Ensuring Drug Safety and Exposing Counterfeit Drugs Using Blockchain and Iot

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***Abstract*—The increase in the work stress and decrease in the time for oneself has led to the rise in the dependency on the medicines and drugs. The drugs and medicines are the key sources for saving the human life when the patient is in the danger. In order to maintain regular and quality supply of the drugs and medicines has to monitor on the regular basis. There are numerous medicines and drugs brought in the store but usually drugs and medicines are stolen to satisfy one's greed, get expired or placed at unknown locations in the store. So to prevent such situation and saving the life of the patient Drug and Medicine Monitoring Model can be used. The model uses the RFID and IoT technology in order to monitor the drugs and medicines in the store. With the help of this system the chemist or the hospital will have the knowledge of the medicines and drugs available, the medicines and drugs quality, their location and their safety.**

1. INTRODUCTION

The project titled ″Ensuring Drug Safety and Exposing Counterfeit Drugs Using Blockchain and IoT″ represents a transformative approach to enhancing the security, transparency, and efficiency of the pharmaceutical supply chain. Counterfeit drugs continue to be a pressing global health issue, infiltrating legitimate distribution channels and exposing millions of people to harmful or ineffective treatments. These fake medications not only undermine patient health and safety but also erode public trust in healthcare systems and pharmaceutical companies. Recognizing the need for a robust solution, this project proposes an integrated technological framework that combines the decentralized transparency of Blockchain with the real-time responsiveness of edge computing and IoT (Internet of Things) devices. The goal is to create a system that can not only trace the origin and journey of every drug in the supply chain but also actively monitor the conditions under which these drugs are stored and transported, ensuring that they reach the end-user in a safe, effective state.

1.1 OBJECTIVE

The objective of the project "Ensuring Drug Safety and Exposing Counterfeit Drugs Using Blockchain and IoT is to enhance the pharmaceutical supply chain by integrating blockchain technologies. The goal is to address the widespread issue of counterfeit drugs, which pose significant health risks. By utilizing blockchain, the project aims to create a transparent and immutable ledger to track and verify the authenticity of drugs at every stage of the supply chain. Additionally, along with IoT devices like RFID and temperature sensors, will provide real-time monitoring of drug storage conditions, ensuring that medications are stored under optimal conditions and anomalies are detected immediately. Ultimately, the project seeks to improve patient safety, build public trust, and contribute to a healthier society by preventing counterfeit drugs from reaching consumers.

2. EXISTING SYSTEM

Health is the highest priority for any person in the world and if there is any problem with the health then medicines and drugs act as the rescuer for the patients. The drug store comes into role when the person is provided with the list of medicines and drugs that has to be bought to save the life of the patient. There are situations when the government drug stores or the other drug store is provided with the medicines and drugs by the company but for the personal greed they do not sell the medicine, or there

are situations when the medicines and drugs are stolen, expired or don't know where they are kept. Presently, there is no proper management of the drugs and medicines. The users don't have the knowledge where the medicines or drugs are kept, their expiry date or quality. Moreover, many costly drugs and medicines are not given by the chemist or stolen in order to gain the monetary funds. So, to avoid such situations Drug and Medicine Monitoring model is used.

3. PROPOSED SYSTEM

The medicines and drugs are brought in the store then they are labeled with the RFID tags so that the information related to its expiry date, their location and others are stored in the database. Similarly, the sensors are like temperature sensor, light intensity sensor and others are placed in the drug store so that the person related to the drug
store has the entire information related to the drug store. In the case of emergency that when the medicines are out of stock or when the theft is taking the notification is sent to the owner using the SOS technology. The notification sent and the entire data related to the drug is also uploaded on the cloud using IoT.

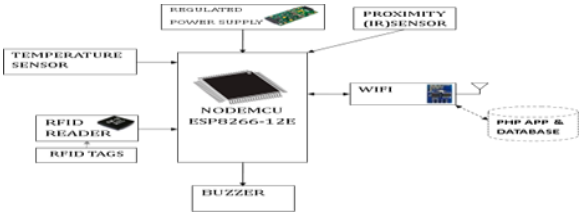

FIG: 3.1 PROPOSED BLOCK DIAGRAM

This system is based on Node MCU ESP8266-12E, which is a popular Wi-Fi-enabled microcontroller. It connects and controls several components:

