A Synopsis of Project on

Blockchain-Enabled Health Monitoring System

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

Bachelor of Engineering

in

CSE(Data Science)

by

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Approval Sheet

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

This project explores the development of a secure and scalable smart health monitoring system that combines Internet of Things (IoT) devices with blockchain technology to enhance patient care and data management. The system uses a wristband equipped with sensors to monitor real-time health metrics like heart rate, pulse, and body temperature. IoT devices collect and transmit data, which is securely stored on a blockchain, ensuring data integrity and preventing unauthorized access. By addressing key challenges such as data privacy, security, and interoperability, the system aims to improve healthcare outcomes, enhance patient engagement, and ensure efficient, secure data handling. The Blockchain-Enabled Health Monitoring System merges IoT technology and blockchain to create a secure, scalable platform for real-time patient health monitoring and data management. Using a wristband equipped with sensors, the system continuously tracks vital health metrics such as heart rate, pulse, and body temperature, transmitting this data securely via IoT devices. Blockchain plays a critical role in ensuring data integrity, privacy, and security by storing health data in a decentralized, tamper-proof ledger, making unauthorized access or data manipulation nearly impossible. The system addresses key healthcare challenges such as data privacy, interoperability, and transparency, allowing seamless data sharing between healthcare providers while maintaining a clear audit trail of data access. Additionally, smart contracts enforce granular access control, ensuring that only authorized personnel can interact with sensitive patient data. This real-time health tracking not only improves patient care and preventive health management but also fosters better engagement by empowering patients with access to their own health information through user-friendly mobile and web applications. By integrating blockchain with IoT, the system enhances security and trust in healthcare data handling, offering a robust solution for modern healthcare needs.

Keywords: *Data Privacy, Blockchain Integration, Secure Data Transmission,User Health Insights, Wireless Communication, Smart Fitness Devices,Health Analytics,Embedded Systems, BLE Communication, Sensor Integration,Personal Health Assistant, Fitness Data Visualization,ecure Health Data Management*

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List of Abbreviations

IoT:	Internet of Things
ESP:	Electric Stability Program
MAX:	Maximum
API:	Application Programming Interface
DHT:	Digital Humidity and Temperature
ACK:	Acknowledgement

Chapter 1

Introduction

The Real-Time Health Monitoring objective focuses on implementing a wristband equipped with IoT sensors to track vital health metrics such as heartbeats, pulse rate, and body temperature. This wristband continuously monitors these metrics in real-time, providing an uninterrupted flow of critical health data. The IoT-enabled sensors collect this data and securely transmit it to healthcare systems, ensuring that healthcare providers can respond swiftly to any health abnormalities. This continuous monitoring is particularly useful for patients with chronic conditions or those requiring constant medical oversight, enhancing preventive care and improving overall patient outcomes.

To address Data Privacy and Security, the system leverages blockchain technology to ensure that the transmission and storage of health data are secure. Blockchain's decentralized nature prevents tampering, while its cryptographic methods protect against unauthorized access, maintaining the integrity and confidentiality of sensitive patient information. This ensures that patient data is protected throughout the process, from data collection to storage, mitigating risks such as data breaches and unauthorized alterations.

The Interoperability and Transparency objective aims to create a system that enables seamless data sharing across various platforms, fostering better communication between healthcare providers, patients, and other stakeholders. By ensuring interoperability, the system allows for efficient integration of health data from multiple sources, improving care coordination. Additionally, blockchain's inherent transparency allows for an auditable and traceable record of data transactions, ensuring that patients and healthcare professionals have full visibility into how and when data is accessed or modified.

Finally, the system incorporates Granular Access Control using blockchain-based smart contracts. Smart contracts enable the enforcement of precise access control policies, allowing only authorized personnel to view or manage sensitive patient data. This fine-tuned control over access rights ensures that patient data remains confidential and that only individuals with appropriate permissions can interact with the data. By automating access control through smart contracts, the system enhances both security and operational efficiency, making it easier to manage who can access specific pieces of patient data based on roles or contexts..

1.1 Motivation

The rapid advancement in wearable technology has revolutionized personal health monitoring, providing individuals with real-time insights into their fitness levels and overall health. However, many existing fitness trackers either lack advanced features, are too expensive, or fail to provide secure and scalable data management. This project aims to fill those gaps by developing an affordable fitness band that monitors vital metrics like heart rate, body temperature, and steps, while securely updating and storing this data via a mobile or web application.

Moreover, the integration of sensor technology with a user-friendly web app allows users to access their health data remotely and track their progress over time. This empowers individuals to make informed decisions about their health and fitness, enhancing personal well-being. The use of blockchain or secure cloud storage ensures privacy and data integrity, addressing concerns about sensitive health data being exposed or manipulated.

This project is also motivated by the increasing demand for IoT-enabled health solutions that can be used in both personal and professional healthcare settings.

1.2 Problem Statement

The problem addressed by the Blockchain-Enabled Health Monitoring System arises from the inadequacies of existing healthcare systems in providing secure, real-time monitoring of patient health data. Current healthcare monitoring systems face significant challenges when it comes to integrating Internet of Things (IoT) devices with robust security frameworks. Traditional systems primarily rely on centralized databases that are susceptible to data breaches, unauthorized access, and tampering. With the growing demand for personalized and real-time patient care, there is an urgent need for a system that can continuously monitor health metrics while ensuring the privacy and security of the data being collected.

At present, many IoT-based healthcare systems struggle to deliver real-time monitoring, as they do not have the infrastructure to process and store large amounts of health data in a scalable and secure manner. In most cases, patient data is collected, stored, and managed through fragmented systems, leading to inefficiencies in data handling and an increased risk of data breaches. Interoperability is another major issue, as healthcare providers often use different platforms and systems that do not communicate with one another effectively, making it difficult to share and analyze patient data across various healthcare organizations.

Additionally, there are growing concerns regarding data privacy and security in healthcare systems. With the increasing digitization of health records and the use of IoT devices, there is a heightened risk of sensitive patient data being accessed by unauthorized entities. The lack of an efficient system to ensure data integrity and confidentiality poses a significant challenge, especially in an era where healthcare systems are becoming more interconnected and reliant on digital solutions. Therefore, there is a clear need for a system that can not only provide continuous health monitoring but also ensure secure, scalable, and private data management.

