Smart Real-Time Healthcare Tracking and Monitoring System

Group Members:

Ganesh Boddu (16342598)

Akhil Gurram (16341518)

Chandana Maruri (16340702)

Sai Sathvik Korrapati (16345436)

TABLE OF CONTENT:

ABSTRACT

The Smart Real-Time Healthcare Tracking and Monitoring System (SRTH-TMS) is an innovative solution designed to revolutionize healthcare through continuous patient monitoring and advanced data analytics. Utilizing a network of wearable devices and sensors, the system collects real-time health data, including vital signs and activity levels. This information is transmitted securely to a centralized cloud-based infrastructure, enabling healthcare professionals to access comprehensive and up-to-date health records.

The objective of this work is to provide an effective application for Real-Time Health Monitoring and Tracking. The system will track, trace, and monitor patients and facilitate taking care of their health; so efficient medical services could be provided at appropriate times. By using specific sensors, the data will be captured and compared with a configurable threshold via a microcontroller which is defined by a specialized doctor who follows the patient; in any case of emergency, a short message service (SMS) will be sent to the Doctor's mobile number along with the measured values through GSM module.

INTRODUCTION

The Smart Real-Time Healthcare Tracking and Monitoring System (SRTH-TMS) introduces a revolutionary approach to healthcare through the integration of advanced technologies. Utilizing wearable devices and sensors, the system enables continuous monitoring of vital health parameters, ensuring a comprehensive view of an individual's well-being. This real-time data is securely transmitted to a cloud-based infrastructure, forming the backbone of the SRTH-TMS and providing healthcare professionals with immediate access to both current and historical health records.

A distinctive feature of the system lies in its utilization of advanced analytics and machine learning algorithms, allowing for early detection of health issues and personalized healthcare insights. The cloud-based repository serves as a centralized hub for data analysis, empowering healthcare providers with tools to predict potential risks and tailor treatment plans to individual needs. Simultaneously, a user-friendly mobile application interface fosters patient engagement by providing real-time access to personal health data, encouraging proactive participation in healthcare management.

In essence, the SRTH-TMS redefines the healthcare landscape by combining real-time monitoring, cloud-based analytics, and mobile accessibility. This comprehensive system not only enhances the quality of patient care but also promotes a proactive and personalized healthcare model that has the potential to significantly improve health outcomes.

HARDWARE COMPONENTS

1. Arduino (ELEGOO R3 UNO)
2. Pulse Sensor
3. Jumper wires
4. Bread board
5. Ethernet module

1. ARDUINO (ELEGOO R3 UNO)

Arduino is an open-source electronics platform that is widely used for creating interactive projects. The ELEGOO R3 UNO is a clone of the official Arduino Uno board, produced by ELEGOO, a company known for providing affordable and compatible Arduino-based products.

Microcontroller:

The ELEGOO R3 UNO is based on the ATmega328P microcontroller, which is the same microcontroller used in the official Arduino Uno.
Compatibility:

Being an Arduino Uno clone, it is compatible with the Arduino IDE (Integrated Development Environment), allowing you to program it using the Arduino programming language.

Inputs and Outputs:

The board features a variety of digital and analog pins that can be used for both input and output operations. These pins allow you to interface with sensors, actuators, and other electronic components.
USB Interface:

It typically includes a USB interface for programming the microcontroller and for serial communication with a computer.
Power Supply:

The board can be powered through the USB connection or an external power source. It can operate in a voltage range of 7 to 12V.

Open-Source:

Arduino follows an open-source model, and the design and schematics of the Arduino Uno are available for anyone to use and modify.

Expansion:

The board is designed to be expandable, allowing users to connect additional modules and shields to add functionality.
Community Support:

Arduino has a large and active community, which can be beneficial for troubleshooting, sharing projects, and seeking advice.

FEATURES:

* ATmega328P microcontroller
* Input voltage - 7-12V
* 5V Electric current: 500MA
* 3.3V Electric current: 50MA
* 14 Digital I/O Pins (6 PWM outputs)
* 8 Analog Inputs
* 32k Flash Memory
* 16Mhz Clock Speed

2. PULSE SENSOR

In the Smart Real-Time Healthcare Tracking and Monitoring System, the inclusion of a pulse sensor is fundamental for continuous health assessment. This sensor delivers real-time insights into a patient's heart rate, a critical indicator of cardiovascular health. Through seamless integration into the Internet of Things (IoT), the pulse sensor ensures immediate data transmission, allowing healthcare professionals timely access to vital information and facilitating rapid responses to changing health conditions.

The pulse sensor's real-time data processing capabilities are central to its role, enabling prompt detection of abnormal heart rate patterns and the generation of timely alerts. Integrated with Electronic Health Records (EHR), the collected data contributes to a comprehensive patient health profile, empowering healthcare providers to make informed decisions and personalize care strategies. The user-friendly interface enhances accessibility for healthcare professionals, facilitating the visualization of heart rate trends over time.

Furthermore, the pulse sensor leverages machine learning models to predict potential health issues based on heart rate data, fostering a proactive healthcare approach. As a privacy-focused component, the sensor incorporates robust security measures, including data encryption and compliance with healthcare regulations. In summary, the pulse sensor in the healthcare system ensures real-time monitoring, personalized interventions, and enhanced data-driven decision-making, ultimately leading to improved patient outcomes.

The connection we made to connect to Arduino are:

- Black ground
- Red power (3v or 5v)
- Purple -is the signal output. Connects to analog input of an Arduino.

3. ETHERNET MODULE-WIZ750SR

The WIZ750SR Ethernet module significantly bolsters the capabilities of the Smart Real-Time Healthcare Tracking and Monitoring System. Its integration facilitates seamless data transmission among healthcare devices, fostering efficient communication and real-time exchange of vital health data. With the WIZ750SR, the system gains the capacity to transmit real-time health information over Ethernet, connecting monitoring sensors, gateways, and control units. This not only streamlines internal data flow but also ensures reliable transmission of critical health data, contributing to the system's responsiveness and overall efficacy.

