AKDENIZ UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF COMPUTER ENGINEERING

Football Manager Game with Unique NFT Integration (ELEVEN HERO)

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GRADUATION SENIOR PROJECT REPORT

SUPERVISOR: Asst. Prof. Dr. Murat Ak

JUNE 2023

ANTALYA

APPROVAL OF GRADUATION SENIOR PROJECT

The B.S. Graduation Thesis titled “Football Manager Game with Unique NFT Integration” prepared by Emre Çil has been unanimously approved as a Graduation Senior Project at Akdeniz University, Faculty of Engineering, Computer Engineering Department.

JURY MEMBERS

Date Signature

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Date Signature

ABSTRACT

Football Manager Game with Unique NFT Integration

Emre ÇİL

Graduation Senior Project **in Computer Engineering**

Supervisor: Murat AK

June 2023

This senior project aims to create a Football Manager game that integrates blockchain technology and Non-Fungible Tokens (NFTs) in a unique way. Players are symbolized by NFT cards in the game, whose attributes are randomly generated and are affected by gameplay, match results, and user lineups. To guarantee a seamless and secure gaming experience, software engineering principles are applied, including frontend and backend development, network system design, and security considerations. Player transfers, squad management, strategic decision-making, and match simulations are important elements. In order to build their teams, users collect and personalize NFT cards, utilizing the authenticity, lack of supply, and transferability of blockchain-based assets. To accommodate a growing user base, the project also emphasizes scalability, performance optimization, and data management. This project focuses on the potential the of NFTs and demonstrates their value in the gaming industry by incorporating blockchain and randomness into the game mechanics. In general, the project combines knowledge of software engineering, blockchain technology, and NFT integration to produce a dynamic and immersive Football Manager Game.

KEYWORDS: backend development, blockchain technology, data management, Football Manager Game, frontend development, network system design, Non-Fungible Tokens (NFTs), randomness, scalability, security considerations, software engineering, UI design.

FOREWORD

It is an honor for me to present this senior project, and I want to start by sincerely thanking Murat Ak, my mentor and professor. Mr. Ak has been an extraordinary mentor throughout this process, offering priceless advice, knowledge, and assistance. His commitment to helping me advance academically and professionally has been crucial to the success of this project. I've learned more about the fundamentals of computer engineering and how to effectively apply them thanks to Mr. Ak's guidance. His enlightening comments and helpful criticism have assisted me in streamlining my ideas, coming to wise conclusions, and overcoming obstacles. I sincerely appreciate his unwavering faith in my competence and his dedication to seeing that I succeed.

Additionally, I want to express my sincere gratitude to my family. They have been my motivation throughout this endeavor thanks to their unflagging support, inspiration, and understanding. Their confidence in my abilities and constant support have given me the willpower and inspiration to persevere even in the most trying circumstances.

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SYMBOLS AND ABBREVIATIONS

NFT - Non-Fungible Token

CMS - Content Management System

JWT - JSON Web Token

CORS - Cross-Origin Resource Sharing

NoSQL - Non-relational Structured Query Language

UFW - Uncomplicated Firewall

1. INTRODUCTION

The gaming industry is undergoing extraordinary growth and change in recent years as a result of technological advancements and changing player expectations. The combination of blockchain technology and NFTs is one notable innovation that has drawn a lot of interest. NFTs have opened up new possibilities for ownership, trading, and value in the virtual world because they stand for distinctive digital assets with measurable scarcity and verifiable ownership. In light of this, the goal of this senior project is to investigate the creation of a Football Manager game that fully utilizes NFTs and offers players an engaging and immersive gaming experience.

The main goal of this project is to use the benefits that NFTs provide to improve the Football Manager Game's authenticity, rarity, and customization options. NFT cards representing individual players will be used in the game, and each card will have randomized traits like DNA, images, points, and types. Each NFT card is distinct and has its own distinctive characteristics because the game incorporates randomness into the generation of these attributes. Users will have the opportunity to collect, trade, and manage these NFT cards, allowing them to build their dream teams and engage in strategic gameplay and match simulations. The NFTs will serve as digital assets within the game ecosystem, providing a sense of ownership and rarity for the players. Through strategic decision-making, squad management, and player transfers, users will compete against each other, striving for success and glory in the virtual football world.

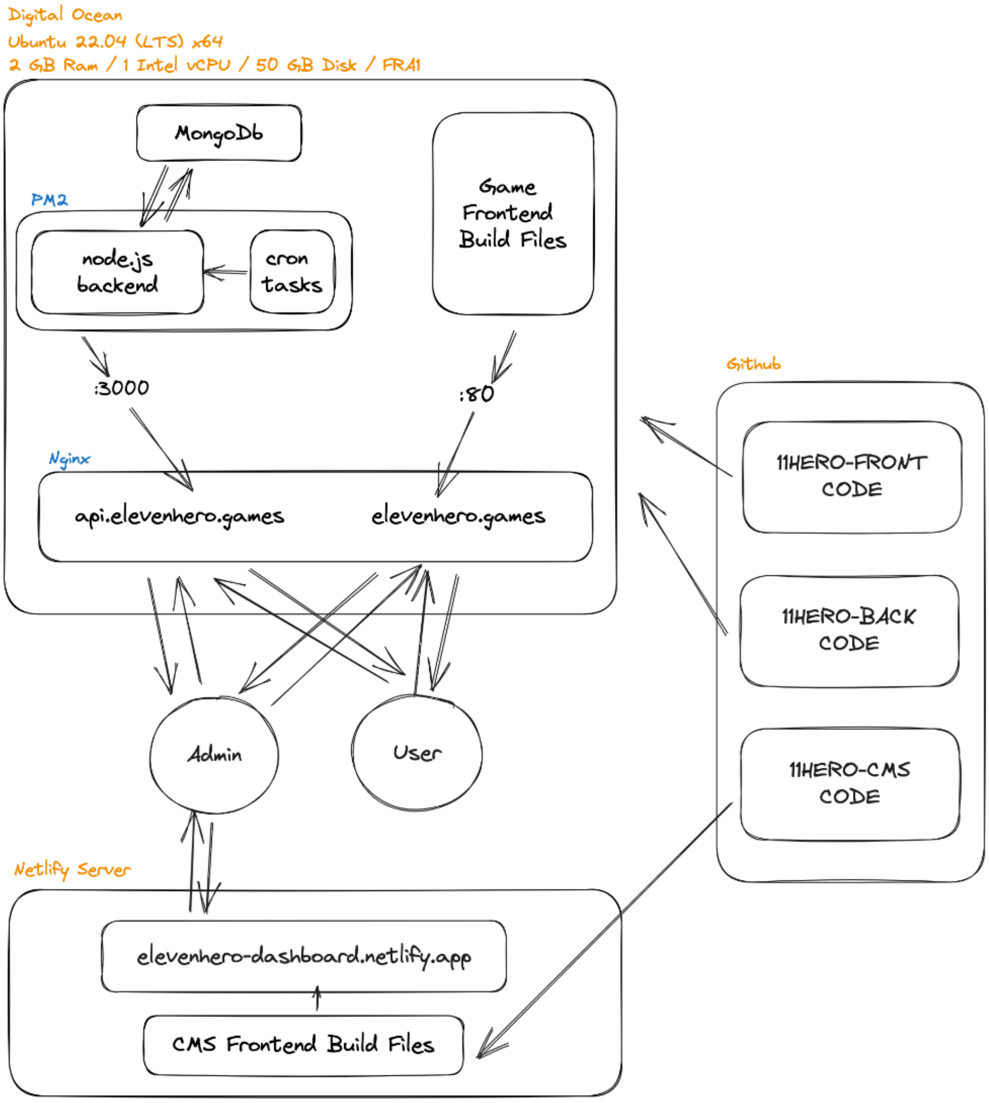
This project includes a number of crucial components from a software engineering standpoint, such as frontend and backend development, network system design, security considerations, and user interface design. To ensure a seamless and enjoyable gaming experience, the frontend development will concentrate on creating an intuitive and aesthetically pleasing user interface. Player attributes, match simulations, database management, and overall game logic will all be taken care of by the backend development. Real-time gameplay and multiplayer interactions will also be made possible by network system design, encouraging a sense of camaraderie and competition among players. The integrity and privacy of user data will be crucially dependent on security factors. Sensitive data will be protected against unauthorized access by measures that will be put in place. A further layer of transparency and immutability will be added with the use of blockchain technology, allowing players to confirm the legitimacy and ownership of their NFT assets.

This study's exploration of NFTs' potential uses in the gaming industry, particularly in the context of football management simulation, is important because it sheds light on their potential. This project offers a distinctive and cutting-edge gaming experience by fusing cutting-edge technologies like NFTs and blockchain with the immersive and strategic gameplay of a Football Manager Game. It not only adds to the body of knowledge in the field of computer engineering but also exemplifies how new technologies can be incorporated into established gaming frameworks.

In conclusion, this senior project aims to develop a Football Manager Game with a distinctive integration of NFTs, leveraging software engineering principles and blockchain technology. By enhancing player authenticity, rarity, and customization options, the project seeks to provide users with an immersive and personalized gaming experience. The subsequent chapters will delve into the technical details, implementation strategies, and evaluation of the game, further highlighting the innovative nature and potential impact of this project.

