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Water Quality Monitoring System Using Cloud and Blockchain

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ABSTRACT

The proposed Water Quality Monitoring System stores real time sensor data in the cloud and provides a secure and transparent verification mechanism using blockchain and QR (Quick Response)codes. IoT sensors continuously measure parameters such as pH and Turbidity .These readings are first uploaded to a cloud server, where they are stored and processed for visualization. Cloud storage ensures fast access, scalability, and easy integration with monitoring dashboards.

To prevent data tampering, each reading stored in the cloud is converted into a unique cryptographic hash, which is recorded on a blockchain network. Since blockchain records cannot be altered, the authenticity of any reading can be verified at any time. The system generates a QR code for every water-quality entry; when the user scans the QR code, they can instantly view the original reading along with its blockchain verification status. The backend recomputes the hash of the stored data and compares it with the hash stored on-chain, ensuring integrity and transparency.

This combination of cloud computing, blockchain security, and QR- code based verification makes the system highly trustworthy, user-friendly, and suitable for environmental monitoring, smart cities, and water-treatment facilities.

1.INTRODUCTION

Water quality monitoring is essential for environmental protection, public health, and efficient water-management systems. Traditional monitoring methods often face issues such as manual data handling, delayed analysis, and the risk of data manipulation. To overcome these limitations, modern technologies like IoT, cloud computing, and blockchain are being integrated to create smarter, trustworthy monitoring solutions.

In this project, IoT sensors continuously measure water-quality parameters such as pH, turbidity . The collected data is first uploaded to a cloud platform, which stores and displays real- time readings for easy access. To ensure the security and authenticity of the data, each reading is converted into a cryptographic hash and stored on a blockchain network. Since blockchain records cannot be altered, it guarantees that the data remains tamper-proof. Additionally, a QR code is generated for every reading, allowing users to scan and instantly verify the data with its corresponding blockchain record. This ensures transparency, trust, and quick public verification.

1.1.OBJECTIVES :

The primary objective of this work is to develop an IoT-based system capable of measuring key water-quality parameters, including pH and turbidity using appropriate sensors. The system continuously collects real-time data and stores it on a cloud platform to enable easy access, visualization, and analysis. To ensure data security and integrity, each sensor reading

is processed to generate a cryptographic hash, which is then recorded on a blockchain network. The immutability and transparency of blockchain technology help prevent data tampering and ensure trustworthy record-keeping. Additionally, QR codes are generated for every stored data entry, allowing users to quickly verify and validate the readings by cross-checking with the blockchain records. Overall, the system is designed to be scalable, reliable, and suitable for practical deployment in water-quality monitoring applications.