This project aims to address these challenges by developing a secure and scalable smart health monitoring system using IoT devices integrated with blockchain technology. The goal is to ensure real-time monitoring of patient health data while maintaining the highest standards of security, privacy, and interoperability. By leveraging blockchain, the system will offer tamper-proof storage of health data, preventing unauthorized access and ensuring that only authorized personnel can interact with sensitive patient information. This solution is particularly crucial in the current healthcare landscape, where security and efficiency in data handling are paramount.

The working of the Blockchain-Enabled Health Monitoring System revolves around integrating IoT devices for real-time health monitoring and blockchain technology for secure data storage and management. The process begins with IoT-enabled wearable devices, such as a wristband equipped with sensors that continuously track vital health metrics, including heart rate, body temperature, and pulse rate. These sensors are designed to capture health data in real time, offering continuous monitoring of a patient's condition. This is particularly useful for patients with chronic conditions or those who require constant medical supervision.

Once the sensors collect health data, the data is transmitted to a central processing system via secure wireless communication channels such as Bluetooth or Wi-Fi. This transmission process is designed to be seamless, ensuring that there are no delays in sending data from the patient's device to the healthcare system. To protect the integrity of the data during transmission, encryption protocols are implemented, ensuring that the data is secure and cannot be intercepted or altered by unauthorized parties.

Upon reaching the central system, the data is immediately stored on a blockchain network. The use of blockchain technology is integral to the system's functionality, as it ensures that the health data is stored in a decentralized, tamper-proof ledger. Blockchain's decentralized nature means that the data is not stored in a single location, but rather across a distributed network of nodes, making it highly resistant to hacking or unauthorized access. Each health data entry is recorded as a block in the blockchain, and once added, the data cannot be altered or deleted, ensuring data integrity.

The blockchain also uses cryptographic techniques to secure the data, ensuring that only authorized individuals—such as healthcare providers and the patients themselves—can access or modify the data. This decentralized approach significantly reduces the risk of data breaches, which are a common concern in traditional centralized systems. The system's immutability ensures that all changes or updates to the patient's health data are recorded transparently, allowing for an auditable and traceable history of data transactions.

One of the key features of the system is its ability to provide real-time monitoring of patient health data. The IoT sensors continuously feed data into the blockchain, enabling healthcare providers to monitor a patient's vital signs in real time. If any abnormality or concerning trend is detected—such as a sudden spike in heart rate or a drop in body temperature—the system can automatically trigger alerts to notify healthcare professionals. This real-time monitoring is crucial for timely interventions, especially for patients in critical conditions where quick responses can make a significant difference in outcomes.

The system also includes a user-friendly interface for both patients and healthcare providers. Patients can access their health data through a mobile or web application, where they can track their health metrics over time, monitor trends, and gain insights into their overall well-being. This empowerment of patients through access to their own health information enhances patient engagement and encourages more proactive management of personal health. Healthcare providers, on the other hand, can use the system to analyze trends, assess historical health data, and make informed decisions based on the real-time metrics provided by the IoT devices.

To further enhance security and data management, the system employs smart contracts to regulate access control. Smart contracts are self-executing agreements with the terms written into code, which automatically enforce access rights based on predefined rules. For example, only specific healthcare providers may be granted access to certain health data, ensuring granular control over who can view or modify sensitive information. These smart contracts not only improve security but also simplify the management of permissions, ensuring that only authorized individuals can interact with the data while maintaining the patient's privacy.

In summary, the Blockchain-Enabled Health Monitoring System operates by integrating IoT devices for real-time data collection with blockchain technology for secure, decentralized data management. By providing continuous health monitoring, encrypted data transmission, and tamper-proof storage, the system addresses the key challenges of data privacy, security, and interoperability in healthcare. It ensures that patients and healthcare providers have access to accurate, real-time health data while maintaining the highest standards of data integrity and confidentiality, ultimately improving patient outcomes and enhancing the overall efficiency of healthcare systems.

1.3 Objectives

Real-Time Health Monitoring objective focuses on implementing a wristband equipped with IoT sensors to track vital health metrics such as heartbeats, pulse rate, and body temperature. This wristband continuously monitors these metrics in real-time, providing an uninterrupted flow of critical health data. The IoT-enabled sensors collect this data and securely transmit it to healthcare systems, ensuring that healthcare providers can respond swiftly to any health abnormalities. This continuous monitoring is particularly useful for patients with chronic conditions or those requiring constant medical oversight, enhancing preventive care and improving overall patient outcomes.

Data Privacy and Security, the system leverages blockchain technology to ensure that the transmission and storage of health data are secure. Blockchain's decentralized nature prevents tampering, while its cryptographic methods protect against unauthorized access, maintaining the integrity and confidentiality of sensitive patient information. This ensures that patient data is protected throughout the process, from data collection to storage, mitigating risks such as data breaches and unauthorized alterations.

Interoperability and Transparency objective aims to create a system that enables seamless data sharing across various platforms, fostering better communication between healthcare providers, patients, and other stakeholders. By ensuring interoperability, the system allows for efficient integration of health data from multiple sources, improving care coordination. Additionally, blockchain's inherent transparency allows for an auditable and traceable record of data transactions, ensuring that patients and healthcare professionals have full visibility into how and when data is accessed or modified

Granular Access Control using blockchain-based smart contracts. Smart contracts enable the enforcement of precise access control policies, allowing only authorized personnel to view or manage sensitive patient data. This fine-tuned control over access rights ensures that patient data remains confidential and that only individuals with appropriate permissions can interact with the data. By automating access control through smart contracts, the system enhances both security and operational efficiency, making it easier to manage who can access specific pieces of patient data based on roles or contexts.

