RV COLLEGE OF ENGINEERING

BENGALURU- 560059

(Autonomous Institution affiliated to VTU, Belagavi)

DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING

"Web 3.0 Real Estate App"

BLOCKCHAIN TECHNOLOGY AND USE CASE (18IS7F2)

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Submitted by

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CERTIFICATE

Certified that the work titled **"Web 3.0 Real Estate App"** has been carried out by **Aryan Wani** (1RV20IS012), bona fide students of RV College of Engineering, Bengaluru, have submitted in partial fulfillment for the Assessment of Course: **Blockchain Technology and Use Case (18IS7F2) – Experiential Learning** during the year 2023-2024. It is certified that all corrections/suggestions indicated for the internal assessment have been incorporated in the report.

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ABSTRACT

The Web 3.0 Real Estate Application presented in this abstract is a groundbreaking platform that integrates advanced technologies from the next generation of the web to transform the real estate industry. Embracing the principles of Web 3.0, or the Semantic Web, the application enhances data understanding and interoperability through semantic data integration. By leveraging blockchain technology, the platform decentralizes property listings, ensuring transparency and security in transactions through the use of smart contracts.

Smart contracts are utilized for escrow services, ensuring secure and automated payment releases upon the fulfillment of predefined conditions, thereby reducing the risk of fraud. The platform also introduces tokenization for real estate investments, allowing fractional ownership and providing users with greater liquidity and accessibility to real estate investments. In essence, this Web 3.0 Real Estate Application represents a significant shift in the industry, offering a more transparent, efficient, and user-centric platform through the convergence of semantic technologies, decentralized systems, artificial intelligence, and immersive experiences.

TABLE OF CONTENTS

Chapter 1
INTRODUCTION

The Web 3.0 Real Estate Application introduces a revolutionary approach to the real estate industry, leveraging cutting-edge technologies such as blockchain, decentralized finance (DeFi), and smart contracts to redefine property transactions. Built on the pillars of Web 3.0, this platform offers users an unprecedented level of transparency, security, and efficiency in real estate dealings. Central to the application's functionality is the use of blockchain technology, specifically Ethereum, with tools like Hardhat and MetaMask. Hardhat, a development environment for Ethereum, streamlines smart contract development and testing, ensuring robust and secure code. MetaMask, a popular Ethereum wallet, provides users with a seamless and secure way to interact with the decentralized application, enhancing the user experience and fostering widespread adoption.

The platform utilizes Solidity, a programming language designed for smart contracts on the Ethereum blockchain. Solidity enables the creation of self-executing contracts with predefined rules and conditions, facilitating trustless and automated property transactions. Through the implementation of smart contracts, the application eliminates intermediaries, reduces the risk of fraud, and expedites the overall real estate process.

Decentralization is a cornerstone of this Web 3.0 Real Estate Application. By leveraging blockchain and smart contracts, property listings become tamper-proof and transparent, ensuring an immutable record of transactions. This not only enhances security but also instills a high level of trust in the real estate ecosystem.

The integration of decentralized finance principles enables tokenization of real estate assets. Users can engage in fractional ownership, breaking down property values into tradable tokens. This democratizes access to real estate investments, providing a more liquid and accessible avenue for users to participate in property markets.

In conclusion, the Web 3.0 Real Estate Application transforms the traditional real estate landscape by embracing the power of blockchain, decentralized finance, and smart contracts. With tools like Hardhat and MetaMask, and utilizing the solidity language, the platform offers a secure, efficient, and transparent solution, setting a new standard for real estate transactions in the decentralized era.

1.1 Topic relevance

- **Immutable Ownership Records:** Blockchain ensures a secure and tamper-proof ledger of property ownership, preventing fraudulent activities and disputes.Immutability of records establishes a transparent and trustworthy history of property transactions.
- **Smart Contracts for Automated Transactions:** Smart contracts automate various real estate processes, such as property transfers, lease agreements, and payments. Automation reduces reliance on intermediaries, streamlining processes and minimizing the risk of errors.
- **Tokenization for Fractional Ownership:** Blockchain enables the tokenization of real estate assets, allowing for the creation of tradable, divisible tokens. Fractional ownership through tokens makes real estate investments accessible to a wider audience, promoting liquidity in the market.
- **Decentralized Identity Management:** Blockchain-based identity solutions enhance security and privacy by giving users control over their identities. Property-related transactions are securely linked to decentralized identities, reducing the risk of identity theft.
- **Reduced Intermediaries and Cost Efficiency:** Blockchain eliminates or minimizes the need for intermediaries in real estate transactions. By reducing the number of intermediaries, transaction costs are lowered, providing cost efficiency for buyers, sellers, and investors.

1.2 Objectives

- **Implement Decentralized Property Ownership Records:** Utilize blockchain technology to establish a decentralized and tamper-proof system for property ownership records, enhancing transparency and reducing the risk of fraudulent transactions.

- **Leverage Blockchain Transparency for Authenticity:** Leverage the immutability of blockchain to boost transparency in the real estate market. Provide consumers with awareness of authentic property details, preventing the proliferation of misinformation and fraudulent activities within the real estate ecosystem.

