HEALTHCARE APP IN CLOUD: AN AMALGAMATION OF CATEGORIES OF APPS

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Abstract: There are many illnesses around us every day and everyone has one or the other type of illness they are facing. People need an application which can fulfil all their needs. They need a healthcare application which can do all the caring for them for their wellness. There are many applications around nowadays which can have the detailed records of the patients which are centralized records and are accessible by the patients as and when needed. These centralized records make it easily accessible to doctors when they review the case of the patient. In this research paper we will discuss the healthcare applications: what technology they use, the challenges and issues they face and try to create a secure and robust application which can build a healthy environment by tracking our day-to-day tasks or health goals.

Index Terms - Healthcare, cloud computing, patient, healthcare application, chatbot, Machine Learning (ML), AI (Artificial intelligence).

I. INTRODUCTION

The field of healthcare has experienced a remarkable transformation since the introduction of cloud computing [1]. Patients worldwide now have the ability to securely store their medical records and essential data, accessing them remotely without the necessity of physically visiting healthcare facilities [1,3]. Through simple interactions with their devices, individuals can conveniently manage their healthcare requirements [1]. Additionally, contemporary healthcare applications offer self-diagnostic features for minor health issues and facilitate connections with specialized healthcare providers globally for cases that exceed the capabilities of self-diagnosis [1]. These applications play a crucial role in diagnosing illnesses, enabling early detection, monitoring health conditions, and preventing chronic diseases [1].

Electronic Healthcare Records (EHRs) have significantly altered the manner in which patients handle their health information, enabling seamless storage and retrieval of critical health data [2]. The integration of cloud computing, Internet of Things (IoT), telehealthcare, and fog computing technologies has heralded the emergence of Healthcare 4.0, signifying a substantial departure from previous healthcare models [2]. This progression from Healthcare 1.0, characterized by its doctor-centric approach, to Healthcare 2.0, which introduced EHRs, and Healthcare 3.0, focusing on patient-centric care, culminates in the adoption of cloud computing technologies in Healthcare 4.0[2].

Furthermore, the healthcare sector is embracing blockchain-based and IoT based solutions to tackle security and privacy concerns, alongside other innovative strategies [2,3].

The amalgamation of Robotic Process Automation (RPA), Artificial Intelligence (AI), and Machine Learning (ML) pledges a revolutionary approach to improving healthcare diagnostics. RPA improves data collecting and pre-processing by automating tedious administrative activities, ensuring that high-quality, standardized data is available for AI and ML algorithms to analyze. These algorithms use advanced analytics to assess massive

volumes of patient data, such as medical imaging, electronic health records (EHRs), and laboratory findings, identifying illness patterns with remarkable precision [46].

The combined RPA-AI-ML system offers predictive analytics for early illness identification, individualized therapy recommendations, and proactive interventions based on specific patient characteristics. While RPA integration with AI and ML offers considerable prospects for improving diagnostic accuracy, it also introduces several hurdles, such as data privacy and security concerns, regulatory compliance, and interoperability constraints. To address these problems, healthcare providers, technology suppliers, legislators, and regulatory authorities must work together to create an environment conducive to healthcare innovation and progress. Looking ahead, combined RPA-AI-ML systems show great promise for revolutionizing healthcare delivery and increasing patient outcomes [46].

II. LITERATURE REVIEW

Healthcare stands as a pivotal factor in securing the overall well-being encompassing physical, mental, and social aspects of the global populace [39]. The fundamental goal of any healthcare framework lies in directing efforts towards activities that enhance, restore, and sustain health services, thereby fostering economic development and industrial progress within a nation [39].
In recent times, there has been a notable shift wherein contemporary consumers actively engage in healthcare decision-making, alongside embracing virtual healthcare solutions and digital advancements [39]. Additionally, there's a growing emphasis on the utilization of interoperable data, data analytics, and collaborative efforts in therapeutic advancements [39]. This trend necessitates adaptation and innovation among governments, healthcare providers, and various stakeholders [39].

Cloud computing is used to provide services such as IaaS, PaaS and SaaS using which one can build their applications or websites [38]. These services are used to create smart applications such as intelligent transportation systems [31], smart healthcare [30], smart retail [33], smart agriculture [34], smart cities [32], and IoT ecosystems [35, 36].