2.ARCHITECTURE

The Football Manager game is built on a Digital Ocean Ubuntu 22.04 instance with 2GB RAM, 1 Intel vCPU, and a 50GB disk. Both the MongoDB database and the Node.js backend are managed by PM2. To handle game-related operations, a cron task is used. The game frontend is built and served via Nginx on port 80, with the URL elevenhero.games. The API is accessible via port 3000 and the URL api.elevenhero.games. There are two user roles in the system: admin and user. Administrators can access the Elevenhero CMS page, which is hosted on elevenhero.netlify.app and manages the application. For the Football Manager game, this architecture ensures efficient resource allocation, secure data management, and streamlined development and deployment processes. The game codes are 11HERO-FRONT, 11HERO-BACK, and 11HERO-DASHBOARD.



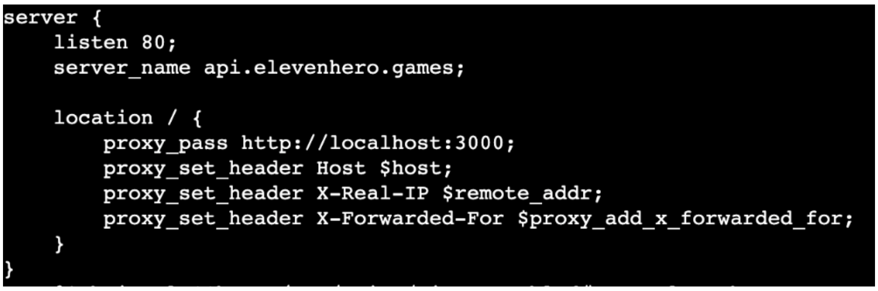
2.1. Server

The Football Manager server infrastructure is built on a Digital Ocean Ubuntu 22.04 instance with 2GB RAM, 1 Intel vCPU, and a 50GB disk. The web server Nginx is used to handle incoming requests and route them to the appropriate backend services. The database for storing game data is MongoDB, while PM2 manages the Node.js processes and ensures their availability and reliability. Cloudflare is used as an additional layer of protection and optimization, enhancing performance and security. Furthermore, the server's security is bolstered by an UFW (Uncomplicated Firewall) that controls incoming and outgoing traffic, protecting the system and user data. This strong server configuration ensures that the Football Manager game runs smoothly, efficiently, and securely.

2.1.1. Nginx Routing

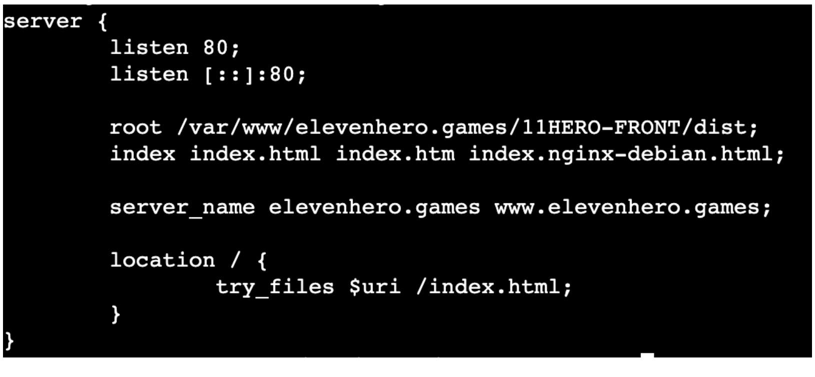
This project's Nginx routing configuration allows access to two main routes: api.elevenhero.games and elevenhero.games. Nginx serves as a reverse proxy, making these routes available to the internet. The frontend for elevenhero.games is accessible via port 80, while the API for api.elevenhero.games is accessible via port 3000. Headers like "Host," "Real IP," and "Forwarded" are used to ensure proper routing and communication between the client and the server, improving overall system functionality and security.

- *api.levenhero.games*



```
server {
    listen 80;
    server_name api.elevenhero.games;

    location / {
        proxy_pass http://localhost:3000;
        proxy_set_header Host $host;
        proxy_set_header X-Real-IP $remote_addr;
        proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
    }
}
```

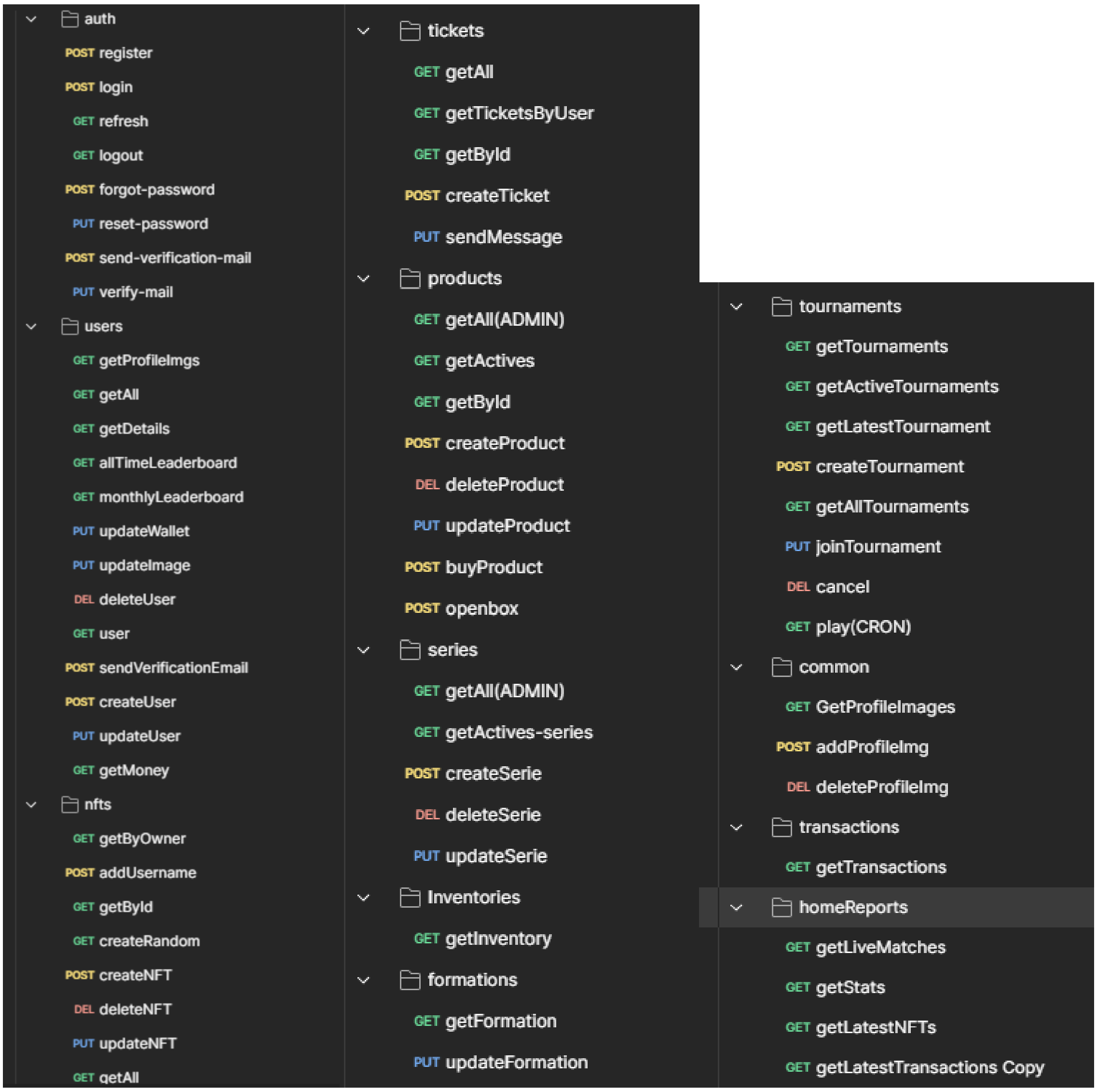
- *elevenhero.games*



```
server {
        listen 80;
        listen [::]:80;

        root /var/www/elevenhero.games/11HERO-FRONT/dist;
        index index.html index.htm index.nginx-debian.html;

        server_name elevenhero.games www.elevenhero.games;

        location / {
                try_files $uri /index.html;
        }
}
```

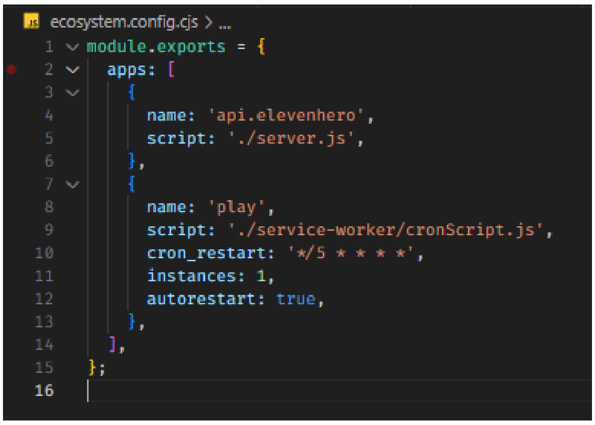
2.2. Backend

The project's backend is built with Node.js and Express.js to handle server-side functionality. In the backend, there are 12 main routes, each of which contains multiple controllers that perform CRUD operations. The backend makes use of a variety of packages, including @openzeppelin/contracts for smart contract interactions, axios for HTTP requests, bcrypt for password hashing, dotenv for environment variable management, express-mongo-sanitize for MongoDB injection protection, jsonwebtoken for authentication, mongoose as the MongoDB ORM, multer for file uploads, and web3 for interacting with the Ethereum blockchain. Cors, helmet, joi, express-rate-limit, nodemailer, and uuid are among the other packages used to improve security, validation, rate limiting, email functionality, and unique ID generation.