- **Enable Fractional Ownership through Tokenization:** Utilize blockchain tokenization to enable fractional ownership of real estate assets. By creating non-fungible tokens (NFTs) representing portions of properties, increase accessibility for a broader range of investors, fostering liquidity and diversification in the real estate market.

Chapter 2
LITERATURE SURVEY

[1] The work titled "Blockchain-based Security Mechanisms for Real Estate Transactions in Web 3.0" delves into the integration of blockchain technology to secure real estate transactions in the Web 3.0 landscape. It explores the impact of blockchain on enhancing transparency, reducing fraud, and ensuring the integrity of property records. The paper proposes practical implementations of blockchain-based security mechanisms and evaluates their effectiveness in real-world scenarios.

[2] The work titled "Decentralized Finance (DeFi) Applications in Real Estate: A Web 3.0 Perspective" focuses on the intersection of DeFi and real estate, investigating the potential of decentralized financial applications in Web 3.0 real estate platforms. It analyzes the implications of tokenization, smart contracts, and decentralized governance models on property transactions. Practical case studies and their impact on user experiences are discussed to provide valuable insights for the development of Web 3.0 real estate applications.

[3] The work titled "Integrating Artificial Intelligence for Personalized Property Recommendations in Web 3.0 Real Estate Platforms" explores the incorporation of artificial intelligence to enhance user experiences in Web 3.0 real estate applications. It investigates machine learning algorithms for personalized property recommendations based on user preferences, historical data, and market trends. The study evaluates the impact of AI-driven features on user engagement and satisfaction within the real estate ecosystem.

[4] The work titled "Smart Contracts in Real Estate: A Comprehensive Survey in the Web 3.0 Era" provides a comprehensive survey of the applications of smart contracts in real estate within the Web 3.0 framework. It analyzes the automation of property transactions, escrow services, and the potential for programmable agreements. The paper discusses challenges and opportunities in implementing smart contracts in real-world real estate scenarios.

[5] The work titled "User-Centric Design and Immersive Technologies in Web 3.0 Real Estate Applications" explores the importance of user-centric design and immersive technologies such as augmented reality (AR) and virtual reality (VR) in Web 3.0 real estate applications. It investigates how these technologies contribute to an enhanced user experience, facilitating property exploration, virtual tours, and interactive 3D visualizations. The study evaluates the impact of immersive features on user engagement and satisfaction.

[6] The work titled "Security Challenges and Mitigation Strategies in Web 3.0 Real Estate Platforms" focuses on security aspects, addressing the unique challenges faced by Web 3.0 real estate platforms. It analyzes potential vulnerabilities and threats in decentralized environments and proposes mitigation strategies. The paper explores the application of innovative defensive frameworks and evaluates their effectiveness in safeguarding real estate transactions, building upon the insights from the "An Analytical Study on Cross-Site Scripting" work.

[7] The work titled "Tokenization of Real Estate Assets: A Web 3.0 Framework for Fractional Ownership" delves into the application of tokenization in real estate within the Web 3.0 context. It explores the implications of breaking down property values into tradable tokens, enabling fractional ownership. The paper examines how tokenization enhances liquidity, accessibility, and inclusivity in real estate investments and evaluates its impact on traditional property ownership models.

[8] The work titled "Decentralized Governance Models in Web 3.0 Real Estate Platforms" focuses on the integration of decentralized governance in the context of Web 3.0 real estate applications. It explores the use of blockchain-based governance mechanisms, allowing users to actively participate in decision-making processes. The paper investigates the impact of decentralized governance on platform evolution, user engagement, and the democratization of decision authority within the real estate ecosystem.