1. Regulated Power Supply:
Provides stable voltage to the entire circuit, especially to the Node MCU and sensors.
2. IR Sensor:
Detects if someone or something is nearby. Sends a signal to the Node MCU when it senses proximity.
3. Temperature Sensor:Measures the temperature. Sends the temperature data to the Node MCU for processing or uploading.
4. RFID Reader:
Reads RFID tags (cards). Sends the unique ID of the RFID tag to the Node MCU.
5. RFID Tags:
These are small devices/cards containing data that can be read by the RFID reader
6. NodeMCU ESP8266-12E:
The main controller of the system. Collects data from sensors and the RFID reader. Makes
decisions based on the received inputs (like activating the buzzer or sending data online).
7. Buzzer:
It is triggered by the Node MCU to make a sound, possibly for alerts or confirmations (like successful RFID scan or proximity detection).
8. Wi-Fi Module (in-built in Node MCU):
Sends the collected data to a PHP Application hosted on a server via Wi-Fi.
9. PHP App (Server + Database):
Receives the data (like RFID ID, temperature, proximity detection) sent by the Node MCU. Stores or processes the data for further actions like attendance tracking, monitoring, etc.

SYSTEM ARCHITECTURE

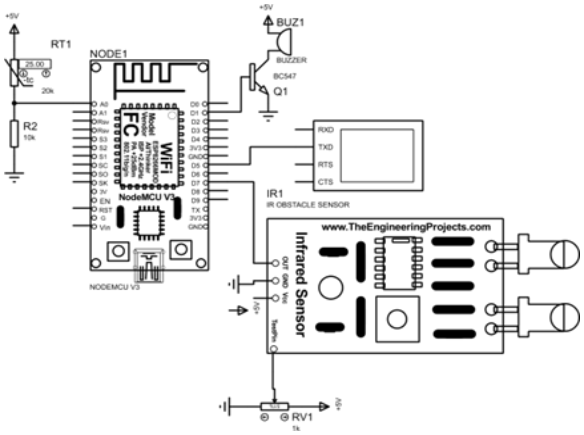

FIG 3.2: CIRCUIT DIAGRAM OF HARDWARE COMPONENTS LIKE IR SENSOR, NODEMCU, BUZZER

The given circuit diagram illustrates an IoT-based monitoring system built around a NodeMCU V3 (ESP8266 Wi-Fi module), capable of detecting temperature variations and obstacle presence. The temperature sensing part is handled by an NTC thermistor (RT1), which changes its resistance based on the surrounding temperature. Together with a fixed resistor (R2, 10kΩ), it forms

a voltage divider network. The output voltage of this divider, which varies with temperature, is fed into the analog input pin (A0) of the NodeMCU. The NodeMCU continuously reads and processes this analog signal to determine the temperature. For obstacle detection, an Infrared (IR) sensor module (IR1) is used, interfaced through a digital I/O pin of the NodeMCU. This IR sensor module contains an IR transmitter and receiver pair and outputs a digital signal indicating the presence or absence of obstacles. A potentiometer (RV1) connected to the IR sensor allows for sensitivity adjustment, making it possible to detect obstacles at different distances.

Whenever the NodeMCU detects a temperature rise beyond a preset threshold or the presence of an obstacle, it activates a buzzer (BUZ1) to provide an audible alert. Since the NodeMCU's I/O pins cannot directly drive the buzzer (due to limited current output), a BC547 NPN transistor (Q1) is used as a switch. The NodeMCU provides a control signal to the base of the transistor, allowing a higher current to flow from the +5V supply to the buzzer, thus turning it on. Moreover, the system is designed to be IoT-enabled: the NodeMCU can connect to a Wi-Fi network and upload temperature and obstacle detection data to a remote server or cloud platform, enabling real-time remote monitoring and alerting. This design ensures efficient monitoring of environmental conditions and physical intrusions, making it suitable for applications like smart boxes, warehouse security, and environmental monitoring systems.

3.1 BLOCKCHAIN

The Blockchain is a distributed database of records of all transactions or digital events that have been executed and shared among participating parties. Each transaction is verified by the majority of participants of the system.It

contains every single record of each transaction. Bitcoin is the most popular cryptocurrency an example of the Blockchain. Blockchain Technology first came to light when a person or group of individuals name 'Satoshi Nakamoto' published a white paper on "*BitCoin: A peer-to- peer electronic cash system*" in 2008. Blockchain Technology Records Transaction in Digital Ledger which is distributed over the Network thus making it incorruptible. Anything of value like Land Assets, Cars, etc. can be recorded on Blockchain as a Transaction.