- auth
  - POST register
  - POST login
  - GET refresh
  - GET logout
  - POST forgot-password
  - PUT reset-password
  - POST send-verification-mail
  - PUT verify-mail
- users
  - GET getProfileImgs
  - GET getAll
  - GET getDetails
  - GET allTimeLeaderboard
  - GET monthlyLeaderboard
  - PUT updateWallet
  - PUT updateImage
  - DEL deleteUser
  - GET user
  - POST sendVerificationEmail
  - POST createUser
  - PUT updateUser
  - GET getMoney
- nfts
  - GET getByOwner
  - POST addUsername
  - GET getById
  - GET createRandom
  - POST createNFT
  - DEL deleteNFT
  - PUT updateNFT
  - GET getAll
- tickets
  - GET getAll
  - GET getTicketsByUser
  - GET getById
  - POST createTicket
  - PUT sendMessage
- products
  - GET getAll(ADMIN)
  - GET getActives
  - GET getById
  - POST createProduct
  - DEL deleteProduct
  - PUT updateProduct
  - POST buyProduct
  - POST openbox
- series
  - GET getAll(ADMIN)
  - GET getActives-series
  - POST createSerie
  - DEL deleteSerie
  - PUT updateSerie
- Inventories
  - GET getInventory
- formations
  - GET getFormation
  - PUT updateFormation
- tournaments
  - GET getTournaments
  - GET getActiveTournaments
  - GET getLatestTournament
  - POST createTournament
  - GET getAllTournaments
  - PUT joinTournament
  - DEL cancel
  - GET play(CRON)
- common
  - GET GetProfileImages
  - POST addProfileImg
  - DEL deleteProfileImg
- transactions
  - GET getTransactions
- homeReports
  - GET getLiveMatches
  - GET getStats
  - GET getLatestNFTs
  - GET getLatestTransactions Copy

2.2.1 Cron Tasks

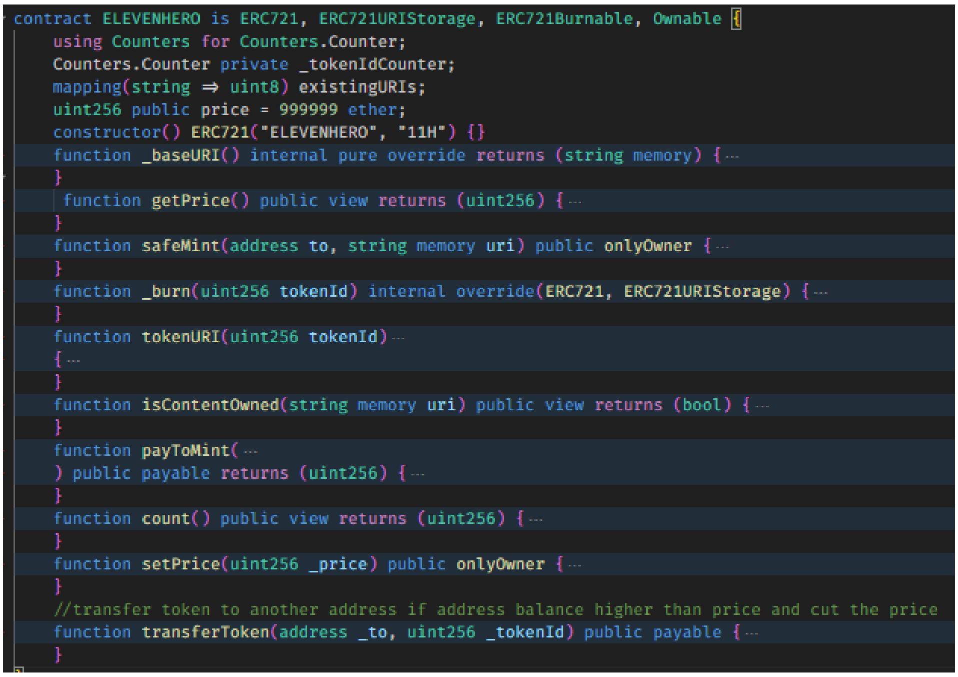


```
module.exports = {
  apps: [
    {
      name: 'api.elevenhero',
      script: './server.js',
    },
    {
      name: 'play',
      script: './service-worker/cronScript.js',
      cron_restart: '*/5 * * * *',
      instances: 1,
      autorestart: true,
    },
  ],
};
```

A cron task has been implemented in the backend to automate the game-playing process. This cron task executes the necessary actions to simulate gameplay at predefined intervals. It ensures that matches are played, game events are triggered, and relevant updates are made in accordance with the logic and rules of the game. The game maintains its dynamic nature and provides a seamless gaming experience for the players by incorporating a cron task.

2.2.2 Contracts

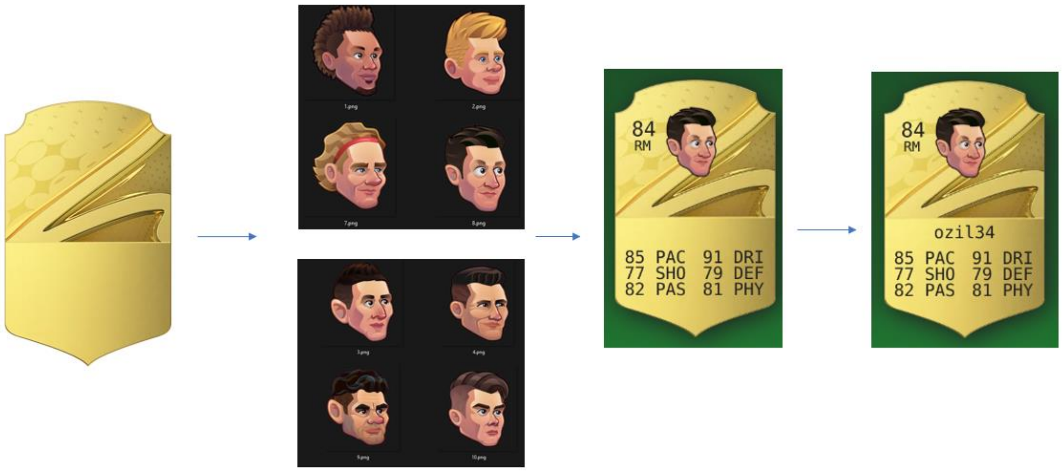
The OpenZeppelin ERC721 standard contracts were used as the foundation for implementing the NFT functionality in the project. These contracts provided the structure and functionality required for the creation and management of non-fungible tokens. Custom methods such as "payToMint" and "transfer" were also added to improve the functionality of the NFTs and enable specific game operations. The project successfully integrated NFTs into the game mechanics by leveraging the OpenZeppelin ERC721 standards and introducing custom methods, allowing for unique ownership and transferability of in-game assets.



```
contract ELEVENHERO is ERC721, ERC721URIStorage, ERC721Burnable, Ownable {
    using Counters for Counters.Counter;
    Counters.Counter private _tokenIdCounter;
    mapping(string => uint8) existingURIs;
    uint256 public price = 999999 ether;
    constructor() ERC721("ELEVENHERO", "11H") {}
    function _baseURI() internal pure override returns (string memory) { ···
    }
     function getPrice() public view returns (uint256) { ···
    }
    function safeMint(address to, string memory uri) public onlyOwner { ···
    }
    function _burn(uint256 tokenId) internal override(ERC721, ERC721URIStorage) { ···
    }
    function tokenURI(uint256 tokenId) ···
    { ···
    }
    function isContentOwned(string memory uri) public view returns (bool) { ···
    }
    function payToMint( ···
    ) public payable returns (uint256) { ···
    }
    function count() public view returns (uint256) { ···
    }
    function setPrice(uint256 _price) public onlyOwner { ···
    }
    //transfer token to another address if address balance higher than price and cut the price
    function transferToken(address _to, uint256 _tokenId) public payable { ···
    }
```