Chapter 3

SYSTEM ARCHITECTURE AND TECHNOLOGY

3.1 Architecture Diagram

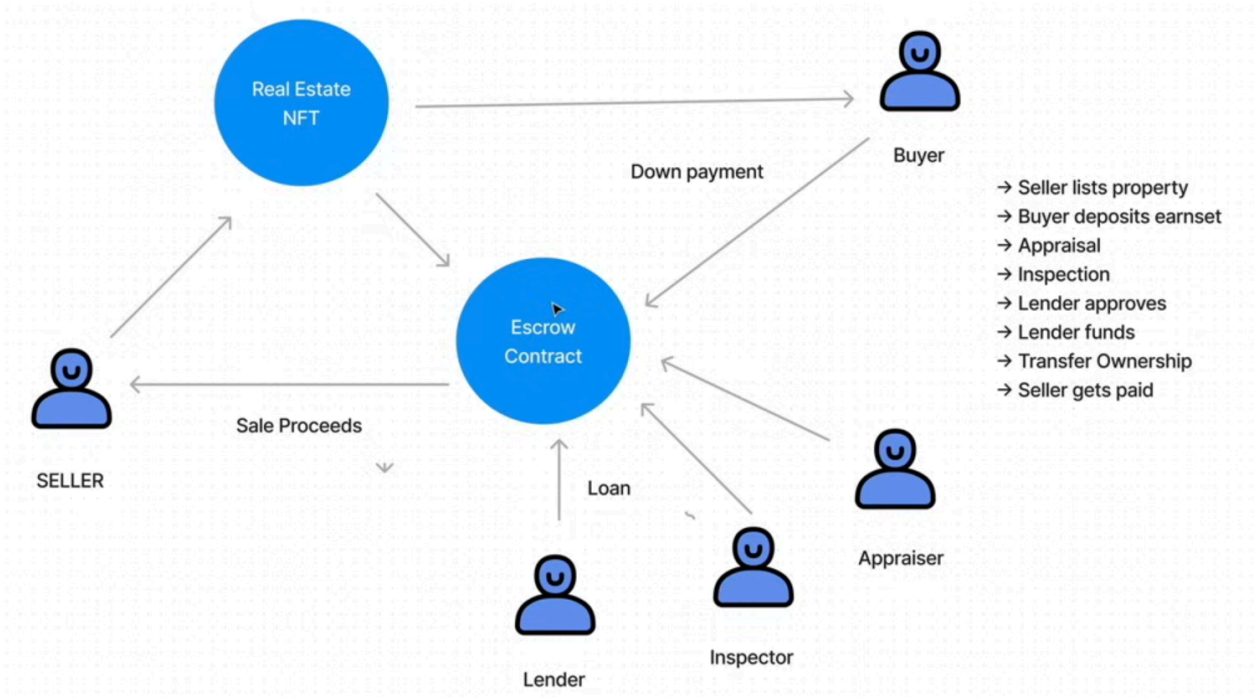

Fig 3.1 High Level Design

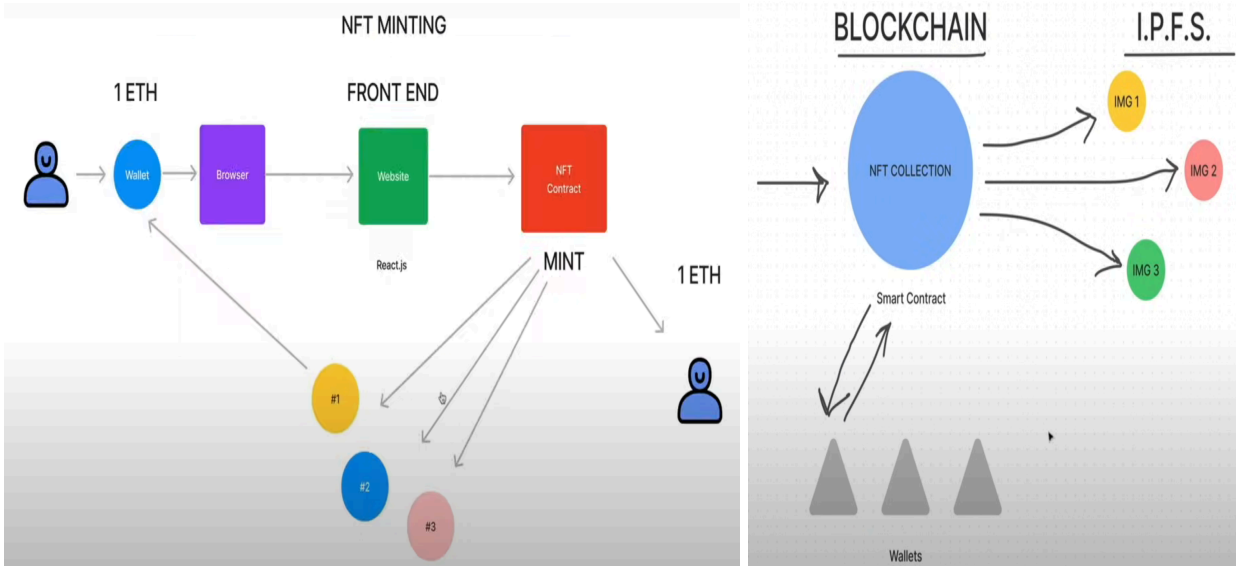

Fig 3.2 Low Level Design

3.2 Technology Used

Solidity: Solidity is a programming language specifically designed for writing smart contracts that run on the Ethereum blockchain. It is employed to create secure and tamper-proof contracts governing real estate transactions and interactions.

Ether.js: Ether.js is a JavaScript library used for interacting with the Ethereum blockchain. It provides a set of tools and utilities to connect the frontend of the application with smart contracts and the Ethereum network, enabling seamless communication.

React.js: React.js is a popular JavaScript library for building user interfaces. In the context of the Web 3.0 Real Estate Application, React.js is employed to create dynamic and responsive UI components, ensuring a smooth and engaging user experience.

Node.js: Node.js is a server-side JavaScript runtime, used to build the backend of the application. It facilitates server-side scripting, handles requests from the frontend, and interacts with the Ethereum blockchain through Ether.js.

MetaMask: MetaMask is a browser extension and mobile application that serves as a cryptocurrency wallet and allows users to interact with the Ethereum blockchain. It is integrated into the application to enable secure transactions and interactions with smart contracts.

HTML/CSS (Hypertext Markup Language/Cascading Style Sheets): HTML is employed to structure the content of the web pages within the application, and CSS is used for styling the visual elements. Together, they create a well-organized, semantic structure, and visually appealing user interface.

