BLOCKCHAIN USAGE IN PLANT HYBRIDIZATION

BLOKĶĒŽU PIELIETOŠANA AUGU HIBRIDIZĀCIJĀ

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Abstract. *The project aims to leverage blockchain technology to address the challenges faced by gardeners and botanists in tracking and managing plant hybridization data. By employing a decentralized ledger system, the project enables users to securely record and verify the genetic makeup, metadata, and ownership of hybrid plants. Through the integration of smart contracts and MetaMask authentication, users can create and claim ownership of plants, ensuring transparency, integrity, and trust in the hybridization process.*

Keywords: *blockchain, smart contracts, plant modification, genetic modifications, regulatory compliance.*

Introduction

In the gardener community, plant hybridization is completed by various organizations and individual gardeners. However, historical data tracking of plant hybridization efforts calls out a significant challenge. An authors' idea is to apply leveraging blockchain technology to solve this challenge.

Leveraging blockchain technology offers a secure and transparent way to record and manage plant hybridization data. By implementing blockchain-based solution, gardeners can sign and authenticate plant hybridization data, ensuring the integrity and traceability of their hybridization efforts. The result product is a web application, which allows users to record hybridization effort data by filling registration form signed by blockchains. For signature authentication, we integrated MetaMask and Moralis Web3, while Ethereum serves as the underlying blockchain technology.

Ethereum is renowned for its decentralized architecture and smart contract capabilities. It presents a novel solution for tackling the complexities of plant modification tracking. By leveraging smart contracts (self-executing agreements encoded directly into code), Ethereum offers a unique approach to manage various aspects of plant science. From overseeing genetic modifications and breeding programs to ensuring regulatory compliance, smart contracts hold the promise of streamlining processes and enhancing transparency in plant modification endeavors.

This introduction provides a succinct overview of Ethereum's potential in the realm of plant science, emphasizing the transformative role of smart contracts in addressing the challenges faced by researchers and industry professionals in this field.

Study goal: to select the best-fitting blockchain framework for plant modification tracking and data storing.

Objectives:

1) select blockchain frameworks suitable for plant hybridization tracking;
2) test selected blockchain frameworks;
3) evaluate the obtained results.

Materials and methods

Ethereum is like the "superstar" of blockchain because it lets people create all sorts of cool things using smart contracts, which are like self-executing contracts without needing a middleman. It is used for making decentralized applications (dApps) and creating new digital tokens. But when lots of people use it at once, it can get slow and expensive.

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Ripple is all about speeding up international money transfers and making them cheaper. It's like a super-fast highway for money to travel between different countries and currencies. But unlike some other blockchain systems, it's not completely run by everyone – there's a smaller group in charge. Some folks worry about this and the rules it has to follow.

Stellar is similar to Ripple in that it wants to make global money transfers easy and affordable for everyone. It is trying hard to create a network where anyone, from big banks to regular people, can send money across borders quickly and cheaply. But Stellar is still growing, and it has to compete with other similar systems while dealing with rules and regulations.

Hyperledger Fabric is like a fancy tool for big companies that want their own customized blockchain. It's flexible, meaning companies can tweak it to fit their needs, and it can handle smart contracts, which are like self-executing agreements. However, it's a bit more complicated to set up and use compared to other blockchains, and it's not as open to everyone.

In our system we plan to use Ethereum blockchain for plant hybridization data sign and authentication (Fig.1)