Furthermore, the WIZ750SR extends the healthcare system into the realm of the Internet of Things (IoT), enabling real-time communication and data sharing among devices. Its compatibility with cloud-based data processing enhances the system's analytical capabilities, providing healthcare professionals with timely insights into patient conditions. The module's modular design promotes scalability, allowing for seamless integration with new devices as the healthcare system evolves. Its commitment to security aligns with stringent privacy regulations, ensuring the confidentiality and integrity of patient information during data transmission. In essence, the WIZ750SR Ethernet module empowers the Smart Healthcare System with enhanced connectivity, real-time data processing, and the flexibility to adapt to evolving healthcare needs.

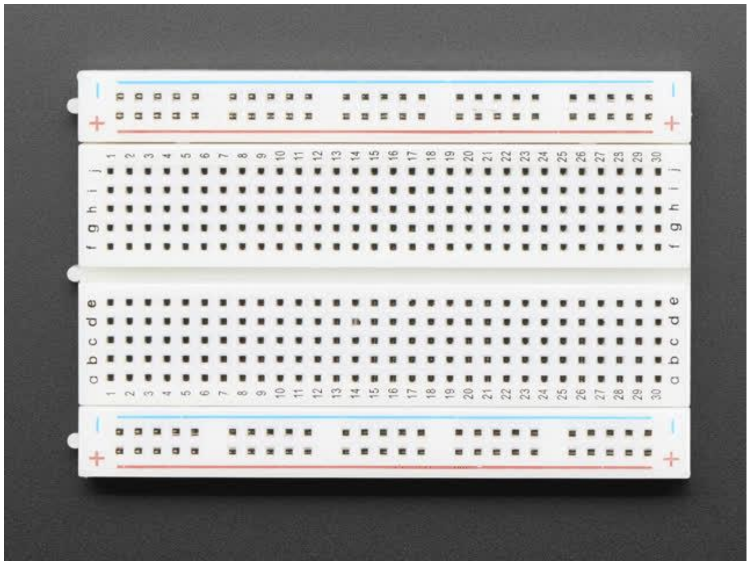
The connections we made to connect to Arduino are:

- WIZ750SR TX to Uno RX (pin 0)
- WIZ750SR RX to Uno TX (pin 1)
- WIZ750SR GND to Uno GND
- WIZ750SR VCC to Uno 5V

4. Jumper wires

In a Smart Real-Time Healthcare Tracking and Monitoring System, jumper wires serve as crucial connectors, facilitating the integration of various electronic components. These wires play a pivotal role in linking sensors, microcontrollers, and communication modules, enabling the seamless flow of data within the system. Whether used for prototyping on breadboards, establishing connections in wearable devices, or modifying circuit configurations, jumper wires provide the flexibility needed for efficient development, testing, and iteration of the electronic components that underpin the system's real-time monitoring capabilities.

5. BREAD BOARD



In a Smart Real-Time Healthcare Tracking and Monitoring System, breadboards serve as versatile platforms for prototyping and testing electronic circuits. The use of breadboards facilitates the initial development and validation of the system's electronic components before a more permanent solution, such as a custom PCB (Printed Circuit Board), is created.

Breadboards are particularly useful for connecting and arranging sensors, microcontrollers, communication modules, and other electronic elements in a temporary and easily modifiable setup. During the prototyping phase, engineers and developers can quickly experiment with different configurations of the system's electronics, allowing for efficient testing, debugging, and iteration. This flexibility is crucial in the early stages of system development, enabling rapid adjustments to the hardware layout as needed.

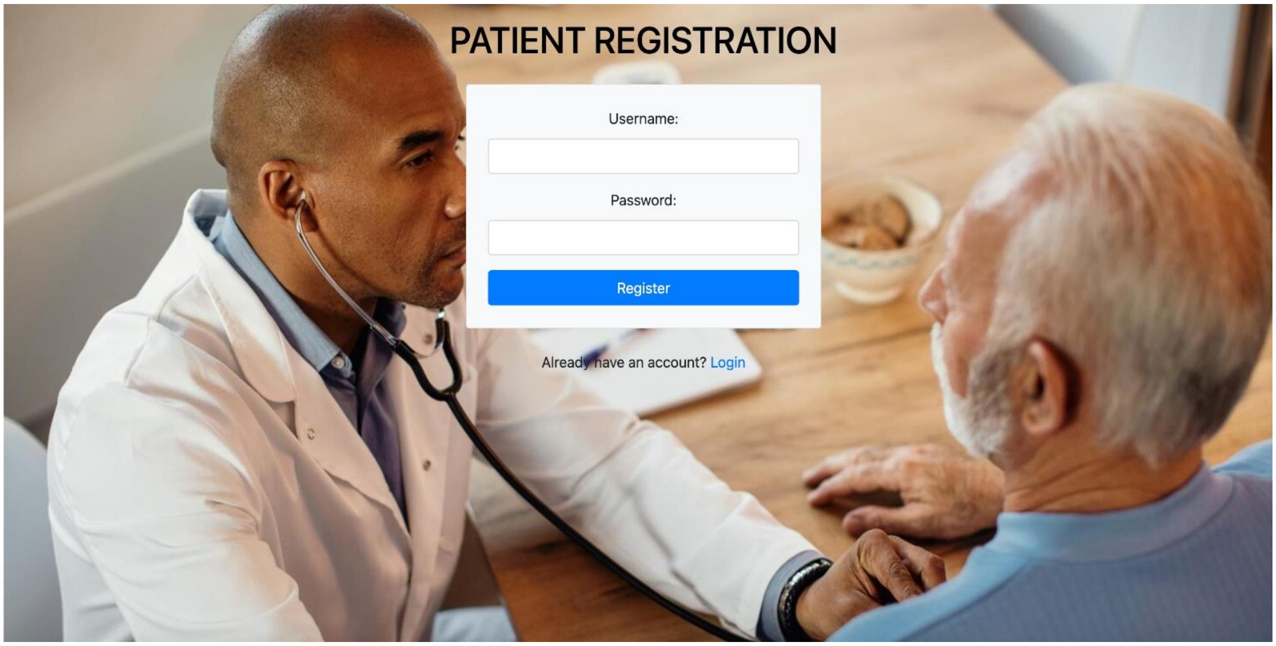
In the context of a Smart Real-Time Healthcare Tracking and Monitoring System, the breadboard becomes a hands-on tool for assembling and evaluating the initial electronic architecture. It provides a practical environment for connecting jumper wires, sensors, and other components, fostering the iterative process essential to refining and optimizing the system's functionality before transitioning to a more permanent hardware implementation.