Hardhat: Hardhat is a development environment for Ethereum that facilitates the creation, testing, and deployment of smart contracts. It is used to ensure the robustness and reliability of the smart contract codebase.

Chapter 4

IMPLEMENTATION

4.1 Smart Contract Escrow

millow > contracts > Escrow.sol

```
//SPDX-License-Identifier: Unlicense
pragma solidity ^0.8.0;

interface IERC721 {
    function transferFrom(
        address _from,
        address _to,
        uint256 _id
    ) external;
}

contract Escrow {
    address public nftAddress;
    address payable public seller;
    address public inspector;
    address public lender;

    modifier onlyBuyer(uint256 _nftID) {
        require(msg.sender == buyer[_nftID], "Only buyer can call this method");
        _;
    }

    modifier onlySeller() {
        require(msg.sender == seller, "Only seller can call this method");
        _;
    }

    modifier onlyInspector() {
        require(msg.sender == inspector, "Only inspector can call this method");
        _;
    }

    mapping(uint256 => bool) public isListed;
    mapping(uint256 => uint256) public purchasePrice;
    mapping(uint256 => uint256) public escrowAmount;
    mapping(uint256 => address) public buyer;
    mapping(uint256 => bool) public inspectionPassed;
```

millow > contracts > RealEstate.sol

```
//SPDX-License-Identifier: Unlicense
pragma solidity ^0.8.0;

import "@openzeppelin/contracts/utils/Counters.sol";
import "@openzeppelin/contracts/token/ERC721/ERC721.sol";
import "@openzeppelin/contracts/token/ERC721/extensions/ERC721URIStorage.sol";

contract RealEstate is ERC721URIStorage {
    using Counters for Counters.Counter;
    Counters.Counter private _tokenIds;

    constructor() ERC721("Real Estate", "REAL") {}

    function mint(string memory tokenURI) public returns (uint256) {
        _tokenIds.increment();

        uint256 newItemId = _tokenIds.current();
        _mint(msg.sender, newItemId);
        _setTokenURI(newItemId, tokenURI);

        return newItemId;
    }

    function totalSupply() public view returns (uint256) {
        return _tokenIds.current();
    }
}
```

4.2 Asset Metadata

millow > metadata > {} 1.json > ...

```
{
    "name": "Luxury NYC Penthouse",
    "address": "157 W 57th St APT 49B, New York, NY 10019",
    "description": "Luxury Penthouse located in the heart of NYC",
    "image": "https://ipfs.io/ipfs/QmQUozrHLAusXDxrvsESJ3PYB3rUeUuBAvVWw6nop2uu7c/1.png",
    "id": "1",
    "attributes": [
        {
            "trait_type": "Purchase Price",
            "value": 20
        },
        {
            "trait_type": "Type of Residence",
            "value": "Condo"
        },
        {
            "trait_type": "Bed Rooms",
            "value": 2
        },
        {
            "trait_type": "Bathrooms",
            "value": 3
        },
        {
            "trait_type": "Square Feet",
            "value": 2200
        },
        {
            "trait_type": "Year Built",
            "value": 2013
        }
    ]
}
```

4.3 Create ERC 721 NFTs

millow > artifacts > contracts > Escrow.sol > {} IERC721.json > ...


```
{
  "_format": "hh-sol-artifact-1",
  "contractName": "IERC721",
  "sourceName": "contracts/Escrow.sol",
  "abi": [
    {
      "inputs": [
        {
          "internalType": "address",
          "name": "_from",
          "type": "address"
        },
        {
          "internalType": "address",
          "name": "_to",
          "type": "address"
        },
        {
          "internalType": "uint256",
          "name": "_id",
          "type": "uint256"
        }
      ],
      "name": "transferFrom",
      "outputs": [],
      "stateMutability": "nonpayable",
      "type": "function"
    }
  ],
  "bytecode": "0x",
  "deployedBytecode": "0x",
  "linkReferences": {},
  "deployedLinkReferences": {}
}
```

4.4 Metamask Integration

millow > src > components > JS Home.js > Home > fetchDetails

```
import { ethers } from 'ethers';
import { useEffect, useState } from 'react';

import close from '../assets/close.svg';

const Home = ({ home, provider, account, escrow, togglePop }) => {
    const [hasBought, setHasBought] = useState(false)
    const [hasLended, setHasLended] = useState(false)
    const [hasInspected, setHasInspected] = useState(false)
    const [hasSold, setHasSold] = useState(false)

    const [buyer, setBuyer] = useState(null)
    const [lender, setLender] = useState(null)
    const [inspector, setInspector] = useState(null)
    const [seller, setSeller] = useState(null)

    const [owner, setOwner] = useState(null)

    const fetchDetails = async () => {
        // -- Buyer

        const buyer = await escrow.buyer(home.id)
        setBuyer(buyer)

        const hasBought = await escrow.approval(home.id, buyer)
        setHasBought(hasBought)

        // -- Seller

        const seller = await escrow.seller()
        setSeller(seller)

        const hasSold = await escrow.approval(home.id, seller)
        setHasSold(hasSold)

        // -- Lender
```