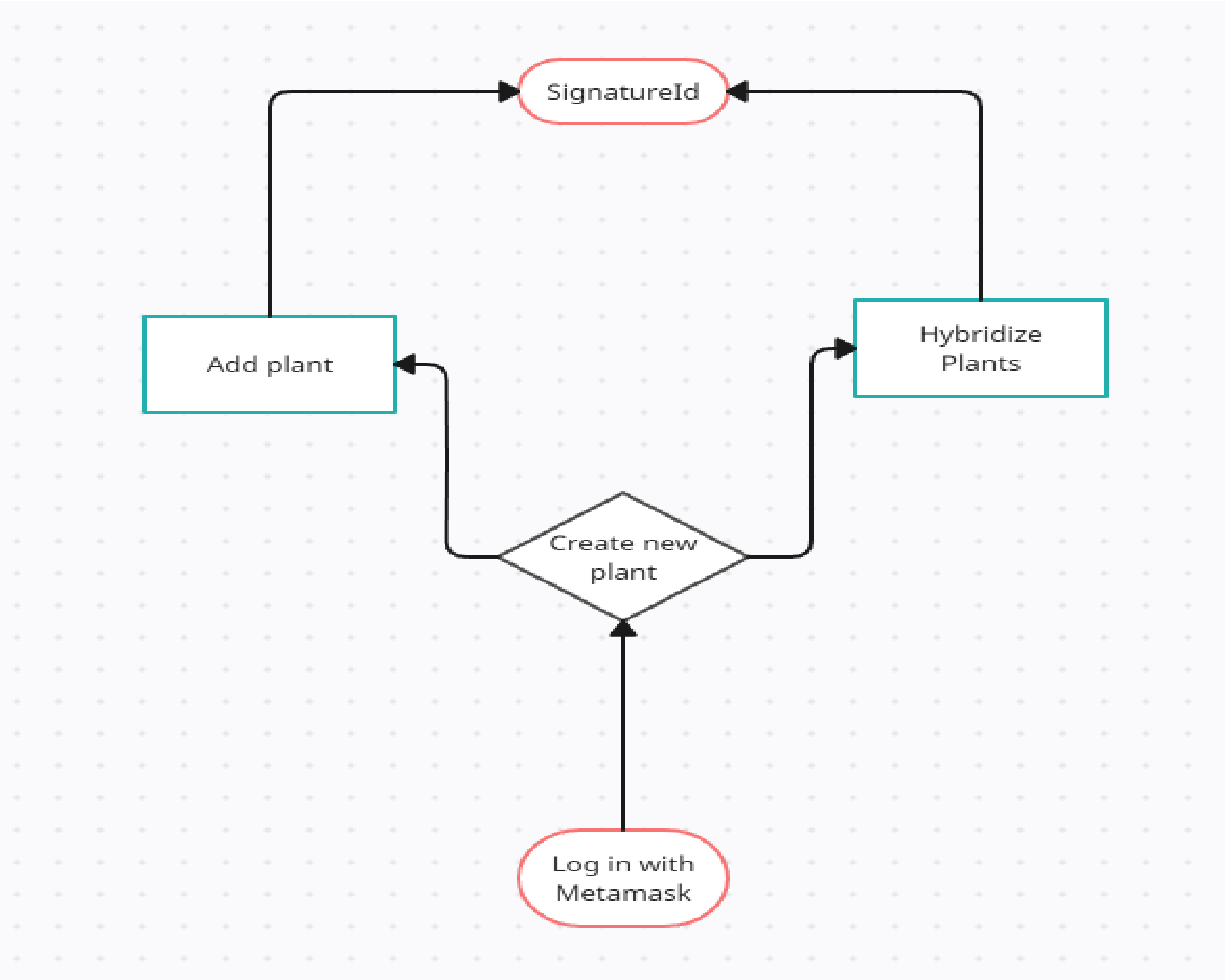

*Fig.1.***Concept of web application**

Results and discussions

To select the best-fitting blockchain framework the following criteria were selected:

1) *Supports Python Django* – Python is one of the most popular and powerful languages. Meanwhile, Django is a popular development framework for web application in Python.
2) *Supports Signatures* – in our system, it will be used to identify who made a plant modification.
3) *Supports Smart Contract* – supports popular programming language "Solidity".
4) *Public blockchain* – a transparent and decentralized governance structure. A public blockchain has the advantage of security on the market right now.
5) *Active developer community and ecosystem* – without previous experience with blockchain framework, it is impossible to do something without documentation and guidelines.

Table.1. **Comparison of databases based on previously mentioned criteria**

	Ethereum	Hyperledger Fabric	Ripple	Stellar
Supports Python Django	X			
Supports Signatures	X	X	X	X
Supports Smart Contracts	X	X	X	X
Public blockchain	X			X
Active developer community and ecosystem.	X			
Total	5	2	2	3

Our idea was to choose Ethereum mostly for its community and popularity. Building smart contracts was easier as guides on the internet, our contract idea was to store some personal data about our users, allowing them to sign the plant with identifier and move ownership to others.

Firstly, we log with MetaMask, Moralis Web3 Api is using as signature that allows users to connect. After user signed in, it will show necessary data for user (*Fig.2*), *profileId* will be used in the future.

