COMP4913 Capstone Project

Integrated Health Monitoring Application

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Part 01

Introduction

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Background and Motivation

- Increasing need for effective healthcare solutions for the elderly.
- Various health challenges, including chronic diseases, limited mobility, and cognitive decline.

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Problem Statement

The traditional healthcare system often struggles to provide effective real-time monitoring and timely interventions for elderly patients.

Scope of the Study

- Development of an Arduino-based data acquisition system
- Creation of a user-friendly mobile application

Research Objectives

- Arduino-based sensor hardware
- Data collection and integration into a unified application
- Monitoring and alerting capabilities for caretakers/healthcare providers

Part 02

Literature Review

Aging and Health Monitoring

- As the population ages, there has been a corresponding rise in age-related health issues such as dementia, Alzheimer's, Parkinson's, arthritis, and chronic conditions like heart disease and diabetes.
- Major tech companies like Apple, Google, and Samsung have been expanding their lineup of smartwatches and fitness trackers with advanced health sensors to monitor vital signs, activity levels, and early signs of chronic conditions.

Arduino in Health Monitoring

- Arduino microcontrollers have gained recognition in the healthcare sector due to their versatility, affordability, and ease of use.
- Arduino in health monitoring is the ability to create a tailored solution that addresses the specific health parameters relevant to elderly individuals.

Part 03

Methodology

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Research Stages of the Integrated Monitoring Application

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Mobile Application Development

Cross-Platform Development

To ensure broad accessibility, the mobile application will be developed using cross-platform frameworks such as React Native or Flutter. This approach allows for simultaneous development for both Android and iOS platforms, reducing development time and costs.

User Interface Design

The user interface (UI) will be designed to prioritize ease of use and clarity. Large fonts, high-contrast color schemes, and intuitive icons will enhance usability for elderly users. The layout will be straightforward, with a dashboard providing an overview of health parameters and easy access to historical data and settings.

Real-Time Data Visualization

The mobile application will establish a real-time connection with the Arduino-based data acquisition system to receive and display health data. The dashboard will feature graphical representations of pulse rate, blood pressure, body temperature, outdoor conditions, activity levels, and visual monitoring.

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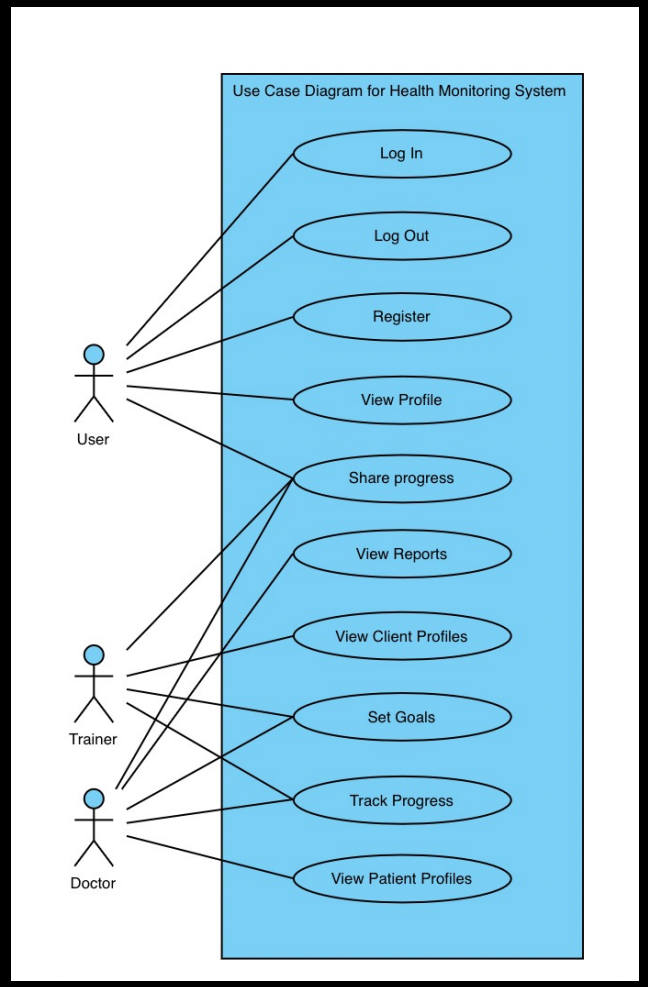

Use Case Diagram

Part 04

System Design

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Arduino

Get the user's data through different sensors

PC and Android

Use Bluetooth to transport the data into the webpage as well as the app.

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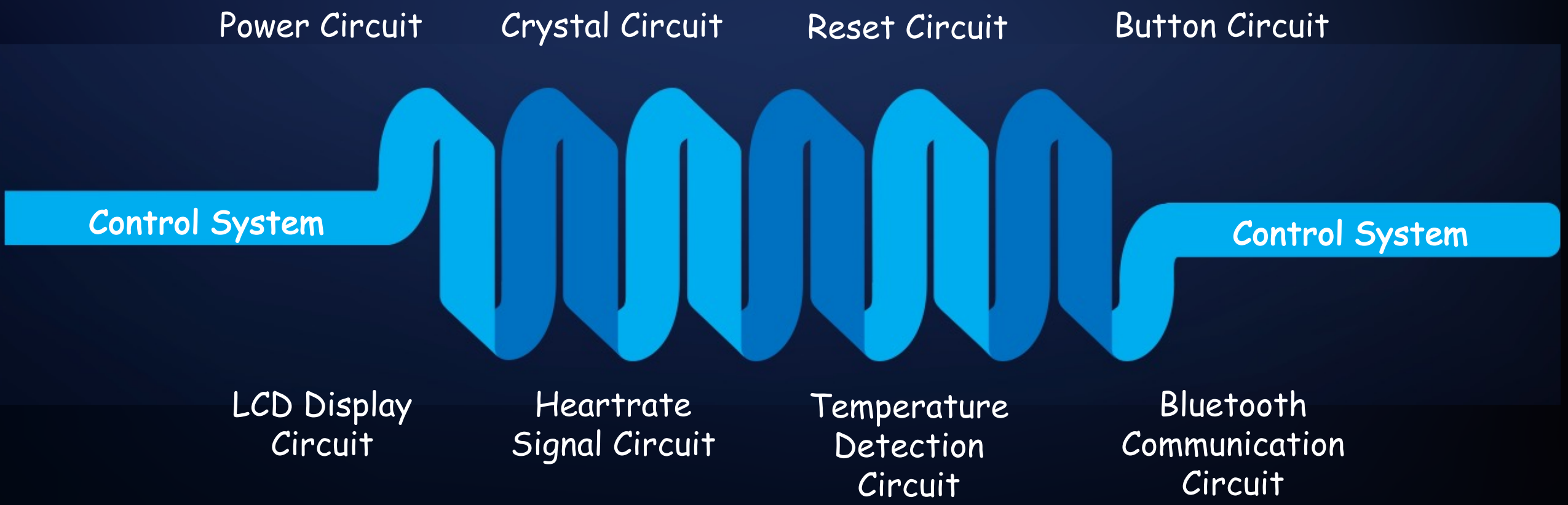