FIG: 3 Pharmaceutical supply chain workflow and areas impacted by Blockchain

A node is a computer connected to the Blockchain Network. Node gets connected with Blockchain using the client. The client helps in validating and propagating transactions onto the Blockchain. When a computer connects to the Blockchain, a copy of the Blockchain data gets downloaded into the system and the node comes in sync with the latest block of data on Blockchain. The Node connected to the Blockchain which helps in the execution of a Transaction in return for an incentive is called Miners.

3.2 INTERNET OF THINGS (IoT)

IoT stands for Internet of Things. It refers to the interconnectedness of physical devices, such as appliances and vehicles that are embedded with software, sensors, and connectivity which enables these objects to connect and exchange data. This technology allows for the collection and sharing of data from a vast network of devices, creating opportunities for more efficient and

automated systems. Internet of Things (IoT) is the networking of physical objects that contain electronics embedded within their architecture in order to communicate and sense interactions amongst each other or with respect to the external environment. In the upcoming years, IoT-based technology will offer advanced levels of services and practically change the way people lead their daily lives. Advancements in medicine, power, gene therapies, agriculture, smart cities, and smart homes are just a few of the categorical examples where IoT is strongly established.

IOT is a system of interrelated things, computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers. And the ability to transfer the data over a network requiring human-to-human or human-to-computer interaction.

3.3 ADVANTAGES

- Real-time Monitoring: Implementing a system that continuously monitors the status of drugs, including their location, temperature, and proximity to unauthorized access points, ensuring that they are stored and transported under optimal conditions.
- Blockchain Integration: Utilizing Blockchain technology to create an immutable ledger for drug transactions and status updates, ensuring transparency and traceability from manufacturer to consumer. This will help to authenticate drug provenance and prevent the introduction of counterfeit products into the supply chain.
- Data Accessibility: Developing a user- friendly interface that allows stakeholders— such as manufacturers, distributors, pharmacists, and consumers—to access real- time data on drug status, enabling informed

decision-making and immediate action in case of anomalies.

- Alerts and Notifications: Implementing an alert system that notifies stakeholders of any breaches in storage conditions (e.g., temperature fluctuations) or unauthorized access attempts, thus enhancing the overall security of the drug supply chain.
- Scalability and Flexibility: Designing a scalable architecture that can adapt to various types of pharmaceuticals and can be easily integrated into existing supply chain processes, thereby increasing the overall efficiency and effectiveness of drug management.

4. SYSTEM REQUIREMENTS

4.1 Hardware Requirements

The minimum RAM required for the system is 2GB. The processor should be Intel Core i5 or above to ensure optimal performance. A minimum of 2GB of free hard disk space is necessary for software installation and operations. The display should support a screen resolution of 1024 x 768 or higher. In addition to these, hardware components such as the ESP8266 microcontroller and a stable power supply unit are essential for interfacing and embedded operations.

4.2 Software Requirements

The system must run on Windows 7 or a later version of the Windows operating system. For simulation and backend services, Arduino IDE is used along with the web framework. Microsoft Office is used for documentation purposes throughout the development process.

