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PROJECT - PART 1

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Introduction

Presently, we are going through the 4th Industrial Revolution. As such, there are many new technologies and innovations which are now able to be utilized like never before. However, proper implementation of these technologies are still challenges which have to be overcome in order to fully utilise these technologies. Thus, the project we will be working on is about how the healthcare industry could benefit from proper implementation of technologies such as cloud computing, artificial intelligence(AI), and internet of things(IoT).

In order to carry out this project, we will be creating a low-fidelity prototype, which is essentially creating a simple sketch to help visualize how the project will operate. Our low-fidelity prototype will be based on the 4IR technology. The application that we choose is smart health care . Based on the client's problem, we designed an architecture to solve the problem. We proposed the client to use cloud computing since it is beneficial while also keeping costs relatively low.

4th IR technology

Artificial intelligence (AI) is an intelligence shown by machines that can accomplish activities that would normally need human intelligence. Artificial intelligence is developed by studying the pattern from the enormous amount of data.

AI is now widely used in many areas. Artificial Intelligence has long been utilized in the business world to aid with decision-making. AI technology can help with data distribution, trend analysis, data integrity, and forecasting. The client is capable of evaluating the data efficiently.

The common AI that is used today mostly rely on deep learning and natural language processing.

For example, Siri, Google search suggestions, and self-driving cars. According to Peter Norvig and Stuart J. Russell, authors of *Artificial Intelligence: A Modern Approach*, there are four main approaches to AI that have shaped this area of research in the past:

- Thinking humanly
- Thinking rationally
- Acting humanly
- Acting rationally

Internet of things(IoT) is a networked system of connected computing devices, objects, or people by utilizing the Internet.

The IoT system has smart devices that have embedded systems such as sensors and communication hardware which are connected to the Internet. The smart devices share and exchange the sensor data together. IoT has the ability to transfer data without involving human involvement.

The Internet of Things(IoT) is linking the digital and physical worlds together to make the world around us smarter and more responsive.

The key advantage of IoT is monitoring. Without having to worry about the location, the information can be obtained quickly and in real time.

Potential client

The potential client is a hospital owner. Although the public perception is that hospitals are similar to a charity, hospitals are businesses and operate on profits and losses. Due to the Covid-19 pandemic, the hospital is receiving a high number of patients to the point that it reaches full capacity and is no longer capable of accepting any more patients. As a result, the hospital is understaffed to help each and every patient. Thus, the client is searching for a solution that is able to increase the hospital's capability to help patients while reducing the number of staff required.

Smart healthcare

Our group decided to choose AI and IoT by applying it in smart healthcare. IoT can acquire data from a variety of sources that is accurate and free of errors. The AI learns from the patterns formed and imitates how humans finish tasks. AI technologies are embedded into IoT devices to supplement solutions and offer intelligence to IoT. The combination of these two technologies gives the healthcare sector a huge advantage. The technology enables the hospital to benefit from the information of big data.

Thanks to the digital transformation of the health sector, the hospital is able to increase productivity, improve patient satisfaction, and provide more flexibility. A Smart healthcare uses the Internet of Things(IoT) to let patients and clinicians connect with one another. The system also allows the interaction of patients and doctors onto a single platform for intelligent day-to-day health monitoring.

1. Monitor patient's health conditions on a daily basis.

- The system takes advantage of IoT by embedding the sensor in a wearable device. The wearable device may track the patient's heart rate, sleep quality, breathing patterns, and other vital health data.
- The IoT system thus enables the doctor to monitor the patient's condition from any location, even if the patient is not in the hospital.
- The AI system will also keep alert of the patient's condition when it is in alarming condition. The data is collected by the IoT system. The AI will analyse the patient's health pattern and generate a report. The AI technology analyses the pattern and requirements, providing feedback and direction for the patient and doctor. It facilitates real-time action by allowing for real-time analysis.
- This eliminates the need to manually track the patient's health in the hospital, which is time-consuming. Freeing up the health staff for more critical work.