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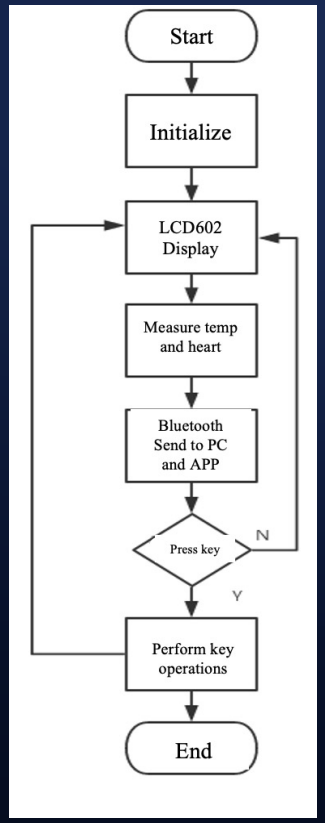
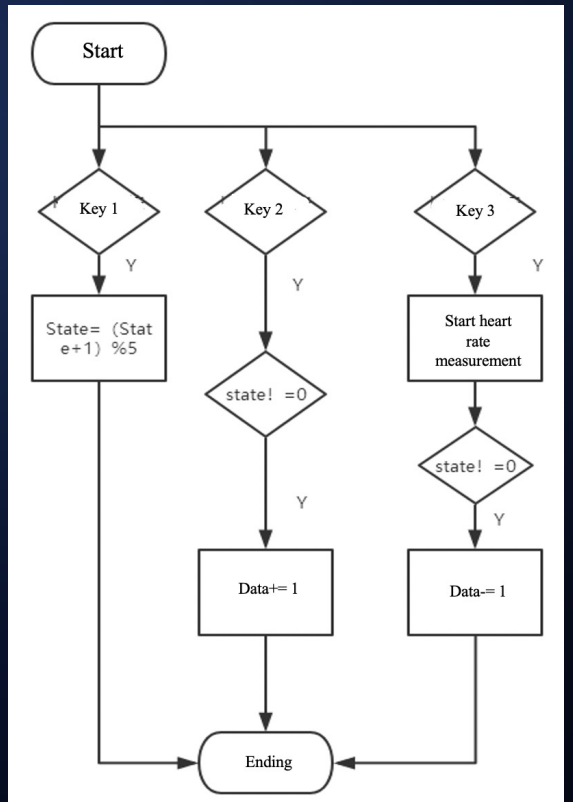


Outline of System Design



The sequence of actions for the key functionality

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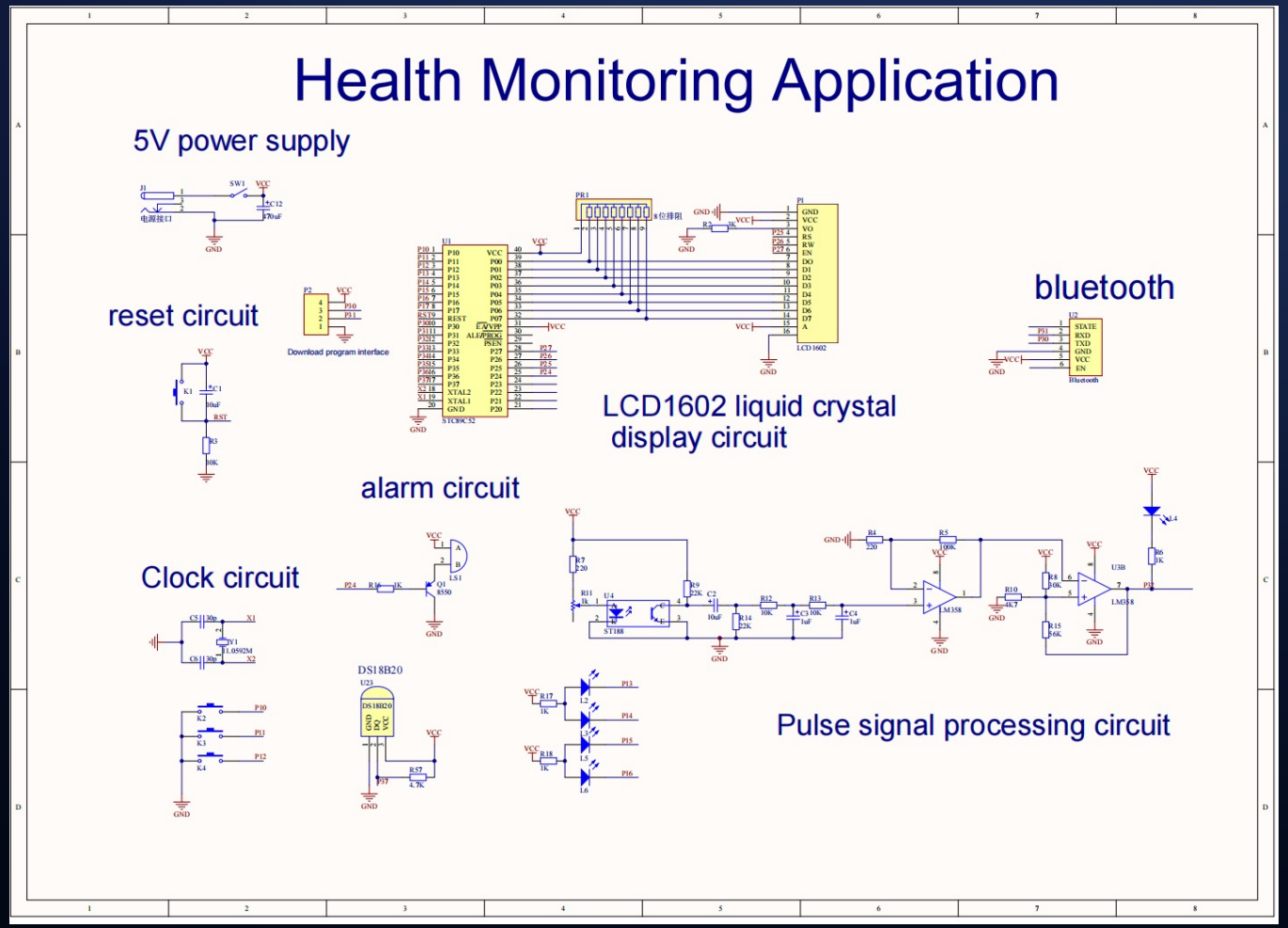

