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Blockchain-Enabled Iot Based Intelligent Health Monitoring System

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Abstract: Both Internets of Things and blockchain technologies are indeed being thoroughly researched and widely used in a variety of domains, namely e-healthcare. With the digital revolution and sensor downsizing, there are trials underway to apply the latest tech in a wide range of domains to improve human livelihood. The medical field is one of the core fields of study that has seen massive technology adoption. Families with a need for medical services often find treatments to be outrageously expensive, and this is certainly the case in poor countries. As a reason, this study is aimed to tackle an existing societal healthcare crisis. As a result, the suggested system utilizes an Arduino microcontroller to gather sensor information and transmit it to the Thing speak platform, where it is gathered and analyzed for remote viewing. The goal of this article is to develop a monitoring device using IoT components such as an Arduino UNO, a temperature sensor (LM35), a humidity and temperature sensor (DHT11), a pulse sensor, an air quality index (MQ135), and an ESP01 that is financially viable and maintain data in a distributed network. Hence, the proposed system collects the sensor data through an Arduino microcontroller and relays it to the Thing speak server where it's processed and analyzed for remote viewing. Data via Sensor nodes are collected for measurement, sorting, and storage. This sort of centralization can be problematic since it can lead to system failure, uncertainty, data modification and manipulation, and invasions of privacy. Blockchain technology has the potential to alleviate such critical issues by enabling distributed computing and storage resources of IoT data. In a conclusion, combining IoT with distributed ledger technology may be a viable option for implementing decentralized IoT-based medical systems.

Keywords – IOT, Embedded System, Decentralized, Sensors, Blockchain Technology.

I. INTODUCTION:

The utilization of gadgets, programs, sensors, and internet connectivity that enhances these systems' ability to obtain and share data is known as the Internet of Things. The continuous surveillance of a patient by checking multiple elements and inferring a favorable outcome from the past of such constant monitoring is the unique characteristic of the Internet of Things in the healthcare system. Many of these technological advancements, which also include medical sensors, can now be utilized in hospitals and nursing homes. Although 24x7 tracking, there may be instances when the health care professional is not notified of a crisis in time. Sharing of records/knowledge with medical experts and anxious members of the family and relatives may also be troublesome. The innovation to improve these aspects is now available, but it is inaccessible and out of range for the great number of people in impoverished countries. As a result, answers to these challenges may be as simple as introducing new features to older devices. IoT is rapidly growing and making its impact felt in nearly every industry of technology. However, its rapid evolution has left it more vulnerable to cyber-attacks. There is indeed a strong need to make IoT more secure.

Technology's recent advancements are having an impact on all aspects of human life, altering how we use and perceive things. Technology is also finding new ways to improve the healthcare sector, just as it has in several other areas of life. The key advantages of technological advancements in the healthcare business are improved security, user experience, and other elements. They do, however, have second thoughts regarding the protection of clinical records, patient rights of information, the integrity of the information, as well as other issues. The adoption of advanced ideas, such as Blockchain, could provide a satisfactory solution. This technology makes a claim to provide a secure and effective infrastructure for medical files and other health-related information storage. Prior to the advent of modern technology, the healthcare business depended heavily on a paper-based system, i.e., a manually written system, to preserve medical history. This storing of patient's information method was wasteful, unreliable, chaotic and subject to temper tantrums. They also had to worry about data repetition and overlap because the patient's medical files were cloned at each of the institutes he or she visited.

This paper suggests how an Arduino Microcontroller can be used to control an Intelligent Patient Monitoring System. The Arduino UNO is a low-cost, adaptable, and easy-to-use open-source microcontroller board that can be used in a variety of electronic applications. First, a system is built in this work to periodically monitor vital data such as pulse, body temperature, temperature and humidity, and air quality index. The information is then stored on a Things speak server using a WIFI module which is used to connect the patient's readings on the ThingSpeak web server by using API key data transmission, which is done by embedding the

SSID, password, and API key of the server channel. Second, an idea is introduced of how we can store data in a decentralized manner using Blockchain technology.