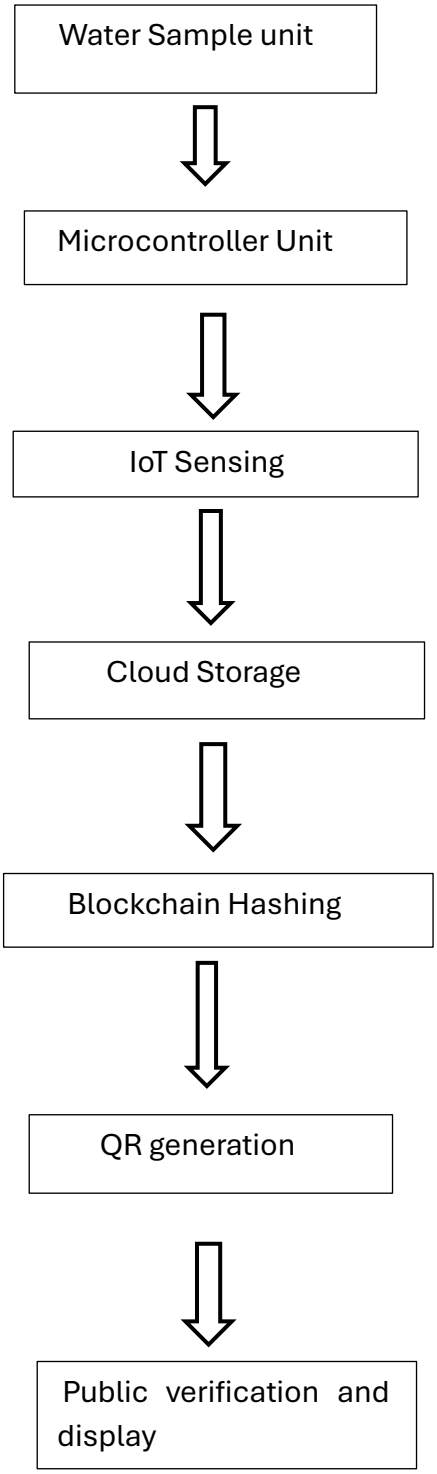
2.PROPOSED SYSTEM

The proposed system provides a simple, transparent, and reliable method for verifying water quality by integrating IoT technology, cloud storage, blockchain-based data protection, and QR-code accessibility. In this system, water samples collected at bottling units or municipal storage points are analyzed using IoT sensors that measure essential parameters such as pH, turbidity, and temperature. All sensor readings are automatically uploaded to a secure cloud database along with the corresponding batch ID, date, time, and testing location. To maintain data integrity and prevent tampering, a cryptographic hash value is generated for each reading and stored on a blockchain network.

After the testing process is completed, the system generates a unique QR code linked to the stored data of that batch. This QR code is either printed on the water bottle or displayed at distribution points. When scanned using any smartphone, the QR code retrieves real-time water-quality details from the cloud, including parameter values, test timestamps, and a user-friendly safety indicator—Green for Safe, Yellow for Caution, and Red for Unsafe.

By integrating IoT-based sensing, secure cloud storage, blockchain verification, and QR-enabled public access, the proposed system ensures batch traceability, accountability, and complete transparency in water-quality monitoring. This end-to-end workflow—from IoT sensors to cloud storage, blockchain hashing, and QR-based public access—enhances security, builds consumer trust, and supports reliable water-quality verification.

2.1 BLOCK DAIGRAM



3.WORKING

Collecting Data and Cloud Storage

The ESP32 microcontroller is connected to pH and turbidity sensors to measure the water quality in real time. The ESP32 reads these sensor values and sends them to the ThingSpeak cloud using Wi-Fi. The cloud dashboard displays the live readings along with the date, time, and batch ID. This confirms that the system is correctly collecting the water-quality data and storing it safely in the cloud.