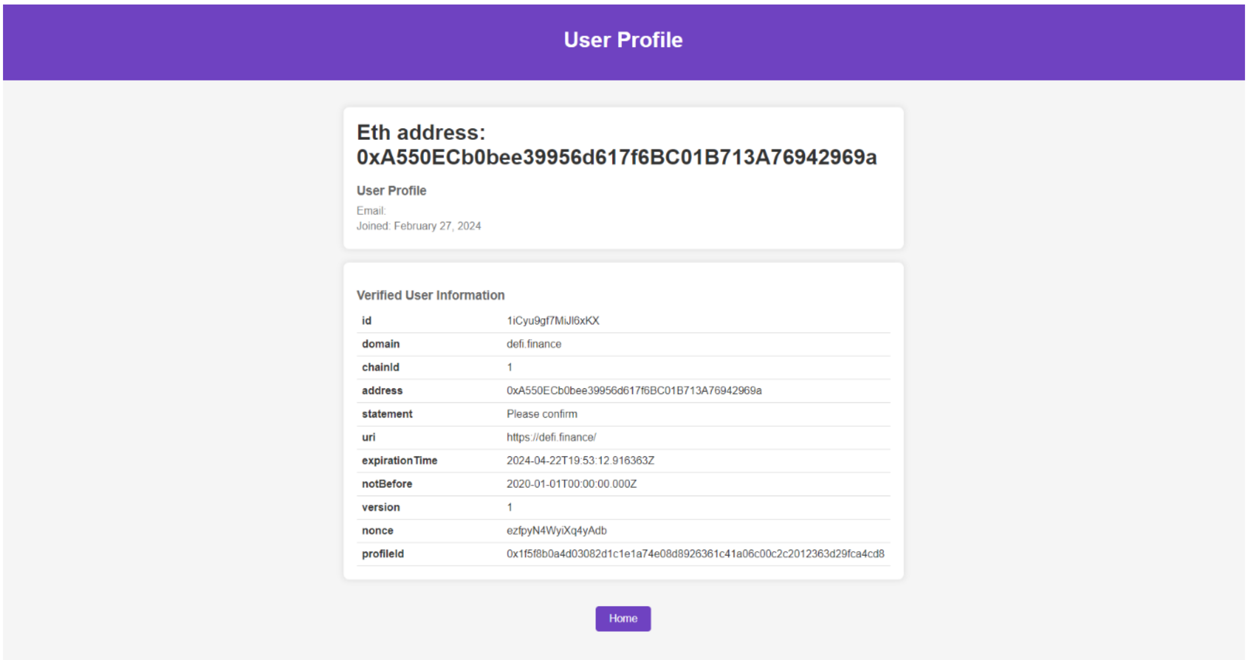

Fig.2. **User interface, profile information**

User will be able to choose between two parents, to create hybrid (*Fig.3*):

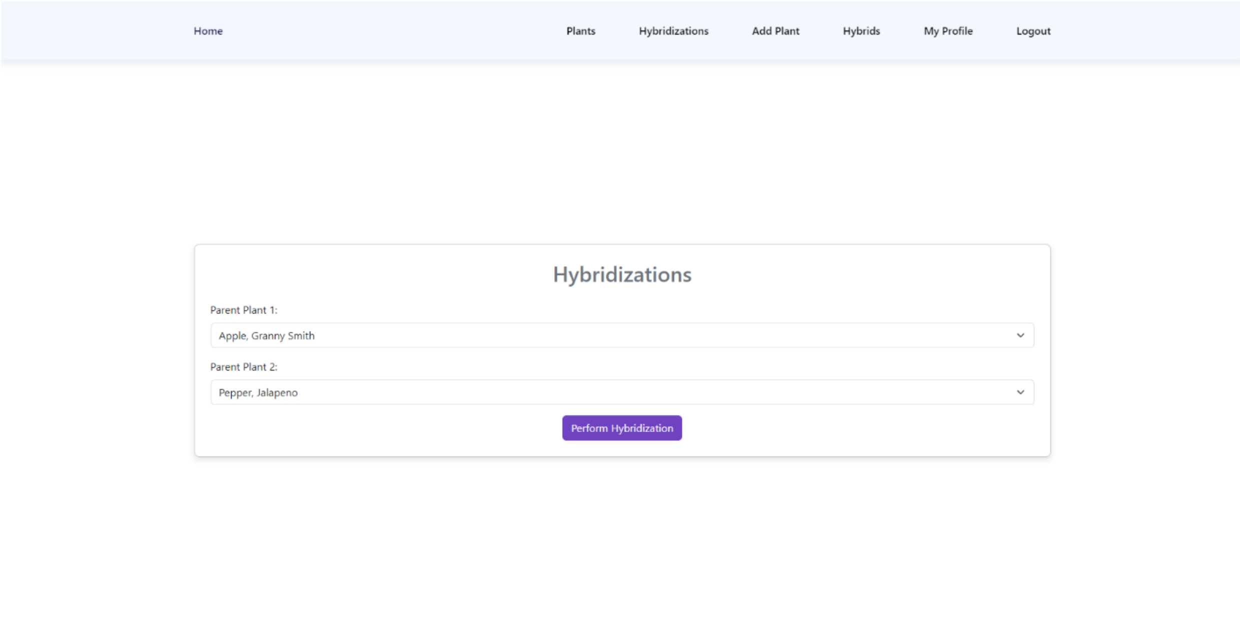

Fig.3. **User interface, parent selection stage**

Information is displayed in JSON data (*Fig.4*), by filling new form to create hybrid. Hybrid will be signed with *profileId* that was given on sign page. This data will be stored on blockchain, so users see who owns ownership about "New Plant".