2.2.3 Image Processing

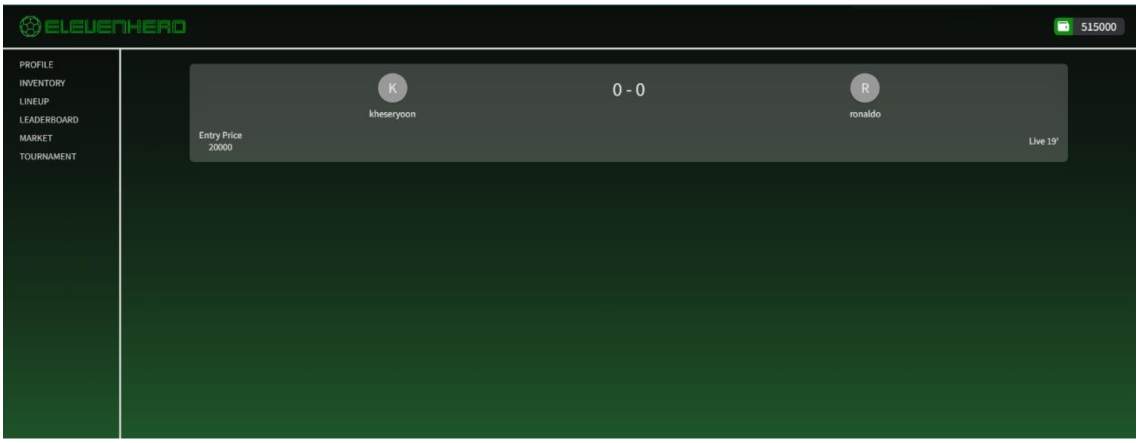
The backend image processing component is critical to the visual presentation and gameplay mechanics of the game. The Sharp library integration enables the collection and merging of various graphical elements such as backgrounds and heads, resulting in visually appealing player cards. Each card stands out with its own unique design thanks to the careful composition and manipulation of these assets. Furthermore, the backend uses an algorithm to generate the attributes and specialties of each player card, adding a random element and strategic decision-making for players. The backend, which incorporates image processing techniques, allows players to personalize their cards by assigning custom names and even customizing their appearance, fostering a stronger sense of ownership and individuality.



Furthermore, the image processing component contributes significantly to the overall gaming experience by improving immersion and personalization. The visually appealing player cards, with their distinct attributes and specialties, not only create a visually appealing collection, but also provide valuable gameplay information to players. This data allows for strategic team building, tactical decision-making, and engaging gameplay simulations. The backend image processing component creates a cohesive and immersive experience that captivates players and immerses them in the world of football management by seamlessly combining aesthetics and gameplay elements.

2.3. Game Frontend

The game frontend was built with React.js and TypeScript, taking advantage of these technologies' advantages to create a dynamic and interactive user interface. Material UI was used to create consistent and visually appealing components, while Redux was used to manage state efficiently throughout the game. In addition to these core libraries, a number of complementary libraries were used to improve functionality and provide a consistent user experience. The game frontend successfully delivered an engaging and responsive interface for players to interact with the game's features and gameplay by combining React.js, TypeScript, Material UI, Redux, and other supporting libraries.



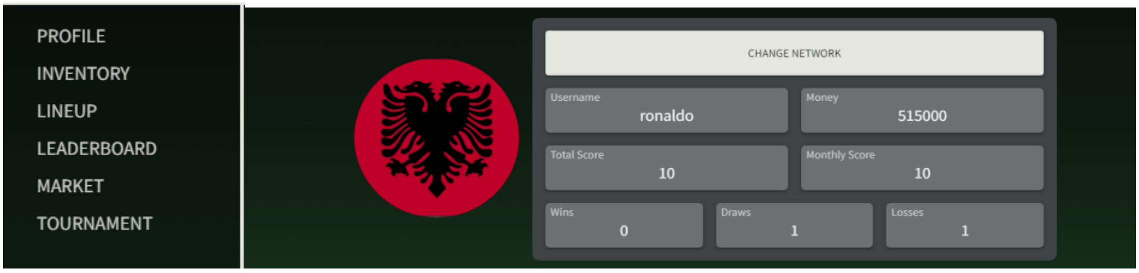
kheseryoon 0 - 0 ronaldo

Entry Price 20000

Live 19'

2.3.1 Profile Page

The profile page provides a detailed look at the player's information and achievements. It works in tandem with the Metamask wallet to provide seamless access to digital assets. The avatar or profile image of the player, as well as their username, are prominently displayed on the profile page. Key metrics such as the player's available balance, scores, wins, and losses are also displayed, providing a snapshot of their progress and performance in the game. This centralized hub makes it simple for players to track their statistics and manage their in-game resources, enhancing their overall gaming experience.



Username: ronaldo

Money: 515000

Total Score: 10

Monthly Score: 10

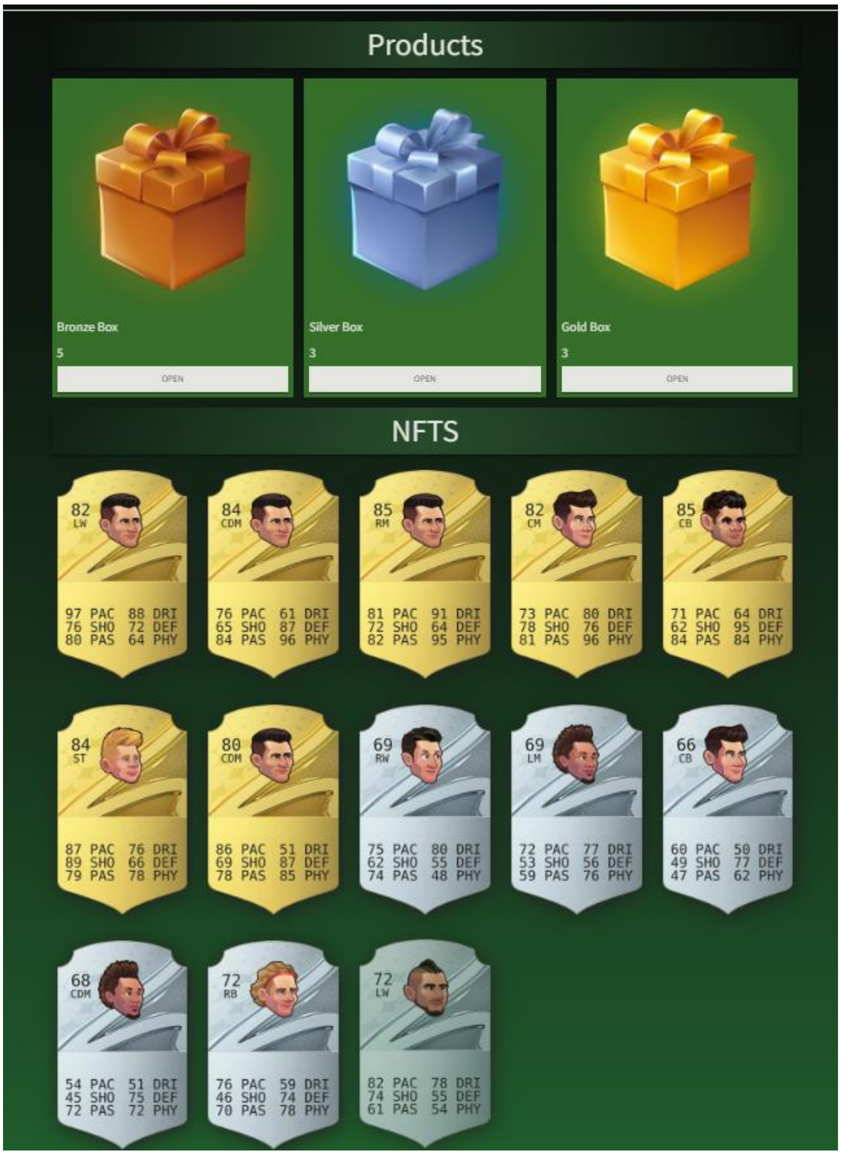
Wins: 0

Draws: 1

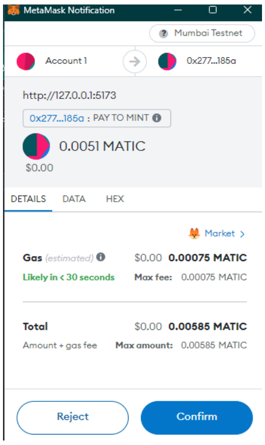
Losses: 1

2.3.2 Inventory Page

The Inventory page is a central location for all of the player's products and collectibles. It offers a comprehensive list of products, both openable and non-openable. The page also features NFT characters, allowing players to interact with them by clicking on individual NFTs and assigning names to them using image processing techniques. Furthermore, players can claim specific items as NFTs, expanding their collection of unique and valuable assets. The Inventory page provides players with a centralized location to manage and explore their inventory, increasing their game engagement and customization options.