The Simulation of the Health Monitoring Application

Contribute by Justin Zhao & Shane XIE
From ME and EIE

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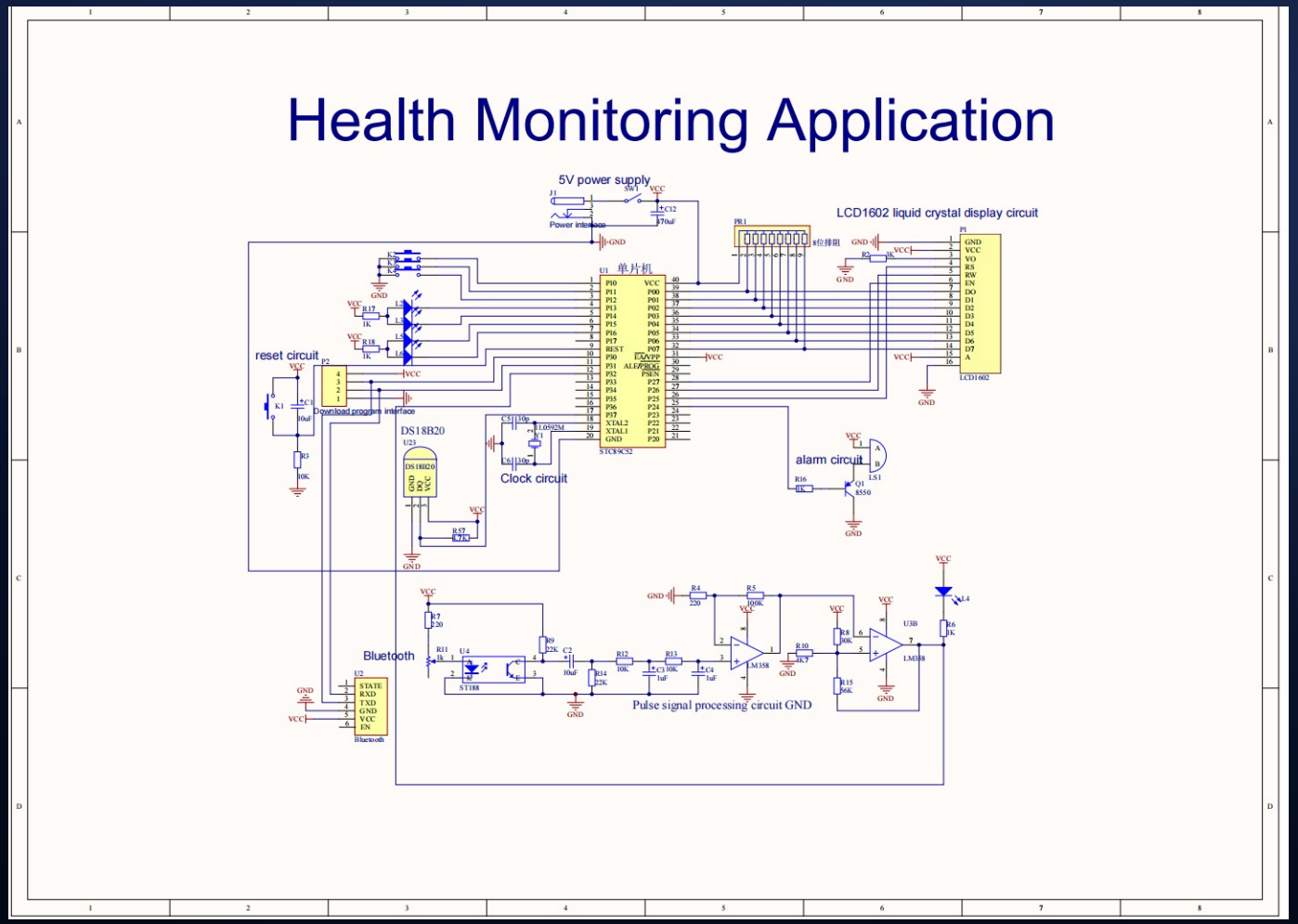

The Simulation of the Health Monitoring Application (Linked)

Contribute by Justin Zhao & Shane XIE
From ME and EIE

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Mobile Applications in Healthcare

Data Visualization and User Interaction 01

Accessibility Features 02

User Testing and Feedback 03

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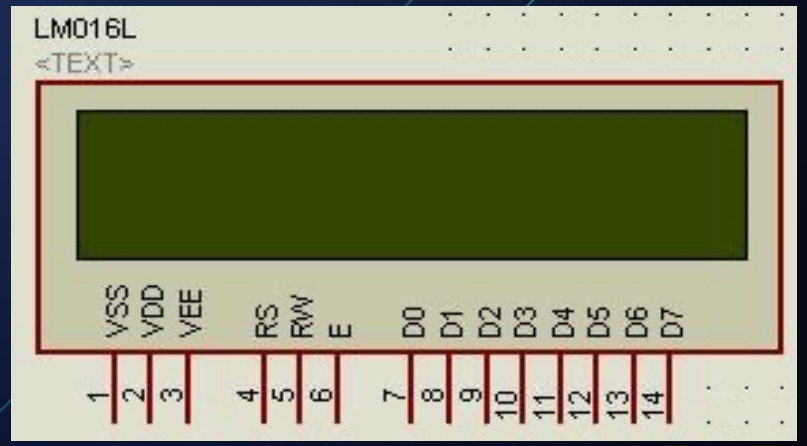
Liquid Crystal Display

- The LCD1602 module utilizes the HD44780 controller, which possesses a simple, yet powerful instruction set capable of character movement, blinking, and other functions.
- Communication between the LM016L module and the microcontroller (MCU) can be achieved through two methods: 8-bit or 4-bit parallel transmission.