4.5 Display of real estate properties on Home page

millow > src > JS App.js > ...

```
import { useEffect, useState } from 'react';
import { ethers } from 'ethers';

// Components
import Navigation from './components/Navigation';
import Search from './components/Search';
import Home from './components/Home';

// ABIs
import RealEstate from './abis/RealEstate.json'
import Escrow from './abis/Escrow.json'

// Config
import config from './config.json';

function App() {
  const [provider, setProvider] = useState(null)
  const [escrow, setEscrow] = useState(null)

  const [account, setAccount] = useState(null)

  const [homes, setHomes] = useState([])
  const [home, setHome] = useState({})
  const [toggle, setToggle] = useState(false);

  const loadBlockchainData = async () => {
    const provider = new ethers.providers.Web3Provider(window.ethereum)
    setProvider(provider)
    const network = await provider.getNetwork()

    const realEstate = new ethers.Contract(config[network.chainId].realEstate.address, RealEstate, provider)
    const totalSupply = await realEstate.totalSupply()
    const homes = []

    for (var i = 1; i <= totalSupply; i++) {
      const uri = await realEstate.tokenURI(i)
      const response = await fetch(uri)
```

4.6 Ethereum Contract Addresses Configuration enabling React to interact with smart contracts

millow > src > {} config.json > ...

```
{
    "31337": {
        "realEstate": {
            "address": "0x5FbDB2315678afecb367f032d93F642f64180aa3"
        },
        "escrow": {
            "address": "0xe7f1725E7734CE288F8367e1Bb143E90bb3F0512"
        }
    }
}
```