1.4 Scope

The scope of the Real-Time Health Monitoring System project encompasses the design, development, and implementation of an integrated platform that enhances patient care through continuous monitoring, secure data management, and user-friendly interfaces. The system will utilize a wearable wristband equipped with IoT sensors to monitor key health metrics, such as heart rate, pulse, and body temperature, in real time. This allows both patients and healthcare providers to receive immediate updates on the patient's condition, enabling more proactive health management and timely intervention when necessary. The wristband will be connected to the broader healthcare ecosystem, allowing for seamless communication between patients and doctors.

A critical component of the project involves ensuring data security and privacy by leveraging blockchain technology. All collected health data will be securely stored and transmitted over a decentralized blockchain network, ensuring that it remains tamper-proof and accessible only to authorized individuals. Blockchain's inherent cryptographic methods will ensure the integrity of sensitive health information, safeguarding it from unauthorized access or data breaches. This provides an additional layer of trust and security, crucial in the handling of personal health data.

In addition to the hardware and security infrastructure, the project will also include the development of a mobile application that allows users to access their health data conveniently. This application will serve as the primary interface for patients and healthcare providers, offering a user-friendly experience for viewing real-time health metrics, historical trends, and personalized health insights. The app will provide a direct connection between patients and their healthcare teams, fostering better communication and more engaged health management.

Furthermore, the project will emphasize the creation of intuitive data visualizations to present health information in a clear and accessible manner. This includes developing visual tools like graphs, charts, and dashboards to represent real-time and historical health data, allowing users to understand their health status at a glance. These visualizations will be designed to help both patients and healthcare providers make informed decisions by presenting complex health data in a more interpretable form. Overall, the scope of the project involves developing a holistic, secure, and user-friendly system that integrates real-time monitoring, blockchain security, mobile access, and effective data visualization to improve healthcare outcomes.

Chapter 2

Literature Review

Blockchain-enabled health monitoring systems using IoT devices offer enhanced security, privacy, and interoperability for healthcare data. IoT devices collect real-time patient information, but concerns over data security and privacy persist. Blockchain, with its decentralized and tamper-proof features, ensures secure transmission and integrity of health data. The integration of blockchain and IoT allows for improved patient control over data access and enhances trust among healthcare stakeholders. However, challenges such as scalability, latency, and regulatory concerns need to be addressed for widespread adoption in healthcare. Research continues to explore solutions like hybrid blockchain models and better consensus mechanisms.

2.1 Comparative Analysis of Recent study

Deependra Sinha et al. (2021) [13] developed a telemedicine-based health monitoring system using IoT technologies, including pulse sensors, an Arduino UNO microcontroller, and the BLYNK App for real-time data transfer, though it is limited by heavy hardware and restricted mobility. Maroua Ahmid et al. (2020)[2] introduced a secure health monitoring system that employs multi-agent systems and cryptography, collecting heart rate data from Raspberry Pi 3 B+ with real-time notifications. However, its reliance on internet connectivity and agent complexity limits its effectiveness, particularly in remote areas. Similarly, Dr. Anil Ramachandran Nair et al. (2019)[11] proposed an IoT-based system using sensors for monitoring physiological parameters like heart rate and ECG, facing issues with managing large-scale data, power dependency, and limited internet accessibility in rural regions. Rajdeep Kumar Nath and Himanshu Thapliyal (2021)[7] created a wearable wristband for stress detection using machine learning on physiological signals, though its accuracy is hindered by environmental factors and potential discomfort from wearing sensors.

Other research includes Rajesh TM et al.'s (2022)[9] IoT-based health monitoring system using homomorphic encryption for secure data transmission, which is limited by slow processing and Bluetooth range issues. Apratim Shrivastav et al. (2022)[12] introduced an optimized algorithm for step count estimation but noted challenges in noisy environments. Kaveri Ramesh Dabhade and Kiran Suresh Mulik (2020)[4] developed a smart health band that monitors vital signs but struggles with internet dependency and sensor accuracy. IoT-enabled systems with deep learning models, such as those proposed by Xingdong Wu et al. (2021)[14] and Shaikh Anowarul Fattah et al. (2017)[5], focus on real-time physiological data analysis but face computational challenges and model complexity.

Rangga Adi F. and Bambang Guruh I. (2019)[6] developed an IoT-based system for remote monitoring of heart rate and body temperature. The system captures ECG signals using electrodes and processes them through amplifiers and filters to eliminate noise, while temperature readings are taken using the DS18B20 sensor. However, the accuracy of the readings is significantly affected by patient movement, introducing a notable error margin.

Alaa Awad Abdellatif (2018)[1] proposed a secure healthcare system using blockchain technology. By leveraging blockchain's decentralized and tamper-resistant ledger, it ensures secure data sharing with encryption for privacy, while smart contracts automate healthcare processes. This approach enhances patient data integrity and system trustworthiness, but faces drawbacks such as potential scalability issues, high energy consumption, and integration challenges with existing healthcare systems.

Suparat Yongjoh, Chakchai So-in, and Peerapol Kompunt S. (2021)[15] explored the use of blockchain with decentralized storage, smart contracts, and encryption for secure patient data sharing across healthcare applications. While this approach aims for immutable and secure data exchange, challenges include complex integration with current healthcare systems, scalability issues, and the energy demands of consensus mechanisms.

Wafaa A. N. A. Al-Nbhany and Ammar T. Zahary (2023)[3] examined blockchain-IoT applications in healthcare, particularly for real-time health monitoring through IoT sensors and machine learning models. Their work focuses on using blockchain for decentralized data storage and smart contracts to ensure data integrity. Key challenges include high latency in processing real-time data, device interoperability issues, and energy consumption concerns that can impact scalability.

Rucha Patel and Vedvyas Dwivedi (2024)[8] reviewed the integration of blockchain with IoT for smart health monitoring, emphasizing the technology's role in secure data exchange and patient privacy. The study highlights significant challenges such as scalability, high energy use, complex integration, and regulatory barriers, which can hinder the widespread adoption of such systems.

Prayag Tiwari and Deepak Gupta (2023)[10] introduced an anonymous IoT-based e-health monitoring system that relies on edge computing for processing data. This approach aims to address privacy concerns and security risks. However, it faces challenges like limited IoT device capacity, dependence on edge nodes, and the complexity of integrating IoT in medical technology (IoMT) with existing healthcare infrastructures.

