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RSET
RAJAGIRI SCHOOL OF ENGINEERING & TECHNOLOGY
(AUTONOMOUS)

Mini Project Report On

Fitness Instructor and Assistance

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Technology

in

Computer Science & Engineering

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CERTIFICATE

This is to certify that the mini project report entitled ***"Fitness Instructor and Assistance"*** *is a bonafide record of the work done by* ***Aaditya Nair (U2103001), Aathira K(U2103004),Abhinand Santhosh (U2103006), Aldrin Lyju (U2103023)*** *submitted to the APJ Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology (B. Tech.) in Computer Science and Engineering during the academic year 2023-2024.*

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Abstract

The modern fitness landscape is shaped by technological advancements, with wearable devices like our innovative fitness band at the forefront. Featuring cutting-edge sensors and microcontrollers, it offers real-time workout tracking, precise heart rate measurement, and seamless timekeeping.

Integrated VL6180X sensors ensure accurate exercise recognition, while a dedicated mobile app provides comprehensive workout data analysis and personalized insights. Synergizing advanced microcontrollers and sensors, our watch accurately detects and analyzes movements, recognizing specific exercises with remarkable precision.

In addition to its workout-specific capabilities, our fitness watch serves as a versatile timepiece, seamlessly transitioning between workout tracking and time monitoring. Its robust heart rate monitoring system, leveraging optical sensors, not only optimizes workout intensity but also promotes cardiovascular health awareness.

Moreover, the watch includes a step counting feature, empowering users to monitor their daily activity levels and progress towards fitness goals. With comprehensive activity insights and app support, our device encourages an active lifestyle.

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Chapter 1

Introduction

1.1 Background

In today's fast-paced world, finding time for fitness amidst busy schedules can be a challenge. Recognizing this, FIA (Fitness Interactive Assistant) has been developed as an innovative solution to streamline and enhance workout experiences.

FIA isn't just another fitness app; it's a personal fitness coach, available at your fingertips whenever and wherever it's needed. The app boasts a comprehensive library of exercises, ranging from classic bodyweight movements like pushups and pullups to targeted strength training exercises such as bicep curls and squats.

What sets FIA apart is its customizable approach to fitness. Understanding that everyone's fitness journey is unique, users are empowered to create personalized workout plans that align with their individual goals and preferences. Whether building muscle, improving endurance, or staying active, FIA allows users to tailor workouts by selecting specific exercises, setting the number of sets and repetitions, and adjusting intensity levels to match their fitness level.

But it's not just about the exercises – it's also about ensuring safety and well-being during workouts. FIA incorporates built-in break times and a timer feature to prevent overexertion and reduce the risk of injury. With real-time heart rate monitoring, users can track intensity levels and stay within their target heart rate zone, while progress tracking features allow monitoring of achievements over time.

At FIA, the focus is not only on helping users reach fitness goals, but also on making fitness accessible, enjoyable, and sustainable for everyone. With FIA by your side, guesswork is eliminated, and a fitter, stronger, and healthier lifestyle becomes achievable.

1.2 Problem Definition

The aim of the project is to develop a Fitness band connected to an App, FIA (Fitness Instructor and Assistant), that addresses the common barriers to regular exercises by providing users with customizable workout sessions and prioritizing safety through features such as built-in break times and real-time heart rate monitoring.

1.3 Scope and Motivation

The scope of the project encompasses the creation of innovative Fitness band which revolutionizes the way users engage with their workout routines. This includes providing users with a diverse range of exercises, customizable workout plans, and safety features to ensure effective and enjoyable workouts. The project aims to create a user-centric platform that caters to the individual needs and preferences of users, empowering them to achieve their fitness goals conveniently and safely.

The motivation driving the FIA project lies in the modern emphasis on fitness and well-being, coupled with the increasing integration of technology into lifestyle choices. FIA's core motivation is its unique capability to accurately track workouts, tallying proper exercise execution through a sensor-driven system. Featuring an LCD screen, FIA displays the count of exercises completed correctly in real-time. Additionally, FIA incorporates a heart rate sensor to monitor users' heart rates during workouts, emitting a beep and initiating breaks if heart rate exceeds safe levels, thus ensuring user safety and preventing cardiovascular issues. This emphasis on safety and effectiveness aligns with contemporary trends toward holistic health and technological facilitation of healthier lifestyles.

1.4 Objectives

- Develop a user-friendly prototype of the FIA app that offers a seamless and efficient workout experience, prioritizing ease of use and intuitive navigation for users of all fitness levels.

- Develop a user-friendly prototype of the FIA app that offers a seamless and efficient workout experience, prioritizing ease of use and intuitive navigation for users of all fitness levels.

- Integrate features for users to specify the number of sets and repetitions for each exercise, providing flexibility and customization options to tailor workouts to individual needs and abilities.
- Incorporate break times into the app's interface to remind users to take adequate rest intervals between sets, helping to prevent overexertion and reduce the risk of cardiovascular problems during workouts.
- Display real-time metrics such as the heart rate, and number of workouts completed within the app's interface, providing users with valuable feedback and motivation to track their progress and stay engaged with their fitness routines.

1.5 Challenges

Developing FIA involves challenges such as technical complexities such as proper functioning of the sensors , accuracy in detecting the exercises done, complexity in capturing the real - time heart rates along with the competitions in fitness band market.

1.6 Assumptions

The following are some of the assumptions made:

- **User Adoption**: Assuming that users will adopt and regularly use the FIA app for their fitness needs, based on the perceived value and effectiveness of its features.
- **Technological Reliability**: Assuming that the technological components of FIA, such as exercise detection algorithms and its associated sensors, will function reliably and accurately across various devices and user scenarios.
- **User Safety**: Assuming that users will follow safety guidelines provided by the app during workouts, and that the safety features, such as heart rate monitoring and form correction, will effectively prevent injuries and health risks.
- **Market Demand**: Assuming that there is a sufficient demand for a fitness band like FIA.
- **Content Relevance**: Assuming that the exercises, workout plans, provided by FIA are relevant and beneficial to users of varying fitness levels and goals.

1.7 Societal / Industrial Relevance

FIA (Fitness Interactive Assistant) holds significant industrial and societal relevance in several ways:

- **Promotion of Health and Wellness**: By providing users with an accessible and convenient tool for planning and executing workouts, FIA promotes regular physical activity, contributing to improved overall health and wellness outcomes at both individual and societal levels.

- **Prevention of Lifestyle-Related Diseases**:Regular exercise is essential for preventing lifestyle-related diseases such as obesity, diabetes, and cardiovascular conditions. FIA's ability to encourage and facilitate consistent workout routines can help mitigate the risk factors associated with these diseases, reducing healthcare costs and improving public health outcomes.

1.8 Organization of the Report

This report begins with an introduction to FIA (Fitness Interactive Assistant) project highlighting it background,problem definition, its scope and motivation , objectives, challenges faced durning its development, assumptions made and its relevance in society/industry. It proceeds with defining FIA's functional and non-functional requirements , its overall description and external interface used.

The System Architecture and Design section provides an overview of the project's objectives emphasizing the working of FIA. Its counting of efficient workouts done, real-time heart rate display and break times etc. It outlines the architectural design, methodology and algorithms used by sensors and application.Additionally, it discusses about the user interface, database design, implementation strategies, module division and work schedule , ensuring a comprehensive approach to system development and deployment.

Chapter 2

Software Requirements Specification

2.1 Introduction

1. **Purpose**

   The purpose of a fitness band solely focused on tracking and updating workouts is to provide users with a convenient and efficient way to monitor their physical activity and progress towards their fitness goals. By accurately recording workout metrics such as duration, calories burned, and exercise intensity. Overall, a fitness band dedicated to tracking and updating workouts serves as a valuable tool for individuals seeking to lead a healthier, more active lifestyle by providing them with actionable insights and motivation to achieve their fitness goals

2. **Product Scope**

   A fitness band dedicated to tracking and updating workouts serves as a valuable tool for individuals seeking to lead a healthier, more active lifestyle by providing them with actionable insights and motivation to achieve their fitness goals and it encompasses the development of a fitness band tailored for Home workout enthusiasts, offering comprehensive tracking of physical activities, heart rate monitoring, activity timeline visualization, and personalized insights to support users in achieving their fitness goals effectively and safely.

2.2 Overall Description

The product is a fitness band designed specifically for Home workout enthusiasts. It tracks simple physical movements associated with calisthenics exercises and basic military workouts, measures heart rates during workouts, and provides a timeline of activities.

With a user-friendly interface and personalized insights, it helps users optimize their training sessions, monitor progress, and achieve their fitness goals effectively. The fitness band features long battery life, durability, and compliance with health and safety standards for reliable and accurate performance.

2.2.1 Product Perspective

The fitness band is a dedicated wearable device tailored for individuals engaged in Home workout exercises. It serves as a comprehensive fitness tracker, capturing and analyzing a wide range of physical movements commonly associated with home workout routines, including push-ups, pull-ups, squats, lunges, planks, and more. Additionally, the device incorporates a heart rate monitor, enabling users to monitor their heart rate in real-time during workouts.

One of the key features of the fitness band is its ability to provide users with a detailed timeline of their activities. This timeline offers insights into the duration and frequency of workout sessions, allowing users to track their progress over time and identify patterns in their exercise routines.

With a user-friendly interface, possibly including a display screen or companion mobile app, the fitness band offers real-time feedback on workout performance, heart rate, and activity timeline. This interface facilitates easy navigation and interaction, ensuring a seamless user experience.

Moreover, the fitness band is designed to provide personalized insights and recommendations based on the collected data. By analyzing workout metrics, such as calorie burn estimates and exercise intensity levels, the device helps users make informed decisions about their training regimens and optimize their fitness goals. Key considerations in the development of the fitness band include long battery life to support extended workout sessions, durability to withstand the rigors of physical activity, and compliance with health and safety standards to ensure accurate heart rate monitoring and data tracking.