Products
Bronze Box
5
OPEN
Silver Box
3
OPEN
Gold Box
3
OPEN
NFTS
82 LW 97 PAC 76 SHO 80 PAS 88 DRI 72 DEF 64 PHY
84 CDM 76 PAC 65 SHO 84 PAS 61 DRI 87 DEF 96 PHY
85 RM 81 PAC 72 SHO 82 PAS 91 DRI 64 DEF 95 PHY
82 CM 73 PAC 78 SHO 81 PAS 80 DRI 76 DEF 96 PHY
85 CB 71 PAC 62 SHO 84 PAS 64 DRI 95 DEF 84 PHY
84 ST 87 PAC 89 SHO 79 PAS 76 DRI 66 DEF 78 PHY
80 CDM 86 PAC 69 SHO 78 PAS 51 DRI 87 DEF 85 PHY
69 RW 75 PAC 62 SHO 74 PAS 80 DRI 55 DEF 48 PHY
69 LM 72 PAC 53 SHO 59 PAS 77 DRI 56 DEF 76 PHY
66 CB 60 PAC 49 SHO 47 PAS 50 DRI 77 DEF 62 PHY
68 CDM 54 PAC 45 SHO 72 PAS 51 DRI 75 DEF 72 PHY
72 RB 76 PAC 46 SHO 70 PAS 59 DRI 74 DEF 78 PHY
72 LW 82 PAC 74 SHO 61 PAS 78 DRI 55 DEF 54 PHY

2.3.3 NFT Claim


MetaMask Notification

Mumbai Testnet

Account 1 → 0x277...185a

http://127.0.0.1:5173

0x277...185a : PAY TO MINT

0.0051 MATIC

$0.00

DETAILS DATA HEX

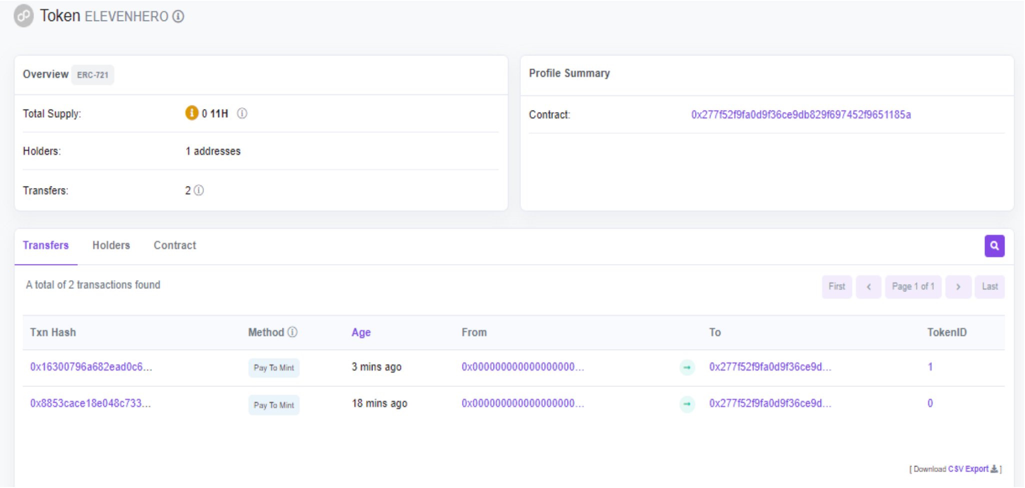
Market >

Gas (estimated)	$0.00	0.00075 MATIC
Likely in < 30 seconds	Max fee:	0.00075 MATIC
Total	$0.00	0.00585 MATIC
Amount + gas fee	Max amount:	0.00585 MATIC

Reject Confirm

The game's transactions feature allows users to connect their wallets, such as MetaMask, and seamlessly mint NFT cards. Users can benefit from low gas fees by using the Matic network on the Mumbai test net, making the minting process more affordable and accessible. This combination of blockchain technology and the Matic network ensures secure and transparent transactions, giving users a more streamlined experience when adding new NFT cards to their collection.

You can see the transactions data on the polygon Mumbai scan.


Token ELEVENHERO

Overview ERC-721

Total Supply:	0 11H
Holders:	1 addresses
Transfers:	2

Profile Summary

Contract: 0x277f52f9fa0d9f36ce9db829f697452f9651185a

Transfers Holders Contract

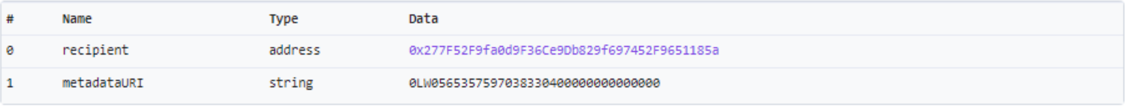
A total of 2 transactions found

First < Page 1 of 1 > Last

Txn Hash	Method	Age	From		To	TokenID
0x16300796a682ead0c6...	Pay To Mint	3 mins ago	0x000000000000000000...	→	0x277f52f9fa0d9f36ce9d...	1
0x8853cace18e048c733...	Pay To Mint	18 mins ago	0x000000000000000000...	→	0x277f52f9fa0d9f36ce9d...	0

[Download CSV Export]

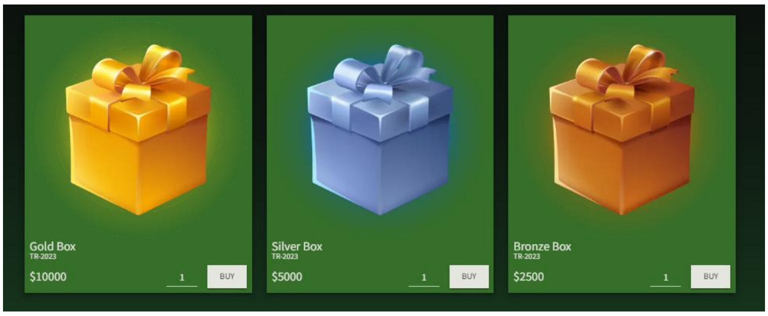
The DNA of NFT players embedded to blockchain you can check on polygon transactions.



#	Name	Type	Data
0	recipient	address	0x277F52F9fa0d9F36Ce9Db829f697452F9651185a
1	metadataURI	string	0LW05653575970383304000000000000000

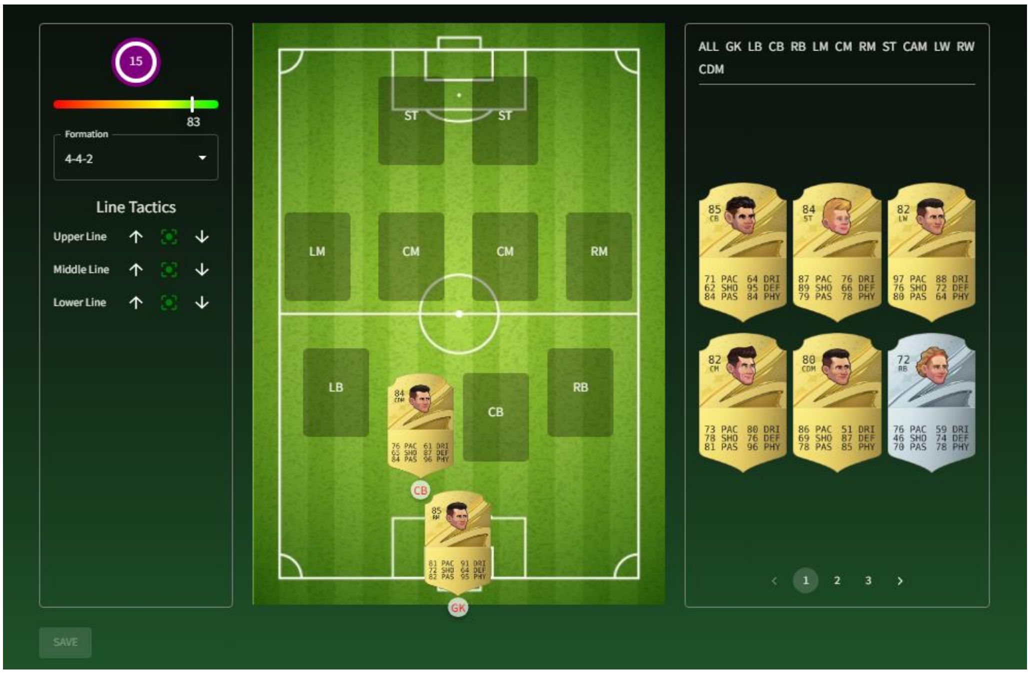
2.3.4 Market Page

The Market page acts as a platform for users to browse and purchase various products available in the game. These products, which administrators can add via the dashboard, provide unique items, enhancements, or in-game assets. Users can browse the available products and make purchases directly from within the game interface. This seamless integration of market functionality deepens the gaming experience by allowing players to obtain valuable resources or items to improve their gameplay and progress in the game world.

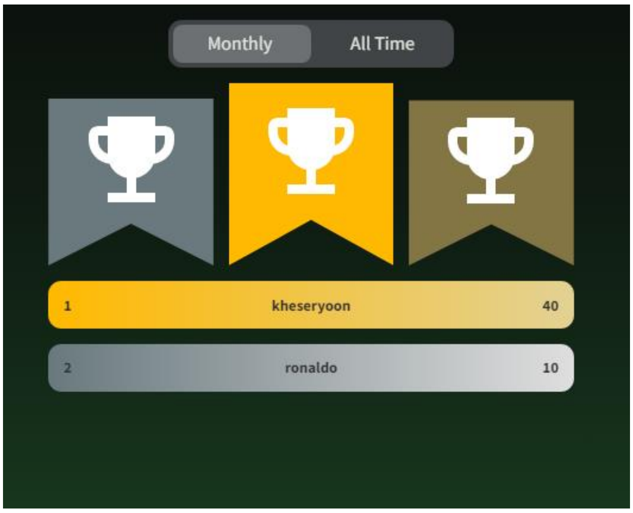


2.3.5 Line Up Page

The Lineup page allows users to strategically arrange their team formations and player positions. Users can select and position their NFT cards on the field using an intuitive drag-and-drop interface based on their preferred tactics and strategies. The lineup page also shows the team's overall points, giving users insight into the strength and effectiveness of their chosen lineup. This feature enables users to make informed decisions about team composition, optimize player positions, and devise winning strategies based on individual player attributes and overall team performance.