Sr. No	Title	Author(s)	Year	Methodology	Drawback
1	Heart Rate Monitoring System[1]	Deependra Sinha, Tapas Gupta, Shraddha Verma, Sweety Verma,Vijaylaxmi	2021	The research focuses on a telemedicine-based patient health monitoring system using IoT technologies. It uses pulse sensors,Arduino UNO microcontrollers, and the BLYNK App for real-time data transfer and visualization. The system uses a wired connection for remote monitoring and aims for simplicity.	The research highlights limitations of a device, including heavy hardware, slow data transfer, and limited mobility due to its tethered nature, which limits the patient's ability to move freely in dynamic environments
2	An Intelligent and Secure Health Monitoring System Based on Agent[2]	Maroua Ahmid, Okba Kazar, Saber Benharzallah, Laid Kahloul, Abdelhak Merizig	2020	The paper presents a secure IoT-based health monitoring system that uses multi-agent systems and advanced cryptography for real-time monitoring. It features an agent-based architecture, collecting heart rate data from Raspberry Pi 3 B+ with a pulse sensor, and uploading it to the cloud for secure storage and real-time access. The system also sends real-time notifications for abnormal heart rate levels.	The advanced system has limitations,including reliance on constant internet connectivity, hardware limitations due to Raspberry Pi and pulse sensors, and agent complexity, which may limit monitoring scope and management over time, especially in rural or remote areas.
3	IoT-based Secure Healthcare Monitoring System[3]	Dr. Anil Ramachandran Nair, Dr. R. K. Sharma, Naveen	2019	The research presents an IoT-based healthcare monitoring system that uses sensors and a cloud-based platform to monitor patient physiological parameters. The system uses sensors like heart rate, body temperature, ECG, and blood pressure, and a Raspberry Pi for processing data.	The system faces challenges in managing large volumes of real-time healthcare data, limited accessibility due to poor internetcoverage, scalability issues for large hospitals, and power dependency due to its dependence on a continuous power supply, which can be problematic in unstable electricity areas.

Table 2.1: Comparative Analysis of Literature Survey

Sr. No	Title	Author(s)	Year	Methodology	Drawback
4	Wearable Health Monitoring System for Older Adults in a Smart Home Environment	Rajdeep Kumar Nath, Himanshu Thapliyal	2021	The methodology involves using wearable sensors (EDA, PPG, and ST) in a wristband to monitor stress, with salivary cortisol as the stress biomarker. Machine learning models were trained using features from these physiological signals for stress detection.	Some drawbacks of the system include the reliance on wearable sensors, which may be uncomfortable or prone to user non-compliance over long periods. The blood pressure model, based solely on PPG signals, may lack the accuracy of multi-sensor approaches like ECG. Additionally, real-time data streaming and processing could introduce delays, and the system's efficacy may be limited by environmental factors affecting sensor accuracy.
5	Secure Remote Health Monitoring System and assessment using IOT	Rajesh TM, Tina Babu, Rekha R Nair, Nivedha S	2022	The system uses embedded sensors (e.g., temperature and heart rate) connected to an Arduino Nano microcontroller to collect health data, which is transmitted via Bluetooth to a cloud server for real-time analysis. Homomorphic encryption ensures secure data transfer, and the system categorizes health status as critical, normal, or dangerous.	The system faces challenges like limited Bluetooth range, which may cause connectivity issues in larger areas. The use of homomorphic encryption can slow down real-time data processing, and the reliance on external sensors adds hardware complexity and maintenance costs. Additionally, sensor accuracy could be impacted by environmental factors, affecting the reliability of health assessments.
6	Optimised Algorithm for Step Count Estimation Using Sensor Data from Smartphones and Wearables	Apratim Shrivastav, Utkarsh Kuchhal, Samarth Singhal, Tanmay Jain, Divyashikha Sethia, Vidushi Chaudhary	2022	The methodology proposes an optimized algorithm for step count estimation using accelerometer data by normalizing acceleration across the x, y, and z axes. A low-pass Butterworth filter reduces noise, and peak detection identifies steps while avoiding false peaks. The algorithm is highly accurate, outperforming machine learning and deep learning models like SVM and CNN in step count estimation.	The algorithm's peak detection may struggle with irregular walking patterns and abrupt movements, leading to missed steps or over-counting in noisy environments.

Table 2.2: Comparative Analysis of Literature Survey

Sr. No	Title	Author(s)	Year	Methodology	Drawback
7	IOT based Wearable Smart Health Band Assistance	Kaveri Ramesh Dabhade, Kiran Suresh Mulik	2020	The methodology involves using sensors (pulse, temperature, and alcohol) connected to an Arduino Nano to monitor vital signs like heart rate, body temperature, and alcohol levels. Data is processed and transmitted via a Bolt IoT Wi-Fi module to the cloud for real-time monitoring through a smartphone app.	The system's drawbacks include its reliance on constant internet connectivity, which may limit functionality in areas with poor coverage. The sensors used, particularly for alcohol detection, may not provide highly accurate medical-grade results.
8	Internet of things-enabled real-time health monitoring system using deep learning	Xingdong Wu, Chao Liu, Lijun Wang, Muhammad Bilal	2021	The methodology involves using IoT-enabled wearable devices to collect real-time physiological data from athletes, which is transmitted via a wireless relay network for analysis. Deep learning algorithms, specifically deep neural networks (DNN), process the data to detect health issues.	The drawbacks of the system include its sensitivity to the number of neurons in the DNN, which can lead to issues like underfitting or overfitting. The deep learning model's complexity increases computational costs, and challenges like vanishing gradients may arise with deeper networks.
9	Wrist-Card: PPG Sensor based Wrist Wearable Unit for Low Cost Personalized Cardio Healthcare System	Shaikh Anowarul Fattah, Mohammad Mahinur Rahman, Nafis Mustakin, Mohammad Tariqul Islam, Asir Intisar Khan, Celia Shahnaz	2017	The methodology involves using IoT-enabled wearable devices to collect real-time physiological data from athletes, which is transmitted via a wireless network for analysis. Deep neural networks (DNN) process this data to detect health risks.	The main drawbacks include the deep learning model's sensitivity to neuron numbers, leading to potential underfitting or overfitting. The system's complexity also increases computational costs, and issues like vanishing gradients may arise with deeper networks.
10	Monitoring Heart Rate And Temperature Based On Internet Of Things	Rangga Adi F,Bambang Guruh I, Sumber	2019	The study uses an IoT-based system to monitor heart rate and body temperature remotely. ECG signals are captured via electrodes, processed through amplifiers and filters to remove noise, while body temperature is measured using the DS18B20 sensor.	The main drawbacks of the system include the significant error margin during patient movement, which affects the accuracy of heart rate and temperature readings.