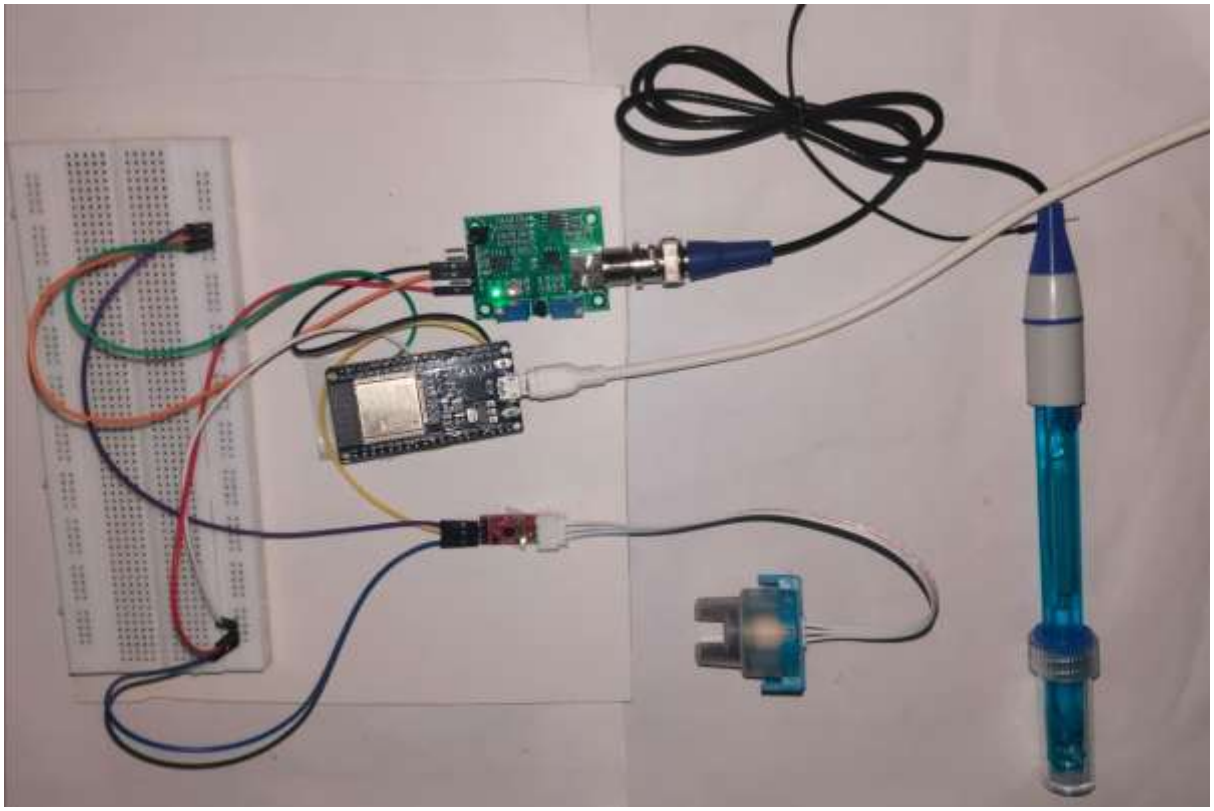
Blockchain Hashing

A Python program is used to fetch the stored sensor values from the ThingSpeak cloud. For every batch of readings, the program creates a unique cryptographic hash. This hash is then uploaded to the Sepolia blockchain through the Alchemy

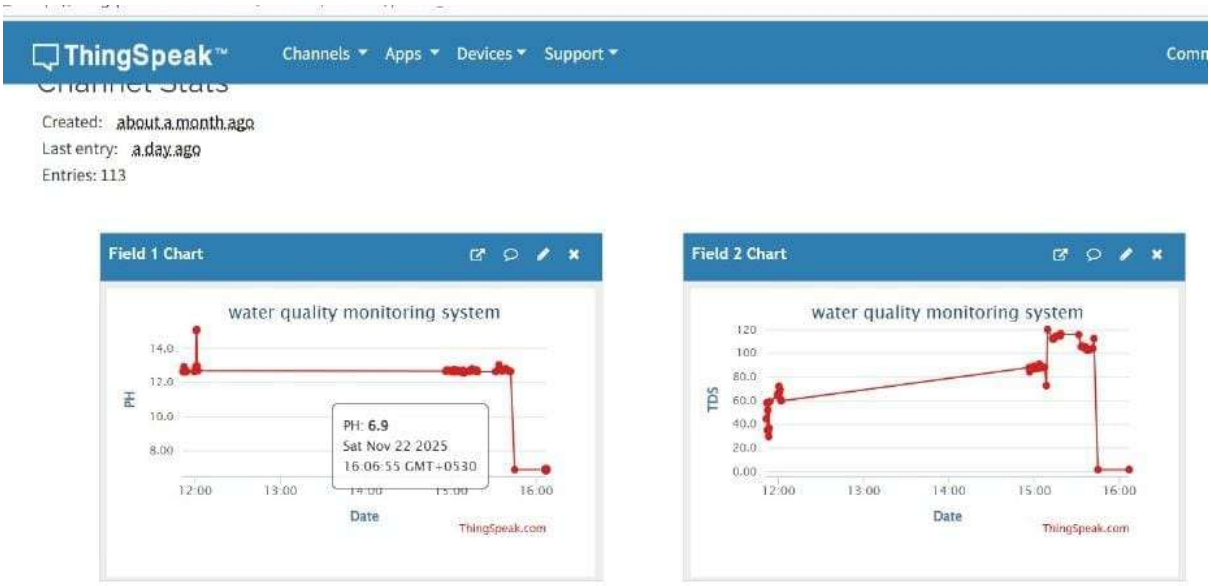
API. The blockchain transaction ID shows that the data has been recorded permanently. Since blockchain entries cannot be changed, this ensures that the water-quality data is tamper-proof.

QR Code Generation and Access

A QR code is generated using Google Colab and linked to the cloud data of each batch. When the QR code is scanned using a smartphone, it displays all the water-quality details such as pH, turbidity, timestamp, and batch information. It also shows a color-coded safety status—Green for Safe, Yellow for Caution, and Red for Unsafe. This makes the system easy to use and fully transparent for the public.



