**CHAPTER 1: INTRODUCTION**

Smart Vital is a portable health monitoring device. It is designed to measure vital signs of an individual. It includes Sp0₂ level, heart rate, ECG, temperature, and blood pressure measurement by utilizing embedded system and IoT. The device provides easy and quick access to essential health parameters in real-time through locally as well as through mobile application. The main purpose for the development of the device is to facilitate users with a reliable and user-friendly product for healthcare management system.

The device is developed so that it can be placed at first aid or medical box at home or it can be used while travelling as it is compact and easy to carry. A single compact device is used unlike having different devices for measuring health vitals. It offering all in one general health measurement, making sure that you have all the necessary health information well within access whether you are on the go or at home. The device Smart Vitals fulfils the increase in the need and demand of the health care system as it is portable and convenient to use. The system uses ESP32 WROVER as microcontroller, which is the main processing segment for collecting the data from sensors like Max30100, AD8232, 10K NTC Thermistor temperature sensor. The readings from the sensor are locally access via OLED display and also transmitted to mobile application made via Flutter. If there is any abnormality in the reading, a alert message is sent, ensuring timely intervention.

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**CHAPTER 2: REVIEW OF LITERATURE**

**CHAPTER 3: REVIEW OF TECHNOLOGY**

The tools, technology and components used in the project are listed below:

1. Hardware Components
2. ESP 32 WROVER TYPE B is a micro-controller, it has powerful ability to process data with built-in Wi-Fi which was the reason for its usage.
3. MAX30100 is a sensor for measuring Sp0₂ and heart rate. It was used as it has high accuracy rate.
4. AD8232 is a device to measure ECG signal. It was used as it gives optimal ECG signal measurement.
5. 10K NTC Thermistor temperature sensor is used for measuring body temperature. Its resistance lowers while temperature is increased, making it suitable for accurate temperature measurement.
6. Resistor is electrical component which controls voltage and limit current. It ensured the components receive proper voltage and current supply.
7. Push Button is electromechanical switch, allowing manual control of the circuit. It was implemented to switch the sensors measurement as per requirement.
8. OLED was used for local display of the real-time measurements.
9. Backend
10. Operating System
11. Windows 11 is used as it supports all the software and hardware components for smooth operation.
12. Language, framework and Libraries
13. C/C++ was used as primary programing language as it helps in effective programing and suitable for hardware like ESP32.
14. Dart was adopted for development of mobile application.
15. Flutter was used for creating responsive UI for real-time data visualization.
16. ThingSpeak allowed to visualize, collect and analyze data after integration with microcontroller.
17. ESP32-SDK allowed effective development, handle wireless communication and hardware integration.
18. Adafruit GFX & Adafruit SSD1306 helped in displaying and controlling the OLED display.
19. Wire.h was used for I2C communication for effective data exchange among ESP32 and components used.
20. WiFi.h library was used as it allows Wi-Fi connectivity for IoT devices which helps in data transmission.
21. MAX30102 Library allowed easy communication with MAX sensor and collect accurate data in real-time.
22. Version Control
23. GitHub was utilized as it helped to manage the codes and files efficiently and keep track of the project history.
24. Documentation
25. MS Word was used to prepare a thorough report of the project.
26. MS Project was used to present a well-constructed workflow of the project for ease development of the project.
27. MS PowerPoint was used to deliver presentation which supports the development of the product.
28. Web Browser
29. Google Chrome was utilized as it is easy to use, offers secure surfing experience and is trusted web browser for debugging and running web portals.

**CHAPTER 4: METHODOLOGY**

Agile methodology has been used for Smart Vitals project. Agile method allows scalability and adaptability which enables to handle technical error effortlessly at early stages without interrupting other components. The flexibility, in Agile methodology allows developers to include new features or components in later stages based on the evolving requirements. Constant feedback is provided which ensures the progression of the project to meet the end goal the expectations. Additionally, the agile method offers iterative process enabling to build and improve the project piece by piece rather than following a linear or firm plan.

The Agile process has different stages each stage contributing for the progressive development of the Smart Vitals project. Research and Specification Collection is the first stage where the essential modules like ESP32, MAX30100 SpO₂ sensor, ECG sensor, Temperature sensor, are examined with the help of the datasheets. The next stage is Planning and Circuit Designing where the sensor connections were validated with the help of Wokwi for circuit diagram layout. After the successful circuit design, the main focus was integration of MAX30100, ECG and Temperature sensor with ESP32 for processing sensor data and with OLED for data monitoring. Then, 3D models and PCB design was developed and designed in TinkerCAD during Designing and Prototyping stage. In the Development stage, the microcontroller was programmed to analyze sensor data to communicate wirelessly with the mobile app. After the system being functional, in the Testing phase the product was regularly tested ensuring precision, stability and working of hardware and software components. Lastly, in deployment and maintenance stage, improvement of the product was done where the product was updated based on user feedback.

The waterfall method is a conventional and sequential approach where each stage must conclude before beginning with the next stage following stable workflow used for project that has well-defined end goal. The project Smart Vitals project has different hardware and software integration which needs to be tested continuously for precision and improvement, in waterfall method testing is conducted following the development stage. Any issue in the project might not be identified until the very end which will be very risky making the process time consuming and complex which is the reason for Agile methodology being used as it offers constant testing and evaluation throughout the product development. RAD focuses on prompt development of the prototypes and user reviews. The Smart Vitals project focuses on providing accurate, dependable and secure data which are essential for health care, RAD focuses on quick deployment which could result in patchy testing and disparity between hardware and software. Therefore, Agile methodology is used as it provides iterative feedback which assures the product is tested thoroughly and reliable medically. The Spiral Model mainly focuses on risk management and developing the project in an iterative manner which can help the developers eliminate or avoid the risks completely during the initial phase. It focuses on thorough reports, planning which is suitable for large-scale project with peak risks which is why agile method is used as it is suitable for small to medium scale projects like Smart Vital with risks like data reliability which can be avoided with regular evaluation.

**CHAPTER 5: PRODUCT DESIGN**

**CHAPTER 6: SOFTWARE REQUIREMENT ANALYSIS**

The table below represents the features of the project with its priority as HIGH, MEDUIM OR LOW.

|  |  |
| --- | --- |
| **Features** | **Priority** |
| The device should be easy to use and portable. | HIGH |
| Button for turning the device on and off. | HIGH |
| The device should connect to Wi-Fi for flawless communication. | HIGH |
| Buttons for switching between the sensors for particular health measurement. | HIGH |
| Accurate readings from sensors. | HIGH |
| The reading taken via sensor should be displayed on the OLED. | HIGH |
| The measurements should be shown in the mobile application through Wi-Fi connection. | HIGH |
| Alert message should be sent to the user if there is any abnormality in the reading. | MEDIUM |
| The data from the measurements should be logged. | MEDIUM |
| Adaptor | MEDIUM |
|  |  |

**CHAPTER 7: IMPLEMENTATION AND TESTING**

**CHAPTER 8: PRODUCT EVALUATION**

**CHAPTER 9: PROJECT EVALUATION**

**Task Sheet**

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The above figure represents the complete flow of how the project was successfully concluded by following a planned task sheet.

**Gnatt Chart**

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**Timeline**

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Key stages of the project are shown in the MS Project Timeline, with initiation phase starting at 12/17/2024, followed by Planning phase, Research phase, Training and implementation phase, Testing and Evaluation phase with Closing phase marking the end of the project at 05/11/2025.

**Resource Sheet**

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**CHAPTER 10: SUMMARY AND CONCLUSION**