2.2.2 Product Functions

The product functions as follows:

a.Tracking Exercises: The fitness band utilizes its built-in sensors to accurately track a variety of home workout exercises. These exercises include push-ups, pull-ups, squats, lunges, planks, and other bodyweight movements. The sensors detect motion and intensity, allowing the device to record each exercise performed by the user.

b.Heart Rate Monitoring: Integrated into the fitness band is a heart rate monitor that continuously tracks the user's heart rate during workouts. This feature provides real-time feedback on the user's cardiovascular response to exercise, helping them gauge their intensity levels and optimize their training accordingly.

c.Activity Timeline Generation: The fitness band compiles a detailed timeline of the user's activities, logging each workout session along with its duration and timestamps. This timeline serves as a comprehensive record of the user's exercise history, allowing them to review past workouts and track their progress over time.

d.Real-time Feedback and Visualization: The device offers a user-friendly interface, which may include a display screen or companion mobile app, to provide real-time feedback on workout performance, heart rate, and activity timeline. This interface allows users to visualize their data and monitor their progress during workouts.

e.Personalized Insights and Recommendations: Based on the collected data, the fitness band provides personalized insights and recommendations to the user. These insights may include calorie burn estimates, exercise intensity levels, and trends in activity over time. By analyzing this information, users can make informed decisions about their fitness routines and set achievable goals.

f.Long Battery Life and Durability: To support extended workout sessions, the fitness band is equipped with a long-lasting battery. Additionally, it is designed to withstand the rigors of physical activity, including sweat and occasional impacts, ensuring durability and reliability during use.

g.Compliance with Health and Safety Standards: The product adheres to rel-

evant health and safety standards to ensure accurate heart rate monitoring and data tracking. Compliance with these standards ensures the reliability and accuracy of the device. performance, providing users with confidence in its capabilities.

The fitness band functions as a comprehensive fitness tracker specifically tailored for home workout enthusiasts. It tracks exercises, monitors heart rate, generates activity timelines, provides real-time feedback and visualization, offers personalized insights and recommendations, and prioritizes durability and compliance with health and safety standards.

2.2.3 Operating Environment

The fitness band is designed for use in indoor and outdoor environments conducive to physical activity, particularly for home workout exercises. It withstands varied terrains and weather conditions, ensuring reliable performance during dynamic movements. Compatible with workout accessories, it seamlessly integrates into diverse workout setups, enhancing the user experience and adapting to different terrains, weather conditions, and movement patterns encountered during calisthenics workouts. Its durable construction, accurate tracking capabilities, and compatibility with workout accessories make it an essential tool for fitness enthusiasts seeking to optimize their training routines and achieve their fitness goals.

2.2.4 Design and Implementation Constraints

The design of the fitness band is centered around providing accurate tracking and monitoring capabilities for Home workout exercises, with a focus on simplicity, durability, and user-friendliness.

a.Sensors and Hardware: The fitness band incorporates high-quality sensors to accurately track movements associated with calisthenics exercises, including accelerometers, gyroscopes, and heart rate monitors. These sensors are carefully calibrated to provide precise data, ensuring reliability during workouts.

b.Compact and Lightweight: The design prioritizes portability, with a compact and lightweight form factor that allows users to wear the band comfortably during exercise. The slim profile minimizes interference with movement, enabling unrestricted performance during workouts.

c.Rugged Construction: To withstand the rigors of physical activity, the fitness band features a rugged construction with durable materials that can endure impacts, moisture,and sweat. Reinforced casing and water-resistant seals protect the internal components, ensuring longevity and reliability in various environments.

d.User Interface: The device incorporates an intuitive user interface, which may include a display screen or companion mobile app, to provide real-time feedback on workout performance, heart rate, and activity timeline. Simple navigation and clear visual cues enhance usability, allowing users to access key information quickly and easily.

e.Long Battery Life: A long-lasting battery ensures uninterrupted operation during extended workout sessions, minimizing the need for frequent recharging. Efficient power management techniques optimize battery life, prolonged usage between charges and enhancing the overall user experience.

2.2.5 Constraints:

a.Cost: The cost of components, including sensors and hardware, may impact the overall affordability of the fitness band. Balancing performance and functionality with cost considerations is essential to ensure the product remains accessible to a wide range of users.

b.Accuracy and Reliability: Achieving high levels of accuracy and reliability in tracking calisthenics exercises and heart rate monitoring is paramount. Strict quality control measures and thorough testing procedures are necessary to mitigate errors and ensure consistent performance across different users and environments.

c.Compatibility: Ensuring compatibility with a variety of devices and operating

systems, such as smartphones and fitness apps, may present challenges. Addressing compatibility issues requires extensive testing and optimization to ensure seamless integration and functionality across different platforms.

d.Regulatory Compliance: Compliance with health and safety regulations, including standards for medical devices and electromagnetic compatibility, imposes constraints on the design and manufacturing process. Adhering to regulatory requirements is essential to ensure the safety and effectiveness of the fitness band for users.

e.User Experience: Meeting the diverse needs and preferences of users, including interface design, customization options, and data visualization, presents challenges in product development. Incorporating user feedback and iterative design processes are essential to creating a fitness band that delivers an optimal user experience.

2.2.6 Assumptions and Dependencies

Assumptions

a. User Engagement: The assumption is that users will actively engage in calisthenics exercises and seek a fitness band specifically designed for tracking such activities.

b.Technological Capability: It is assumed that the sensors and hardware incorporated into the fitness band have the necessary technological capabilities to accurately track movements and monitor heart rate during calisthenics workouts.

c.User Interaction: The assumption is that users will interact with the fitness band through its user interface, whether it's a display screen on the device itself or a companion mobile app.

d.Environmental Conditions: It is assumed that the fitness band will be used in environments where it can withstand typical conditions encountered during physical activity, including moisture from sweat and occasional impacts.

e.User Expectations: The assumption is that users have certain expectations regarding the accuracy, reliability, and usability of the fitness band, and that the product will meet or exceed these expectations. It is assumed that the fitness band will be used in environments where it can withstand typical conditions encountered during physical activity, including moisture from sweat and occasional impacts.

Dependencies:

a.Sensor Integration: The accuracy and reliability of the fitness band depend on the seamless integration of sensors such as accelerometers, gyroscopes, and heart rate monitors into the device's hardware and firmware.

b.Data Processing: The functionality of the fitness band relies on effective data processing algorithms to interpret sensor data, calculate workout metrics, and generate real-time feedback for users.

c.Battery Performance: The usability of the fitness band is dependent on the battery performance, including factors such as capacity, longevity, and efficiency of power management.

d.Software Development: The development of the fitness band's user interface, companion app (if applicable), and firmware requires expertise in software development, including user experience design, mobile app development, and embedded systems programming.

e.Manufacturing Processes: The production and assembly of the fitness band depend on various manufacturing processes, including sourcing components, PCB assembly, enclosure fabrication, and quality control testing.

f.Regulatory Compliance: Ensuring compliance with health and safety regulations, as well as industry standards for electronic devices and medical devices, is necessary for the fitness band to be legally sold and used by consumers.

g.User Feedback: Iterative design and development processes depend on user feedback to refine the product and address any usability issues or feature requests identified during testing and usage.

h.Market Demand: The success of the fitness band is contingent on market demand for such a product, influenced by factors such as consumer preferences, trends in fitness technology, and competition from existing products in the market.

2.3 External Interface Requirements

2.3.1 User Interfaces

interface for FIA primarily includes a user-friendly mobile application that can connect to the sensor-based prototype glove/band via Bluetooth. The app will display real- time data obtained from the Fitband's sensors, such as arm-to-shoulder distance, wrist-to-chest distance and the heart rate monitoring. The app also displays workout options that the user can choose from such as the type of workout ,the number of reps and the number of sets for the workout. The app will also have a visually appealing and consistent design that will be minimalistic and easy to follow. The app will also keep workout data recorded in it so that the user can view it whenever at their own convenience.

2.3.2 Hardware Interfaces

The fitband will be equipped with various sensors ,namely 2 VL6180x Time Of Flight(TOF) sensors and Heart rate sensor. The hardware interface also provides a way for the sensors to communicate with the app via Bluetooth Low Energy (BLE) technology. The app will then be able to connect to the fitband and read and write data to them. The hardware interface should also provide a way for the fitband to receive power and communicate with a charging dock or USB port.

2.3.3 Software Interfaces

On the software side of this project, the mobile application is developed using flutter and also provides a coded interface in order to connect to the fitness band using Bluetooth to receive the sensor data and display it in a user-friendly manner. The data sent to the mobile application is then stored in a cloud based database known as Firebase.

Firebase makes sure to securely store all the user workout information and these stored data are then displayed within the app and can be viewed by the user anytime they want. The application user interface is particularly minimalistic so as to keep the vibe of working out immersive and not to distract the user during his workout. The user interface basically consists of a home screen which shows the summary of the past workout such as the time spent ,reps and sets taken and previously recorded heart rate. The workout selection screen includes a button to select the user's required workout and other buttons to set the reps and sets of their corresponding workout. The summary of the workout will then be displayed in the home screen later as mentioned previously.

2.3.4 Communications Interfaces

The communication interface involves the active use of Bluetooth technology to enable the fitness band prototype to communicate with the mobile application. Bluetooth is a wireless communication technology that is commonly used for short-range communication between devices. It enables the transfer of data between devices over short distances, making it ideal for use in IoT-based projects where devices are in close proximity to each other. Thus in order to enable the communication between the Fitness band and the mobile application we use a microprocessor module namely ESP32-C6 which is a module that also has a built in Wi-fi/Bluetooth connectivity with low latency and high efficiency. Also the type of data transferred via this communication will include the data from the heart rate monitoring and also the proximity data from the two VL6180X sensors. The data from both the sensors will be transferred regularly in order to ensure that there is consistent transfer of data from the fitness band to the mobile application.

2.4 System Features

2.4.1 Distance and Repetition Tracking

2.4.1.1 Description and Priority

FIA utilizes the VL6180 -VL6180X Time Of Flight(TOF)Sensor for precise measurement of the distance between the sensor and user's shoulder during the exercise like push ups, bicep curls and counts the number of perfectly executed exercises and provides the user feedback on their form and progress. Priority: High. Accurate tracking of the repetitions allows users to monitor their progress over time and maintain consistency in their workouts, also precise measurement of distance helps ensure that users maintain proper form during exercises, reducing the risk of injury and maximizing the benefits of each repetition.

2.4.1.2 Stimulus/Response Sequences

User Action: User performs the Push-ups , Pull-ups and Bicep curls. System Response:System records each perfectly executed repetitions by measuring the distance between the user's shoulder and the fitness band during each push-up, pull-up or bicep curls using VL6180X Sensors.

2.4.1.3 Functional Requirements

REQ-1.1: The system must accurately measure the distance between the sensor and the user's shoulder using VL6180X sensors.

REQ-1.2: The system must count and record each perfectly executed push-ups, pull-ups, or bicep curl.

REQ-1.3: The system must differentiate between perfectly executed repetitions and incomplete ones how to make them in proper alignment in latex

2.4.2 Heart Rate Monitoring

2.4.2.1 Description and Priority This feature involves monitoring the user's heart rate in real-time during workouts.It ensures that users can track their cardiovascular exertion

and provide alerts if their heart rate exceeds a safe threshold ,promoting safe and efficient exercise sessions. Priority :High High priority is assigned to heart rate monitoring because it is essential for ensuring user safety during workouts. Monitoring heart rate in real-time allows users to adjust their intensity levels and avoid overexertion, reducing the risk of injury or health complications.