OUTPUT:


ThingSpeak™
Channels
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Field 2 Chart
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ThingSpeak™
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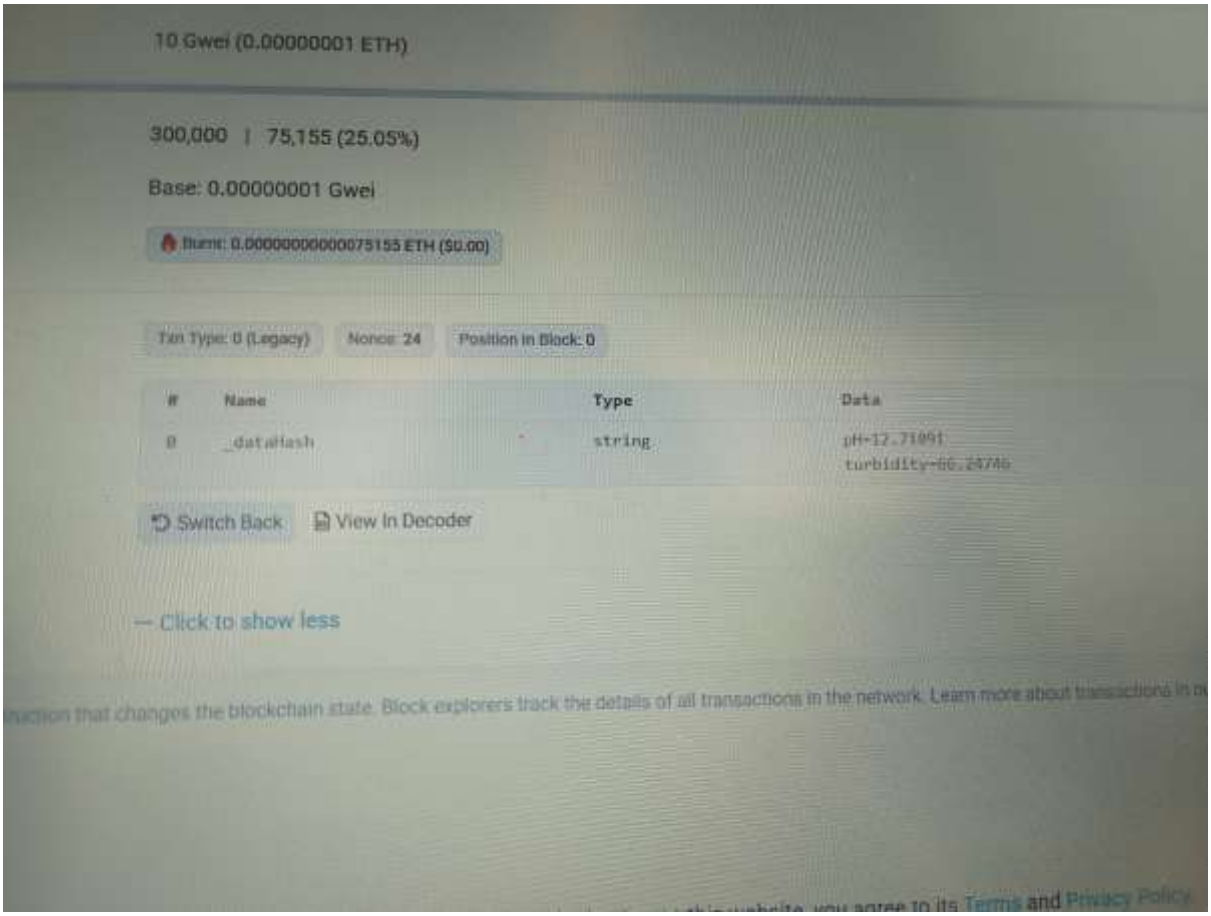
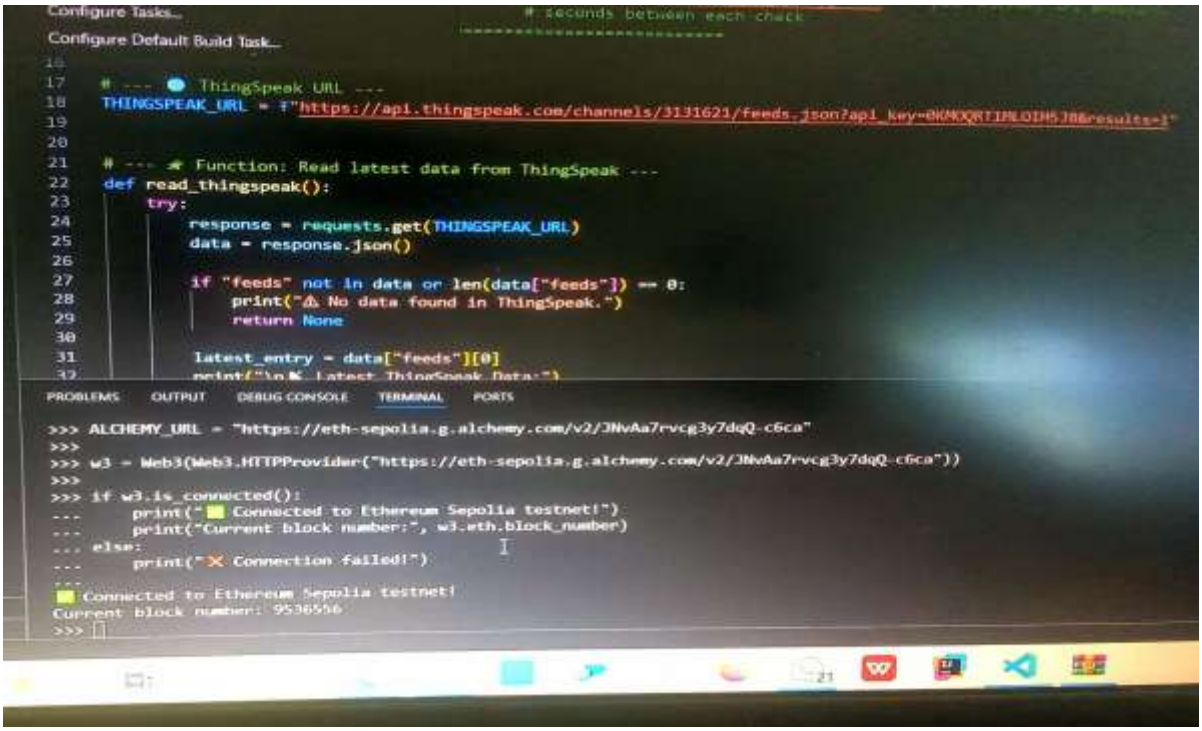