Formation: 4-4-2

2.3.6 Leaderboard Page



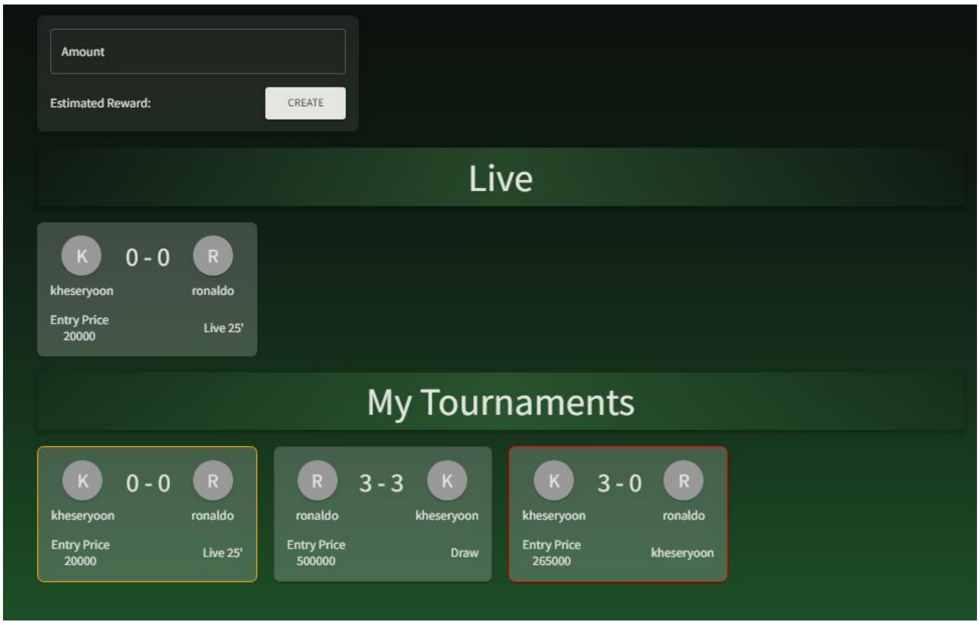
1 kheseryoon 40

2 ronaldo 10

The Leaderboard page highlights the game's competitive spirit by listing users' points and scores on a monthly and all-time basis. It provides a platform for players to compare their performance and achievements to those of others, encouraging competition and motivation. The points and scores of users are accumulated and displayed in a ranked format, allowing them to track their progress and strive for the top positions. The Leaderboard page inspires and recognizes users, encouraging them to improve their gameplay, climb the ranks, and establish their presence as top performers in the game.

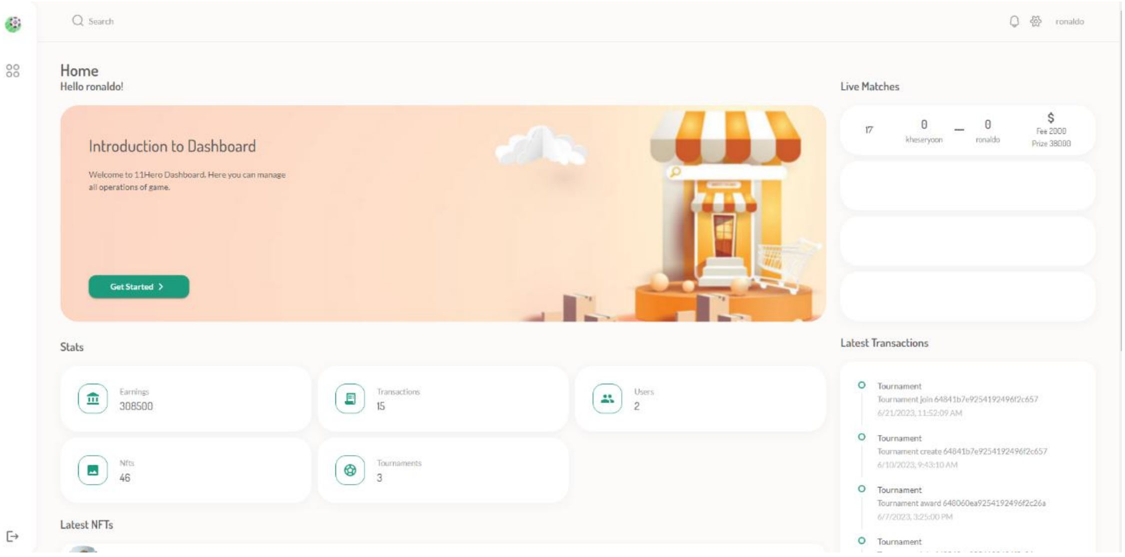
2.3.7 Tournaments Page

The Tournaments page provides users with an exciting platform for competitive gameplay by allowing them to create, cancel, and join tournaments. Users can organize their own tournaments, setting the rules, format, and schedule, as well as participate in tournaments hosted by other players. The page displays both live tournaments, which allow users to watch ongoing matches in real time, and past tournaments for reference and historical purposes. This dynamic and interactive feature improves the multiplayer experience by fostering a sense of community and camaraderie among players who enjoy competitive gaming.



2.4. CMS Frontend

The Dashboard website, which can be found at https://elevenhero-dashboard.netlify.app/, serves as a centralized platform for administrators only. Administrators are greeted on the Dashboard's home page with a comprehensive overview of the platform's latest updates and key statistics. They can easily navigate through various sections, such as the latest matches dashboard, where they can view match details, scores, and player performances. Furthermore, the stats section provides useful information about user activity, gameplay trends, and overall platform performance.



Home

Hello ronaldo!

Introduction to Dashboard

Welcome to 11Hero Dashboard. Here you can manage all operations of game.

Live Matches

17	0 kheseryoon	—	0 ronaldo	$ Fee 2000 Prize 38000

Stats

Earnings	Transactions	Users
308500	15	2

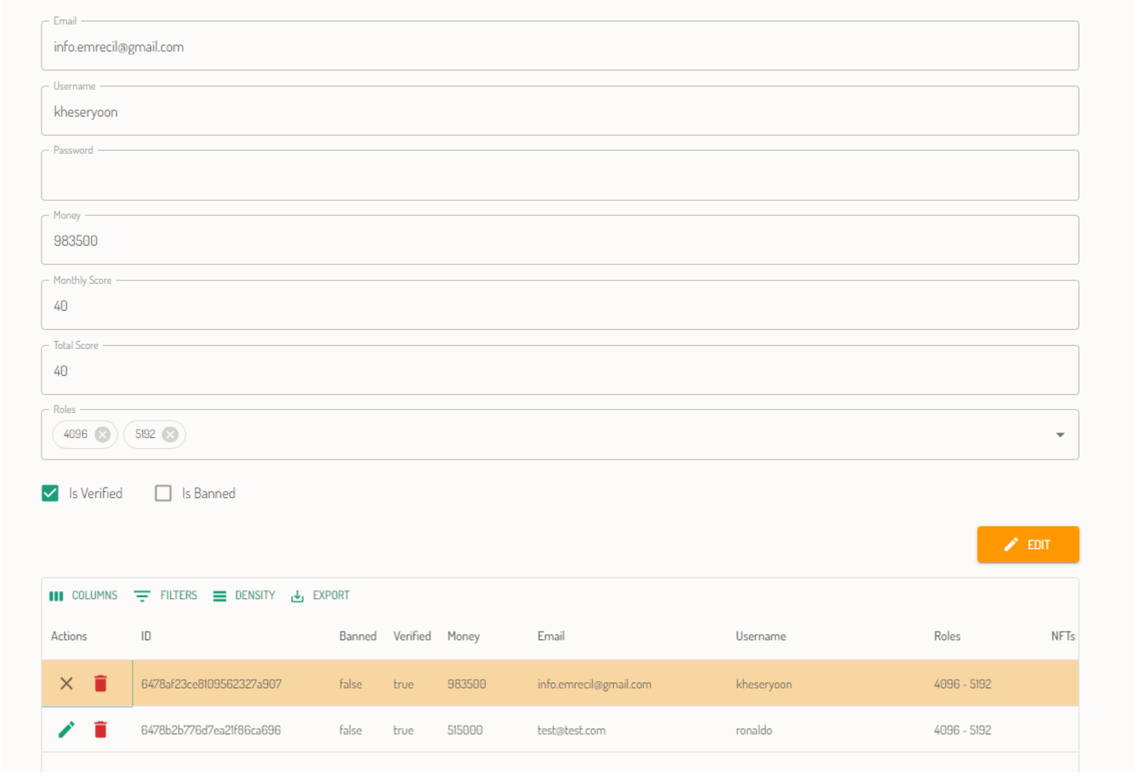
Nfts	Tournaments
46	3

Latest NFTs

Latest Transactions

- Tournament
  Tournament join 64841b7e9254192496f2c657
  6/21/2023, 11:52:09 AM
- Tournament
  Tournament create 64841b7e9254192496f2c657
  6/10/2023, 9:43:10 AM
- Tournament
  Tournament award 648060ea9254192496f2c26a
  6/7/2023, 3:25:00 PM
- Tournament

The Dashboard home page, in addition to match-related information, provides a glimpse into the platform's transactional aspect. Administrators can monitor and manage user transactions, ensuring transparency and accountability. Furthermore, the most recent NFTs section highlights the platform's most recent additions, allowing administrators to keep up with the platform's ever-growing inventory. Overall, the Dashboard home page provides administrators with a centralized hub to oversee and manage various aspects of the ElevenHero platform, ensuring efficient administration, data-driven decision-making, and a seamless user experience.