2.4.2.2 Stimulus/Response Sequences User Action: User starts the workout sessions . System Response: Heart Rate sensor detects the user's heart rate , System displays the real-time heart rate on device screen,if the heart rate exceeds normal range , system alerts the user and suggests the user to take a break.

2.4.2.3 Functional Requirements

REG 1.1: The system must continuously monitor the user's heart rate during workouts.

REG 1.2: The system must display the current heart rate on the device screen.

REG 1.3: If the heart rate exceeds the normal range,the system must provide an auditory alert to the user.

2.4.3 Customizable Workout Plans

2.4.3.1 Description and Priority This feature provides the users with a mobile app interface where they can select from a variety of workout options and customize their exercise sessions according to their preferences. Users can specify the number of sets and repetitions for each exercise,allowing for personalized workout routines. Priority:High High priority is assigned to customizable workout plans to enhance user engagement and satisfaction.Offering a diverse selection of workout options and allowing customization promotes user autonomy and flexibility in their fitness regimen.

2.4.3.2 Stimulus/Response Sequences

User opens the mobile app.

User selects the desired workout from the available options.

User specifies the number of sets and repetitions for each exercise.

2.4.3.3 Functional Requirements

REQ 1.1: The mobile app must provide a selection of workout options for the user to choose from.

REQ 1.2: The app must allow users to customize the number of sets and repetitions for each exercise.

REQ 1.3: The system must save user preferences for future workouts.

2.4.4 Real-Time Time Display

2.4.4.1 Description and Priority

Displays the current time on the device screen in real-time.

Priority : Medium.

2.4.4.2 Stimulus/Response Sequences

User initiates the device.

Device establishes a Bluetooth connection with the mobile app.

Device retrieves the current time from the mobile app.

Device updates and displays the current time on the device screen.

2.4.4.3 Functional Requirements

REQ 1.1: The device must establish a bluetooth connection with the mobile app to retrieve the current time.

REQ 1.2: The device must synchronize with the mobile pp to update the time display in real time.

REQ 1.3: The time display on the device screen must be accurate and reflect the current time obtained from the mobile app.

2.4.5 Real-Time Rest Display

2.4.5.1 Description and Priority It displays the rest time duration on the screen after each workout session(set) to allow users to rest adequately between sets. Priority: High

2.4.5.2 Stimulus/Response Sequences

User completes a workout session (set).

Device detects the end of the session.

Device calculates and displays the rest time duration on the screen.

User acknowledges the rest time or initiates the next session.

2.4.5.3 Functional Requirements

REQ-1: The device must track the duration of each workout session (set).

REQ-2: After completing a session, the device must calculate and display the rest time duration based on predefined settings or user preferences.

REQ-3: The rest time display must be clear and visible to the user on the device screen.

REQ-4: The device must provide options for users to adjust the rest time duration or skip the rest period if desired.

REQ-5: If the user initiates the next session before the rest time elapses, the device must reset the rest time display and proceed to the next session.

2.5 Other Nonfunctional Requirements

2.5.1 Performance Requirements:

a.Sensor Data Acquisition Rate: The system should be capable of acquiring sensor data from the VL6180X sensors and heart rate sensor at a minimum rate of 10 samples per second. This requirement ensures timely data acquisition for real-time monitoring and analysis of vital signs.

b.Communication Latency: The communication latency between the IoT device

and external devices, such as a mobile application or server, should not exceed 100 milliseconds. This requirement ensures prompt transmission of sensor data and responsiveness to user commands.

c.Data Processing Time: The microcontroller should be able to process sensor data and perform necessary computations, such as heart rate calculation and proximity analysis, within 20 milliseconds per data sample. This requirement ensures timely processing of sensor data for real-time feedback and decision-making.

d.Power Consumption: The system should consume no more than 10 mA of current during normal operation, excluding power peaks during sensor activation or communication. This requirement aims to optimize power efficiency and prolong battery life, especially for battery-powered applications.

2.5.2 Safety Requirements

Safety is paramount when designing and using a fitness device, Here are some safety requirements to consider:

a. Accurate Heart Rate Monitoring: Ensure that the heart rate sensor provides accurate readings to prevent overexertion and maintain safe exercise intensity levels.

b.Form Correction: The ToF sensor should accurately detect movements and provide real-time feedback to users to correct their form and reduce the risk of injury.

c.Appropriate Exercise Recommendations: The companion app should provide suitable calisthenic exercises based on the user's fitness level and capabilities to avoid strains or injuries.

d.User Education: Include comprehensive instructions and safety guidelines within the app or user manual to educate users on proper form, warm-up techniques, and rest

intervals between sets to prevent injuries.

e.Data Privacy and Security: Ensure that user data collected by the device and app is encrypted and securely stored to protect user's privacy and prevent unauthorized access to sensitive information.

f.Quality Materials and Construction: Use durable and sweat-resistant materials in the construction of the watch to withstand the rigors of regular exercise and prevent any potential hazards such as breakage or malfunction during workouts.

g.Battery Safety: Implement safeguards to prevent overheating or malfunction of the battery, especially during intense workouts, to reduce the risk of burns or electrical hazards.

h.Compliance with Regulations: Ensure that the device complies with relevant safety regulations and standards for wearable fitness devices in the regions where it will be marketed and sold.

By adhering to these safety requirements,we can provide users with a safe and effective tool for enhancing their skills.

2.5.3 Security Requirements

Some security requirements for a better experience:

a.Secure Data Storage: Store user data securely within the companion app, using robust encryption and access control measures to prevent unauthorized access or data breaches. This includes implementing secure authentication mechanisms for user accounts.

b.Secure Communication: Ensure that data transmission between the fitness watch and the companion app is encrypted to prevent interception or tampering by malicious actors. This involves implementing secure communication protocols such as Bluetooth

encryption.

c.User Privacy: Respect user privacy by implementing strict policies regarding the collection, use, and sharing of personal data. Obtain explicit consent from users before collecting any sensitive information and provide them with transparent information about how their data will be used.

d.Firmware Security: Regularly update the firmware of the fitness watch to patch any security vulnerabilities and ensure that the device remains protected against potential exploits or attacks.

2.5.4 Software Quality Attributes

Qualities related to its attributes:

a.Reliability: The companion app and firmware of the fitness watch should be reliable, ensuring consistent performance and accurate tracking of workouts and health metrics. Users rely on the device to provide accurate data and guidance during their fitness routines.

b.Usability: The user interface of the companion app should be intuitive and user-friendly, allowing users to easily navigate through features, input their workout routines, and view their progress without confusion. The app should also provide clear instructions and guidance for using the fitness watch effectively.

c.Performance: The software should be optimized for performance, ensuring fast response times and minimal latency in tracking and displaying workout data. This includes efficient data processing and communication between the fitness watch and the companion app.

d.Security: As mentioned earlier, the software should prioritize security by imple-

menting strong encryption protocols, secure data storage, and secure communication channels to protect user data and privacy.

e.Scalability: The software should be designed to accommodate future updates and expansions, such as adding new features or supporting a larger user base, without sacrificing performance or reliability.

f.Maintainability: The code base of the software should be well-structured and modular, making it easy for developers to maintain and update over time. This includes clear documentation, consistent coding standards, and version control practices.

g.Compatibility: The software should be compatible with a wide range of devices and operating systems to ensure accessibility for users with different preferences and hardware setups.

Chapter 3

System Architecture and Design

3.1 System Overview

The Home Fitness Tracker Band is a cutting-edge wearable device tailored for individuals dedicated to maximizing their home workout routines. With a focus on essential metrics such as repetitions, sets, heart rate, and time, this advanced fitness band revolutionizes the way users monitor and optimize their exercise sessions. Equipped with two VL6180x Time Of Flight (TOF) sensors alongside a precise heart rate sensor, the device ensures unparalleled accuracy in tracking workout performance. By seamlessly communicating with the companion mobile app via Bluetooth Low Energy (BLE) technology, users can effortlessly sync their workout data for in-depth analysis and personalized feedback. With customizable workout routines, intuitive interface, and long-lasting battery life, the Home Fitness Tracker Band empowers users to achieve their fitness goals with precision and convenience, all from the comfort of their home environment. This architecture enables effortless synchronization of workout data, allowing users to access detailed insights and analysis directly on their smartphones or tablets. Through the app, users can create personalized workout routines, set goals, and track their progress over time, empowering them to optimize their fitness journey according to their individual needs and preferences.

The user interface of the Home Fitness Tracker Band is designed for simplicity and ease of use, featuring intuitive controls and clear display of essential workout metrics. The device's architecture prioritizes user experience, ensuring that users can navigate through menus, view their progress, and interact with the device seamlessly during their workout sessions.

Furthermore, the device is engineered with a robust and energy-efficient design, featuring a long-lasting battery life to support extended workout sessions also emphasizing durability and reliability, ensuring the device's resilience to the rigors of home workouts.

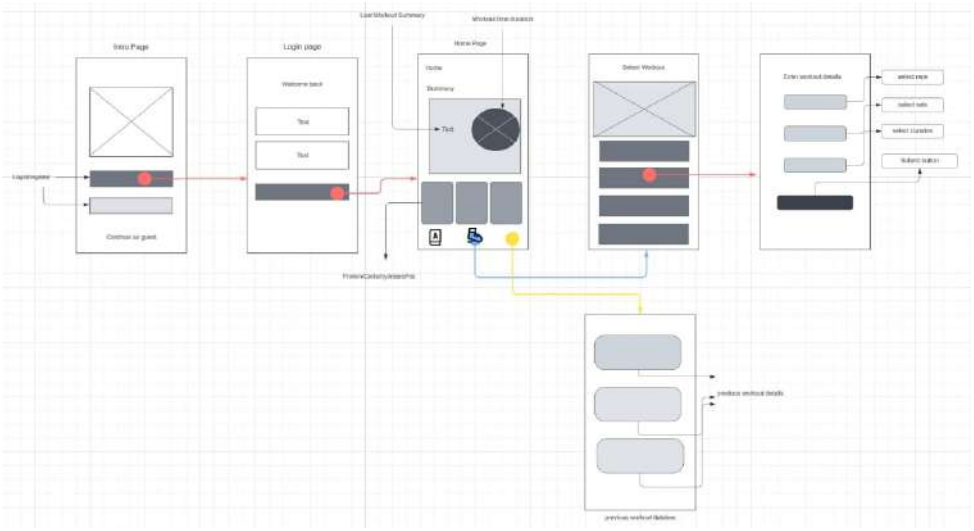


Figure 3.1: Wire Frame

Overall, the architectural design of the Home Fitness Tracker Band combines advanced sensor technology, seamless connectivity, and user-centric features to deliver a comprehensive solution for individuals seeking to optimize their home workout experiences.Refer Figure 3.1.