Table 2.3: Comparative Analysis of Literature Survey

Sr. No	Title	Author(s)	Year	Methodology	Drawback
11	ssHealth: Toward Secure, Blockchain-Enabled Healthcare Systems	Alaa Awad Abdellatif	2018	The methodology leverages blockchain's decentralized, tamper-resistant ledger to ensure secure data sharing, encryption for privacy, and smart contracts to automate healthcare processes, enhancing patient data integrity and system trustworthiness.	Drawbacks include potential scalability issues, high energy consumption of blockchain networks, integration challenges with existing systems, and regulatory uncertainties regarding data privacy and compliance in healthcare.
12	Development of an Internet-of-Healthcare	SUPARAT YONGJOH,CHAKCHAI SO-IN and PEERAPOL KOMPUNT S	july 13, 2021	The methodology involves using blockchain technology with decentralized storage, smart contracts, and encryption to ensure secure, immutable patient data sharing across various healthcare applications and cloud systems.	TPotential drawbacks include integration complexity with existing healthcare systems, scalability issues, reliance on energy-intensive consensus mechanisms, and challenges in regulatory compliance and user adoption.
13	Blockchain-IoT Healthcare Applications and Trends	WAFAA A. N. A. ALNBHANY 1 , AMMAR T. ZAHARY	14 December 2023	wisthband fir monitoring using ml models , iot sensors Utilizes blockchain for secure, decentralized data storage, smart contracts for automated transactions, and IoT devices for real-time health monitoring and data integrity assurances.	Challenges include high latency in real-time data processing, interoperability issues between diverse IoT devices, and increased energy consumption impacting scalability and network efficiency.
14	A Review of Secure IoT based Smart Health Monitoring	Rucha Patel and Vedvyas Dwivedi	2024	Meteorology studies the atmosphere, focusing on weather processes like temperature, humidity, air pressure, wind, precipitation, clouds, storms, and forecasting using tools like satellites, radars, and computer models.	Blockchain-IoT healthcare faces challenges like scalability, high energy use, complex integration, privacy issues, storage limitations, regulatory hurdles, user adoption hesitance, and high initial costs.
15	An Anonymous IoT-Based E-Health Monitoring System	Prayag Tiwari , Deepak Gupta	2023	Meteorology branches include synoptic meteorology (weather patterns), dynamic meteorology (atmospheric motions), climatology (climate patterns), physical meteorology (clouds, precipitation), and atmospheric chemistry (pollutants, composition).	The project faces challenges like limited IoT device capacity, dependency on edge nodes, privacy concerns, data security risks, and complex integration of IoMT into existing systems.

Table 2.4: Comparative Analysis of Literature Survey

Chapter 3

Project Design

3.1 Proposed System Architecture

The image 3.1 Proposed System Architecture depicts an architecture for an IoT Health Monitoring System that integrates IoT sensors, a microcontroller, a central system, and mobile applications.

The system utilizes IoT sensors like MPX5010 for blood pressure, MAX30102 for oxygen saturation, DS18B20 for temperature, and MAX30100 for heart rate monitoring. These sensors collect health-related data and send it to an ESP32 microcontroller, which acts as the system's processing unit. The microcontroller secures and transmits this data to the central system, which comprises two components: Blockchain for secure, decentralized storage and a centralized server for managing data and operations.

The data can be accessed through a mobile application that has two main interfaces: a Doctor App, which receives health trends and alerts, and a Patient App, which allows patients to fetch their health metrics. The Doctor App can request live updates from the microcontroller, ensuring real-time monitoring, while the Patient App fetches periodic health metrics for review. The system is designed to ensure secure data handling, real-time updates, and integration of multiple IoT devices for comprehensive health monitoring.