Software Requirements:

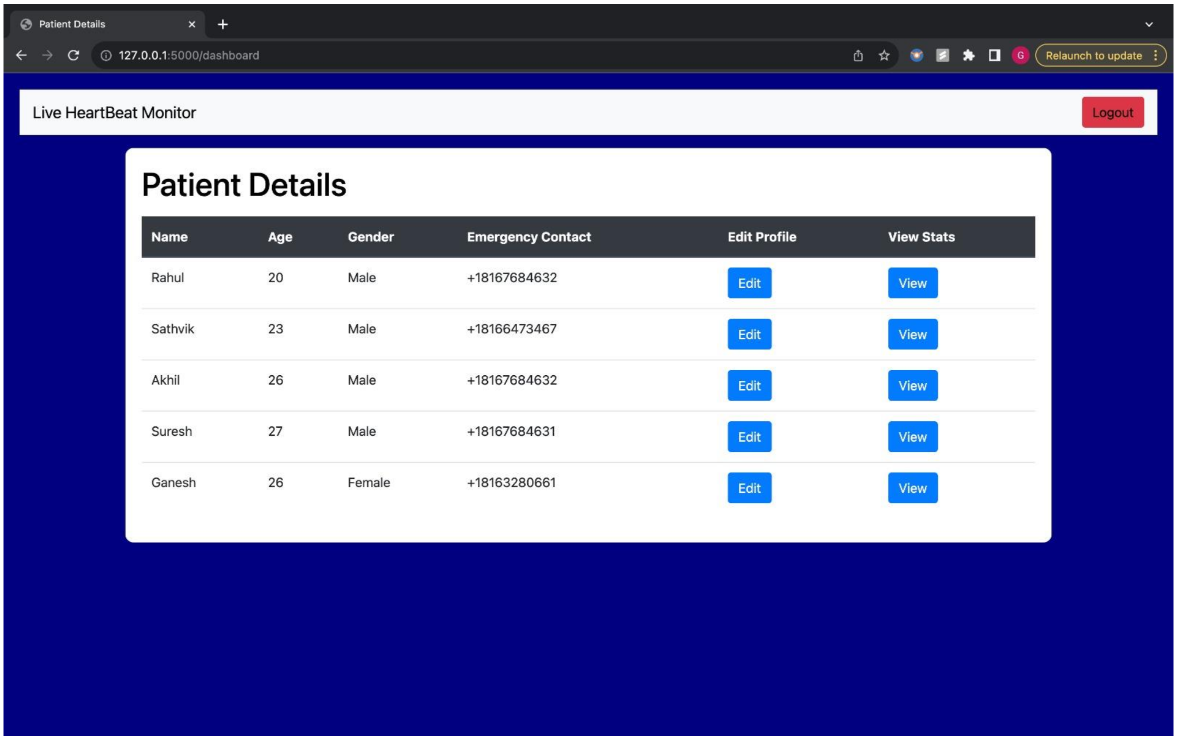
FRONT END- HTML, CSS, Bootstrap, JSS
BACK END- Python, Flask (Framework)
DATABASE- POSTGRESQL
ARDUINO IDE- to code the Arduino circuit board

Front end:

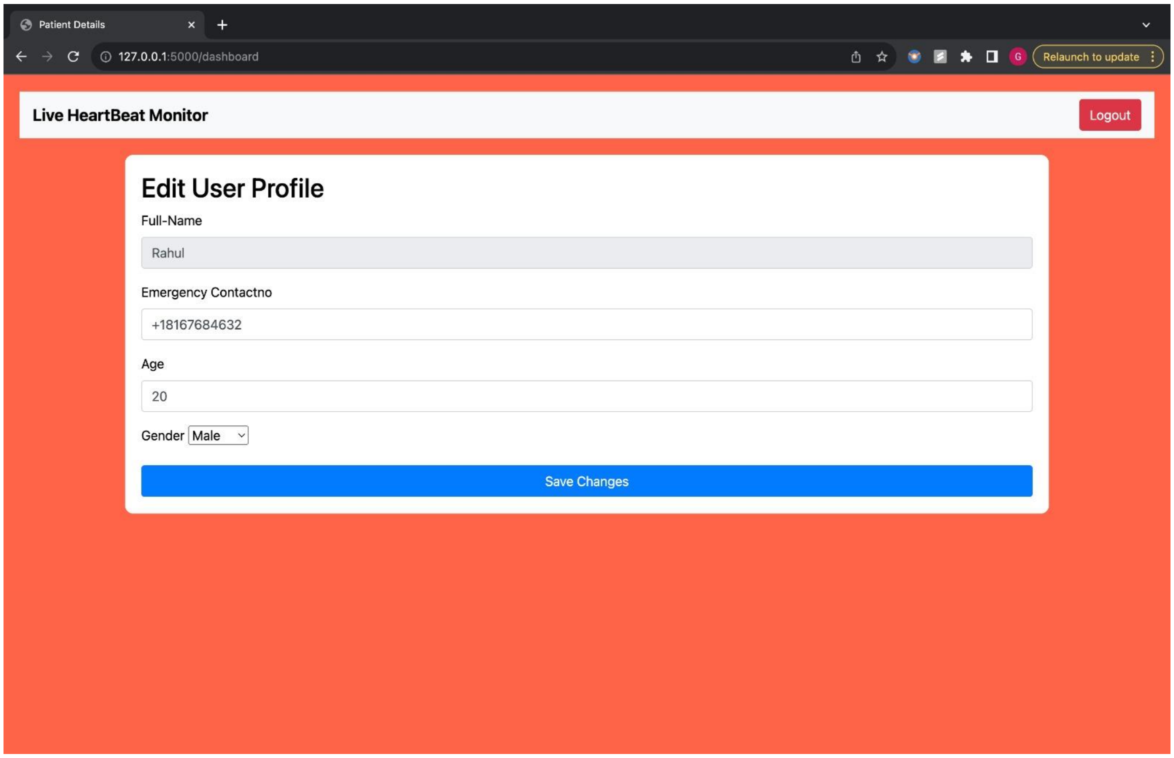
The above is the user login page where both the User and Admin can log in to view the statistics. If a particular user doesn't have an account, he/she can click on register to create their account.