The paper's main goal can be summarized as follows:

- Using IoT to collect real-time medical information about a patient
- To provide healthcare solutions based on the Internet of Things at any time and from any location.
- An idea of how we can store data in decentralized manner using Blockchain technologies.

II. LITERATURE SURVEY:

A number of researchers have proposed several models for IoT in Healthcare, as well as the usage of blockchain in healthcare via various methodologies.

Gautam Srivastava et. al., (2019) has discussed the challenges of how to apply blockchain to IoT and then explained how to solve the problem by introducing a novel blockchain-based IoT model to provide advanced security and privacy properties to the present IoT based remote patient monitoring system. As we know, the Use of blockchain in IoT-based models is not straightforward, and therefore they tried to get rid of many challenges and improved the security of healthcare data. The model provides authentic data communication over the network and storage over the cloud with more advanced and lightweight cryptographic techniques like the ARX encryption scheme. The concept of Ring Signatures was introduced which provides important privacy properties like Signer's Anonymity and Signature Correctness. Also, they used a double encryption scheme to make the symmetric key more secure over the network and used the concept Diffie-Hellman key exchange technique in their blockchain-based network which protects their public key from an intruder [1].

Shubham Banka et. al., (2018) have proposed a system that is controlled by Raspberry Pi. It consists of varied several devices like sensors and web-based or mobile-based applications which communicate via network-connected devices and helps to watch and record patients' health data and medical information. The end result was to develop a system that could provide exceptional medical support to patients even in remote locations where there are no hospitals, by connecting over the internet and obtaining information about their health status via wearable devices provided in the kit, which could record the patient's heart rate and blood pressure using a Raspberry Pi microcontroller. The system would be smart to intimate the patient's relations and their doctor about the patient's current health status and full medical information just in case any medical emergency arises. They developed and demonstrated a prototype for an automatic system that assures continuous monitoring of numerous health indices and prediction of any form of disease or disorder, sparing the patient the agony of several hospital visits. The proposed system can be set up in hospitals and an enormous amount of data can be obtained and stored in the online database. Even the results are often made to be accessed from mobile through an application [2].

Md. Milon Islam et. al., (2020) had introduced a system that is implemented using the hardware components. They introduced smart healthcare to monitor the basic important signs of patients like heart rate, body temperature, and some measures of hospital room's condition such as room humidity, the level of CO and CO2 gases. The rate of success between the observed data and actual data is approximately greater than 95% for all cases of the developed healthcare system. Trustworthy medical staff can view and track the data in real-time even though the patients perform the tests away from the hospital. The model can also help nurses and doctors in situations of pandemic or crises as raw medical data can be analyzed in a short time. The developed model is very simple to design and use. The system is very useful in the case of contagious disease like a novel coronavirus (COVID-19) treatment. The developed system will the current healthcare system that may protect lots of lives from death [3].