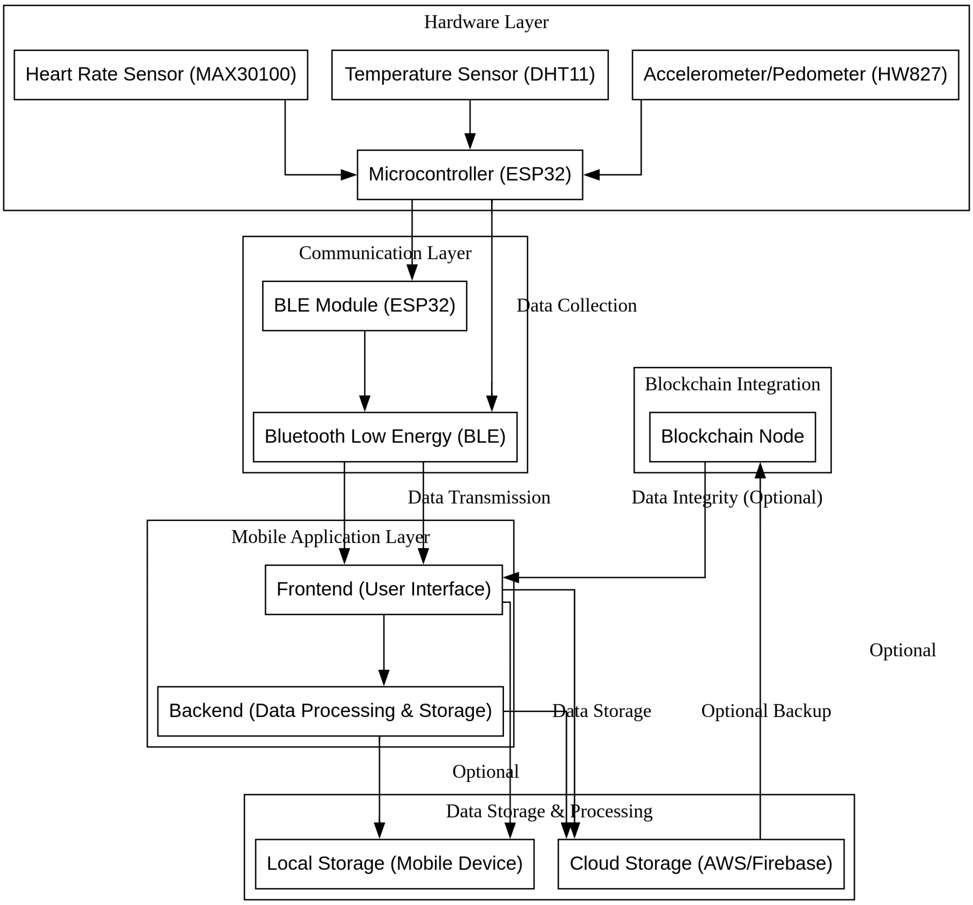

Figure 3.1: Proposed System Architecture

3.2 Data Flow Diagrams

The data flow of the IoT Health Monitoring System depicted in the below 3.2 System Data Flow Diagram can be described as follows:

IoT Sensors:Sensors like MPX5010 (blood pressure), MAX30102 (oxygen saturation), DS18B20 (temperature), and MAX30100 (heart rate) are responsible for capturing real-time physiological data from the patient. Each sensor collects a specific health parameter (e.g., heart rate, temperature, oxygen saturation) and sends data to the microcontroller.

Microcontroller (ESP32):The ESP32 microcontroller acts as the hub for data processing and transmission. It collects data from all connected IoT sensors and performs preliminary operations such as data validation, encryption, and security measures. Once the data is secured, it is transmitted to the central system. The microcontroller also handles live update requests from the mobile applications, specifically from the Doctor App, ensuring that health metrics are sent in real-time when requested.

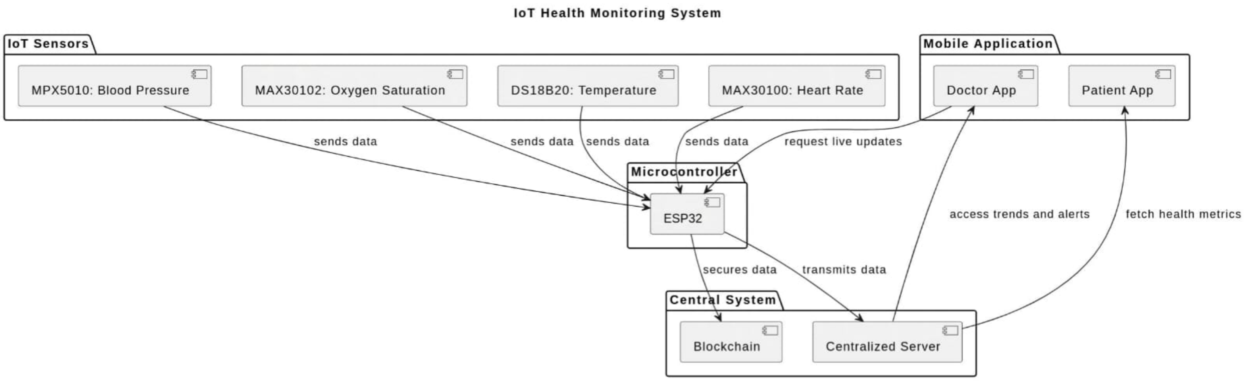

Figure 3.2: System Data Flow Diagram

Central System:The central system consists of two main components:

Blockchain: Used for securing the data in a decentralized manner. The blockchain ensures data integrity and immutability, making it a secure ledger for storing patient health records.

Centralized Server: The transmitted data is processed and stored in the centralized server, where advanced analysis, processing, and historical data management can occur. Mobile Application:The mobile applications serve two types of users: doctors and patients.

Doctor App: The doctor can access trends and alerts based on the patient's health data. The app allows the doctor to request live updates from the microcontroller, ensuring real-time health monitoring when necessary.

Patient App: The patient app is designed to let the patient fetch health metrics, enabling continuous self-monitoring of vital signs such as heart rate, temperature, and oxygen saturation. It interacts with the centralized server to retrieve these metrics, giving the patient a user-friendly interface for tracking their health.

3.3 Use Case Diagrams

The Health Monitoring System in the 3.3 diagram below illustrates a process where health metrics from a patient are continuously monitored using wearable technology, with secure data management and real-time access by doctors through mobile applications.

1. Metrics Collection: The patient wears a wristband equipped with sensors that monitor vital signs such as heart rate, temperature, and blood pressure. These physiological metrics are collected continuously, offering real-time data about the patient's health condition.

2. Data Transmission: The collected health data is transmitted to a central system for secure processing. This ensures that the data is delivered in a timely manner for storage and analysis.

3. Data Management: Once the data is transmitted, it is processed for secure storage and is managed through access control mechanisms. The data is securely stored using blockchain technology, which ensures data immutability, security, and traceability. Blockchain also helps in managing access rights, ensuring that only authorized individuals can retrieve and manipulate the stored health data.

4. Data Visualization: A mobile application allows healthcare providers, such as doctors, to access the health data. Through the app, doctors can view health metrics and receive alerts for abnormalities if any irregularities or health risks are detected in the patient's data.

This enables quick decision-making and intervention when necessary.

Overall, this use case shows a robust health monitoring system where a patient's vital signs are securely monitored, transmitted, and analyzed in real-time with data protection measures in place, offering healthcare providers the tools to make informed decisions via mobile applications.