After clicking on register, It navigates to the above page where a patient can register. After successful registration, the data is saved into our database where we will check the credentials while logging in to the website.



The above is an Admin dashboard where he can view all patient details and also, he can edit personal information like Emergency Contact Number, Age, and gender by clicking on the edit button. The admin can view all the patient's blood pressure in the form of graphs if he clicks on the view option.



As explained before, the above is the edit patient details page where they can change Emergency Contact Number, Age, and Gender.

BACKEND:

➢ Here we have 2 role permissions, and we toggle between them.

a) ADMIN

b) PATIENT

2) The OUTPUT is represented in the form of a LINE GRAPH which

represents the BPM of an individual.

Explanation for backend:

1) Initially, we read the data from Arduino by pre-defining the threshold value. In this case, we have set a threshold of 120 BPM.
If the output exceeds the threshold value, the message will be sent to the emergency number via text message.
2) Here, we used TWILIO to send the message, after that we saved the data to database for the future reference and the patient could visualize the data fluctuations.

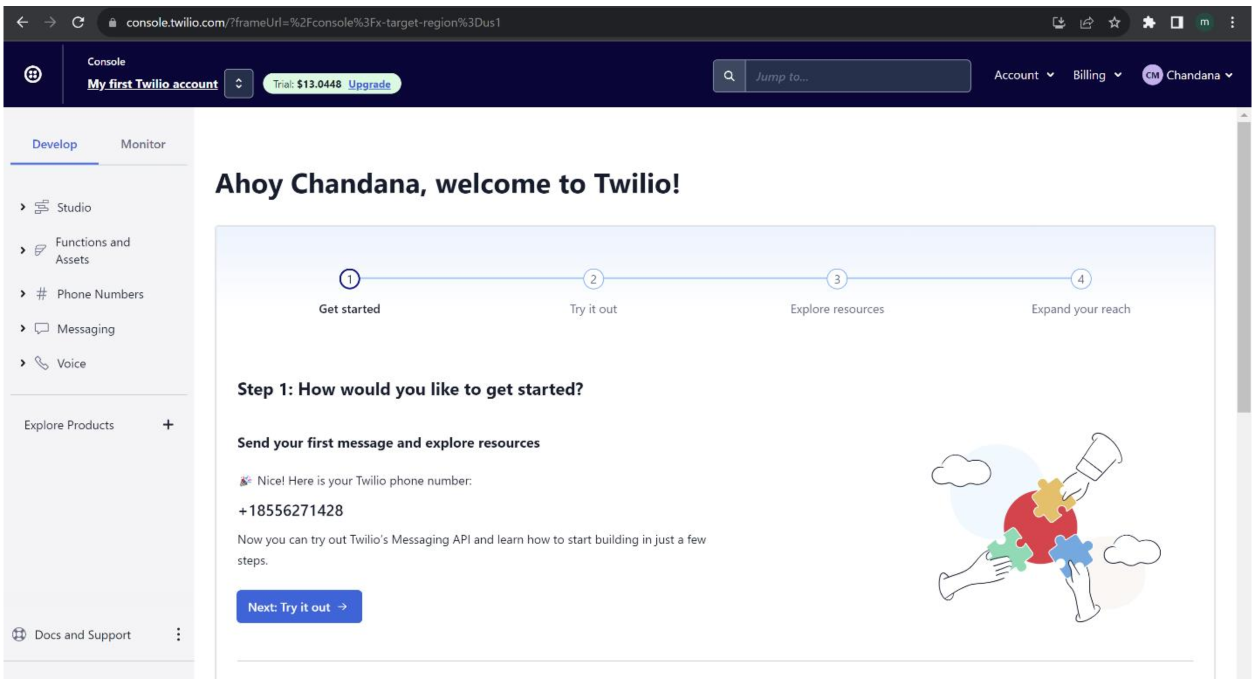
- Here we send an alert message to a pre-defined number as:

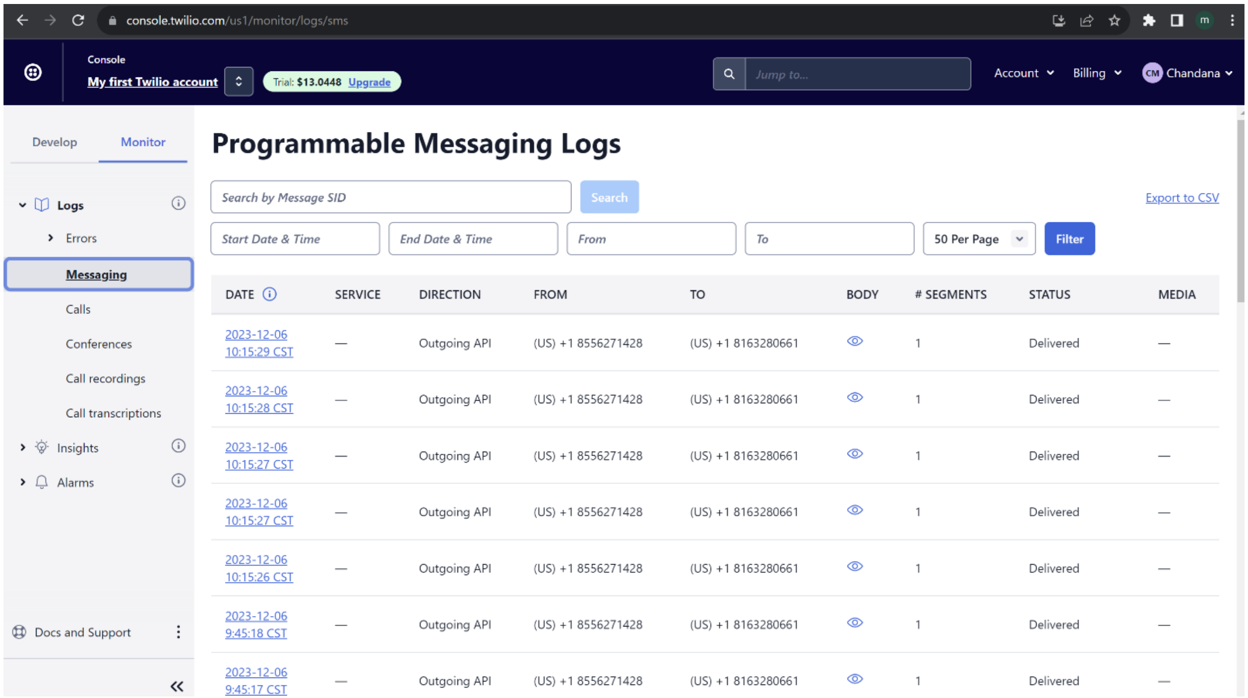
“Twilio trial account - EMERGENCY!!! Heartbeat Exceeded”