The use of various clouds such as public, private and hybrid clouds is prevailing and they each bring in their own pros and cons in the healthcare industry [37]. The applications are made using various services and technologies which aim to make the humans healthier [38]. The Cloud Service Providers (CSPs) such as: GCP (google cloud Platform), Microsoft Azure and AWS (Amazon Web Services) enable users to use their infrastructure to build their own applications and which enable us to host the applications and websites. They allow us to use VM (Virtual machines) like Windows and Linux. We can create and host the VMs like web application.

The healthcare industry is now using wearable devices (WDs) and implantable medical devices (MDs)for monitoring which are used to measure blood pressure, temperature, glucose level, heart rate to watch patients remotely and store them [3]. E-Health is the now a trend [3].

IoT is another one of the trends in healthcare applications which is used for integrating the IoT devices to the healthcare applications to diagnose the patients and watch them.

2.1 Advantages of healthcare applications

The advantages of healthcare applications are [4,5,6,7,8,9,10,11,28]: -

1. Self-evaluation: People can self-evaluate their conditions if the have specified their symptoms [28].
2. Contact tracing: People can contact various services such as ambulance, nearest hospital or pharmaceuticals [28].
3. Dissemination of information: Once one comes to know about some new symptoms of the disease or something else, they can spread their knowledge of the illness or their symptoms [28].
4. Limiting disease exposure: This makes people aware of the illnesses they have which can be transmitted to others. This is mainly applicable to infectious diseases such as: COVID-19 [28].
5. Minimizing in-person interactions: People can minimize the interactions with the professionals or people around them in case of infectious diseases [28].

6. Managing disease symptoms: People can keep a track of their symptoms or the severity of these symptoms so as to facilitate the study of these symptoms in case of new diseases and in case of known diseases these can be used for the prescription of the drugs [28].

7. Enabling healthcare accessibility: It involves ensuring that individuals have equitable access to healthcare services and resources, regardless of factors such as income, location, ethnicity, gender, age, or disability. It encompasses a range of efforts aimed at removing barriers and improving opportunities for people to obtain timely and appropriate healthcare when needed [28].

8. Offering personalized guidance to users: Users will be guided as they tell their symptoms and will get personalized prescriptions which will solve their ailments [4].

9. Sending daily prompts to users: the application sends the users reminders or notifications related to their medication or appointments or when they need to get the vaccination done [5].

10. Notifying users of outcomes: It delivers the results of the various tests to users through notifications or messages [6].

11. Confidentiality and privacy: The option to delete information upon user request. Ensuring a prominent level of data confidentiality for all users and safeguarding their privacy [7,8,9].

2.2 Disadvantages of healthcare applications

Despite the manifold advantages of cloud computing, it comes with its share of drawbacks and challenges. Healthcare institutions exhibit reluctance towards embracing cloud computing primarily due to apprehensions regarding security, encompassing concerns over patient data confidentiality, privacy, and the financial implications of services [12, 13].

While the vast volume of data generated within healthcare establishments should ideally be accessible to medical practitioners and researchers alike, it is imperative to address confidentiality issues [14,15,16].

Challenges related to data recording, storage, sharing, uploading, and analysis include:

1. The challenge of linking consecutive user data: There arises a challenge when maintaining continuity and consistency of user data while aggregating and analysing data collected from individual users over time [17].

2. Difficulties in uploading data: Users may find it difficult to upload their diagnosis reports or other data when the file format is different form the ones accepted by the application or when the users don't know how to upload the data [18].

3. Delays in data sharing: people might forget to upload the data necessary for the further diagnosis or face connectivity issues while sharing / uploading data where it needs to be shared [19].

4. The unpredictability of long-term consequences of illnesses: Some illnesses are chronic illnesses and are unpredictable or the illnesses which seem minor may take a turn for the worse if not properly treated [19].

5. Limited analysis capabilities: the applications are designed so that they can treat minor illnesses without much input from the users but id something new (for the application) occurs the application might not be able to analyse it [18].

6. Inability to accurately estimate hospitalization periods: the doctors are the only ones who can estimate the damage of the illnesses to our bodies, they can even ask you to hospitalize yourselves if need be and keep you there till your illness is completely treated. The application may seem easier to use and predict your illness but it doesn't know the severity of your case and may not be able to forecast the timeline at which you should get hospitalized or for how much time [20].