LCD1602 Pin Diagram

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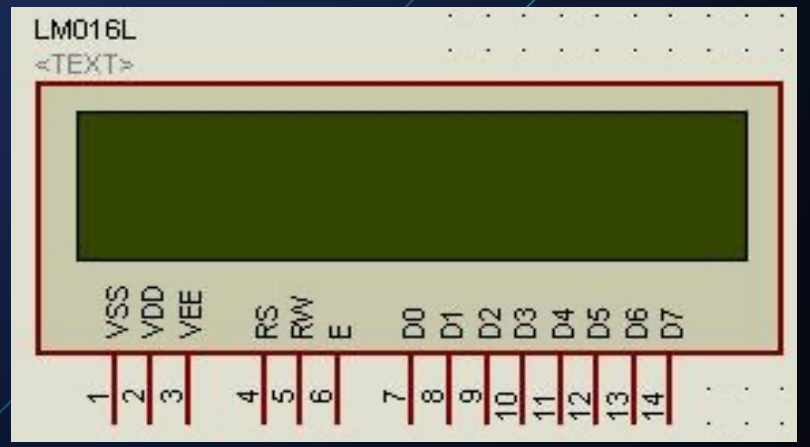
RS	R/W	Instructions
0	0	Write to the command register (clear screen, etc.)
0	1	Read the busy flag (DB7), and read the address counter (DB0~DB6) value
1	0	Write data register (display each font, etc.)
1	1	Read data from data register

Register Selection Control Table



LCD1602 Pin Diagram

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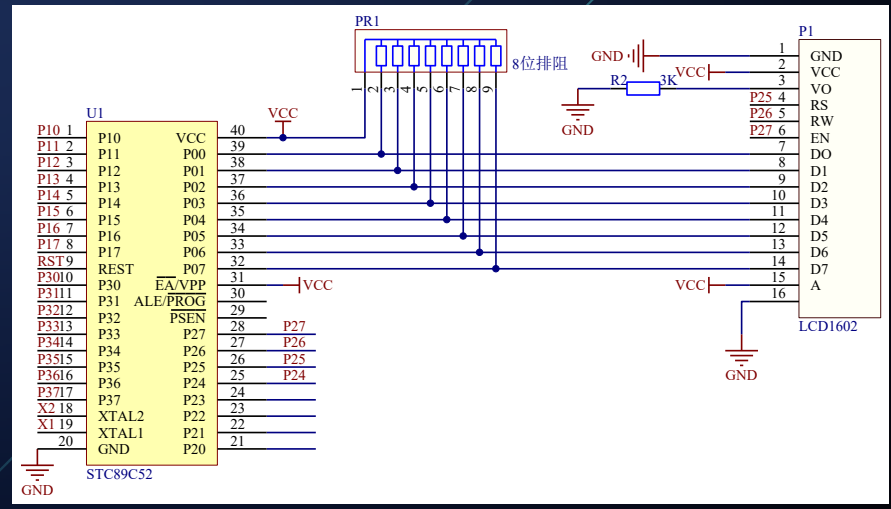
LCD1603 Circuit

- The interface connection between the LCD display and the STC89C52 microcontroller is show in the diagram. The data line of the Arduino Board is designated as the P0 port, while the EN, R/W, and RS signals of the LCD module are assigned to P1.2, P1.1, and P1.0, respectively.



LCD1602 Pin Diagram

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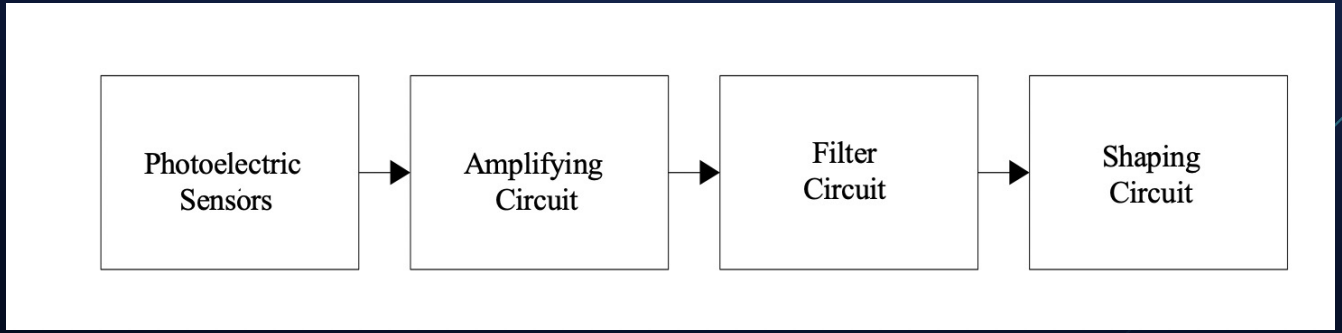
Signal Acquisition Circuit Design



Amplified shaping circuit diagram

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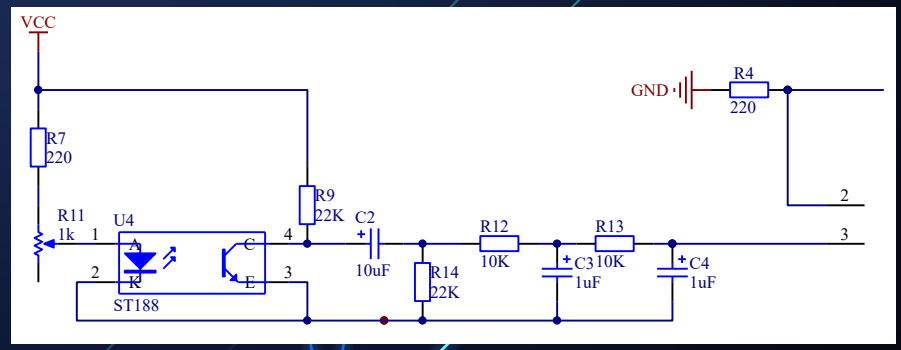
The Filter Circuit

- The use of the filter circuit improves the overall accuracy and reliability of the system. It enables the system to effectively extract the desired information from the sensor signal, making it suitable for various applications, including medical monitoring, industrial control, and security systems.



The Filter Circuits

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Simplicity and Clarity

Simplicity of Navigation

- To simplify navigation, the application will employ a clear and straightforward menu structure. Primary functions, such as monitoring health parameters, setting alerts, and viewing historical data, will be readily accessible from the home screen.