2. Virtual care.

- Allow patients to communicate with an AI assistant through a chat box. Chat boxes can deal with minor health issues.
- Patients do not require making appointments with their doctors. Sometimes the patient's problem could be a minor one that they can handle on their own. This allows the doctor to concentrate on more major matters.
- Patients benefit from the chat box because it provides an immediate response to their questions and concerns, and it is available 24/7.
- The patient does not need to visit the hospital or seek medical advice, which reduces the frequency of unnecessary clinic visits.

3. Aids in clinical decision-making.

- The Internet of Things (IoT) technology enables the system to connect many users such as patients, health workers, hospital management, diagnostic centres, and insurers, speeding up data flow.
- In terms of medical histories and reports, the data in the system is extremely well-organized. Allowing health-care workers to quickly and efficiently access data, even though the data is large and complicated.
- The technology can also help staff make better decisions by providing early detection of a patient's health, since the system monitors the patient's condition from time to time.

4. Keep track of every patient in the hospital.

- When the hospital gets overcrowded, particularly when there is an influx of patients infected with Covid-19, it is hard to determine which patient has the most critical issue and require immediate assistance. The process is difficult since it involves analysing a large amount of patient data and making decisions in a short amount of time.
- IoT, on the other hand, will collect the patient's data in the system. When the patient's condition begins to deteriorate, the AI will assist in determining the condition and will warn the doctors. The AI virtual assistant will also take care of patients who do not have any major issues.

Architecture Planning and Design

Problem

Since the entry of smart healthcare, developed concepts and systems have been shaped. In any case, with the rise of unused advances and unused issues, there's still impressive room for advancement, and numerous challenges are presently developing.

- Currently, smart healthcare needs large-scale direction and automatic reports, which leads to a large amount of data. In addition, restorative education requires uniform measurements between separate premises and different organizations, and progress is needed to ensure judgment on the information. The sum of information is as well complicated and as well huge, which leads to challenges in information sharing and communication.
- There are two issues with compatibility between distinctive stages and gadgets. From a patient's viewpoint, smart healthcare requires pertinent lawful standards, and there are dangers concerning individual data and protection breaches. Some customers do find it difficult to use the innovation.
- Taking a few advances related to SHREWD healthcare are still within the test stages and require a huge sum of financing to be maintained and updated. There is a lot of data stored since there is a lot of data collected from different devices, which leads to insufficient size in data centres. Hence, the client needs to invest in building new data centres to store more data, the client also needs to maintain the data centre every month which will require a lot of cost.
- There's moreover an obscure hazard if connected carelessly and because of Covid-19, there is a burden on the doctors physically and mentally because of the huge amount of patients that came every day.

Summary of the problem

- Hard to manage the data from many sources and huge amounts of data to store.
- Security issues.
- The data centre needs to be maintained continuously and is costly.

Solution

Cloud computing will be used in smart healthcare. Amazon Web Services is the cloud computing service provider that we have chosen (AWS). This is because the client does not have to develop a data centre and does not have to invest for data centre maintenance. AWS also offers a great deal of flexibility and scalability because you only pay for what you use. Providing a simple way for the hospital to keep its data since the storage demand for IoT is high. AWS also provides a secure cloud computing platform.

Moving a healthcare system to the cloud is not an easy task, as there are a lot of systems in place that need to be changed. Therefore, we suggest the typical 4-layer design architecture for a healthcare system with the addition of one additional AI layer, making it 5 layers. Each layer will depend on the subsequent layer. Adopting Software as a Service (SaaS) is in the hospital's best interests, as they do not need to worry about infrastructure, and it is the easiest to start with.

The frontend platform is the user interface which the customer, sensing device and healthcare workers use this platform to access the cloud. Users can interact with the system by using apps in smartphones or browsers on a laptop or computer. The communication between our AI assistant in the chat box also is in the frontend.