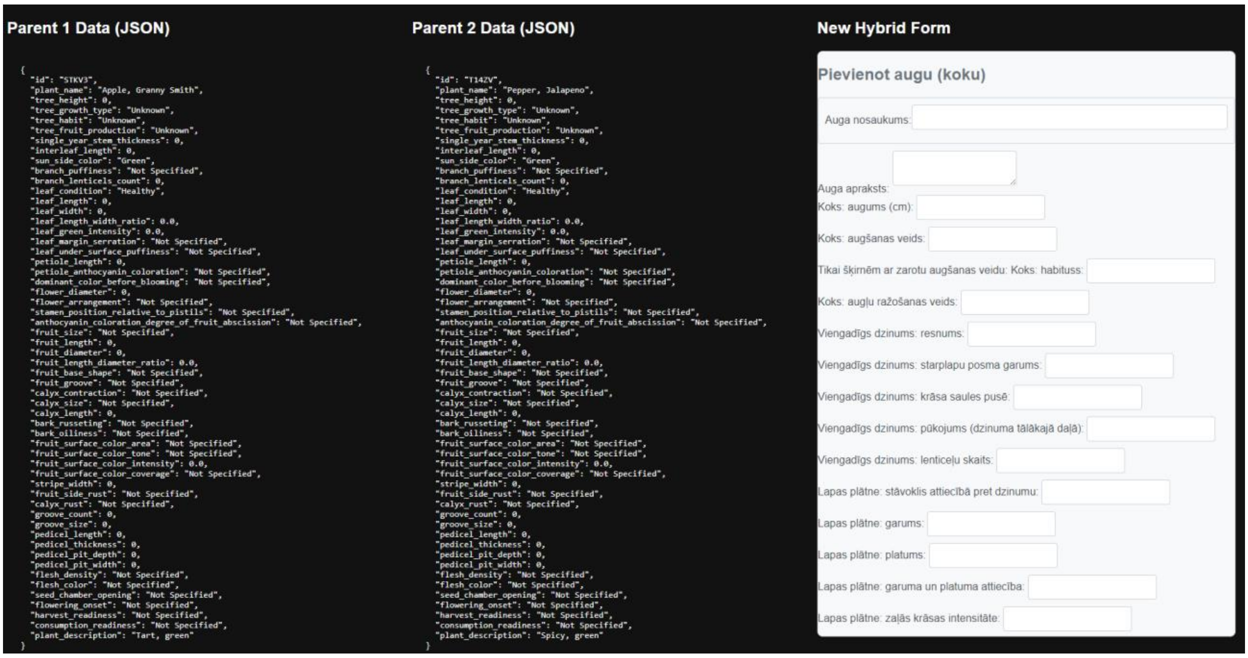

Fig.4. **User interface, JSON data about plants used for hybridization**

For ownership being used Ethereum framework, smart contract with solidity programming language (*Fig.5*), users will be able to post and retrieve data from blockchain, also move ownership to other hand.

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

contract PlantOwnership {
    struct Plant {
        uint256 id;
        address owner;
        string identifier;
    }

    mapping(uint256 => Plant) public plants;
    uint256 public nextPlantId;

    event PlantCreated(uint256 indexed id, address indexed owner, string identifier);
    event PlantOwnershipTransferred(uint256 indexed id, address indexed previousOwner, address indexed newOwner);

    function createPlant(string memory _identifier) public {
        uint256 plantId = nextPlantId;
        plants[plantId] = Plant(plantId, msg.sender, _identifier);
        nextPlantId++;
        emit PlantCreated(plantId, msg.sender, _identifier);
    }

    function transferOwnership(uint256 _plantId, address _newOwner) public {
        Plant storage plant = plants[_plantId];
        require(msg.sender == plant.owner, "Only the current owner can transfer ownership");
        plant.owner = _newOwner;
        emit PlantOwnershipTransferred(_plantId, msg.sender, _newOwner);
    }
}
```

Fig.5. **Smart contract code showing ownership of plants**

Conclusions

In the realm of plant hybridization, the challenges of tracking historical data and ensuring ownership integrity have long persisted within the gardeners' community. Traditional methods often fall short, leaving gaps in records and hindering progress in the field. However, the emergence of blockchain technology presents a promising solution to these issues.

By harnessing the immutable and decentralized nature of blockchain, gardeners can now securely record and manage plant breeding data. Through the implementation of smart contracts, each plant's genetic makeup, metadata, and ownership can be stored transparently and tamper-proof on the blockchain. Additionally, utilizing Metamask IDs for ownership verification adds an extra layer of security and authentication, ensuring that only authorized individuals can claim ownership of hybrid plants.

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