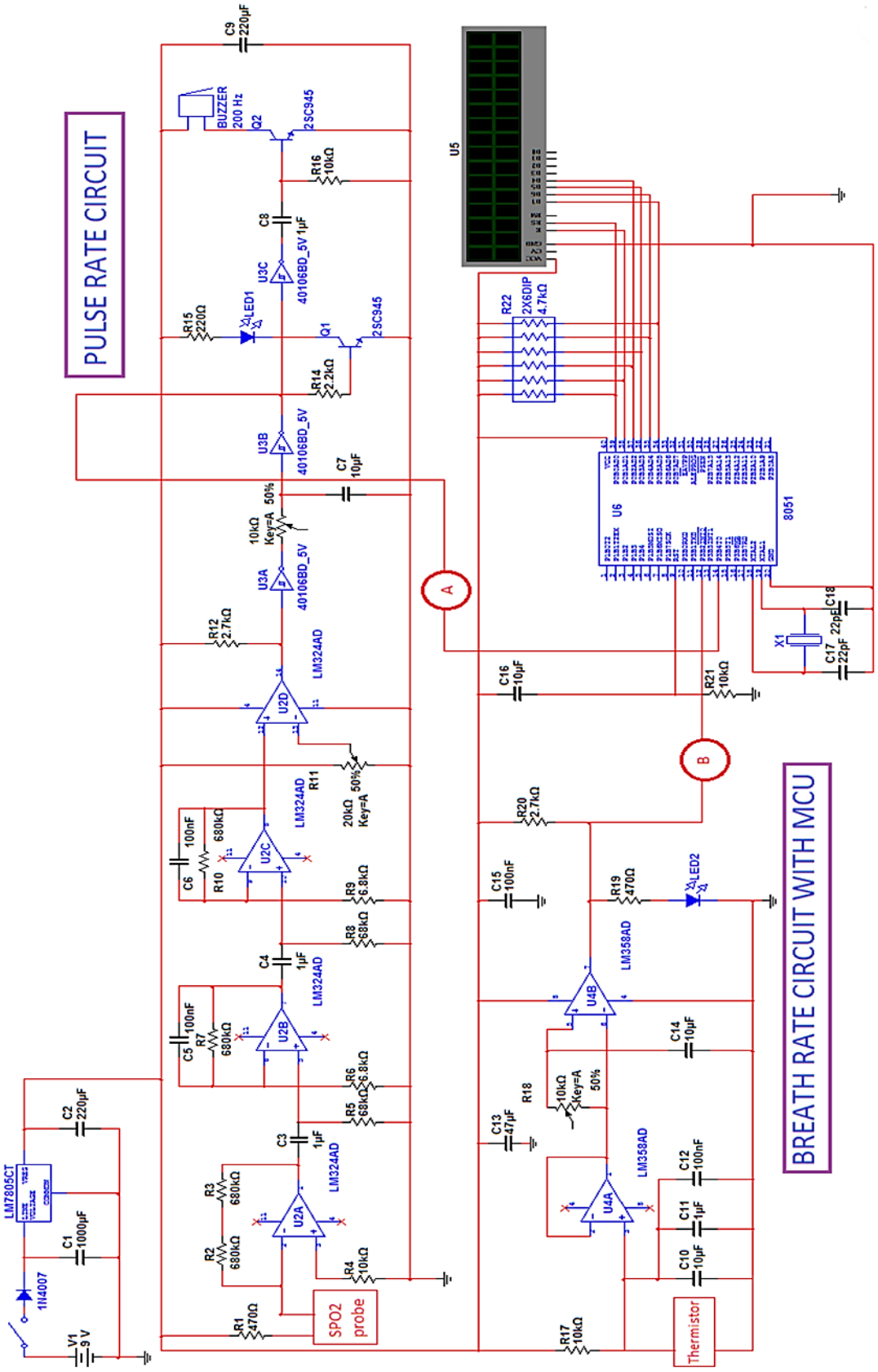

Figure 2: Circuit Diagram

CE 1.15 I programmed the microcontroller ATMEL 89C51 and developed a software for acquisition of data and its display. I used my programming skills in C language to write the efficient and optimized code for communication between the hardware components. I implemented user-friendly features like backlit LCD display. I ensured that interface was easy to navigate and was successful in providing users with clear instructions and feedback.

CE 1.16 I used port 3 for connecting LM324 and LM358 ICs and port 0 for connecting LCD module. I used LM324 IC for measuring the pulse rate and I did the voltage control using 7805bregulator. There were 4 op-amps present in LM324 IC where 3 of them served as noise filters and one served as a comparator. CD40106 hex Schmitt triggered generated a single pulse output which was linked to both microcontroller and C945 transistor.

CE 1.17 In order to make sure the effective reception of signal, I connected buzzer and LED to port 3 for visual as well as audio confirmation. I used capacitor type thermistor with model number 103 for monitoring the breath rate. I enhanced the breathing signals using LM3589 IC with two separate op-amps. I displayed the count on LCD module and LED served as an additional indictor. I also used resistor array for regulating the flow of current.

CE 1.18 I divided duties among the teammates as per their strengths and knowledge. I arranged discussions and meetings throughout the project. I planned the project, established timeline and set the milestones.

CE 1.19 I also faced several several technical difficulties and challenges. However, I overcame them using strategies. One of the challenges I faced was the removal of noise and interference form the data. To address this, I implemented signal conditioning techniques like amplification, filtering and groundings. I analysed the characteristics of signals and applied filtering algorithms on them. By doing this I was able to minimize noise.

CE 1.20 Another challenge I faced was related to power management. The device required efficient management of power for extending the life of battery. In order to optimize the consumption of the power, I applied sleep mode operation, voltage regulation and other power solving algorithms in firmware of microcontroller. By doing this I allowed the device to operate for extended period of time using only single set of batteries. I devised a calibration methodology which involved the comparison of readings of device with a reference standard. I calibrated the sensors and implemented mathematical algorithms for compensating the inherent errors.

CE 1.21 I created a collaborative environment and encouraged open communication. I continuously received input from my teammates for sharing knowledge. I worked with electronics engineers, software developers and other industrial designers for making sure that this device I designed work effectively.

Summary

CE 1.22 I designed a device for measuring the pulse and breath rate. This was a very enriching project which allowed me to apply my theoretical knowledge in a practical setting. I created a reliable and user-friendly device for medical purpose. This device was capable of accurately measuring the pulse and breath rate. I combined the elements of multiple disciplines; biomedical engineering, development of software and user-interface design. I carried out research, designed circuit, write code and also coordinated with my teammates and supervisors.

CE 1.23 This device I designed was efficient and gave accurate results. I addressed the challenges of signal noise and interference by using signal conditioning techniques.

CE 1.24 I was the leader of my team, I planned the project. I applied my skills and chose hardware components.

CE 1.25 From this project, I learned how the engineering principles are implemented practically. I also learned how to work in a team towards common goals. Working on this project was an enriching experience for me, it bolstered my engineering skills.