Chapter 5

RESULTS AND OUTPUT

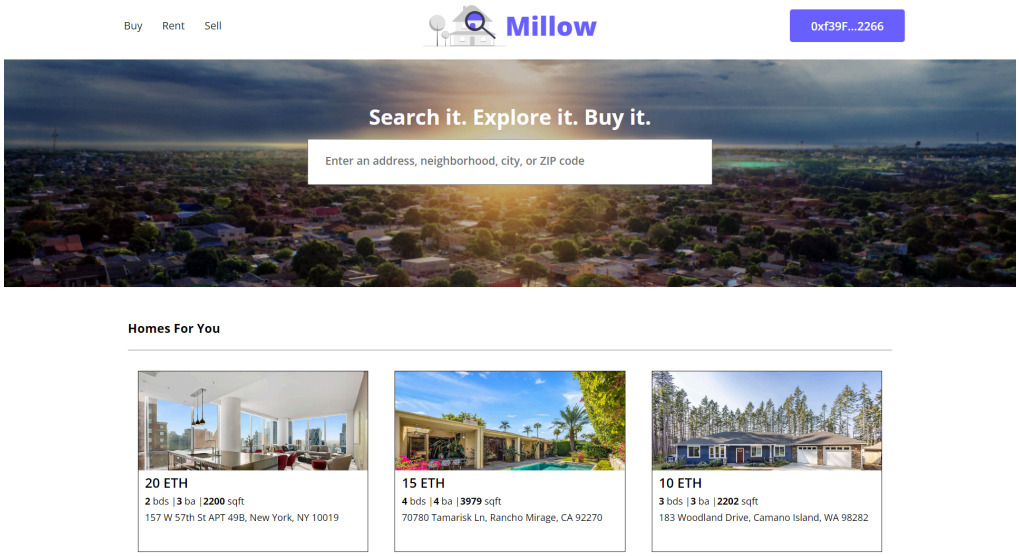

Fig 5.1 Home Page

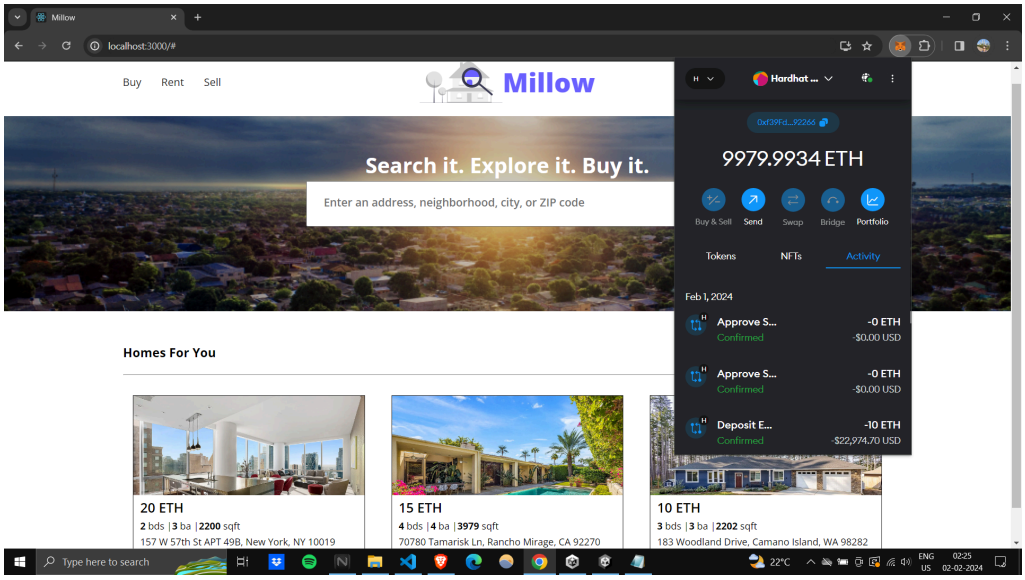

Fig 5.2 Connecting MetaMask Wallet

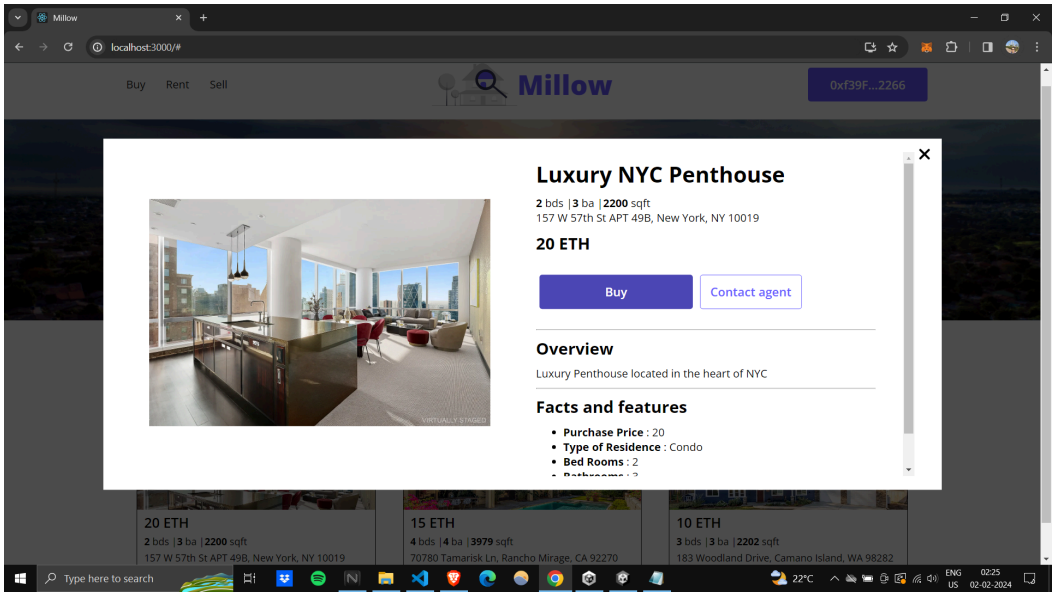

Fig 5.3 Viewing Real Estate Properties

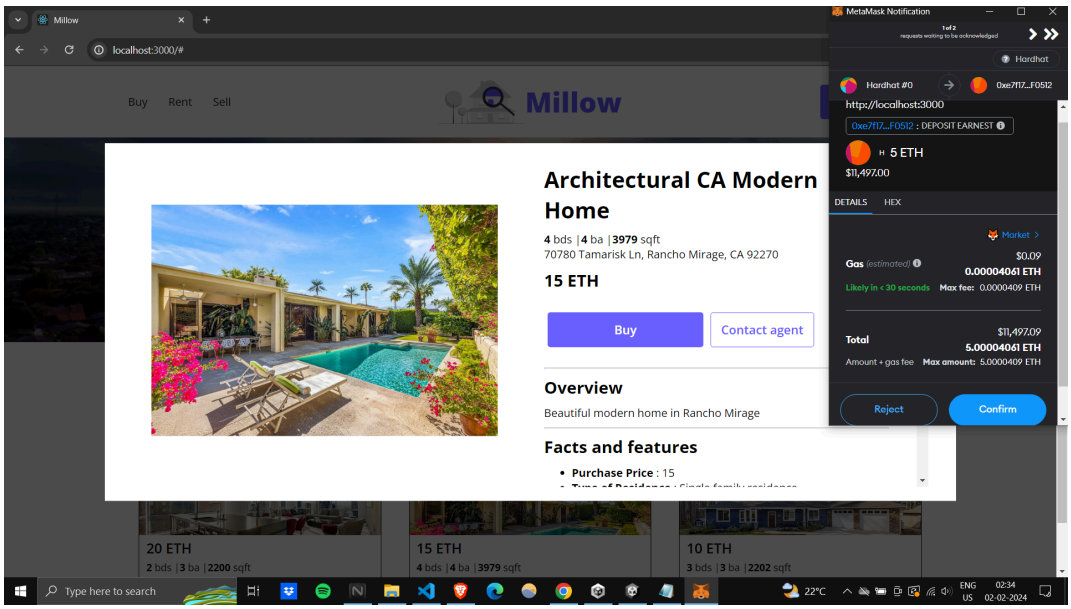

Fig 5.4 Buying and Confirming Asset using Ethereum

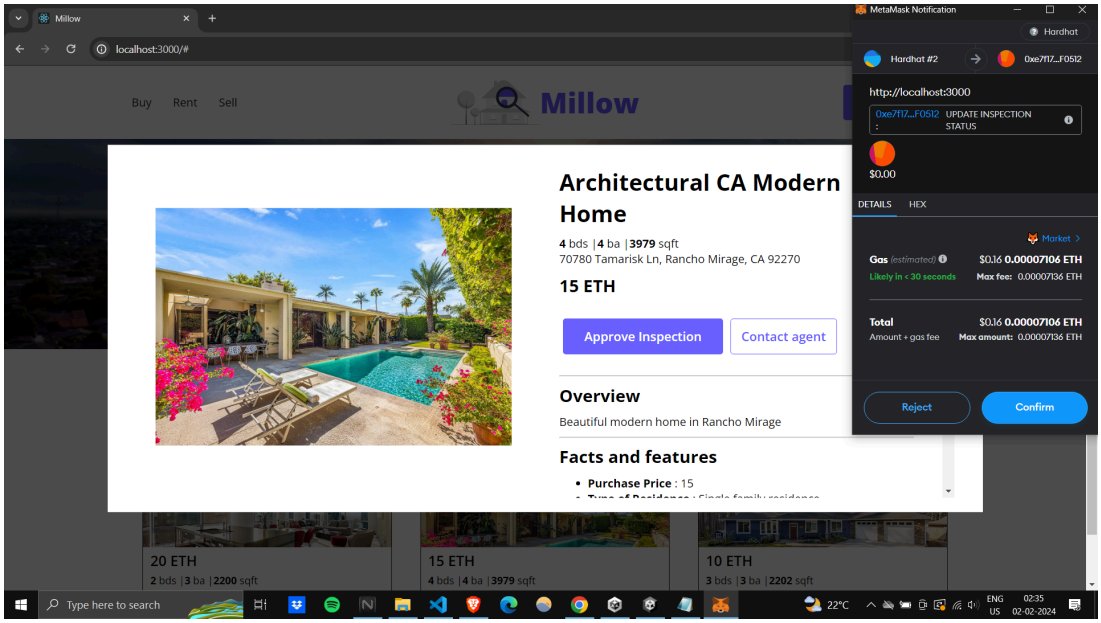

Fig 5.5 Approving Inspection and Gas Fees

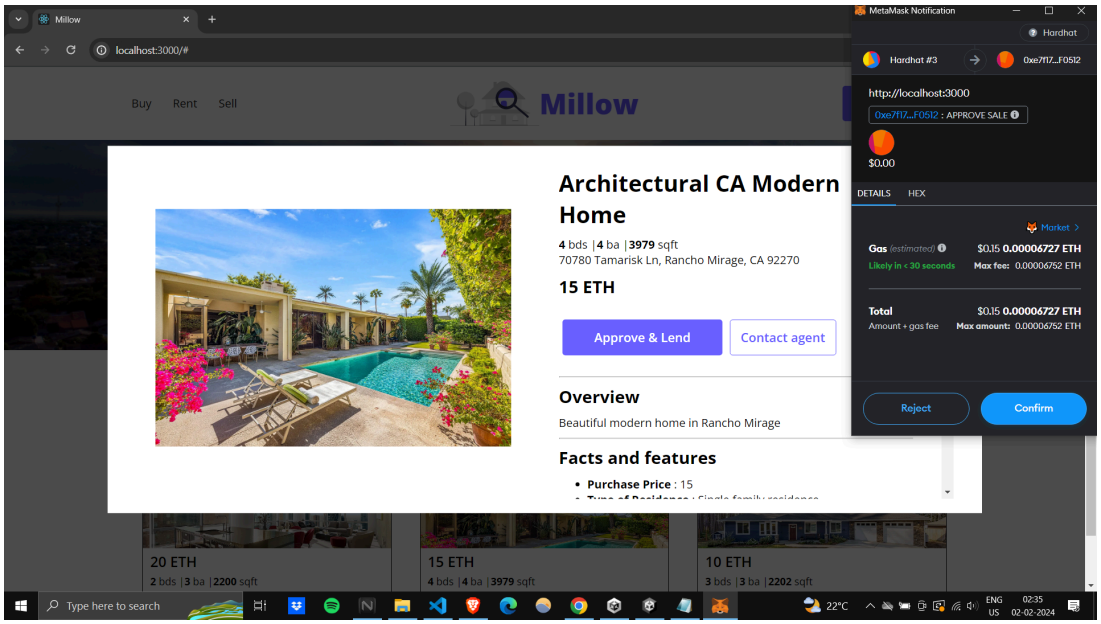

Fig 5.6 Approve and Lend

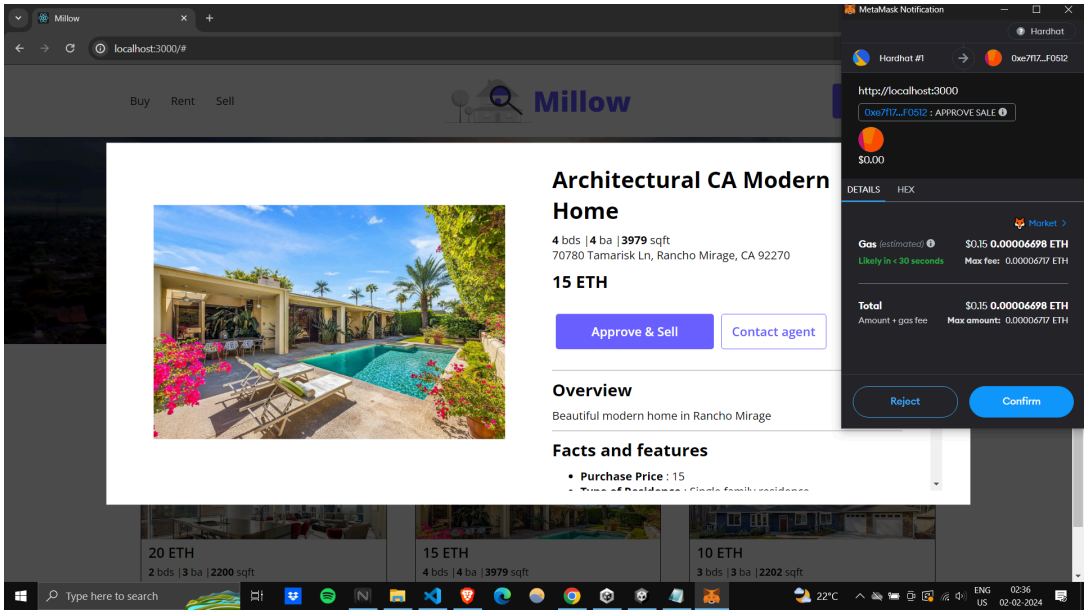

Fig 5.7 Approve and Sell

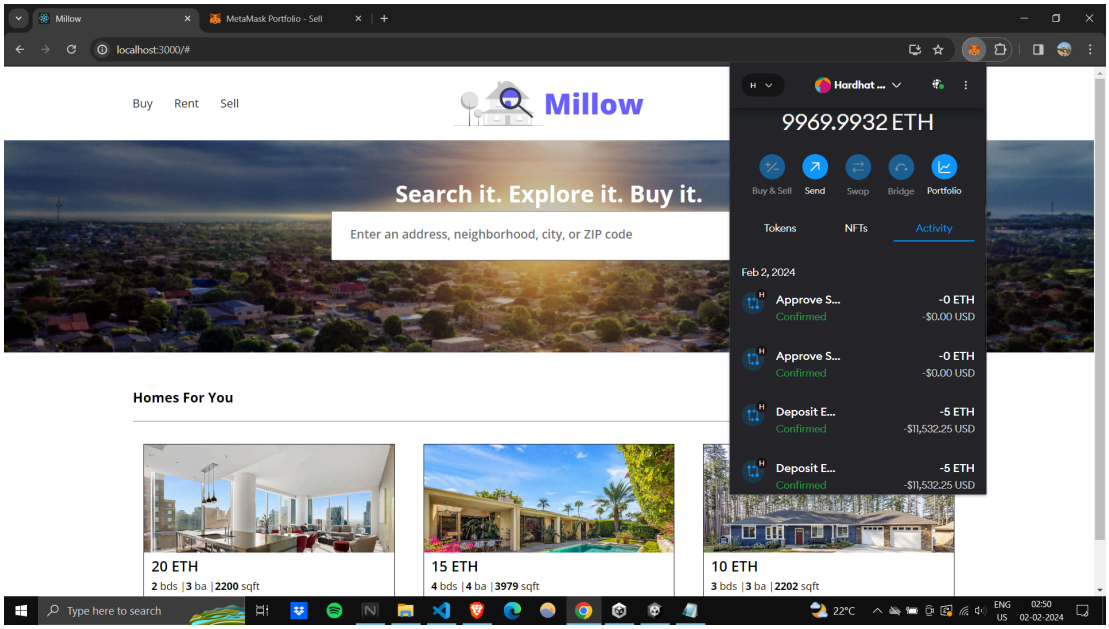

Fig 5.8 Order Confirmed

Chapter 6
CONCLUSION AND FUTURE SCOPE

In envisioning the future of the Web3 Real Estate application, the integration of Augmented Reality (AR), Virtual Reality (VR), and Artificial Intelligence (AI) emerges as a transformative direction. These advancements promise to redefine user experiences and elevate the platform's capabilities.

The incorporation of AR and VR technologies breaks free from traditional interfaces. Users can virtually tour properties, experiencing them as if physically present. AR overlays provide real-time neighborhood insights, historical context, and potential developments, ushering in a fusion of real and virtual environments.

AI algorithms revolutionize property discovery by analyzing user preferences, historical data, and market trends. This results in tailored recommendations that go beyond property features, creating a dynamic, user-centric space that ensures heightened engagement and satisfaction. AI becomes a cornerstone for intelligent decision support. Machine learning models analyze market trends, predict property value fluctuations, and offer insights into potential investment opportunities. This empowers users with data-driven insights, transforming the platform into a comprehensive real estate intelligence hub.

In conclusion, the future of the Web3 Real Estate application holds promises of unparalleled, intelligent, and immersive real estate experiences. The integration of AR, VR, and AI signifies not only elevated capabilities but also heralds a dynamic and transformative era in decentralized applications. The journey towards a more immersive, personalized, and intelligent real estate exploration has just begun, promising a horizon of limitless possibilities.

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