10 Gwei (0.00000001 ETH)
300,000 | 75,155 (25.05%)
Base: 0.00000001 Gwei
Burnt: 0.000000000000075155 ETH ($0.00)
Txn Type: 0 (Legacy)
Nonce: 24
Position in Block: 0
Name Type Data
0 _dataFlash string pH=12.71091
turbidity=66.24746
Switch Back
View In Decoder
— Click to show less
action that changes the blockchain state. Block explorers track the details of all transactions in the network. Learn more about transactions in
Terms and Privacy Policy


Configure Tasks...
Configure Default Build Task...
# seconds between each check
# --- 🔵 ThingSpeak URL ---
THINGSPEAK_URL = f"https://api.thingspeak.com/channels/3131621/feeds.json?api_key=0KMXQRTIMNLOIH5J88&results=1"
# --- 🧠 Function: Read latest data from ThingSpeak ---
def read_thingspeak():
try:
response = requests.get(THINGSPEAK_URL)
data = response.json()
if "feeds" not in data or len(data["feeds"]) == 0:
print("⚠️ No data found in ThingSpeak.")
return None
latest_entry = data["feeds"][0]
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
>>> ALCHEMY_URL = "https://eth-sepolia.g.alchemy.com/v2/JNvAa7rvcg3y7dqQ-c6ca"
>>> w3 = Web3(Web3.HTTPProvider("https://eth-sepolia.g.alchemy.com/v2/JNvAa7rvcg3y7dqQ-c6ca"))
>>> if w3.is_connected():
print("✅ Connected to Ethereum Sepolia testnet!")
print("Current block number:", w3.eth.block_number)
... else:
print("❌ Connection failed!")
✅ Connected to Ethereum Sepolia testnet!
Current block number: 9536556

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