3.2 Architectural Design

This sequence diagram captures the flow of interactions between the user, the fitness band, and the companion app throughout the workout session, from authentication to workout tracking and summary display.

Here, at first the user needs to login into their account and select the type of workout he?she wants to do for the day , after selecting they need to provide the workout description indicating the number of REPS and SETS they want to do, and then on clicking on the START SENSING button , the band will get activated , the number of sets and reps will be set and on each correctly done exercise, the counter will decrement and correspondingly it will be displayed on the OLED display and will get automatically stored in the systems database as well. The history of workouts done will be easily accessible by the users through the device's application.Refer Figure 3.2.

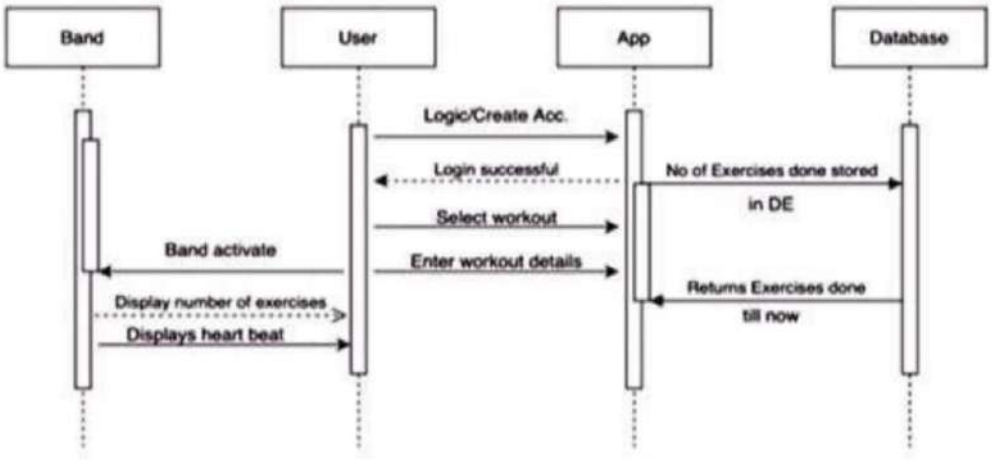


Figure 3.2: Sequence diagram

This simplified diagram provides an overview of the key functionalities offered by the fitness band system, focusing on user interactions related to authentication, workout selection, tracking, and summary display.

To begin their workout session, the user first logs into their account via the fitness device's application. Once logged in, they select the type of workout they wish to undertake for the day, choosing from a variety of options such as pushups, pullups, bicep curls, and more. After selecting the workout type, the user provides specific details for their session, including the number of repetitions (REPS) and sets (SETS) they intend to perform. Once the workout details are set, the user clicks on the 'START SENSING' button within the application. This action activates the fitness band. The device then sets the specified number of reps and sets. As the user begins their workout, the fitness band tracks their movements. With each correctly executed exercise, the repetition counter decrements, displaying the remaining reps in real-time on the band's OLED display. Simultaneously, the number of completed sets and repetitions is automatically stored in the system's database. This allows users to easily track their workout history and monitor their progress over time. The workout history, along with detailed insights, is readily accessible to the user through the fitness device's application, providing them with the necessary information to stay motivated and achieve their fitness goals effectively. Refer Figure 3.3.

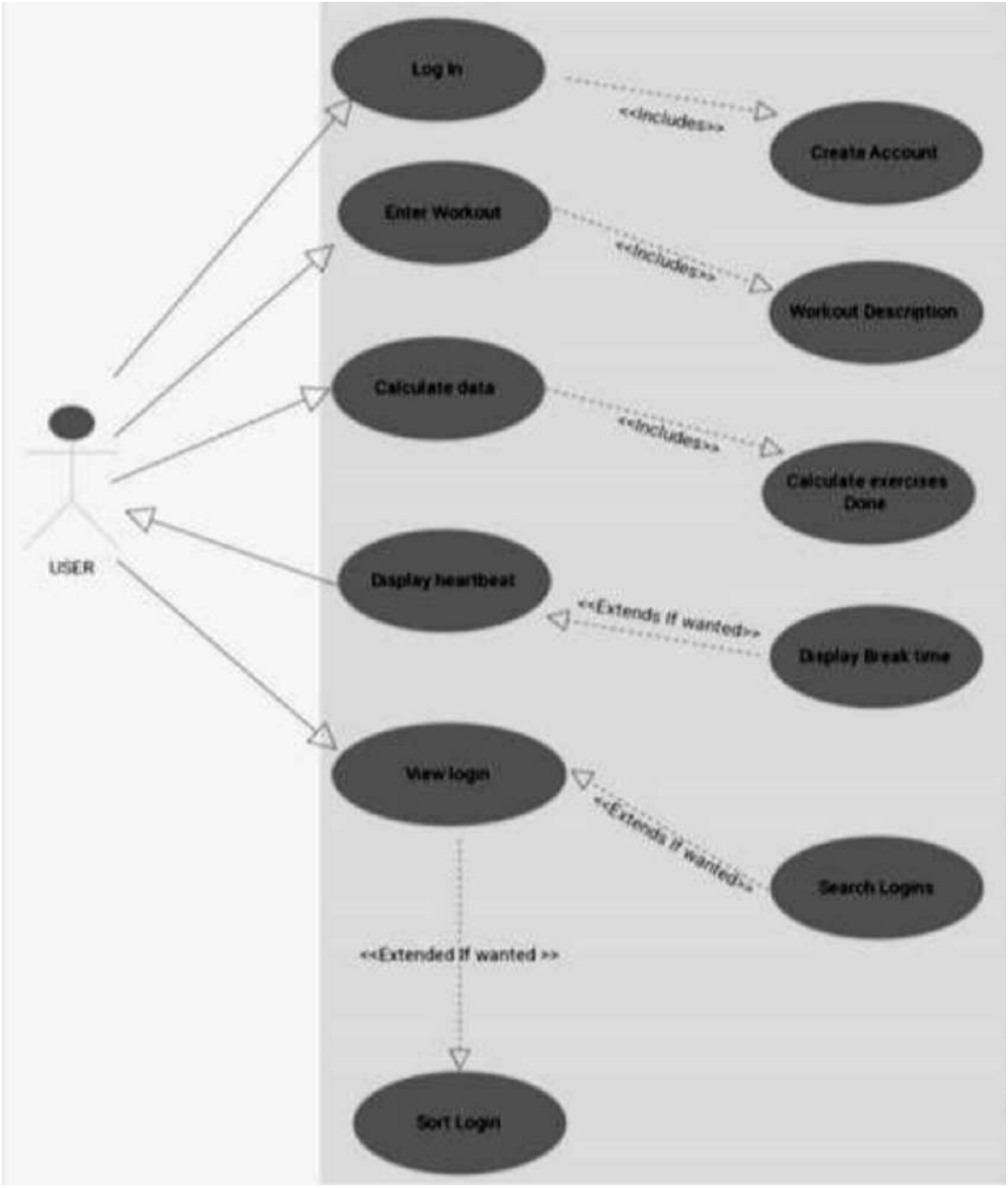


Figure 3.3: Use-Case diagram

3.3 Proposed Methodology/Algorithms

Start: Begin program execution

- 1.1. Start the program execution.

Initialize Variables: Set up initial values

- 2.1. Initialize the `below60Count` variable to 0 (to count occurrences below 60).

Setup: Configure communication and sensors

- 3.1. Begin serial communication at a baud rate of 9600.

- 3.2. Initialize I2C communication for the OLED display.

- 3.3. Initialize the VL6180X sensor.

- 3.4. Set the buzzer pin (`BUZZER_PIN`) as an output pin.

- 3.5. Initialize the pulse sensor pin. (`PULSE_SENSOR_PIN`) for reading the heart rate.

Main Loop: Continuous monitoring loop

- 4.1. Read the range value from the VL6180X sensor.

- 4.2. Read the heart rate value from the pulse sensor.

- 4.3. Check if the range is less than 60:

 - 4.3.1. If true, increment the below60Count variable.

 - 4.3.2. Turn on the buzzer for a short beep.

- 4.4. Clear the OLED display buffer.

- 4.5. Print the range value on the OLED display.

- 4.6. Display the content on the OLED display.

- 4.7. Check if the `below60Count` is greater than or equal to 5:

 - 4.7.1. If true, turn on the buzzer for a longer and louder beep.

 - 4.7.2. Reset the `below60Count` variable to 0.

- 4.8. Check if the heart rate is above 100 bpm:

 - 4.8.1. If true, give a warning signal (e.g., continuous buzzer sound).

- 4.9. Delay for 1000 milliseconds before the next iteration of the loop.

End: Program termination

- 5.1. End of the program.

3.4 Database Design

For FIA, a well-designed database is essential for storing user data, workout routines, and other relevant information. Here's a description of the database design: **1. User Authentication and Profile:**

- **User Table**: Contains user information such as username, password, and any other relevant details.

- **Profile Table**: Stores additional user profile information like age, weight, height, fitness goals, etc.

2. Workout Tracking:

- **Workout Table:** Records details of each workout session, including the date, duration, and any additional metadata.

- **Exercise Table:** Stores information about specific exercises, such as exercise name, description, and muscle groups targeted.

Workout Exercise Table: Acts as a many-to-many relationship table linking workouts to the exercises performed, including details like repetitions, sets, and intensity.

3. Sensor Data:

- **Heart Rate Table:** Logs heart rate data during workouts, associating each record with a user and timestamp.

- **ToF Sensor Table**: Stores movement data captured by the Time-of-Flight sensor during exercises, linked to the user and workout session.

4. App Data:

- **Routine Table:** Contains predefined workout routines created by the app or users, including details like routine name, description, and associated exercises.

- **User Routine Table:** Links users to their customized or selected workout routines, allowing for personalization and tracking of progress.

5. Security and Logging:

-**Session Table:** Tracks user sessions for authentication and authorization purposes, including session ID, user ID, and timestamps.

- **Error Log Table:** Records any errors or exceptions that occur within the system for troubleshooting and debugging purposes.

6. Data Privacy:

- **Privacy Settings Table:** Stores user preferences regarding data privacy.

7. Metadata:

- **Timestamps:** Include timestamps for relevant data entries to track when activities occurred.

- **Unique IDs:** Use unique identifiers for each record to ensure data integrity and facilitate efficient querying.

3.5 Description of Implementation Strategies

1. Interfacing with Sensors and Actuators:

- Utilize the Arduino IDE and ESP32 libraries to interface with the VL6180X distance sensor and the heart rate sensor.