III. SYSTEM ARCHITECTURE:

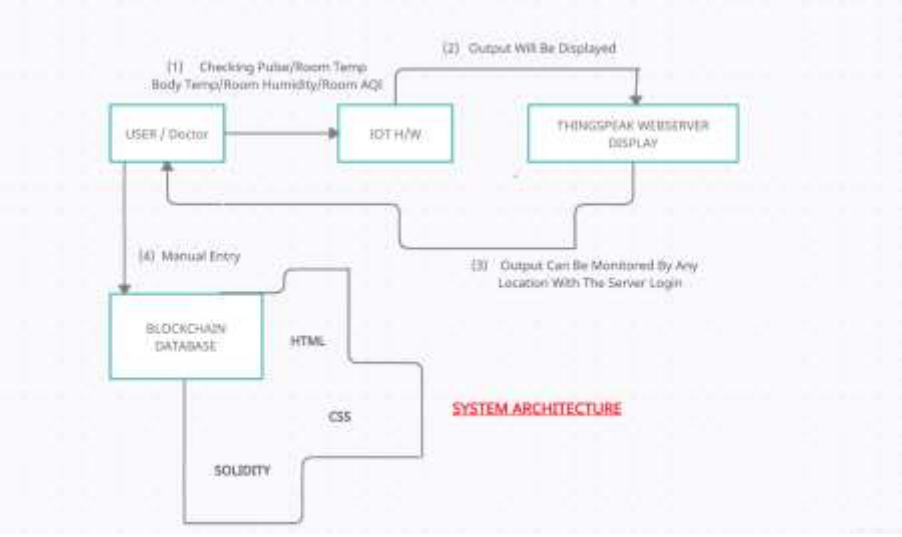


Figure 1 - System Architecture

IV. METHODOLOGY:

In this research topic, we suggest an automatic approach for assessing a person's body temp, room temperature, heart beat and room air quality index in. The server collects and stores data from various IoT devices. Temperature sensor (LM35), pulse sensor, room temperature and humidity sensor (DHT11), air quality index (MQ135), and WIFI module (ESP01) are some of sensors utilized in these systems. All the functionalities are controlled by an Arduino UNO. It serves as the foundation for all sensors and other IoT components. The C# (Embedded C) language was used to write the application in the IDE. The patient's readings are then

communicated to the ThingSpeak web server via the web server's API key, which is done by embedding the SSID, password, and the server channel's API key. The ESP-01 is used to create a link between the patient's reading and the ThingSpeak web server. The patient's readings are then recorded using blockchain technology in a decentralized way. The data is manually entered on the website, where we may edit patient/doctor information and add/retrieve medical records using the patient ID and code. The process will be carried out by connecting the HTML/CSS code to the web3 network, which will then be linked to Metamask. The saved medical data will be stored in blocks in the ganache Ethereum blocks, and Metamask will take Ethereum from the ganache.

V. IMPLEMENTATION:

In this paper, we propose a way to monitor the person's body temp, room temperature, pulse, and room air quality index measurements using a system. The components are connected to the person's body and acquire data before relaying it to the Arduino board. The Arduino Uno has a USB interface, 6 analogue pin inputs, and 14 digital I/O port facilities for interfacing with other digital devices. Multiple sensors are used to detect the person's body temp, pulse, and room temperature, and the readings are broadcast to a thing speak server, which can be viewed through the use of the internet from all over the globe. An Arduino code is written in the Embedded C language, and it relays data about the patient's health condition to a server. With proper identification, the information may be conveniently accessed online, and the patient's health state can be tracked.

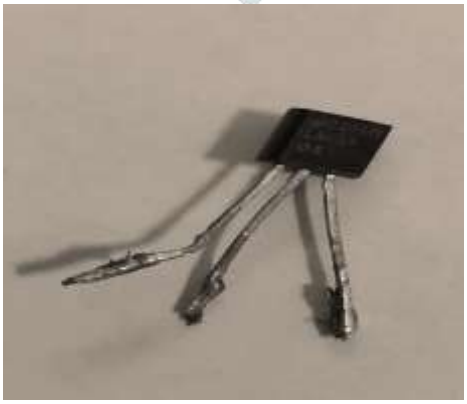
The readings are then manually entered and kept on the website in a decentralized manner. We set up a workspace in which we received ten blocks of Ethereum. Each block contains 100 Ethereum coins. The Metamask wallet plugin is linked to the Ethereum currency and stores the data. A Metamask plugin is for adding any test network. Ganache serves as our Ethereum wallet in our case. We link it and gain access to Ethereum blocks in order to store data and run smart contracts. To execute a smart contract, we used Solidity Language. The smart contract is linked to the JavaScript files, which is connected to the website.

The following are the various system requirements:

ARDUINO -

Figure 2 - Arduino Microcontroller

The Arduino Microcontroller has a USB interface, six analog pins, and fourteen digital I/O interfaces for linking to certain other electronic gadgets. PWM output is possible on six of the 14 I/O ports. It enables developers to engage with and experience external electronic tools in the reality. It's an open-source framework, which indicates the circuits and software are gratis to use, and anyone may tweak and modify the devices for greater performance. Development Environment (IDE) is the software used to programme Arduino gadgets, and it is available for free download and also use. It really does, however, necessitate some fundamental understanding. C and C++ are two languages that can be used to design it.