Email
info.emrecil@gmail.com

Username
kheseryoon

Password

Money
983500

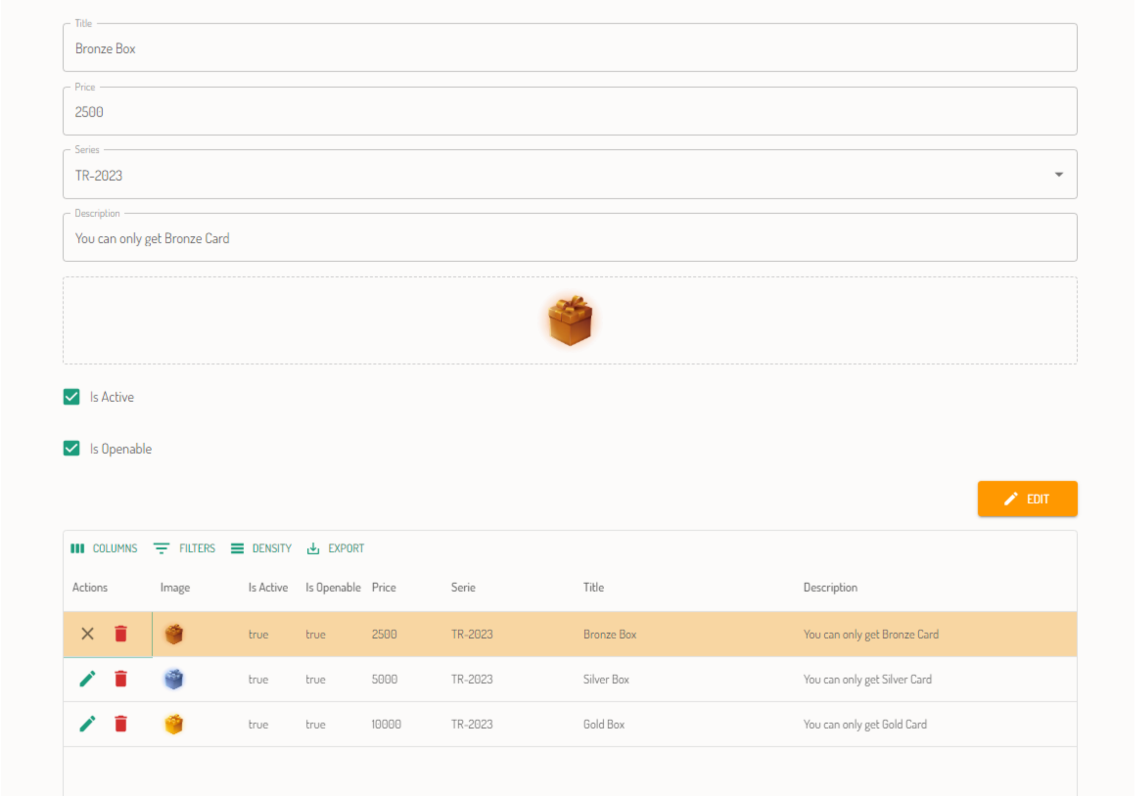
Monthly Score
40

Total Score
40

Roles
4096 ⊗ 5192 ⊗

☑ Is Verified ☐ Is Banned

Actions	ID	Banned	Verified	Money	Email	Username	Roles	NFTs
✕ 🗑	6478af23ce8109562327a907	false	true	983500	info.emrecil@gmail.com	kheseryoon	4096 - 5192	
✎ 🗑	6478b2b776d7ea21f86ca696	false	true	515000	test@test.com	ronaldo	4096 - 5192	



Title
Bronze Box

Price
2500

Series
TR-2023

Description
You can only get Bronze Card

☑ Is Active

☑ Is Openable

Actions	Image	Is Active	Is Openable	Price	Serie	Title	Description
✕ 🗑		true	true	2500	TR-2023	Bronze Box	You can only get Bronze Card
✎ 🗑		true	true	5000	TR-2023	Silver Box	You can only get Silver Card
✎ 🗑		true	true	10000	TR-2023	Gold Box	You can only get Gold Card

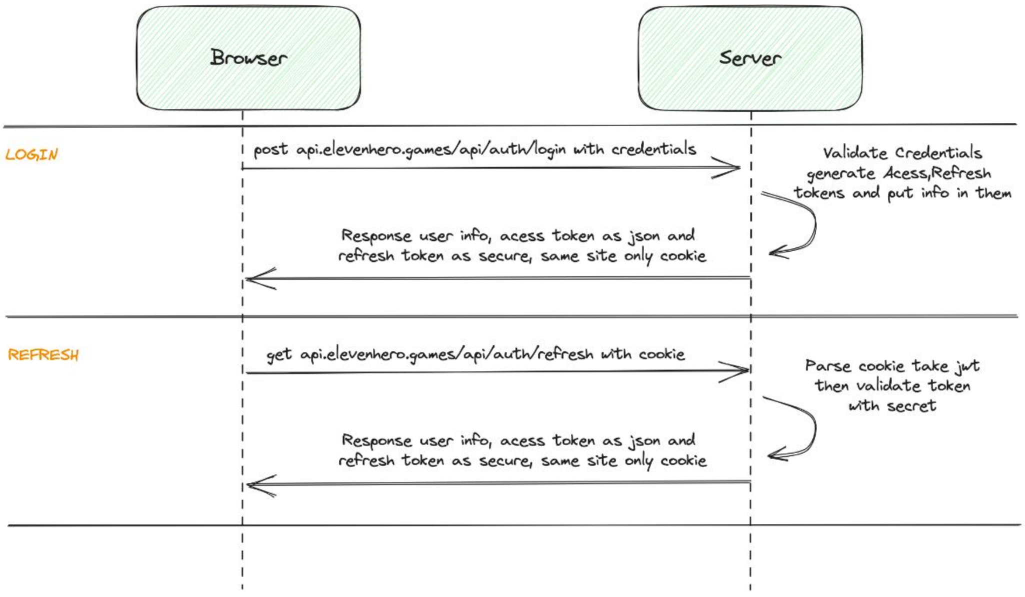
3. MATERIAL AND METHOD

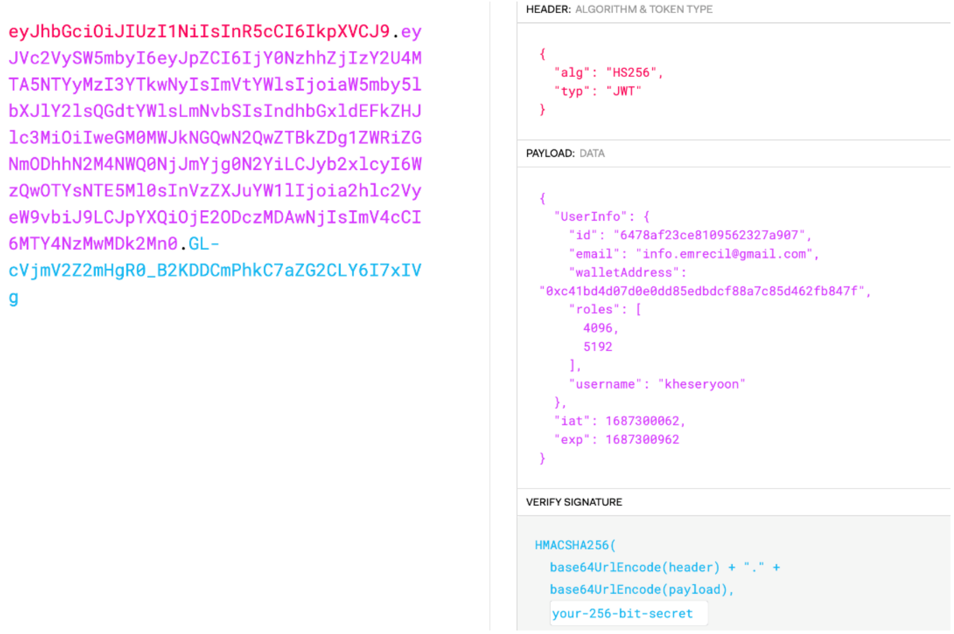
3.1. Security

The ElevenHero platform's security measures are intended to safeguard user data and protect against potential threats. JSON Web Tokens (JWT) ensure secure authentication and authorization, improving the overall security of user accounts and sensitive data. Furthermore, Cross-Origin Resource Sharing (CORS) and Allowed Origins settings are used to control platform access, reducing the risk of unauthorized requests. Helmet.js, a powerful Node.js security package, is integrated to further strengthen the platform by implementing essential security headers and protecting against common vulnerabilities. Sanitization and validation techniques are used to prevent NoSQL injection attacks, ensuring the integrity and security of data stored in the platform's database. Furthermore, the database is protected by a variety of mechanisms, including encryption and access control, to prevent unauthorized access and maintain the confidentiality of user information. These comprehensive security measures provide a solid foundation for protecting the ElevenHero platform and ensuring a safe user experience.