- Use the Adafruit VL6180X library for the distance sensor and appropriate libraries for the heart rate sensor.

- Example code snippet for VL6180X distance sensor:

article listings

```

#include <Wire.h>
#include <VL6180X.h>

VL6180X sensor;

void setup() {
    Wire.begin();
    sensor.init();
}

void loop() {
    int range = sensor.readRange();
    // Process range data
    delay(100);
}
```

Listing 3.1: VL6180X Sensor Setup in C++

- Example code snippet for heart rate sensor (assuming it's a pulse sensor):

article listings

```
#include <Wire.h>
#include <VL6180X.h>

```

```
VL6180X sensor;

void setup() {
    Wire.begin();
    sensor.init();
}

void loop() {
    int range = sensor.readRange();
    // Process range data
    delay(100);
}
```

Listing 3.2: VL6180X Sensor Setup in C++

2. Device Identification and Flashing:

- Generate unique device IDs using the ESP32's MAC address or other methods.

- Flash the microcontroller with the generated IDs using appropriate programming tools or methods supported by the ESP32 development environment.

- Example code snippet for retrieving ESP32 MAC address:

article listings

```
#include <WiFi.h>

uint8_t mac[6];

void setup() {
    WiFi.macAddress(mac);
    // Use MAC address for device ID generation
}
```

Listing 3.3: WiFi Setup in C++

3. Monitoring Heart Rate and Providing Warning Signals:

- Continuously read heart rate data from the sensor and compare it against a threshold

(e.g., 100 BPM).

- Trigger warning signals (LED flashing, buzzer sound) if the heart rate exceeds the threshold.

- Example code snippet for monitoring heart rate and triggering warning signals:

article listings

```
void loop() {
    heartRate = analogRead(sensorPin);
    if (heartRate > 100) {
        // Trigger warning signal (e.g., LED flashing)
        digitalWrite(ledPin, HIGH);
        delay(500);
        digitalWrite(ledPin, LOW);
        delay(500);
    }
    delay(100);
}
```

4. Proper Repetition Counting and Range Measurement:

- Implement logic to count proper repetitions of the exercise by monitoring range data from the VL6180X sensor.

- Discard range readings if the motion is less than 40 mm.

- Example code snippet for proper repetition counting:

article listings

```
void loop() {
    int range = sensor.readRange();
    if (range > 40) {
        // Increment repetition count
    }
    delay(100);
}
```

3.6 Module Division

1. Sensor Interface Module:

- Responsible for interfacing with the VL6180X distance sensor and the heart rate sensor.

- Reads data from sensors and provides it to other modules for further processing.

2. Device Identification and Flashing Module:

- Generates unique device IDs for each device using the ESP32's MAC address or other methods.

- Handles the flashing of microcontrollers with the generated IDs.

3. Heart Rate Monitoring Module:

- Monitors the user's heart rate using the heart rate sensor.

- Implements logic to detect abnormal heart rates and trigger warning signals if necessary.

4. Proper Repetition Counting Module:

- Tracks proper repetitions of the exercise by monitoring range data from the VL6180X sensor.

- Ensures that only valid repetitions, with a range greater than 40 mm, are counted.

5. Warning Signal Module:

- Generates warning signals, such as LED flashing or buzzer sounds, based on inputs from the heart rate monitoring module.

- Alerts the user when their heart rate exceeds a predefined threshold.

6. Mobile App Control Module:

- Develops a mobile application for controlling and monitoring the device remotely.

- Enables users to start/stop the device, adjust settings, and view real-time data through a user-friendly interface.

7. User Interface Module (Optional):

- Provides a user interface for displaying real-time data and settings adjustments.

- Can be implemented using an OLED display, mobile app, or other suitable means.

8. Device Enclosure Design Module (Optional):

- Designs and fabricates an enclosure for the device to make it portable and user-friendly.

- Ensures that the enclosure accommodates all components and provides adequate protection.

Assignment of Modules:

- **Sensor Interface Module:** Assigned to Aaditya Nair
- **Device Identification and Flashing Module:** Assigned to Aathira K
- **Heart Rate Monitoring Module:** Assigned to Aldrin Lyju
- **Proper Repetition Counting Module:** Assigned to Aaditya Nair
- **Warning Signal Module:** Assigned to Aaditya Nair
- **Mobile App Control Module:** Assigned to Abhinand Santosh
- **User Interface Module** (Optional): Assigned to Abhinand Santosh
- **Device Enclosure Design Module** (Optional): Assigned to Aathira K

3.7 Work Schedule - Gantt Chart

The construction and implementation of Fia was divided into different phases which is mentioned in the Gantt chart below. Refer Figure 3.4.

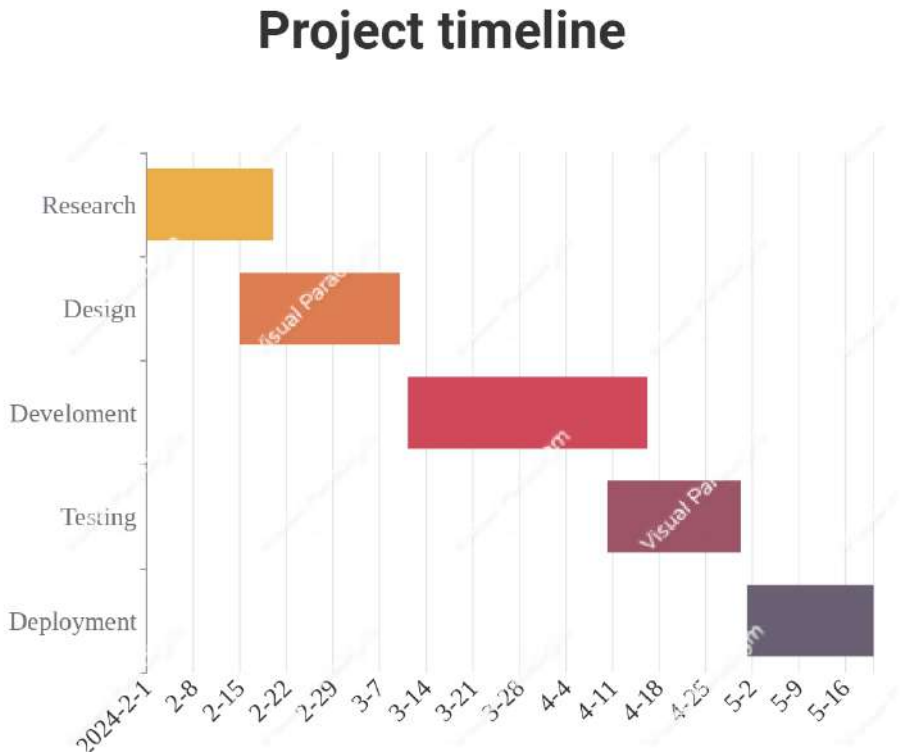


Figure 3.4: Project Timeline

Chapter 4

Results and Discussions

4.1 Overview

The development of the fitness band has yielded a functional prototype that effectively tracks and reports workout metrics. The band successfully measures and transmits the number of reps and sets to an app, providing real-time feedback both on the band and through the app. Quantitative results indicate a high degree of accuracy in counting repetitions and reliable heart rate monitoring. Further analysis highlights the band's robust performance and data accuracy, demonstrating its potential as a valuable fitness tool. This prototype serves as a solid foundation for future iterations aimed at enhancing overall user experience.

4.2 Testing

Testing phrase of was divided into various phrases: Phrase one involved manual connection of the components of the project , which involved the usage of jumper wires and external power supply. Refer figures 4.1 to 4.3. Phrase two involved integrating the components into the glove , which involved the processes like soldering of jumper wires into the components and securing the components into the gloves using glue gun. Refer figures 4.4 to 4.7. Phrase three involved giving the prototype a final finish look by covering the jumper wires and other components ,other than the LED display with another layer of clothing. Refer figure 4.8. Phrase four involved the construction of the application. Refer figures 4.9. The screenshots of the test results are:

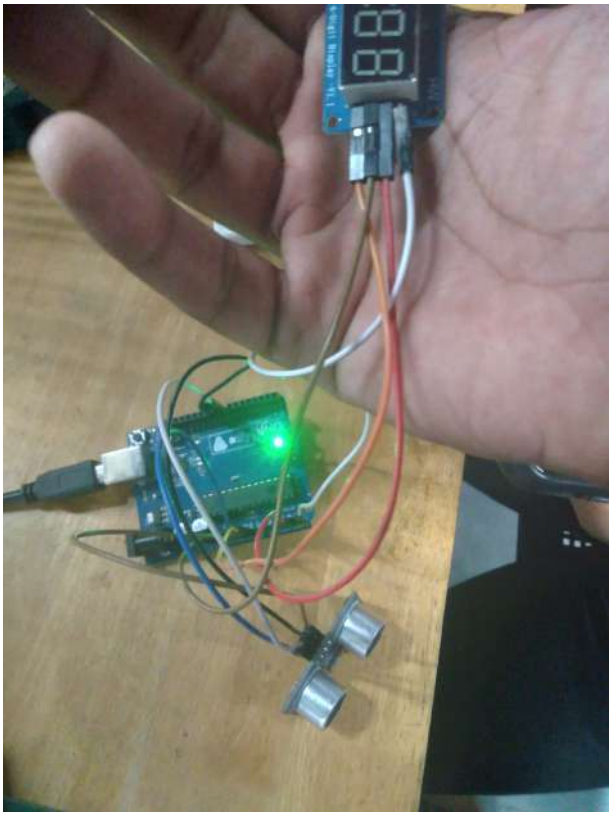


Figure 4.1: wiring and app development

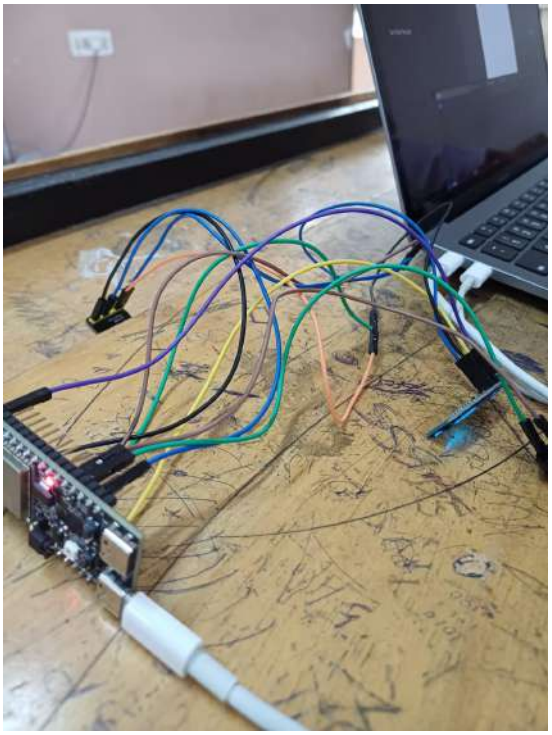


Figure 4.2: wiring and app development

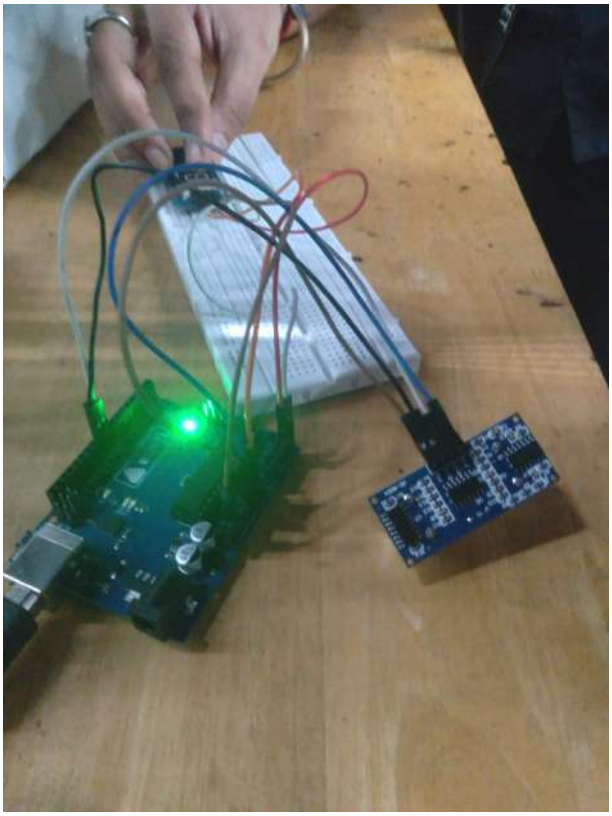


Figure 4.3: wiring and app development

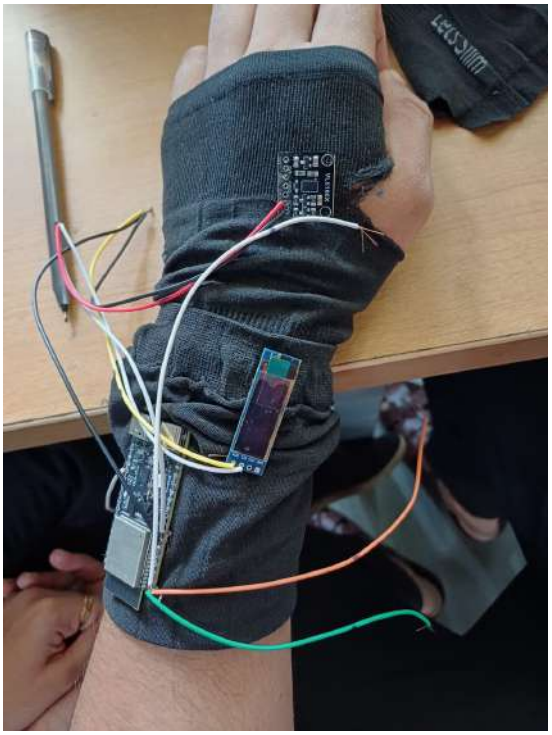


Figure 4.4: prototype of the project

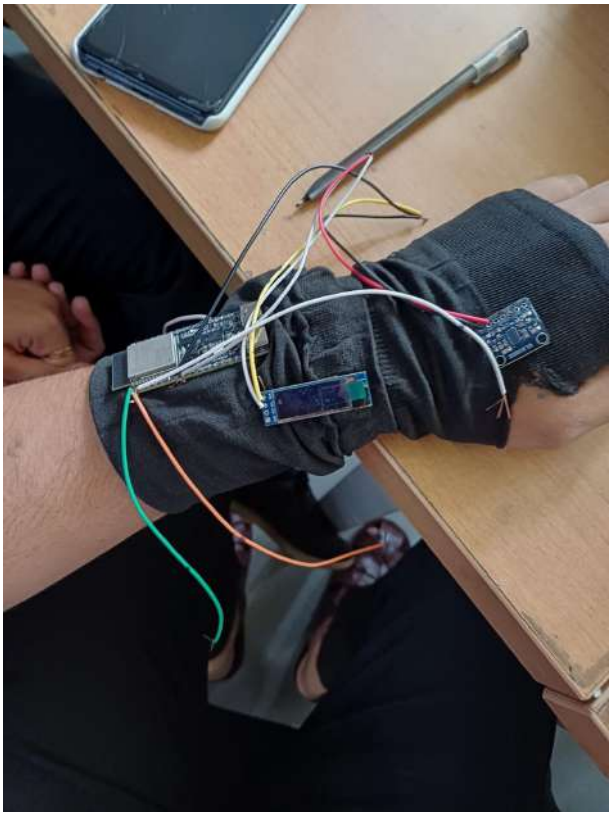


Figure 4.5: prototype of the project

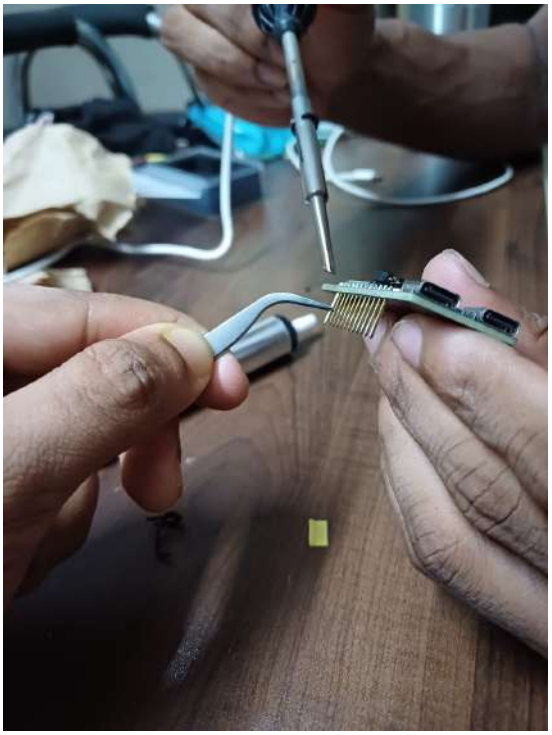


Figure 4.6: prototype of the project

Figure 4.7: prototype of the project

Figure 4.8: prototype of the project

Figure 4.9: app template

4.3 Quantitative Results

FIA incorporates the feature of calculating the total number of calories burned during a particular workout. For example, 10 proper push-ups burn a total of 3.3 calories. Similarly, as the number of push-ups or any exercise increases, the total number of calories burned also increases. Refer to Figure 4.10

Number of Push-Ups	Calories Burned
10	3.3
20	6.6
30	9.9
40	13.2
50	16.5
60	19.8
70	23.1
80	26.4
90	29.7
100	33.0

Figure 4.10: calorie burned

Chapter 5

Conclusion

5.1 Conclusion

The development of the fitness band prototype has successfully demonstrated its core functionality in tracking and reporting workout metrics. The device efficiently collects and transmits data to an accompanying app, providing users with real-time feedback on their exercises. This capability underscores the fitness band's potential as a valuable tool for fitness enthusiasts looking to monitor their performance and progress. Moving forward, the focus should be on refining the prototype to enhance user comfort and usability. While the current version lays a strong foundation with its reliable performance, improvements in design and ergonomics will be essential to ensure broader adoption and user satisfaction. These advancements will help transition the prototype into a market-ready product that effectively combines functionality with ease of use.

5.2 Future Scope

- Utilizing advanced technology to transform the device into a versatile, all-encompassing tool that seamlessly integrates into any workout or physical activity, requiring minimal preparation time.

-Incorporating advanced analytics capabilities to track progress over time, identify patterns, and offer personalized recommendations for workout optimization based on individual performance data.

-Advance additional skills that is performed in higher levels with different stages of progress.

Bibliography

[1] Neil Cameron. *ESP32 Formats and Communication: Application of Communication Protocols with ESP32 Microcontroller*. Apress.

[2] Fabio Remondino and David Stoppa. *ToF Range Imaging Cameras*. Springer.

[3] Nikantha Ghosh. *Microcontroller-based Human Pulse Monitoring System*.

[4] Kung Linliu, Ph.D. *Micro-LED Display Process*.

[5] John 'Lofty' Wiseman. *SAS and Special Forces Fitness Training: An Elite Workout Programme for Body and Mind*.

Appendix A: PRESENTATION

FIA

Guide:
Dr. Jincy Fernandez

Members:
Aaditya Nair
Aathira k
Abhinand Santhosh
Aldrin Lyju

CONTENTS

INTRODUCTION

Introducing our wristband device Promoting full range of motion during workouts by detecting and encouraging complete repetitions, addressing the common challenge of incomplete movement.

PROBLEM DEFINITION

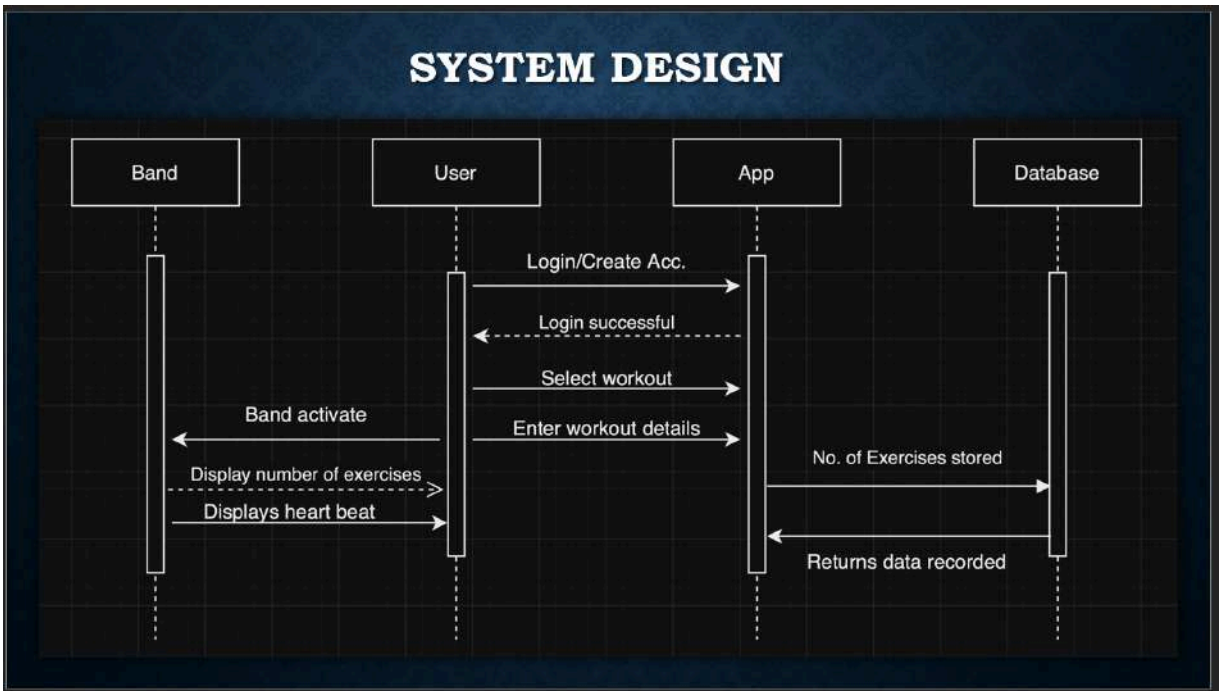
Incomplete range of motion during workouts, leading to suboptimal results and potential discouragement from continuing.