LM35 -

Figure 3 - LM35 Temperature Sensor

The LM35 sensor, an IC sensor that employs an analogue output equal to temperature to sense the temperature, was used to obtain temperature measurements. The LM35 is a precision temperature sensor that produces a voltage related to the temperature in Celsius. Because it does not require removing a large constant voltage from the output value to obtain the Celsius value, the LM35 surpasses linear temperature readings with Kelvin calibration. The LM35 sensor's distinguishing characteristics make it simple to interface with any sort of circuit.

DHT11 -

Figure 4 - Humidity And Temperature Sensor

The DHT11 is an inexpensive digital thermometer and humidity sensor. This sensor seamlessly connects to any microcontroller, such as an Arduino or a Raspberry Pi, and tracks humidity and temperature on a real-time basis. The DHT11 Temperature & Humidity Sensor is comprised of a humidity and temperature sensor complex with a calculated digital signal output. Its ground-breaking digital signal receiving area, as well as temperature and moisture monitoring technologies, give exceptional dependability and brief sustainability. This sensor interfaces with a high-performance 8-bit microcontroller and combines a resistive-type measuring unit with an NTC temperature measuring component, leading to great quality, quick response, anti-interference capability, and expenditure.

PULSE SENSOR -

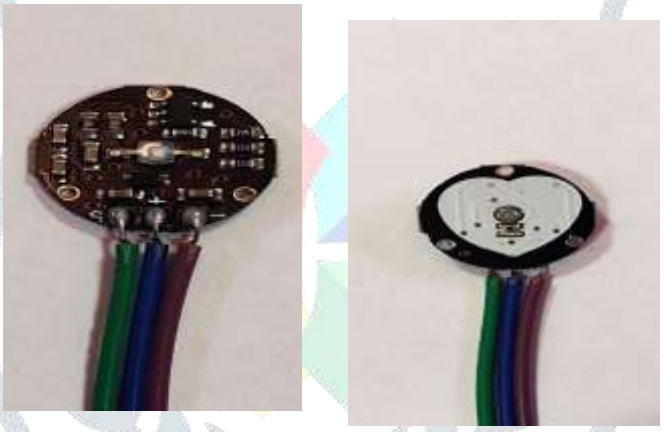


Figure 5 - Pulse Sensor

The Pulse Sensor Amped is a heart-rate sensor that is Arduino-compatible. Learners, artist, athletes, innovators, and app and phone builders that wish to leverage real heart-rate statistics in their work can use it. It combines a basic electrical heart sensor with amplification and sound cancellation capabilities to easily and accurately deliver reliable pulse measurements. It also draws relatively minimal power at 5V, using only 4mA, making it perfect for mobile applications. Attach the Pulse Sensors to your ear or fingertip and power it with a 3 *or *5 Volt battery.

MQ135 -

Figure 6 - MQ135 Sensor

The MQ-135 Gas Sensors are used to detect ammonia (NH3), Sulphur (S), benzene (C6H6), CO2, and other harmful gases and smoke. Like the other MQ series gas sensors, this sensor offers a digital and analogue output pin. When the level of these gases in the air exceeds a preset limit, the digital pin swings high. The onboard potentiometer can be used to set the threshold value. The analogue output pin generates an analogue output that can be used to assess gas concentrations in the atmosphere. The MQ135 air quality sensor module is powered by 5 volts and requires around 150mA. The MQ135 has been a well gas sensor from the MQ series that is commonly used in air quality control systems. It can generate both digital and analogue signals and operates between 2.5 volts and 5.0 volts.