5. RESULT ANALYSIS

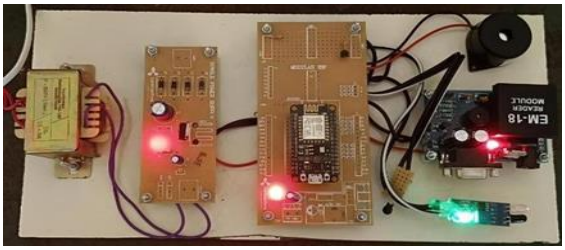

FIG 4.1: PROJECT ON ACTIVE STATE

FIG 4.2: LOGIN PAGE

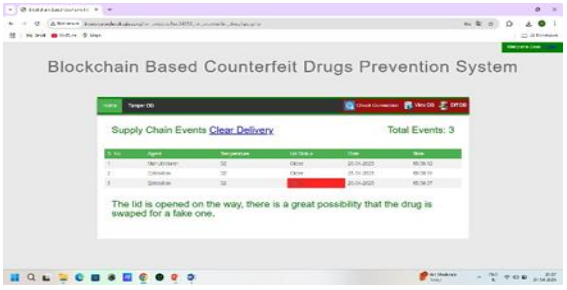

FIG 4.3: INTERFACE PAGE

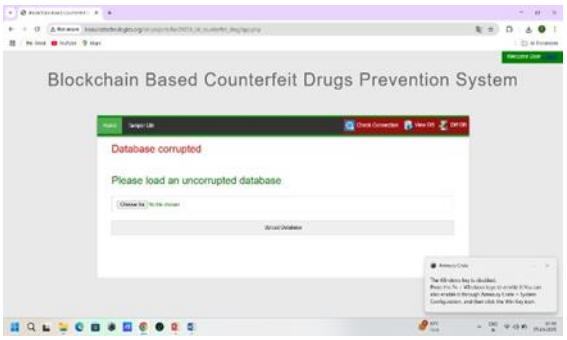

FIG 4.4: DATABASE CORRUPTED PAGE

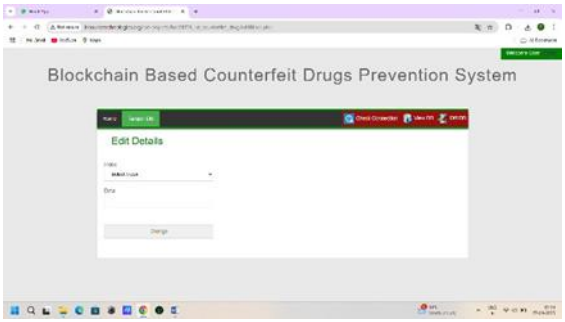

FIG 4.5: EDIT DETAILS PAGE

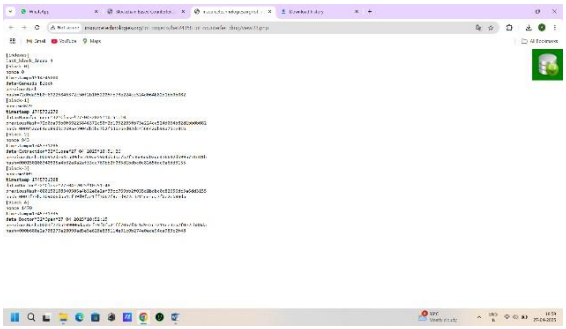

FIG 4.6: DATA DETAILS PAGE

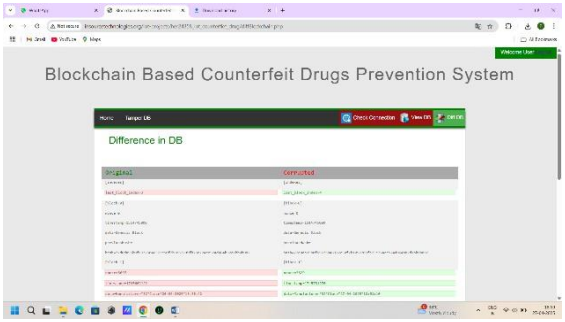

FIG 4.7: DIFFERENCE IN DATABASE PAGE

7. CONCLUSION

In conclusion, the integration of Blockchain and edge computing technologies, reinforced by a robust network of IoT devices, presents a comprehensive and future-ready solution to the global crisis of counterfeit drugs. This system enhances the pharmaceutical supply chain by ensuring end-to-end traceability, real-time environmental monitoring, and automated compliance enforcement. Ultimately, this innovation restores public confidence in the safety and authenticity of pharmaceuticals, strengthens regulatory oversight, and fosters a more resilient and transparent healthcare ecosystem As the pharmaceutical industry continues to evolve, adopting such advanced technologies will be essential to protecting patient health and maintaining the integrity of life-saving medical treatments worldwide.

7.1 FUTURE ENHANCEMENT

1. Integration with AI for Predictive Analytics

Future work can focus on integrating AI with Blockchain and IoT to analyze supply chain data and predict risks of counterfeit activity or drug spoilage before it occurs.

2. Interoperability with Global Healthcare Systems

Develop solutions that enable cross- border interoperability between different countries' drug regulation systems, using standardized Blockchain protocols.

3. Smart Contracts for Regulatory Compliance

Design smart contracts that automatically enforce compliance with FDA, WHO, and other drug safety regulations, reducing manual auditing effort.

4. Energy-efficient IoT Devices

Explore low -power, long-range IoT devices optimized for rural or resource-constrained environments where counterfeit drugs are more prevalent.

5. Public-Private Collaboration Frameworks

Propose collaborative models between governments, pharma companies, and tech providers to adopt and fund Blockchain-IoT systems for drug safety.

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