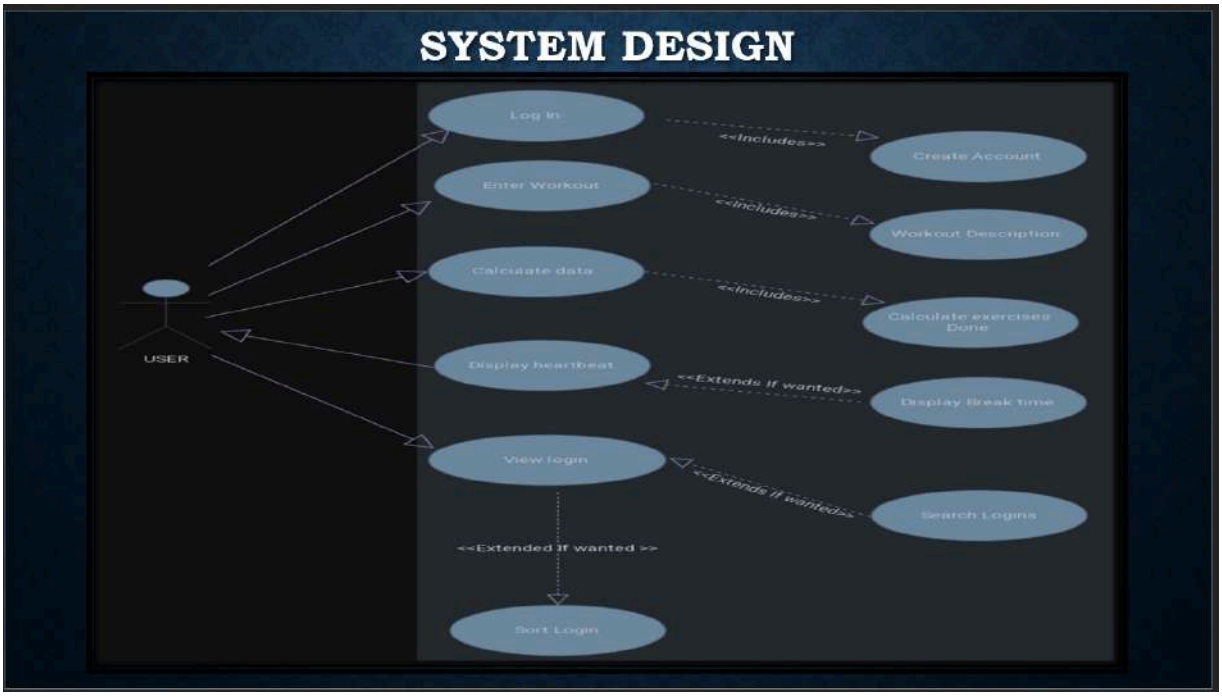
OBJECTIVES

- Develop wristband for accurate motion tracking.
- Offer real-time feedback for proper exercise form.
- Maximize workout effectiveness and results.
- Implement heart rate monitoring.
- Alert users of high heart rates.
- Provide rest time countdown for safety.

SCOPE AND RELEVANCE

Our project focuses on developing a wristband device to address incomplete repetitions during workouts, aiming to optimize exercise effectiveness and motivation. By promoting full range of motion, that offers a solution to a common challenge in fitness training, enhancing the overall workout experience for users.


SYSTEM DESIGN
Band
User
App
Database
Login/Create Acc.
Login successful
Select workout
Band activate
Enter workout details
No. of Exercises stored
Display number of exercises
Displays heart beat
Returns data recorded


SYSTEM DESIGN
Log In
Create Account
Enter Workout
Workout Description
Calculate data
Calculate exercises Done
USER
Display heartbeat
Display Break time
View login
Search Logins
Sort Login
<<Includes>>
<<Extends if wanted>>
<<Extended If wanted >>

WORK DIVISION

SOFTWARE/HARDWARE REQUIREMENTS

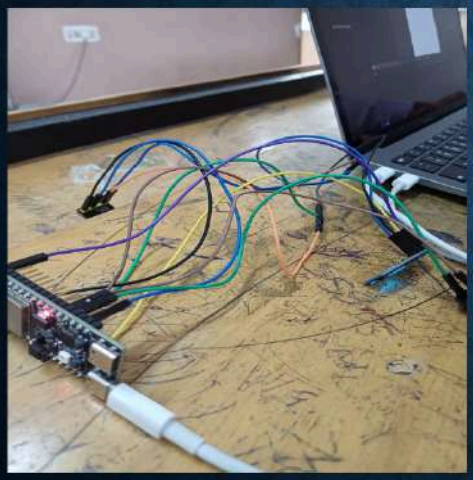
HARDWARE REQUIREMENTS

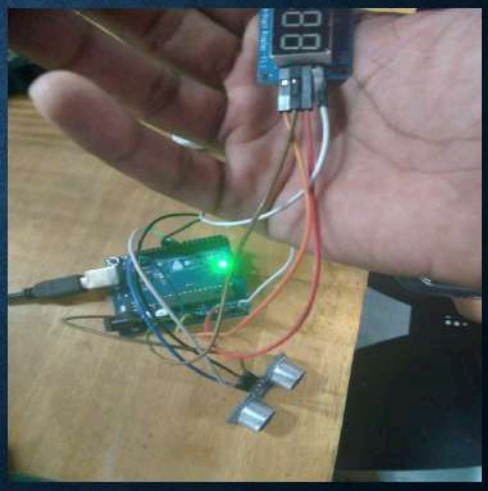
- ESP32-C6
- VL6180X
- PULSE SENSOR
- OLED DISPLAY
- BUZZER
- SWITCH
- LED

SOFTWARE REQUIREMENTS

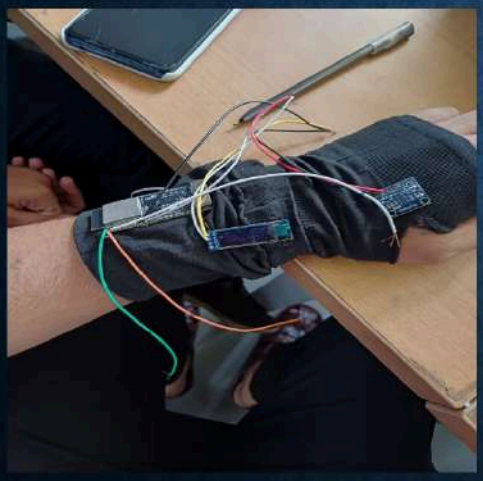
- FLUTTER (DART)
- FIREBASE
- ARDUINO IDE(C++)
- DEVICE WITH BLE CONNECTIVITY

RESULTS
Manually connecting components





RESULTS
Sample Prototype



RESULTS
Sample Prototype

RESULTS
Final Prototype

RESULTS

APP Layout

CONCLUSION

Our project revolutionizes fitness tracking by ensuring users perform exercises with proper form and full range of motion, fostering more effective workouts and better results, ultimately transforming fitness journeys for the better.

FUTURE ENHANCEMENTS

- Utilizing advanced technology to transform the device into a versatile, all-encompassing tool that seamlessly integrates into any workout or physical activity, requiring minimal preparation time.
- Incorporating advanced analytics capabilities to track progress over time, identify patterns, and offer personalized recommendations for workout optimization based on individual performance data.

REFERENCES

- Neil Cameron. ESP32 Formats and Communication: Application of Communication Protocols with ESP32 Microcontroller.
- Fabio Remondino and David Stoppa. ToF Range Imaging Cameras. Springer.
- Nikantha Ghosh. Microcontroller-based Human Pulse Monitoring System.
- Kung Linliu, Ph.D. Micro-LED Display Process.
- John 'Lofty' Wiseman. SAS and Special Forces Fitness Training: An Elite Workout

Appendix B: Vision, Mission, Programme Outcomes and Course Outcomes

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
RAJAGIRI SCHOOL OF ENGINEERING & TECHNOLOGY (AUTONOMOUS)
RAJAGIRI VALLEY, KAKKANAD, KOCHI, 682039
(Affiliated to APJ Abdul Kalam Technological University)

Vision, Mission, Programme Outcomes and Course Outcomes

Institute Vision

To evolve into a premier technological institution, moulding eminent professionals with creative minds, innovative ideas and sound practical skill, and to shape a future where technology works for the enrichment of mankind.

Institute Mission

To impart state-of-the-art knowledge to individuals in various technological disciplines and to inculcate in them a high degree of social consciousness and human values, thereby enabling them to face the challenges of life with courage and conviction.

Department Vision

To become a centre of excellence in Computer Science and Engineering, moulding professionals catering to the research and professional needs of national and international organizations.

Department Mission

To inspire and nurture students, with up-to-date knowledge in Computer Science and Engineering, ethics, team spirit, leadership abilities, innovation and creativity to come out with solutions meeting societal needs.

Programme Outcomes (PO)

Engineering Graduates will be able to:

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and Team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

10. Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Programme Specific Outcomes (PSO)

A graduate of the Computer Science and Engineering Program will demonstrate:

PSO1: Computer Science Specific Skills

The ability to identify, analyze and design solutions for complex engineering problems in multidisciplinary areas by understanding the core principles and concepts of computer science and thereby engage in national grand challenges.

PSO2: Programming and Software Development Skills

The ability to acquire programming efficiency by designing algorithms and applying standard practices in software project development to deliver quality software products meeting the demands of the industry.

PSO3: Professional Skills

The ability to apply the fundamentals of computer science in competitive research and to develop innovative products to meet the societal needs thereby evolving as an eminent researcher and entrepreneur.