The frontend and backend communicate with each other using the Internet.

The backend is the part where it will run on the cloud, which is the AWS Services.

The 5-layer architecture:

1. Sensing Layer

- Collects health-related information from the patients through wearable
- Gathers health data including blood pressure, temperature, blood sugar level etc
- Generate the real-time data
- Core IoT technology
- Data transmission depends on the required power consumption
- Main communication layer receives all this data and transmit it via the Internet or store at a cloud platform

2. Communication Layer

- Responsible for all telecommunication services and access
- Allows IoT systems to function
- Wireless networks and broadcasting networks (Provide high speed and reliable internet connectivity)
- Wi-Fi builds a network very fast and easily. Hence, Wi-Fi is applied in the communication technology
- Provides huge capacity, robust internet facilities, and storage of huge amounts of data and sharing the information among the doctors and patients
- Transmit the data to the remote server

3. Data Integration Layer

- Handles resources for medical data of patients and doctors
- Directly uses cloud computing platforms, distributed data storages
- Allows information sharing, data processing, predictive modelling and data analysis with the help of IoT applications and devices. This is required for the AI layer
- The Amazon Simple Storage Service (S3) is the world's largest and fastest object storage service. It is suitable for constructing a data lake. Client can utilize native AWS services to execute big data analytics and artificial intelligence with a data lake created on Amazon S3

4. AI Layer

- With cloud computing in the picture, big data analysis, which is required by AI, is much more accessible and affordable.
- Performs situation assessments on patients and provides suggestions to medical professionals.
- Intelligent decision-making and assistance.
- Critical in terms of assessing patient situations, recognizing a course of action, and communicating with the health care provider and patient.
- Aid in virtual care by analysing the information collected from the patient.
- To create online analytical queries and processing databases, a data warehouse is created. Amazon Redshift is chosen. Amazon Redshift is a data warehousing solution from Amazon Web Services. It allows real time analysis.