ESP-01 -

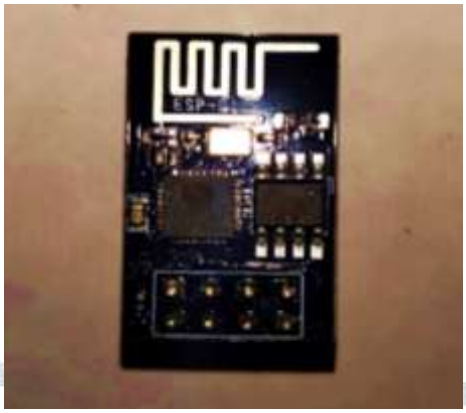


Figure 7 - ESP-01 WIFI Module

The ESP-01 is a Wi-Fi service that enables an Arduino to easily connect to a Wi-Fi connection. It incorporates an antennas switch, a radiofrequency balun, a power amplifier, a low noise reception amplifier, and a power executive, making it one of the industry's most extensively used Wi-Fi chips. We're using this microcontroller with a Wi-Fi module to broadcast sensor data to the ThingSpeak webserver, allowing doctors to view the patient at any time and from any location by simply inputting their credentials.

METAMASK

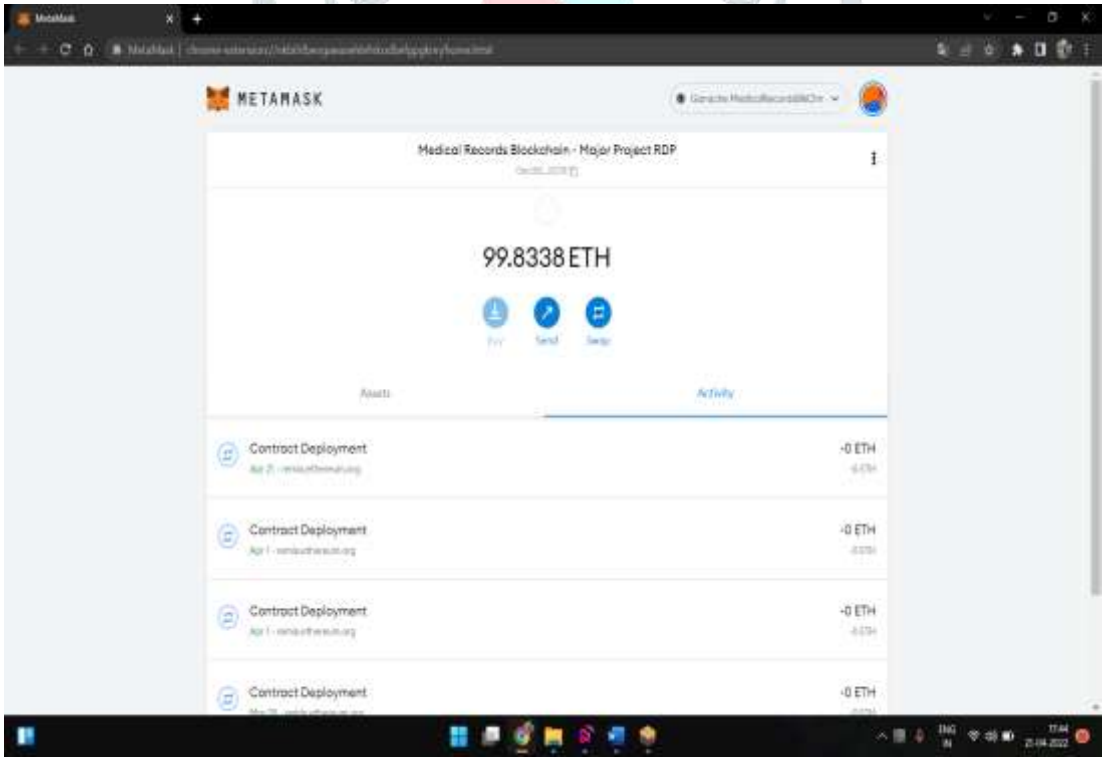


Figure 8 - Metamask Wallet

Metamask is a crypto wallet that connects to Ethereum via software. It grants members access to their Eth wallet through a plugin or mobile app, which they will use to connect to decentralized applications. Metamask was invented by ConsenSys Software Inc., a blockchain software company focused on Ethereum-based tools and infrastructure. Users can use Metamask to securely connect to decentralized applications, manage and store account keys, broadcast transactions, transfer and receive Ethereum-based coins and tokens, and securely connect to decentralized applications using a suitable web browser or the smartphone application's built-in website. Developers integrate Metamask into their decentralized applications by defining interactions between Metamask and Smart Contracts using a JavaScript plugin such as Web3js or Ethers.