Problems with the method and technology employed include:

1) Limited accessibility to mobile phones and Wi-Fi [21]
2) Contact identification via Bluetooth and without GPS [22].
3) Insufficient e-mail for data interchange [21]
4) Inadequate user monitoring and follow-up [23]
5) Privacy concerns [24]
6) Lack of confirmation of user-recorded outcomes and reports [25]

7) Difficulties with daily symptom reporting due to personal interpretation of questions and outcome bias. [26,27]

2.3 Cloud services or other services used in healthcare apps

The services which are used in healthcare are: -

1. Amazon Elastic MapReduce: It is used for handling big data and to get onto the cluster.
2. Amazon S3: It is utilized to store data (for example sensor data).
3. Apache Pig: It is used to analyse data in the distributed database.
4. Hadoop: It is mainly used for huge data processing [40,41].
5. Microsoft Entra ID (formerly known as Azure Active Directory): It is used for providing security and compliance [42].
6. Azure OpenAI and Azure AI Services: these are used for making chatbots so as to receive personalized responses to users [43].
7. Microsoft Teams: It is used for virtual consultations and appointments [44].
8. Amazon EventBridge: it is used to transform, receive, filter, route and deliver events [45].
9. Amazon Chime SDK: It is used for real-time communication such as audio, video, messaging and screen sharing [45].
10. Amazon Transcribe: Speech to text conversion service provided by Amazon [45].
11. Amazon SNS (Simple Notification Service): It sends notification to user [45].
12. Amazon SQS (Simple Queue Service): It provides fully managed message queuing for microservices, distributed systems, and serverless applications [45].
13. Amazon CloudWatch: It collects and visualizes near-real-time logs, metrics, and event data in automated dashboards [45].
14. Amazon EC2 (Elastic Cloud Compute): It provides sizable compute capacity in the cloud.
15. Amazon RDS (Relational Database Service): It is a relational database management system that facilitates user in creating database instances as per user's requirements i.e. resizable, variety of database types, etc.
16. Amazon ELB (Elastic Load Balancer): It is used to distribute network traffic to improve the scalability of applications [46].
17. Amazon VPC (Virtual Private Cloud): It is a virtual network or datacentre inside AWS for one client.
18. Amazon Route53: It is used to connect user requests to infrastructure in AWS, such as Elastic Load Balancers, Amazon EC2 instances, or Amazon S3 buckets.

2.4 Security issues faced in healthcare apps

Any application can have security issues related with them. They could be related to confidentiality and privacy of the users.

There are various security attacks which are hampering the customer service by attacking the medical devices. The attacks are targeting active therapeutic, non-invasive and invasive devices.

The security attacks include some of the common attacks such as : malware, ransomware, eavesdropping, DOS, man-in-the-middle and impersonation.

Some of the attacks faced by users in healthcare applications are shown in Table 1: -

Table 1: attacks, its type and target medical devices [7]

Attack	Attack Type	Target Medical Device
Hardware	Hardware Trojans	Active therapeutic
Software	Malware	Active therapeutic
	Ransomware	Active therapeutic
	Outdated Operating Systems	Active therapeutic
	Electroencephalograpgy	Non-invasive
	Counterfeit firmware update	Invasive, Non-invasive
System level	Weak authentication schemes exploitations	Invasive, Non-invasive, Active therapeutic devices
	Privilege escalation	Invasive
Side Channel	Electromagnetic interface	Invasive
	Sensor Spoofing	Invasive
	Differential power analysis	Non-invasive
Communication Channel	Eavesdropping	Invasive, Non-invasive
	Replay	Non-invasive
	Impersonation	Non-invasive
	DOS	Invasive, Non-invasive, Active therapeutic
	Multiple input and multiple output	Invasive
	Man-in-the-middle	Invasive, Non-invasive devices
	Battery depletion	Invasive, Non-invasive

The most frequent of the challenges in cloud is confidentiality [29]. The most prone and important aspect of any application is the confidentiality of the data which you have, you need to keep it secure at all times so that the customers or users are satisfied of the fact that their data is secure. the other main aspect is data security [29]. The data of the users should be secure otherwise the data if leaked could be misused by other people [29].