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Simplicity and Clarity

Intuitive Icons

- The use of intuitive icons alongside text labels will aid users in understanding the functions of various buttons and features. For example, a heart icon might represent pulse rate monitoring, while a thermometer icon signifies body temperature.

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Simplicity and Clarity

Large Fonts and High Contrast

- Elderly users often experience diminished visual acuity. Therefore, the application will feature large fonts with high contrast to enhance readability. Users should be able to comfortably view and interpret information without straining their eyes.

Part 05

Implementation and Demo

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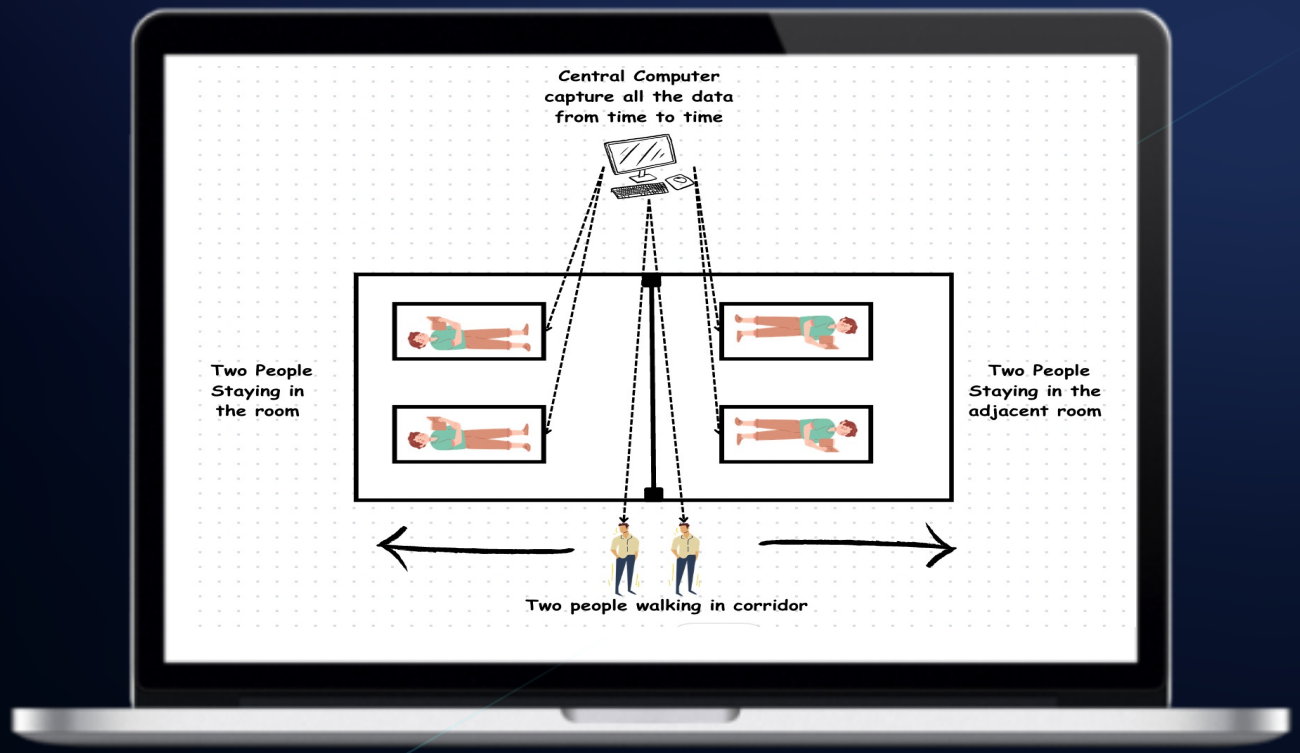

Monitor Experiment

- The test aims to collect data from multiple devices
- Four people lying on two rooms with another 2 people walking around
- Central Computer collect all the data from time to time

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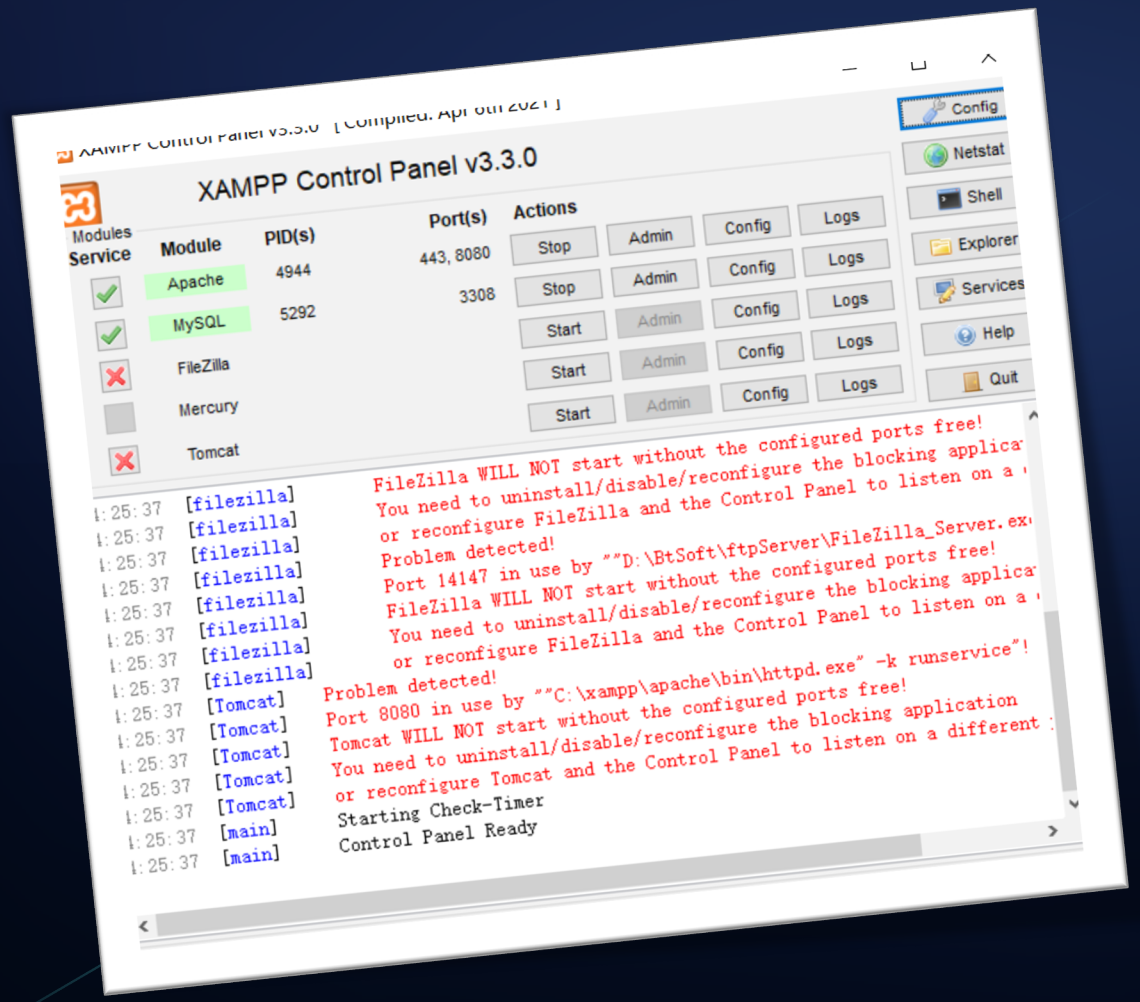