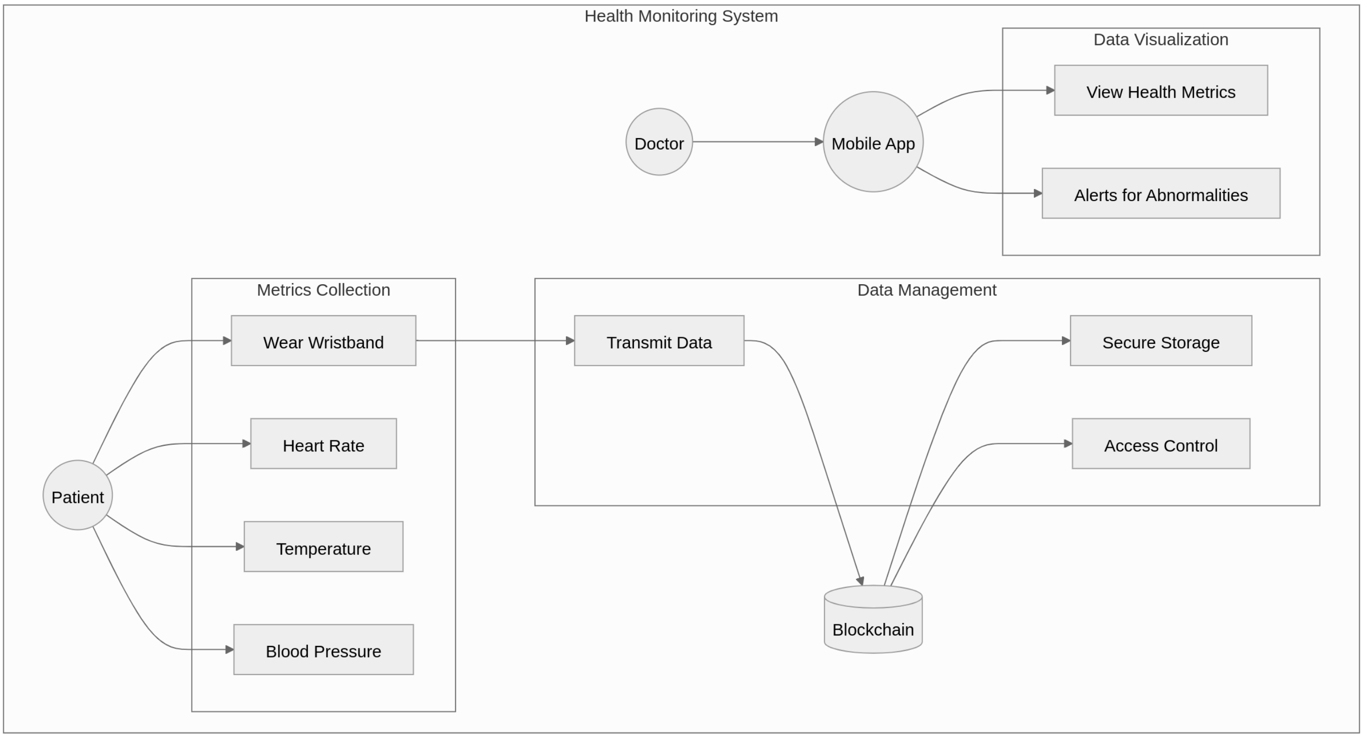

Figure 3.3: Use Case Diagram

Chapter 4

Project Implementation

4.1 Result

The following project implementation deals with Blockchain-Enabled Health Monitoring System. The system provides the real time detection of blood pressure, body temperature and oxygen saturation.

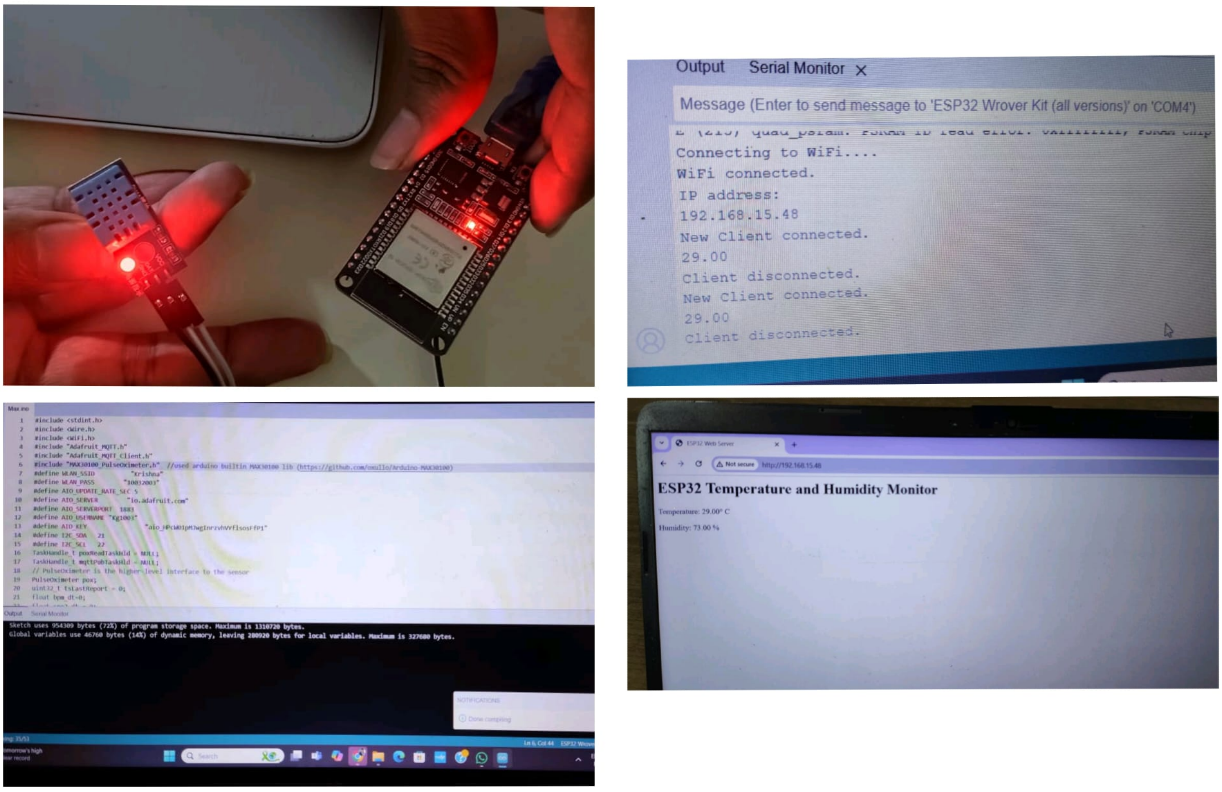

Figure 4.1: Starting the iot device and result

During testing, the system demonstrated reliable data transmission over both Bluetooth and Wi-Fi, with sensor readings being consistently logged and displayed on the app. The web app interface effectively visualizes the collected data, giving users a clear understanding of their health metrics. Additionally, the use of a secure server and potential blockchain integration ensures that the health data remains private and tamper-proof.