GANACHE -

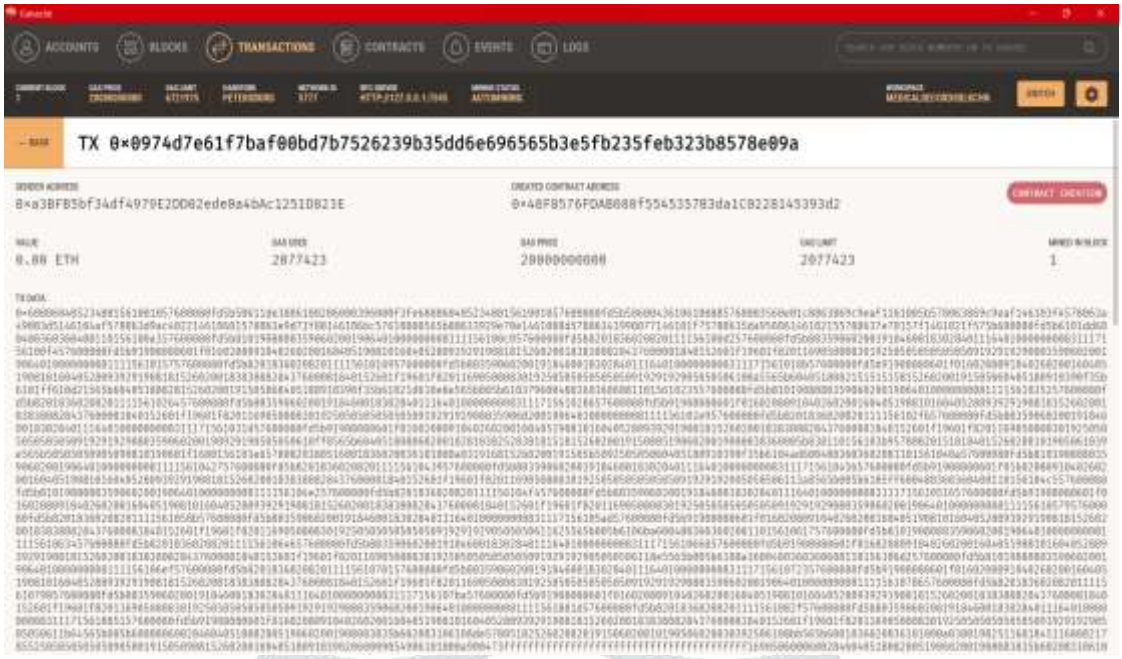


Figure 9 - Hash Code And Generated Output From Metamask Plugin

Ganache is used to build a personal Ethereum Blockchain for testing Solidity contracts. In our project, we are going to use our workspace named - MEDICALRECORDSBLKCHN.

VI. RESULT -

As the title suggests, the result of a Blockchain-Enabled IoT-Based Intelligent Health - monitoring System is extremely beneficial to both patients and doctors. Patients can monitor their health status from the comfort of their own homes at any time, and visit hospitals only when absolutely necessary. This can be achieved by utilizing our technology, the results of which are made available online and can be accessed from anywhere in the world. Because it is a prototype model, our system displays near-real-time values of numerous health parameters and simulates how they might be applied in the actual world. The main objective of the experiment is to give four-factor output and to store data in a decentralized manner. All the individual IOT components i.e., Arduino Uno, Temperature sensor (LM35), Room Temperature and Humidity sensor (Dht11), Pulse sensor, Air quality index (MQ135) and ESPO1 gave out the intended result. Throughout the project, it was observed that almost all of the circuit components employed in the remote healthcare monitoring system are easily accessible and cost-effective. Body Temperature and pulse rate will be displayed on the Thing speak server. Blockchain Database is executed on the Remix Ethereum IDE with Metamask plugin, ganache truffle suite, WEB3 which is manually entered with the Webpage developed by html5 / CSS. In a circumstance like a coronavirus outbreak, this approach could be extremely useful for doctors and patients as well.