Project Setup

- Use XAMPP to connect to apache and MySQL.

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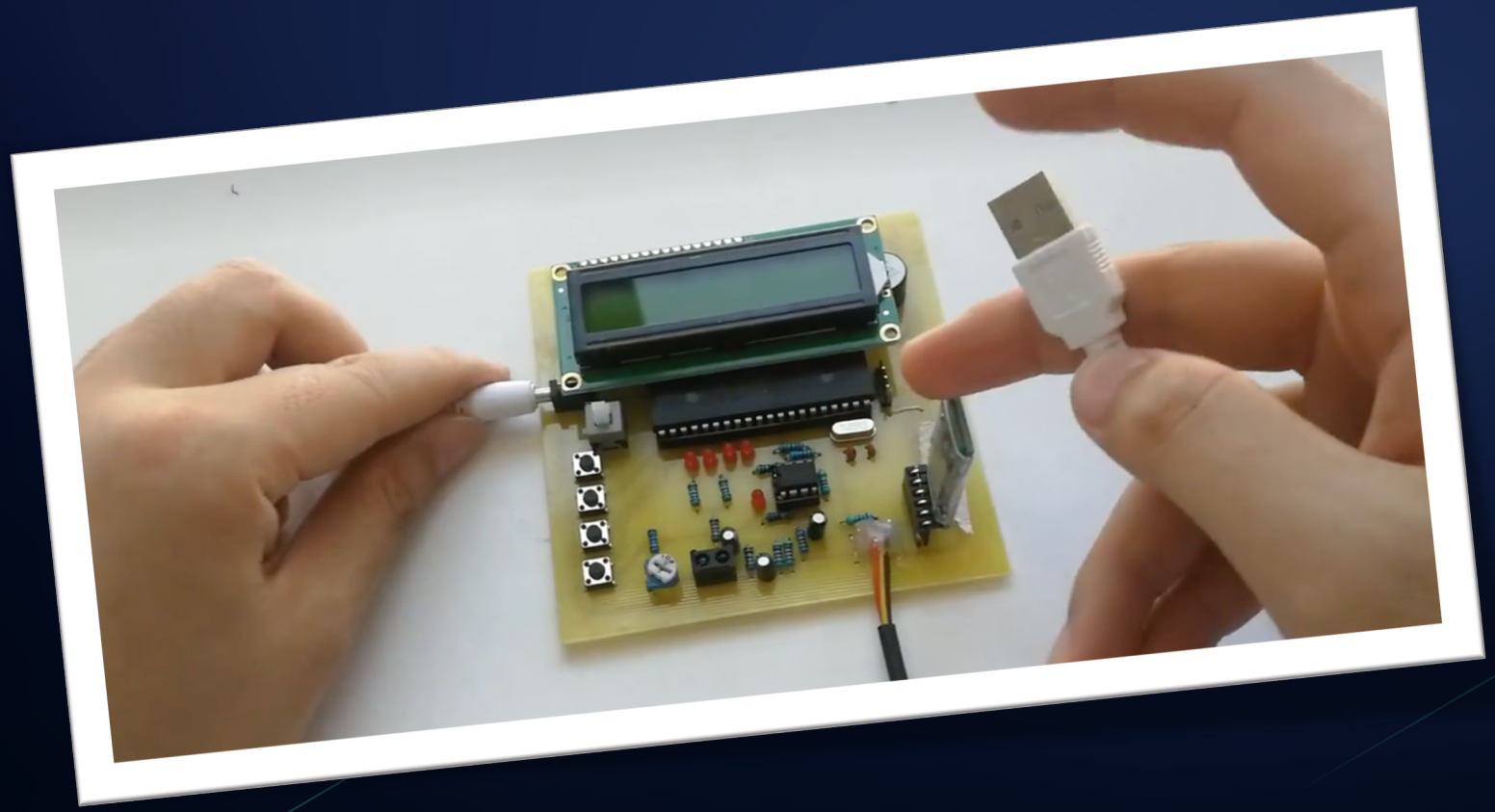

Project Setup (Arduino)

- Charge the machine by using 5V 2A charger.
- Connect the Bluetooth for the related items, the password of them is 1234.