Course Outcomes

After the completion of the course the student will be able to:

CO1:

Identify technically and economically feasible problems (Cognitive Knowledge Level: Apply)

CO2:
Identify and survey the relevant literature for getting exposed to related solutions and get familiarized with software development processes (Cognitive Knowledge Level: Apply)

CO3:
Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques (Cognitive Knowledge Level: Apply)

CO4:
Prepare technical report and deliver presentation (Cognitive Knowledge Level: Apply)

CO5:
Apply engineering and management principles to achieve the goal of the project (Cognitive Knowledge Level: Apply)

Appendix C: CO-PO-PSO Mapping

COURSE OUTCOMES:

After completion of the course the student will be able to

SL. NO	DESCRIPTION	Blooms' Taxonomy Level
CO1	Identify technically and economically feasible problems (Cognitive Knowledge Level: Apply)	Level 3: Apply
CO2	Identify and survey the relevant literature for getting exposed to related solutions and get familiarized with software development processes (Cognitive Knowledge Level: Apply)	Level 3: Apply
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques (Cognitive Knowledge Level: Apply)	Level 3: Apply
CO4	Prepare technical report and deliver presentation (Cognitive Knowledge Level: Apply)	Level 3: Apply
CO5	Apply engineering and management principles to achieve the goal of the project (Cognitive Knowledge Level: Apply)	Level 3: Apply

CO-PO AND CO-PSO MAPPING

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	3	3	3		2	2	3	2	2	2	3	2	2	2
CO2	3	3	3	3	3	2		3	2	3	2	3	2	2	2
CO3	3	3	3	3	3	2	2	3	2	2	2	3			2
CO4	2	3	2	2	2			3	3	3	2	3	2	2	2
CO5	3	3	3	2	2	2	2	3	2		2	3	2	2	2

3/2/1: high/medium/low

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	LOW/ MEDIUM/ HIGH	JUSTIFICATION
101003/CS622T.1-PO1	**HIGH**	Identify technically and economically feasible problems by applying the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
101003/CS622T.1-PO2	**HIGH**	Identify technically and economically feasible problems by analysing complex engineering problems reaching substantiated conclusions using first principles of mathematics.
101003/CS622T.1-PO3	**HIGH**	Design solutions for complex engineering problems by identifying technically and economically feasible problems.
101003/CS622T.1-PO4	**HIGH**	Identify technically and economically feasible problems by analysis and interpretation of data.
101003/CS622T.1-PO6	**MEDIUM**	Responsibilities relevant to the professional engineering practice by identifying the problem.
101003/CS622T.1-PO7	**MEDIUM**	Identify technically and economically feasible problems by understanding the impact of the professional engineering solutions.
101003/CS622T.1-PO8	**HIGH**	Apply ethical principles and commit to professional ethics to identify technically and economically feasible problems.
101003/CS622T.1-PO9	**MEDIUM**	Identify technically and economically feasible problems by working as a team.
101003/CS622T.1-PO10	**MEDIUM**	Communicate effectively with the engineering community by identifying technically and economically feasible problems.
101003/CS622T.1-P011	**MEDIUM**	Demonstrate knowledge and understanding of engineering and management principles by selecting the technically and economically feasible problems.
101003/CS622T.1-PO12	**HIGH**	Identify technically and economically feasible problems for long term learning.
101003/CS622T.1-PSO1	**MEDIUM**	Ability to identify, analyze and design solutions to identify technically and economically feasible problems.
101003/CS622T.1-PSO2	**MEDIUM**	By designing algorithms and applying standard practices in software project development and Identifying technically and economically feasible problems.
101003/CS622T.1-PSO3	**MEDIUM**	Fundamentals of computer science in competitive research can be applied to Identify technically and economically feasible problems.
101003/CS622T.2-PO1	**HIGH**	Identify and survey the relevant by applying the knowledge of mathematics, science, engineering fundamentals.

101003/CS622T.2-PO2	**HIGH**	Identify, formulate, review research literature, and analyze complex engineering problems get familiarized with software development processes.
101003/CS622T.2-PO3	**HIGH**	Design solutions for complex engineering problems and design based on the relevant literature.
101003/CS622T.2-PO4	**HIGH**	Use research-based knowledge including design of experiments based on relevant literature.
101003/CS622T.2-PO5	**HIGH**	Identify and survey the relevant literature for getting exposed to related solutions and get familiarized with software development processes by using modern tools.
101003/CS622T.2-PO6	**MEDIUM**	Create, select, and apply appropriate techniques, resources, by identifying and surveying the relevant literature.
101003/CS622T.2-PO8	**HIGH**	Apply ethical principles and commit to professional ethics based on the relevant literature.
101003/CS622T.2-PO9	**MEDIUM**	Identify and survey the relevant literature as a team.
101003/CS622T.2-PO10	**HIGH**	Identify and survey the relevant literature for a good communication to the engineering fraternity.
101003/CS622T.2-PO11	**MEDIUM**	Identify and survey the relevant literature to demonstrate knowledge and understanding of engineering and management principles.
101003/CS622T.2-PO12	**HIGH**	Identify and survey the relevant literature for independent and lifelong learning.
101003/CS622T.2-PSO1	**MEDIUM**	Design solutions for complex engineering problems by Identifying and survey the relevant literature.
101003/CS622T.2-PSO2	**MEDIUM**	Identify and survey the relevant literature for acquiring programming efficiency by designing algorithms and applying standard practices.
101003/CS622T.2-PSO3	**MEDIUM**	Identify and survey the relevant literature to apply the fundamentals of computer science in competitive research.
101003/CS622T.3-PO1	**HIGH**	Perform requirement analysis, identify design methodologies by using modern tools & advanced programming techniques and by applying the knowledge of mathematics, science, engineering fundamentals.
101003/CS622T.3-PO2	**HIGH**	Identify, formulate, review research literature for requirement analysis, identify design methodologies and develop adaptable & reusable solutions.

101003/CS622T.3-PO3	**HIGH**	Design solutions for complex engineering problems and perform requirement analysis, identify design methodologies.
101003/CS622T.3-PO4	**HIGH**	Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
101003/CS622T.3-PO5	**HIGH**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools.
101003/CS622T.3-PO6	**MEDIUM**	Perform requirement analysis, identify design methodologies and assess societal, health, safety, legal, and cultural issues.
101003/CS622T.3-PO7	**MEDIUM**	Understand the impact of the professional engineering solutions in societal and environmental contexts and Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions.
101003/CS622T.3-PO8	**HIGH**	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions by applying ethical principles and commit to professional ethics.
101003/CS622T.3-PO9	**MEDIUM**	Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.
101003/CS622T.3-PO10	**MEDIUM**	Communicate effectively with the engineering community and with society at large to perform requirement analysis, identify design methodologies.
101003/CS622T.3-PO11	**MEDIUM**	Demonstrate knowledge and understanding of engineering requirement analysis by identifying design methodologies.
101003/CS622T.3-PO12	**HIGH**	Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change by analysis, identify design methodologies and develop adaptable & reusable solutions.
101003/CS622T.3-PSO3	**MEDIUM**	The ability to apply the fundamentals of computer science in competitive research and prior to that perform requirement analysis, identify design methodologies.
101003/CS622T.4-PO1	**MEDIUM**	Prepare technical report and deliver presentation by applying the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
101003/CS622T.4-PO2	**HIGH**	Identify, formulate, review research literature, and analyze complex engineering problems by preparing technical report and deliver presentation.

101003/CS622T.4-PO3	**MEDIUM**	Prepare Design solutions for complex engineering problems and create technical report and deliver presentation.
101003/CS622T.4-PO4	**MEDIUM**	Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions and prepare technical report and deliver presentation.
101003/CS622T.4-PO5	**MEDIUM**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools and Prepare technical report and deliver presentation.
101003/CS622T.4-PO8	**HIGH**	Prepare technical report and deliver presentation by applying ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
101003/CS622T.4-PO9	**HIGH**	Prepare technical report and deliver presentation effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.
101003/CS622T.4-PO10	**HIGH**	Communicate effectively with the engineering community and with society at large by prepare technical report and deliver presentation.
101003/CS622T.4-PO11	**MEDIUM**	Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work by prepare technical report and deliver presentation.
101003/CS622T.4-PO12	**HIGH**	Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change by prepare technical report and deliver presentation.
101003/CS622T.4-PSO1	**MEDIUM**	Prepare a technical report and deliver presentation to identify, analyze and design solutions for complex engineering problems in multidisciplinary areas.
101003/CS622T.4-PSO2	**MEDIUM**	To acquire programming efficiency by designing algorithms and applying standard practices in software project development and to prepare technical report and deliver presentation.
101003/CS622T.4-PSO3	**MEDIUM**	To apply the fundamentals of computer science in competitive research and to develop innovative products to meet the societal needs by preparing technical report and deliver presentation.
101003/CS622T.5-PO1	**HIGH**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
101003/CS622T.5-PO2	**HIGH**	Identify, formulate, review research literature, and analyze complex engineering problems by applying engineering and management principles to achieve the goal of the project.

101003/CS622T.5-PO3	**HIGH**	Apply engineering and management principles to achieve the goal of the project and to design solutions for complex engineering problems and design system components or processes that meet the specified needs.
101003/CS622T.5-PO4	**MEDIUM**	Apply engineering and management principles to achieve the goal of the project and use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
101003/CS622T.5-PO5	**MEDIUM**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools and to apply engineering and management principles to achieve the goal of the project.
101003/CS622T.5-PO6	**MEDIUM**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities by applying engineering and management principles to achieve the goal of the project.
101003/CS622T.5-PO7	**MEDIUM**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and apply engineering and management principles to achieve the goal of the project.
101003/CS622T.5-PO8	**HIGH**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice and to use the engineering and management principles to achieve the goal of the project.
101003/CS622T.5-PO9	**MEDIUM**	Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings and to apply engineering and management principles to achieve the goal of the project.
101003/CS622T.5-PO11	**MEDIUM**	Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments and to apply engineering and management principles to achieve the goal of the project.
101003/CS622T.5-PO12	**HIGH**	Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change and to apply engineering and management principles to achieve the goal of the project.
101003/CS622T.5-PSO1	**MEDIUM**	The ability to identify, analyze and design solutions for complex engineering problems in multidisciplinary areas. Apply engineering and management principles to achieve the goal of the project.

101003/CS622T.5-PSO2	**MEDIUM**	The ability to acquire programming efficiency by designing algorithms and applying standard practices in software project development to deliver quality software products meeting the demands of the industry and to apply engineering and management principles to achieve the goal of the project.
101003/CS622T.5-PSO3	**MEDIUM**	The ability to apply the fundamentals of computer science in competitive research and to develop innovative products to meet the societal needs thereby evolving as an eminent researcher and entrepreneur and apply engineering and management principles to achieve the goal of the project.