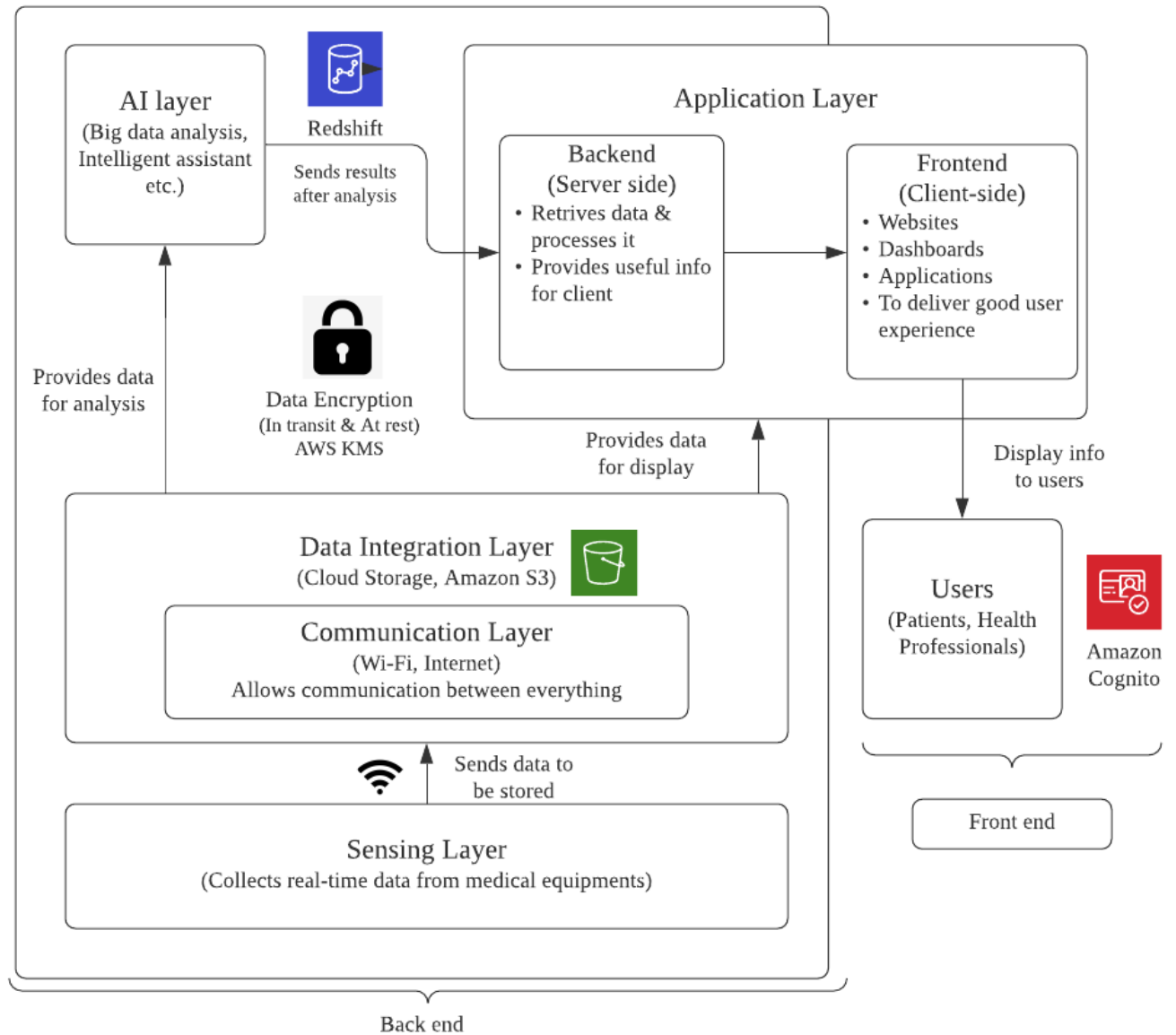
5.Application Layer

- Provide the features of dashboards, virtualize the data collected from the sensor.
- Platform for personal health records, smart monitoring & tracking.
- Allowing data to be accessed and displayed by both patients and doctors through the cloud.
- Utilizes websites, IoT devices, and applications.

Security in the Architecture:

- Blocks unwanted visitors that infiltrate medical records.
- Only granting access to registered professionals.
- Amazon Cognito offers methods for controlling access to AWS resources from the app.
- For the web and mobile apps, Amazon Cognito handles authentication, authorization, and user management. The users can log in using their own username and password or through a third-party service like Facebook, Amazon, Google, or Appl. This is suitable for our smart healthcare system since we have thousands of users.
- AWS supports data encryption at rest and data in transmit to protect digital data. AWS Key Management Service (AWS KMS) is used to manage the secret key.

Architecture Diagram



Conclusion

The implementation of a smart healthcare system will greatly benefit both patients and healthcare personnel as patients will be able to receive proper treatments meanwhile healthcare personnel will be able to allocate their resources more effectively as well as being able to obtain more data regarding their patients.

Smart health help patients to have more pleasant hospital experiences and eliminate clinical decision-making errors. It also boosts productivity and improves communication between the devices, patient and doctor. In addition, it allows for remote monitoring, which saves the patient time because they don't have to go to the hospital as often for less severe cases.

Although there are an abundance of benefits, there is still a limitation to implement this system, which is cost. The client must be willing to pay for the costs that come with the implementation. Some of the costs that the client must consider include:

- Purchasing IoT capable devices for the entire hospital to collect data
- Hospital requires a reliable internet connection at all times
- Increased electricity consumption

Although these costs seem substantial, we believe that the benefits that are achieved by implementing a smart healthcare system will greatly outweigh the downsides. In conclusion, deploying a smart healthcare system is greatly beneficial for all those involved despite its costs.

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