Working of Twilio:

In a Smart Real-Time Healthcare Tracking and Monitoring System, Twilio functions as a pivotal communication platform, facilitating seamless interactions between healthcare providers, patients, and monitoring devices. Twilio's capabilities enable the system to send real-time alerts and notifications, ensuring prompt responses to critical health events. It supports remote patient communication through video calls, voice calls, and SMS, allowing healthcare professionals to conduct virtual consultations and monitor patients remotely.

Twilio's Interactive Voice Response (IVR) system contributes to interactive communication, and it can be employed for patient updates, medication adherence reminders, and appointment scheduling. The platform ensures secure messaging, complying with healthcare data privacy regulations, and its scalability accommodates the dynamic needs of evolving healthcare systems. By integrating Twilio, the healthcare system can enhance communication efficiency, improve patient engagement, and enable timely interventions for better overall healthcare outcomes

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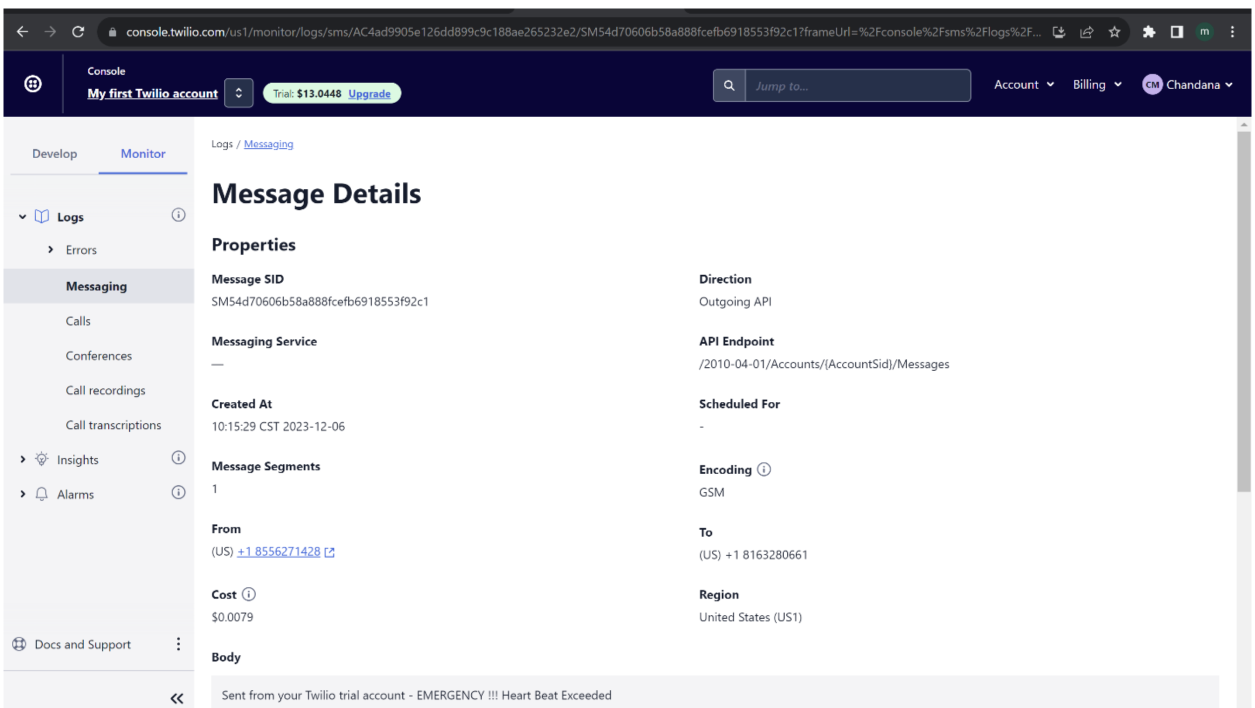
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Billing
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Properties
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To
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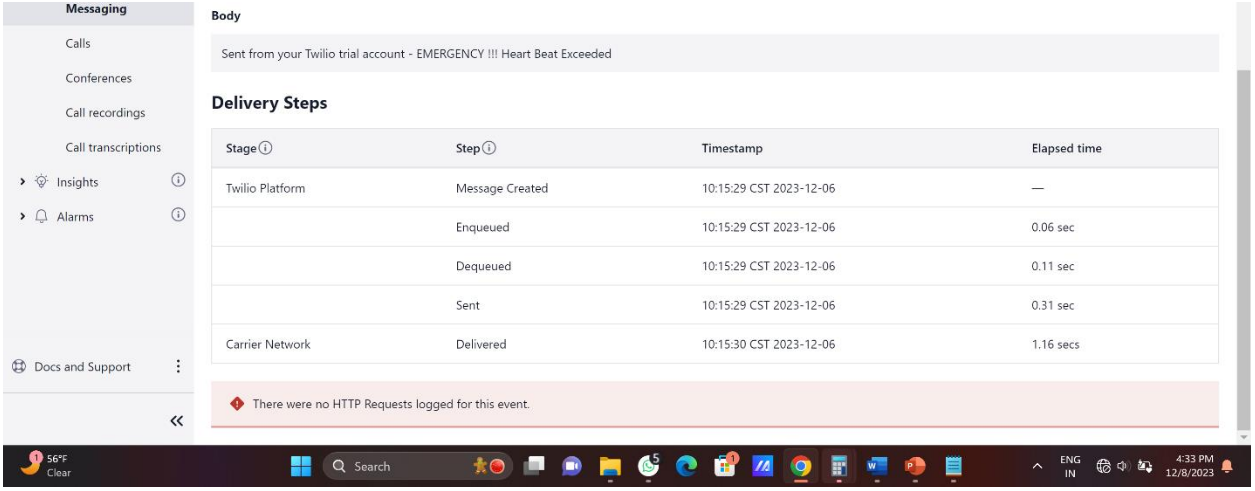
Sent from your Twilio trial account - EMERGENCY !!! Heart Beat Exceeded