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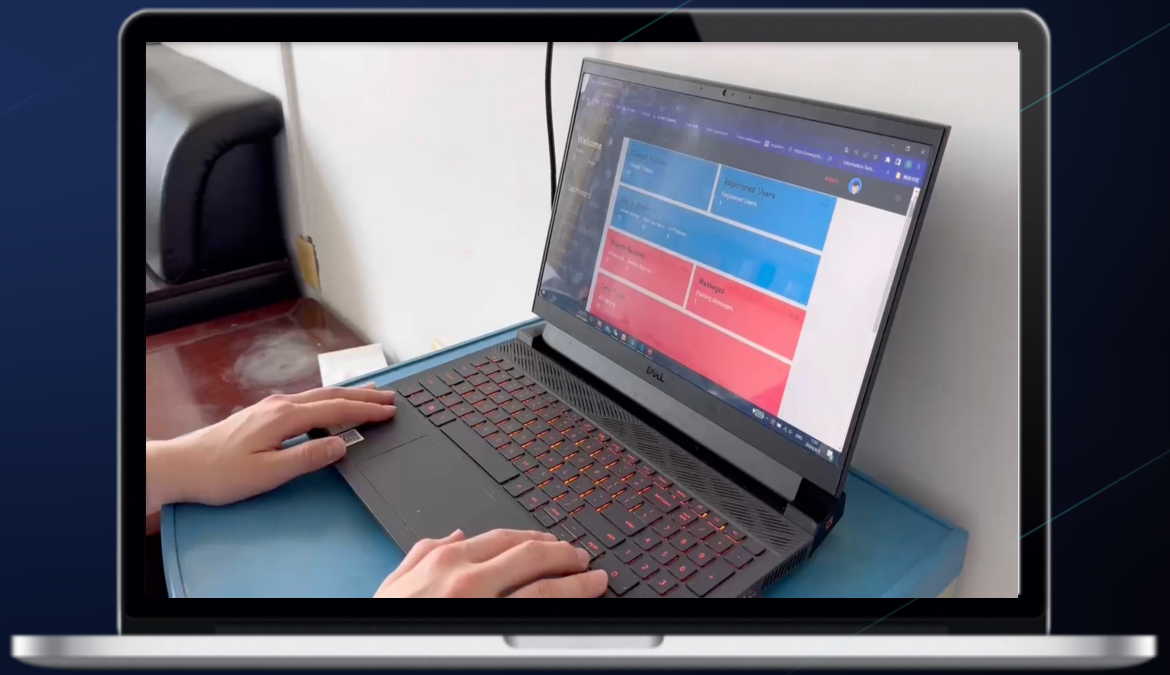
Video Demo

- Part 01: Link with Platform
- Part 02: Link with Arduino
- Part 03: Monitor Real-time Situation



Part 06

Data Collection and Analysis

Temperature and Humidity Sensor Calibration

- **Calibration Procedure:** Calibration of the temperature and humidity sensors will involve exposing them to controlled environments with known temperature and humidity levels.
- **Testing and Validation:** The calibrated temperature and humidity sensors will be subjected to a battery of tests to evaluate their accuracy under various environmental conditions.

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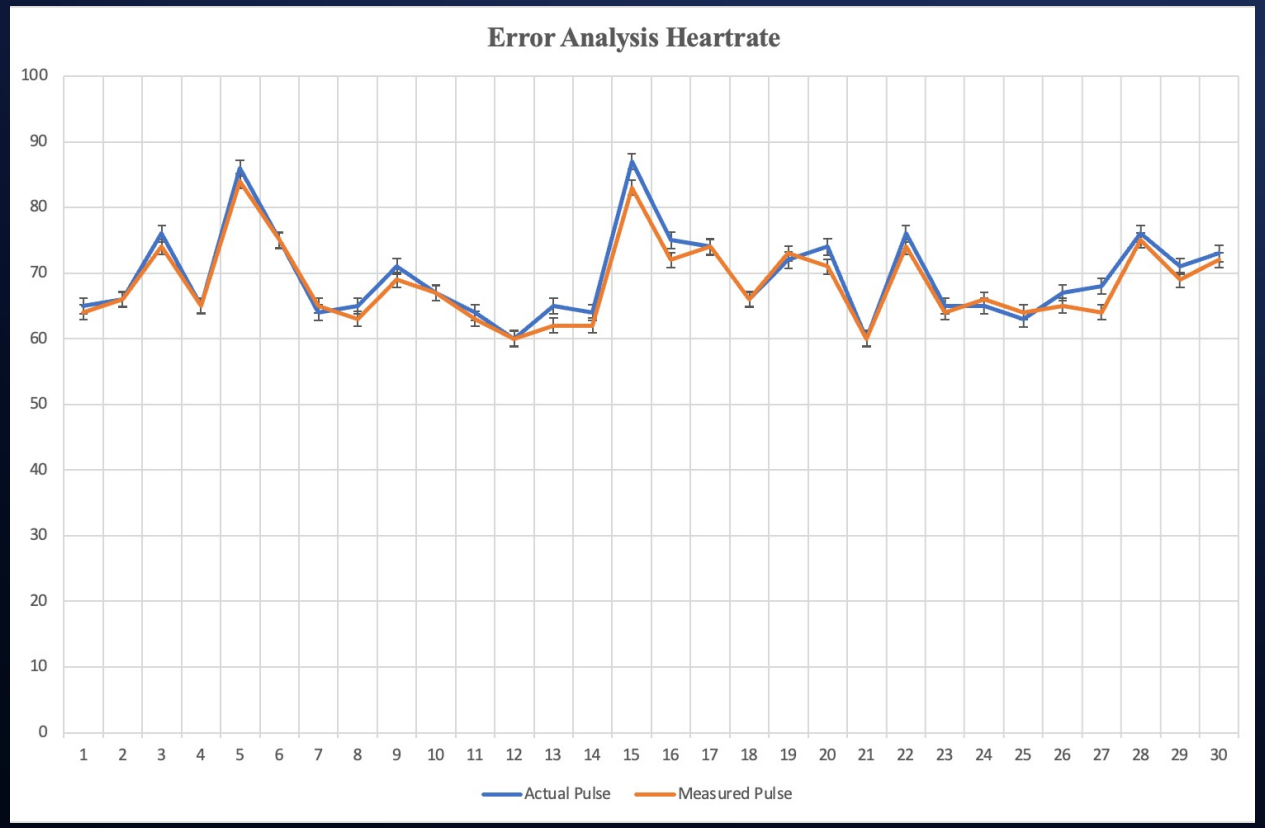