4.2 Timeline Sem VII

As software development projects grow in complexity, the need for well-organized project management and clear milestones becomes critical. The timeline presented in this section highlights the progress of our project during Semester VII, tracking key milestones from the conceptualization phase to design, implementation, and testing. Each stage has been carefully planned to maintain efficiency, mitigate risks, and ensure alignment with project goals.

This project involves numerous tasks that demand close collaboration between team members and adherence to deadlines. The Gantt chart below visually represents the progress and scheduling of these tasks, illustrating how each activity contributes to the overall workflow. As seen in Figure 4.2, the timeline captures task dependencies, reflecting how one task's completion influences the next, and how any delays could affect the project as a whole. This is particularly important as modern development workflows often involve overlapping tasks, requiring careful coordination to avoid bottlenecks or inefficiencies.

Throughout the semester, the team has adhered to a structured project schedule, broken down into various phases, each addressing specific goals. Initial phases included defining project scope, researching methodologies, and laying out architectural foundations, while later stages focused on coding, integration, and testing. Regular review meetings and progress checks ensured that the project remained on track, allowing for adjustments in task prioritization where necessary.

In addition to mapping out task timelines, the Gantt chart (Figure **??**) also incorporates task completion percentages, offering a clear view of project progress at a glance. The team faced challenges typical of large-scale development projects, such as the need to manage multi- ple concurrent tasks, ensure timely collaboration, and meet set deadlines for deliverables. Nonetheless, through strategic planning and regular updates, these challenges were met, allowing the team to progress smoothly through each phase of development.

Overall, this timeline serves as a comprehensive overview of the project's lifecycle during Semester VII, providing insight into how the team has managed the complexities of the project while adhering to deadlines and ensuring timely task completion.

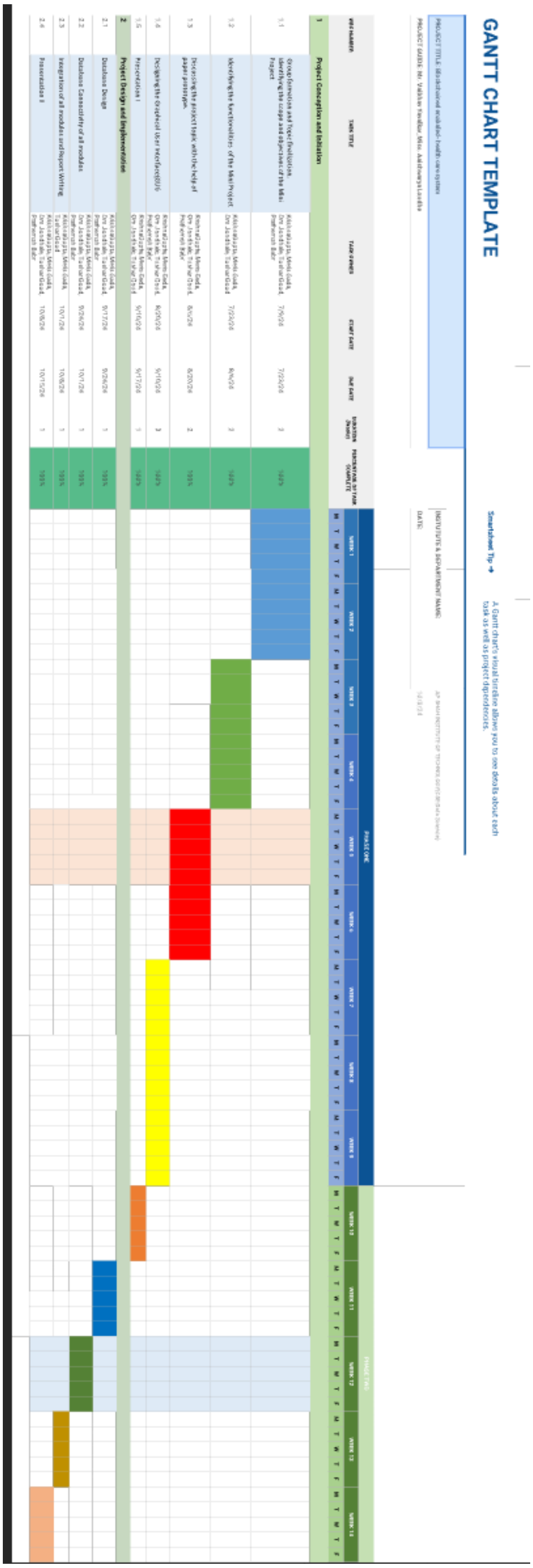

Figure 4.2: Gantt Chart

Chapter 5

Summary

The Blockchain-Enabled Real-Time Health Monitoring System is an innovative solution that combines IoT and blockchain technology to improve continuous patient monitoring, data security, and interoperability. Using a wearable device, it collects real-time health metrics like heart rate and body temperature, providing timely updates to both patients and healthcare providers. The blockchain component ensures data privacy and tamper-proof storage, allowing only authorized access to sensitive information, thus building trust between patients and providers.The system also features a user-friendly mobile app that enables patients to view health data and gain insights through clear visualizations, fostering better engagement and proactive health management.For the future, the system could integrate AI for predictive analytics, improving early detection of health risks. Expanding sensor capabilities could provide a more comprehensive view of patient health, while interoperability with existing health records would enhance data sharing. Blockchain-based smart contracts could streamline processes like insurance claims and patient consent management. These advancements could transform the system into a robust platform for comprehensive health management, driving improved patient outcomes and efficiency in the healthcare sector.

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