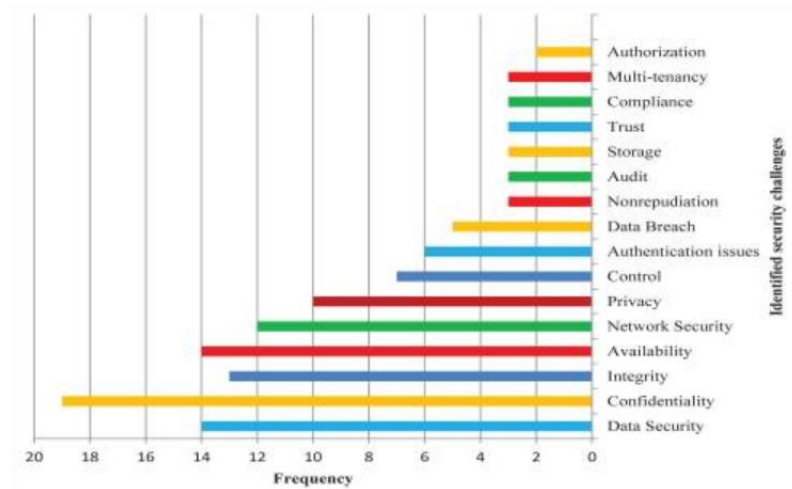Fig.1 shows these challenges and their frequency.

Fig. 1: Security challenges and their frequency in the cloud [29].

People like to use an application which can ensure the safety, confidentiality and availability of the data they entrust the application with. They feel secure to use the application when they use the cloud services when it is secure and no data can be breached and no data leaks can hamper or misuse their data.

While using the internet the network security is also a challenge that can be a deal breaker for many users as various attacks can happen while using an insecure network.

The challenges which have more frequency in the cloud are [29]: -

1. Confidentiality
2. Integrity
3. Data Security
4. Availability
5. Network security
6. Privacy

Other challenges or security attacks in the cloud include [29]   : -

1. Authorization
2. Multi–Tenancy
3. Compliance
4. Trust
5. Storage
6. Audit
7. Nonrepudiation
8. Authentication Issues
9. Availability.

2.5 Security solutions

The security solutions include usage of [29]: -

1. Blockchain
2. IDS (Intrusion Detection Systems)
3. Access Controls
4. Security tools
5. Firewalls
6. SLA (Service Level Agreements)
7. Security Management Protocol
8. Digital Signatures
9. Data Classification
10.   Authentication
11.   Data Encryption

12.   API (Application Programming Interfaces)

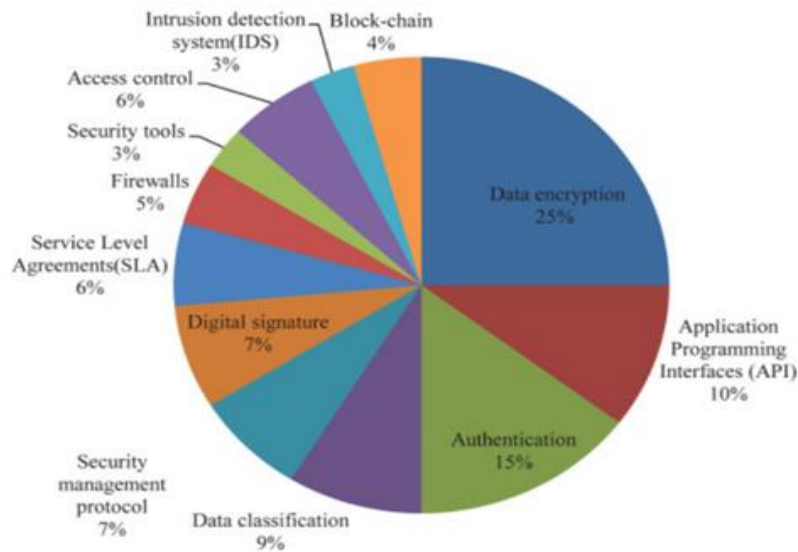Fig.2 Shows these solutions as well as their usage percentage as well.