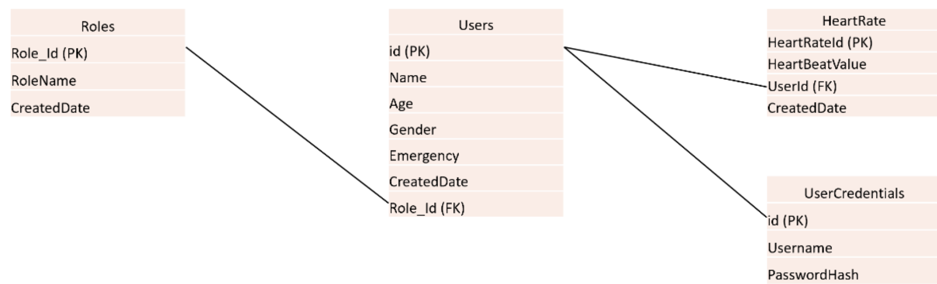
Database Design:

Data from the heart rate sensor is gathered and stored in the database using PostgreSQL. The database comprises the following tables:

1. Users
2. Roles
3. HeartRate
4. UserCredentials

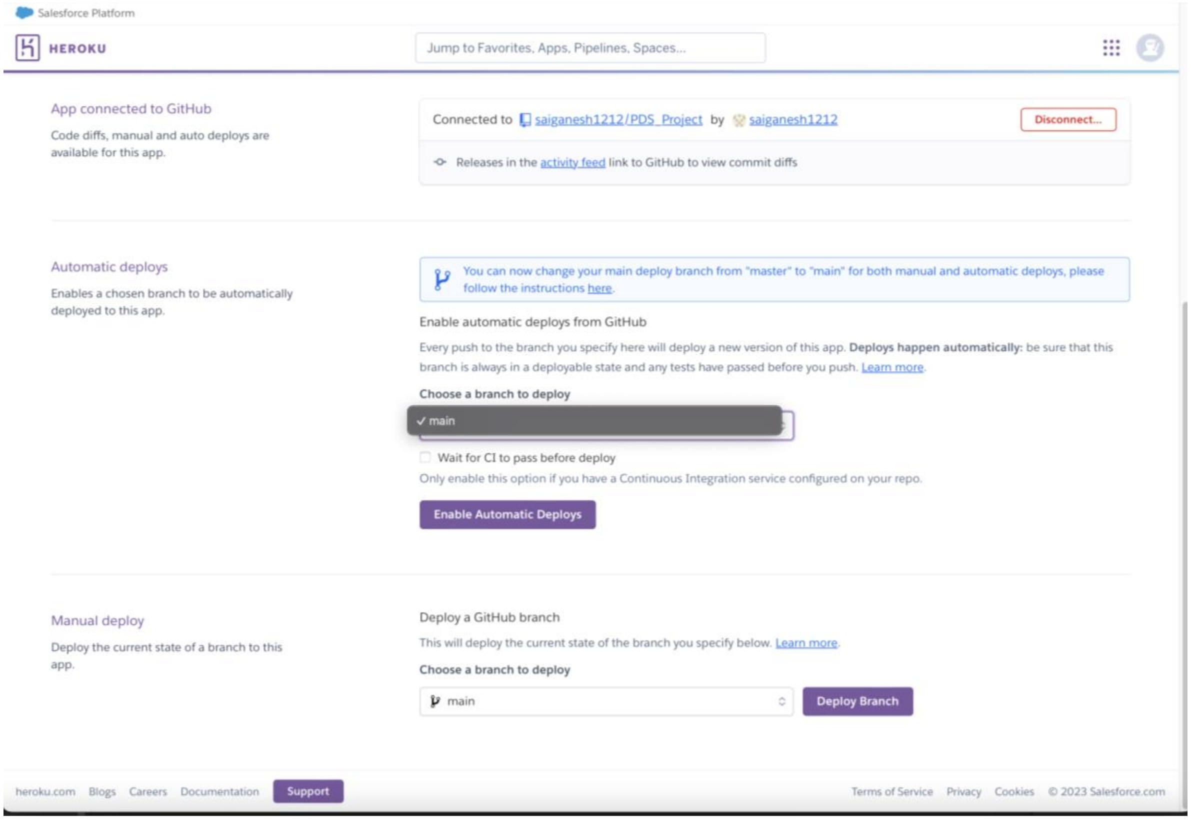
We utilized the neon free tier to establish our database, which is a serverless PostgreSQL system.

Relationship Diagram of the Database



Deployment of the project:

1. Initially, the entire code is committed to GitHub.
2. Subsequently, GitHub is integrated with Heroku.
3. Next, a specific branch is selected for deployment.
4. During deployment, all libraries listed in the requirements.txt file are installed using pip.
5. The command ‘pip freeze -r requirements.txt’ generates a list of all installed packages, storing them in the requirements.txt file in the format ‘package version’.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Code diffs, manual and auto deploys are available for this app.
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Disconnect...
Releases in the activity feed link to GitHub to view commit diffs
Automatic deploys
Enables a chosen branch to be automatically deployed to this app.
You can now change your main deploy branch from "master" to "main" for both manual and automatic deploys, please follow the instructions here.
Enable automatic deploys from GitHub
Every push to the branch you specify here will deploy a new version of this app. Deploys happen automatically: be sure that this branch is always in a deployable state and any tests have passed before you push. Learn more.
Choose a branch to deploy
✓ main
Wait for CI to pass before deploy
Only enable this option if you have a Continuous Integration service configured on your repo.
Enable Automatic Deploys
Manual deploy
Deploy the current state of a branch to this app.
Deploy a GitHub branch
This will deploy the current state of the branch you specify below. Learn more.
Choose a branch to deploy
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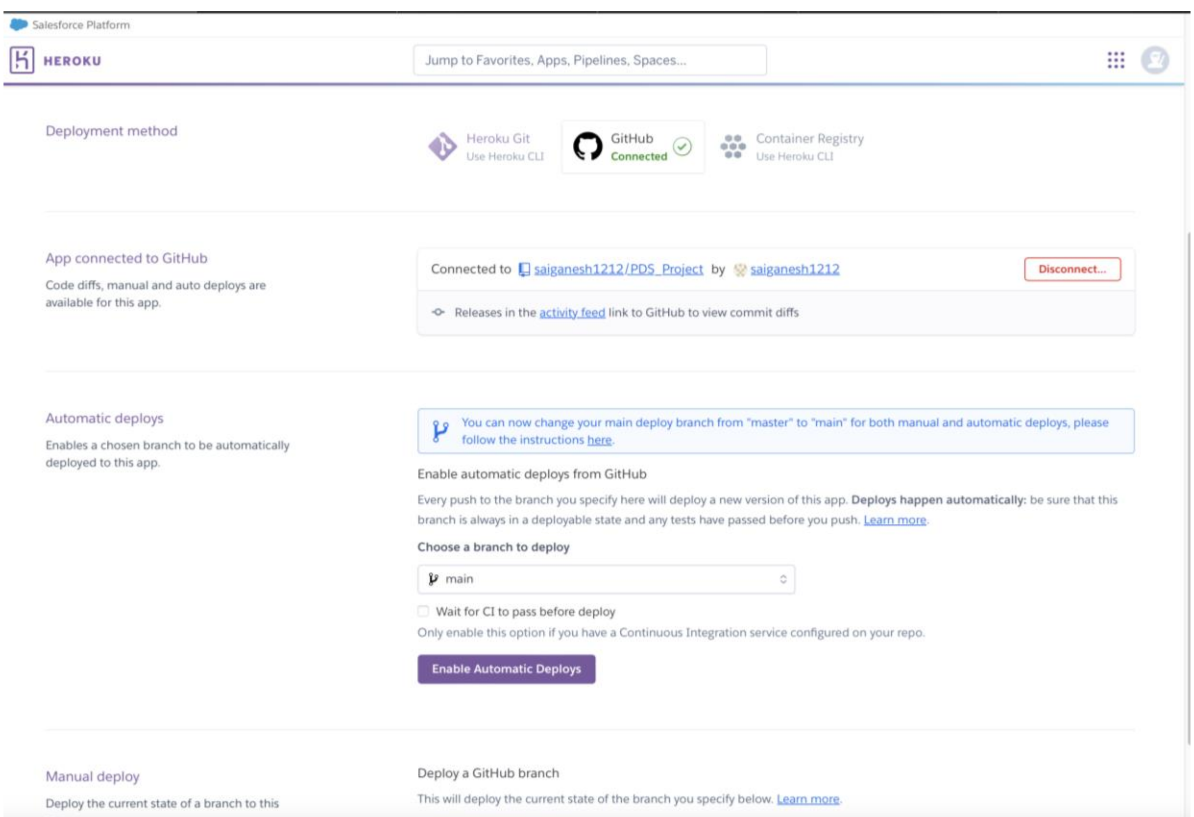
heroku.com Blogs Careers Documentation Support
Terms of Service Privacy Cookies © 2023 Salesforce.com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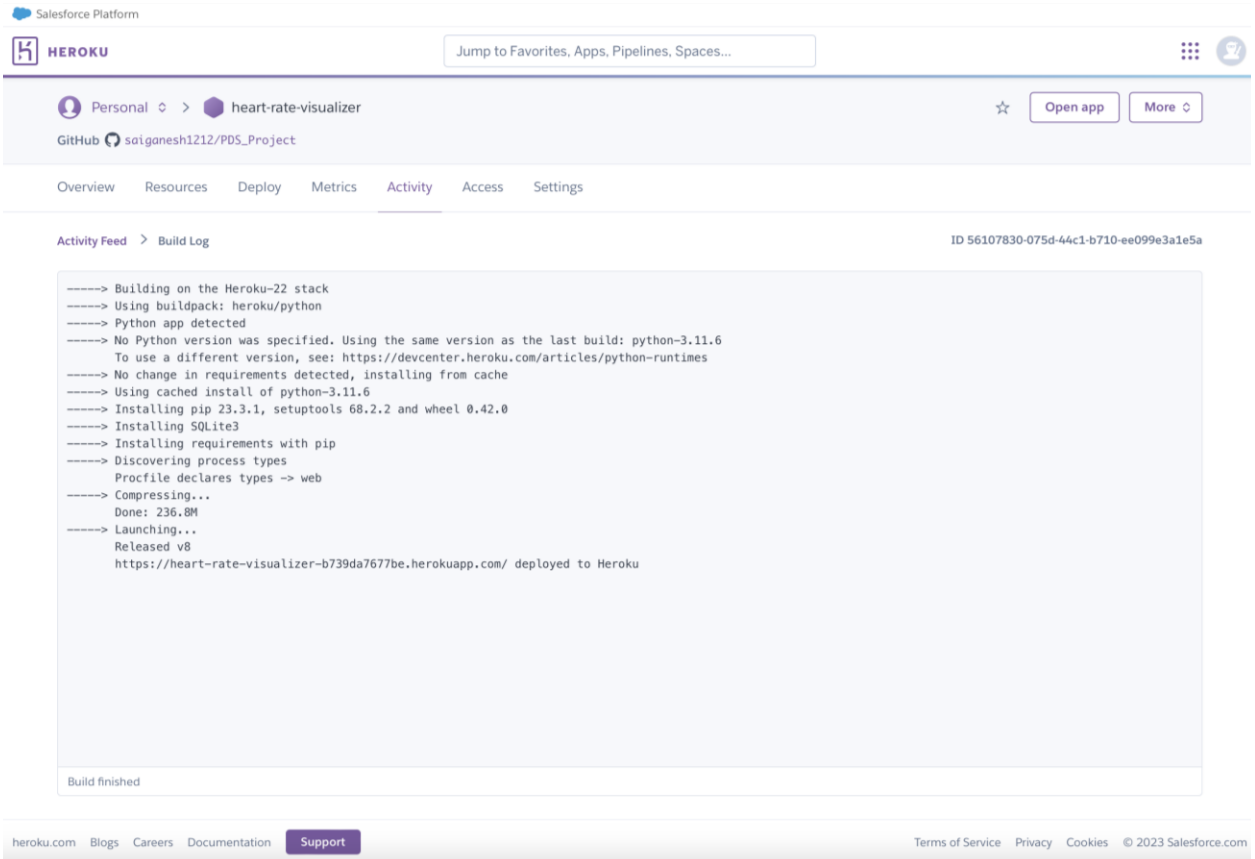
Manual deploy
Deploy the current state of a branch to this app.
Deploy a GitHub branch
This will deploy the current state of the branch you specify below. Learn more.
Choose a branch to deploy