Figure 10 - ThingSpeak Web Server Patient's Readings.

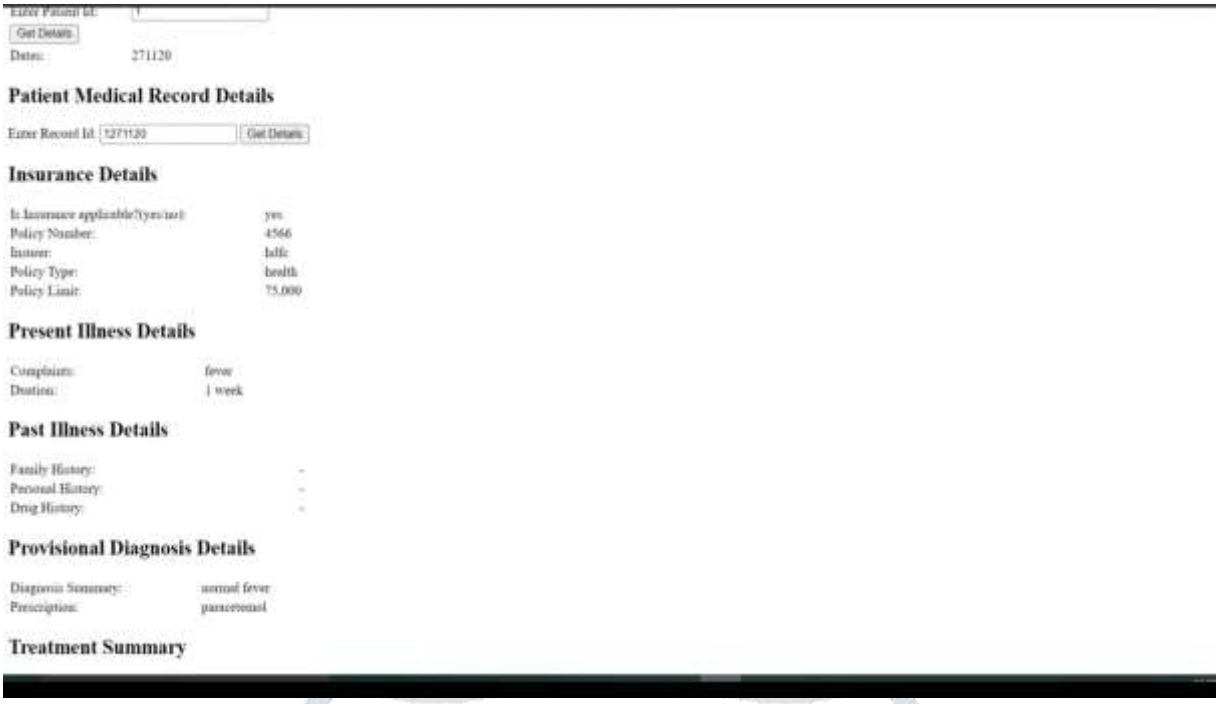


Figure 11 - Medical Website For Storing Patient Details

VII. CONCLUSION AND FUTURE SCOPE

We present and illustrate a concept for an autonomous system which assures surveillance of numerous health indices, allowing patients to avoid the agony of numerous medical visits. The proposed technology allows for the collecting and storing of large volumes of data in a database, which can be further utilized in hospitals. The findings can also be obtained from a mobile device via a website. The method can be enhanced even more by incorporating artificial intelligence components to assist doctors and patients. In future, a chatbot might be implemented to assist users with their doubts about whatever they are unsure about.

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