Fig. 2: Security solutions which are most commonly used in cloud computing [29]

III. HEALTHCARE CHATBOT

AI and ML techniques are employed within chatbots to simulate human-like conversations autonomously, eliminating the need for direct human interaction. [48]. An online questionnaire aimed at gathering insights from experts revealed favourable views regarding the utilization of healthcare chatbots for self-care management. Respondents noted various advantages, including enhancements in physical, psychological, and behavioural aspects, with a significant emphasis on their effectiveness in handling administrative tasks [48].
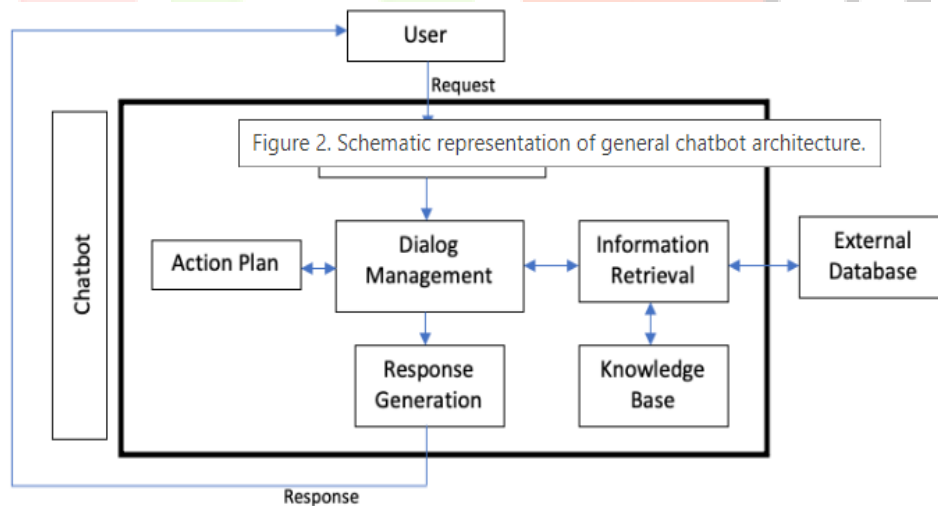

Fig. 3 General chatbot architecture

A general architecture is shown in Fig.3. Initially, the user submits a request either through text input or speech, which the chatbot receives and interprets [48]. Subsequently, the received information may be stored for further references, or additional details might be sought to ensure clarity [48]. Once the request is comprehended, the chatbot proceeds to execute the requested actions, retrieving the relevant data from either its internal database or external sources [48].

Usage scenarios of chatbots [48]: -

1. Screening and diagnosis: They are used in imaging diagnostic, symptom screening and hereditary assessment [48].
2. Treatment: It is used in Physician treatment planning, patient treatment recommendation and connecting patients with providers or resources [48].
3. Monitoring: It is used in remote patient monitoring [48].
4. Support: It is used in counselling and Emotional support [48].

IV. PROPOSED SYSTEM

There are various categories of healthcare applications which aim at different aspects of healthcare. We have existing applications which aim at various health goals and are made for specific purposes only, for e.g. we have fitness apps, telemedicine apps, clinical reference and diagnostic apps, health management apps, health test booking apps and online consultation apps. People having multiple health goals such as fitness and health management need to download multiple applications so as to fulfil their goal.

To overcome this, we purpose an application which bridges many of the categories that people need to improve their daily life.