$$S = sqr\left[\frac{(X_n - \overline{X})^2}{n(n-1)}\right]$$

- Sample Size: 40
- Mean Square error: 0.59
- Acceptable

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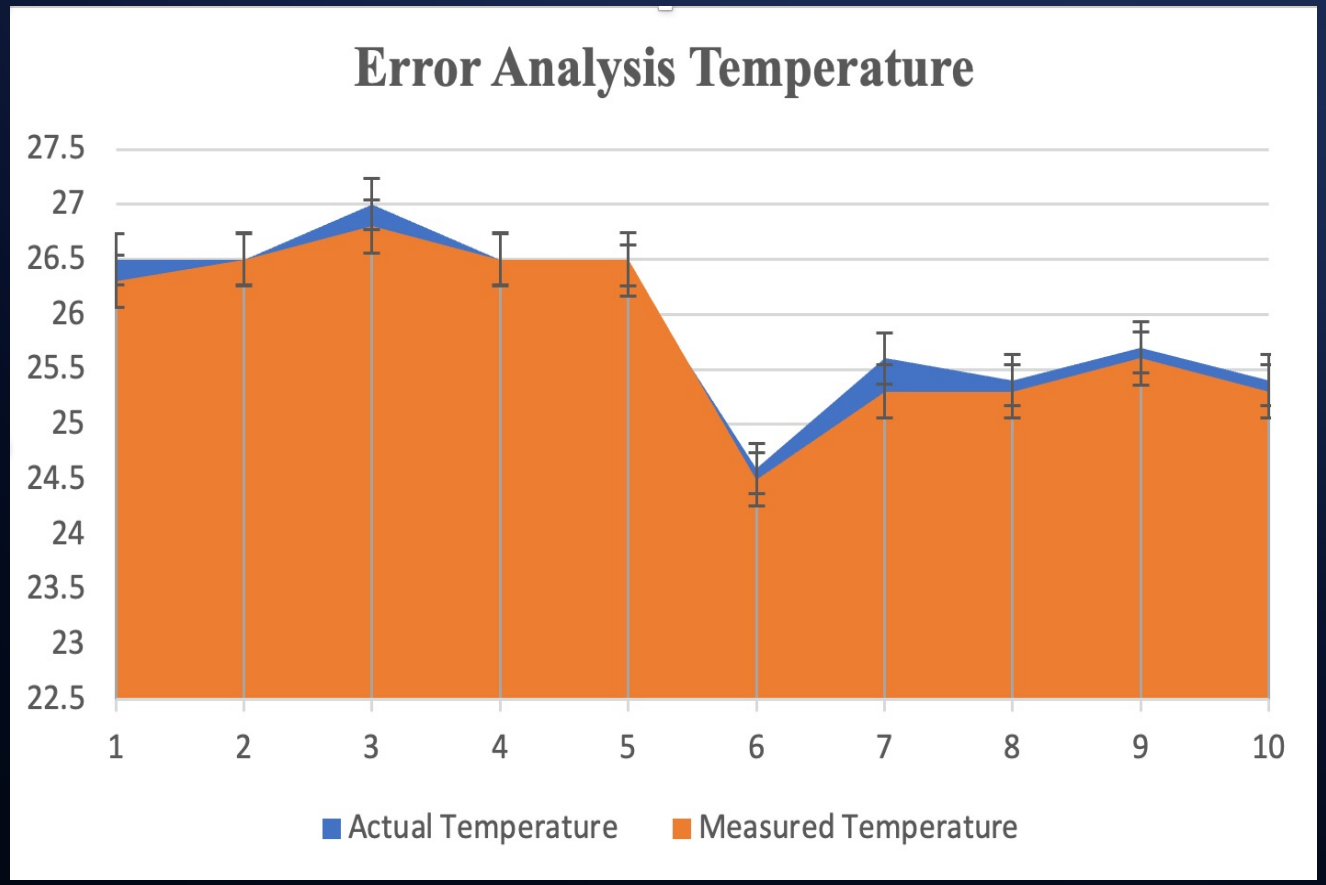

$$S = sqr\left[\frac{(X_n - \overline{X})^2}{n(n-1)}\right]$$

- Sample Size: 10
- Mean Square error: 0.08
- Acceptable

Part 07

Challenges and Solutions

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Software Debugging

Problem

Upon programming, the LCD display exhibited flickering and uneven brightness

Solution

The system utilizes dynamic scanning for digit display, which is imperceptible to the human eye due to its rapid nature, precautions were taken in the display program to mask the final assignment, preventing the occurrence of excessive brightness. This solution successfully resolved the issue.

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Hardware Debugging

Problem

The extremely weak nature of the pulse signal led to the microcontroller's failure in detecting the pulse signal.

Solution

Thorough investigation and consultation of relevant literature enabled the determination of the pulse signal's amplitude range. By increasing the amplification factor of the amplifier, the issue was effectively resolved.

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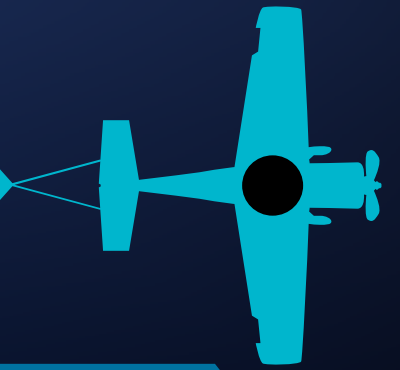
Challenges Faced

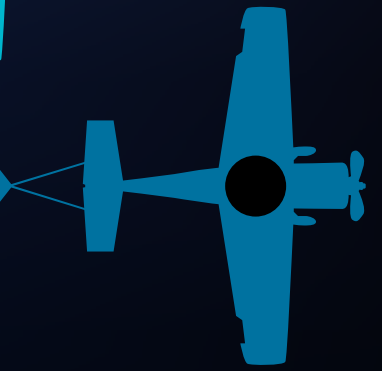
Sensor Calibration

Extensive testing and iterative adjustments were conducted to ensure reliable health parameter monitoring.



Power Consumption

Achieved a balance between power efficiency and real-time data updating, thereby enhancing the device's battery life and overall usability.



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Arduino based

- More flexibility in sensor integration and system design
- Ability to customize and build specialized monitoring applications
- Lower cost compared to commercial wearables

Apple Watch/Fitbit

- Famous commercial wearable health tracking devices
- Monitor heart rate, activity, sleep, and some basic health metrics
- Rely on proprietary hardware and software ecosystems

Part 08

Conclusion and Future Work

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01 Innovation in Health Monitoring

02 Real-time Data Acquisition

03 User-friendly Platform

04 Data Analysis and Alerts

Summary of Achievements

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Conclusion

The aim of the platform is collecting data from a group of people such as elderly or patients is to create a monitoring system that can track their vital signs, physical activity, and environmental conditions.

Health Monitoring

Environmental Monitoring

Future Work

By continuously collecting and analyzing vital health data, this system has the potential to improve the quality of life and extend the independence of elderly individuals while providing valuable insights to caregivers and healthcare providers.

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Finally, I would like to express our heartfelt gratitude to Dr. Henry Chan, who has been instrumental in the conceptualization and implementation of this project. His expertise, invaluable insights, and unwavering dedication have been crucial throughout the entire process. Despite his busy schedule, Dr. Chan has consistently been available for regular meetings and discussions, providing us with the necessary direction and encouragement to overcome various challenges.

I truly thankful for the collaborative effort and unwavering support of all the individuals involved in this project. Their collective dedication and expertise have been instrumental in the successful development of this innovative healthcare solution.

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