Advantages:

The implementation of a Smart Real-Time Healthcare Tracking and Monitoring System offers several advantages that contribute to improved patient care, streamlined processes, and enhanced healthcare outcomes:

- Timely Intervention and Proactive Care:

  Real-time monitoring of patient vital signs and health metrics enables healthcare professionals to identify potential issues promptly. This facilitates timely intervention and the implementation of proactive care strategies, reducing the risk of complications and improving patient outcomes.

- Continuous Monitoring and Data Accessibility:

  The system allows for continuous monitoring of patient health, providing a comprehensive view of their condition over time. This continuous data stream enables healthcare providers to make informed decisions and adjustments to treatment plans. Additionally, the accessibility of real-time data supports quicker responses to changes in a patient's health status.

- Personalized Treatment Plans:

  Data analytics and machine learning capabilities in the system enable the creation of personalized treatment plans. By analyzing individual patient data, healthcare professionals can tailor interventions and medications to specific needs, optimizing the effectiveness of the care provided.

- Reduced Hospital Readmissions:

  Early detection of health issues and continuous monitoring post-discharge contribute to a reduction in hospital readmissions. By providing patients with the tools for remote monitoring and timely interventions, the system supports a more sustainable and cost-effective healthcare model.

- Improved Patient Engagement and Empowerment:

  Smart Real-Time Healthcare Tracking and Monitoring Systems often involve patient-centric technologies, such as wearable devices and mobile apps. This engagement empowers patients to actively participate in their own care, fostering a sense of responsibility for their health and encouraging adherence to treatment plans.

- Enhanced Data Accuracy and Record Keeping:

  Automation in data collection reduces the risk of human error and ensures the accuracy of health records. Integration with Electronic Health Records (EHR) centralizes patient information, promoting a comprehensive and up-to-date view of each individual's medical history.

Future scope:

The future scope of Smart Real-Time Healthcare Tracking and Monitoring Systems holds promising potential as technology continues to advance. Several key trends and developments are likely to shape the future of these systems:

- **Integration of Advanced Sensors and Wearables:**

  Future systems will likely incorporate more advanced sensors and wearable devices capable of monitoring a broader range of health metrics. This could include sensors for continuous glucose monitoring, advanced imaging devices, and more sophisticated wearables for comprehensive health tracking.

- **Artificial Intelligence and Predictive Analytics:**

  Increased utilization of artificial intelligence (AI) and machine learning (ML) algorithms will enhance predictive analytics capabilities. These systems will evolve to not only detect anomalies in real-time but also predict potential health issues based on historical data, enabling even more proactive and personalized healthcare interventions.

- **Telehealth and Remote Patient Monitoring:**

  The integration of telehealth services and remote patient monitoring will likely become more seamless and widespread. Future systems will support expanded telemedicine capabilities, allowing healthcare providers to remotely monitor and interact with patients, especially in the context of post-discharge care and chronic disease management.

- **Blockchain for Secure Data Sharing:**

  Blockchain technology may be increasingly adopted to address security and privacy concerns related to healthcare data. Blockchain provides a decentralized and secure method for storing and sharing patient data, ensuring transparency and integrity while maintaining patient confidentiality.

- **5G Technology for Enhanced Connectivity:**

  The implementation of 5G technology will significantly improve connectivity and data transmission speeds. This will enable more real-time and high-definition data streaming, supporting applications like remote surgeries, augmented reality (AR) for medical training, and other data-intensive healthcare processes.

- **Human-Centric Design for User Experience:**

  Future systems will prioritize human-centric design principles to enhance user experience for both healthcare professionals and patients. Intuitive interfaces, improved usability, and seamless integration into existing workflows will be central to the design of Smart Real-Time Healthcare Tracking and

Monitoring Systems.

- **IoMT (Internet of Medical Things) Expansion:**

  The Internet of Things (IoT) in healthcare, often referred to as the Internet of Medical Things (IoMT), will expand further. More medical devices and equipment will be interconnected, facilitating data exchange and collaboration among different healthcare technologies.

- **Collaboration between Healthcare and Tech Companies:**

  Collaboration between traditional healthcare institutions and technology companies will continue to grow. Partnerships and joint ventures will drive innovation, bringing together medical expertise and technological advancements to create more robust and effective healthcare solutions.

- **Focus on Mental Health Monitoring:**

  Future systems may increasingly incorporate technologies for mental health monitoring. This could include the integration of sensors and AI algorithms to assess mental health indicators, offering early detection of issues such as stress, anxiety, or depression.

Conclusion:

In summary, Smart Real-Time Healthcare Tracking and Monitoring Systems represent a groundbreaking evolution in healthcare, harnessing state-of-the-art technologies to provide continuous monitoring and personalized care. The integration of advanced sensors, real-time data analytics, and future advancements in artificial intelligence and telehealth positions these systems at the forefront of healthcare innovation, promising improved patient outcomes and a more efficient, interconnected healthcare landscape. As these systems continue to evolve, their impact is anticipated to extend beyond the realms of diagnosis and treatment, shaping a future where healthcare is not only proactive and tailored to individual needs but also characterized by heightened accessibility and responsiveness.