4.1 Services/ Technologies Used

The technologies used in the proposed system are: -
- Firebase: It is used to store the data of the application.
- Android Studio: It is used for designing and coding of the application.
- XML: It is used to make or design layout.
- Java: It is used in coding.
- Google Map API: It is used in integration with our application to find nearby hospitals/ clinic.
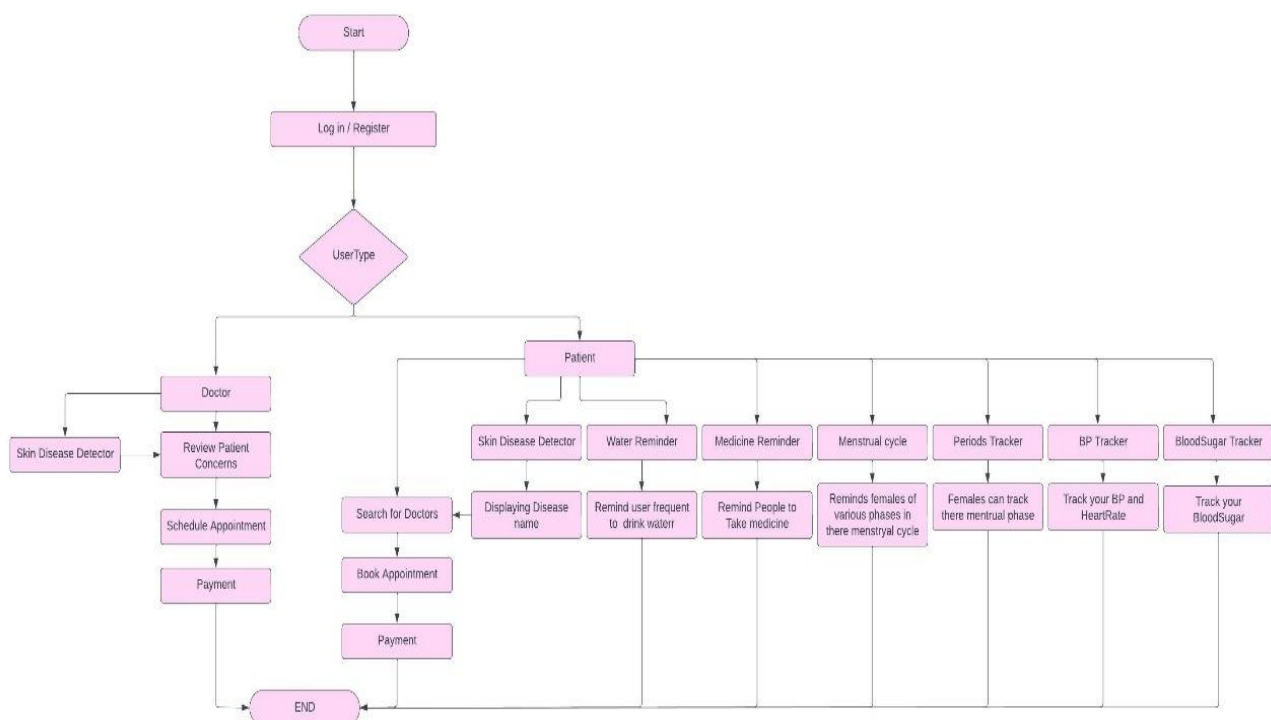
Fig.4 depicts the flow of the entire application

Fig. 4 flow chart of application

V. RESULTS

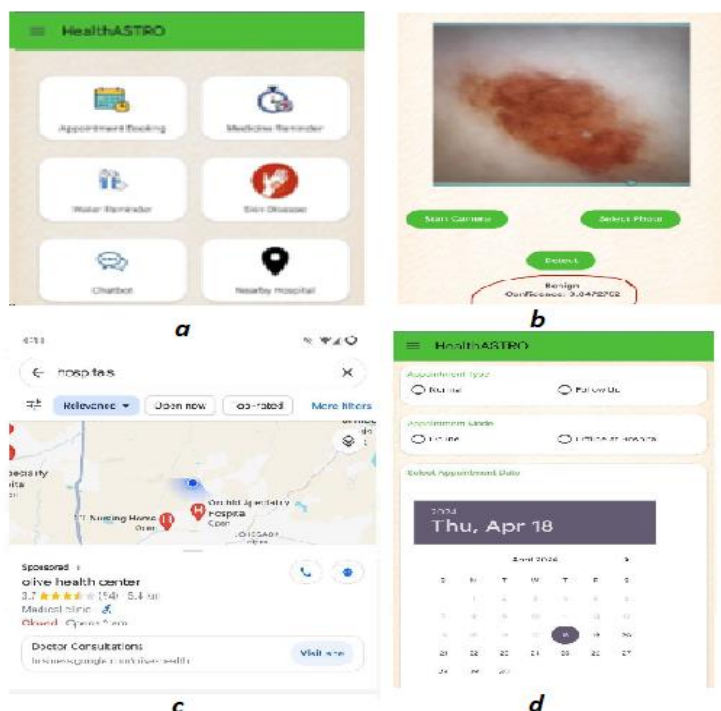Fig. 5 depicts the results obtained by using the application's features: -

Fig. 5 results of the application, a) Home page of the application, b) skin disease detection, c) Nearby hospitals or clinics d) scheduling appointment

VI. CONCLUSION AND FUTURE WORKS

The software successfully amalgamated various categories of healthcare applications, enabling individuals to pursue their healthcare objectives through a unified platform. This integrated app serves as a comprehensive solution for fitness and health management needs.

Our goal is to develop a customer-centric healthcare application that facilitates the establishment of healthier habits among users, aiding them in maintaining fitness and accomplishing daily objectives. This will be achieved by seamlessly integrating the app with a variety of IoT devices and wearable technology.

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