3.1.1. JWT – Auth Security

JSON Web Tokens (JWT) are used for authentication security in ElevenHero. When a user successfully logs in, the server responds with an access token string, which is used for subsequent authenticated API requests. In addition, a refresh token is returned as a secure SameSite-only cookie. This method ensures that both the access token and the refresh token are securely transmitted and stored, lowering the risk of unauthorized access and session hijacking. The platform improves authentication security by using JWT and implementing secure cookie settings, protecting user accounts and ensuring the integrity of user sessions.


Browser
Server
LOGIN
post api.elevenhero.games/api/auth/login with credentials
Validate Credentials generate Acess,Refresh tokens and put info in them
Response user info, acess token as json and refresh token as secure, same site only cookie
REFRESH
get api.elevenhero.games/api/auth/refresh with cookie
Parse cookie take jwt then validate token with secret
Response user info, acess token as json and refresh token as secure, same site only cookie



```
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.ey
JVc2VySW5mbyI6eyJpZCI6IjY0NzhhZjIzY2U4M
TA5NTYyMzI3YTkwNyIsImVtYWlsIjoiaW5mby5l
bXJlY2lsQGdtYWlsLmNvbSIsIndhbGxldEFkZHJ
lc3MiOiIweGM0MWJkNGQwN2QwZTBkZDg1ZWRiZG
NmODhhN2M4NWQ0NjJmYjg0N2YiLCJyb2xlcyI6W
zQwOTYsNTE5Ml0sInVzZXJuYW1lIjoia2hlc2Vy
eW9vbiJ9LCJpYXQiOjE2ODczMDAwNjIsImV4cCI
6MTY4NzMwMDk2Mn0.GL-
cVjmV2Z2mHgR0_B2KDDCmPhkC7aZG2CLY6I7xIV
g
```

HEADER: ALGORITHM & TOKEN TYPE

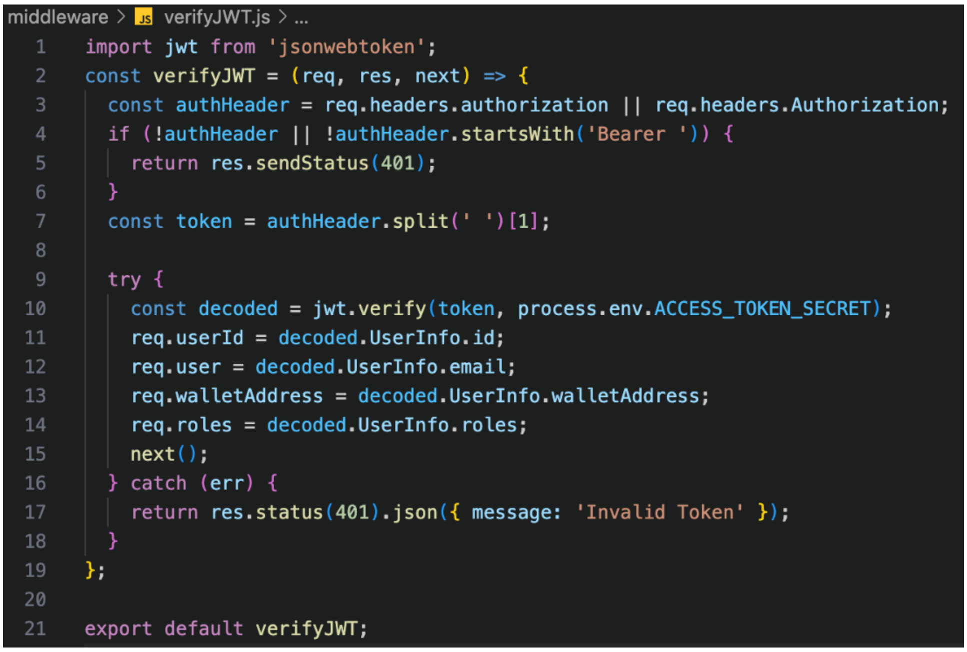
```
{
  "alg": "HS256",
  "typ": "JWT"
}
```

PAYLOAD: DATA

```
{
  "UserInfo": {
    "id": "6478af23ce8109562327a907",
    "email": "info.emrecil@gmail.com",
    "walletAddress":
"0xc41bd4d07d0e0dd85edbdcf88a7c85d462fb847f",
    "roles": [
      4096,
      5192
    ],
    "username": "kheseryoon"
  },
  "iat": 1687300062,
  "exp": 1687300962
}
```

VERIFY SIGNATURE

```
HMACSHA256(
  base64UrlEncode(header) + "." +
  base64UrlEncode(payload),
  your-256-bit-secret
```

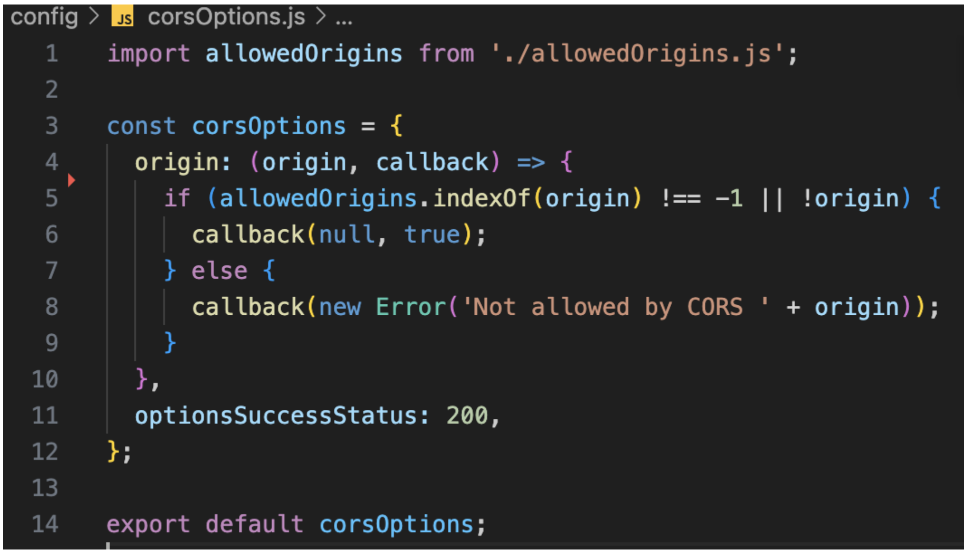


middleware > JS verifyJWT.js > ...

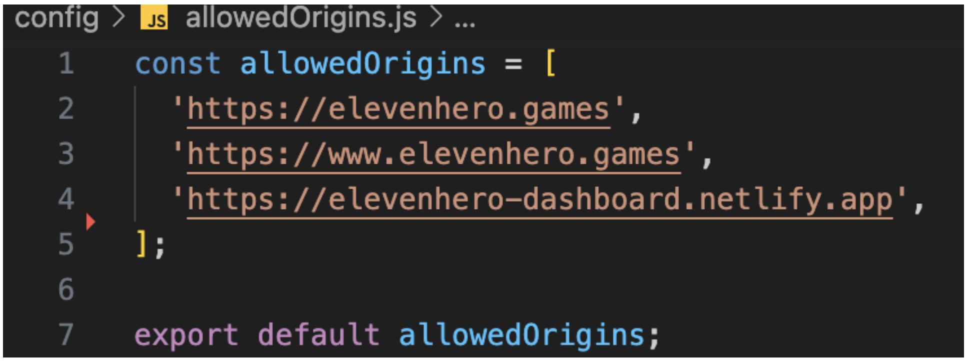
```javascript
import jwt from 'jsonwebtoken';
const verifyJWT = (req, res, next) => {
  const authHeader = req.headers.authorization || req.headers.Authorization;
  if (!authHeader || !authHeader.startsWith('Bearer ')) {
    return res.sendStatus(401);
  }
  const token = authHeader.split(' ')[1];

  try {
    const decoded = jwt.verify(token, process.env.ACCESS_TOKEN_SECRET);
    req.userId = decoded.UserInfo.id;
    req.user = decoded.UserInfo.email;
    req.walletAddress = decoded.UserInfo.walletAddress;
    req.roles = decoded.UserInfo.roles;
    next();
  } catch (err) {
    return res.status(401).json({ message: 'Invalid Token' });
  }
};

export default verifyJWT;
```

3.1.2. Cors & Allowed Origins

Cross-Origin Resource Sharing (CORS) is used in ElevenHero to control and restrict access to the platform's resources from different origins. To ensure secure communication between the client and the server, the application is configured to allow requests from three specific origins, which are whitelisted. The CORS mechanism examines the origin of each incoming request to see if it matches any of the permitted origins. This aids in the prevention of unauthorized access from unauthorized sources, reducing potential security risks and protecting the system from cross-origin attacks. ElevenHero maintains a controlled and secure communication channel with trusted clients by implementing CORS and specifying the allowed origins.



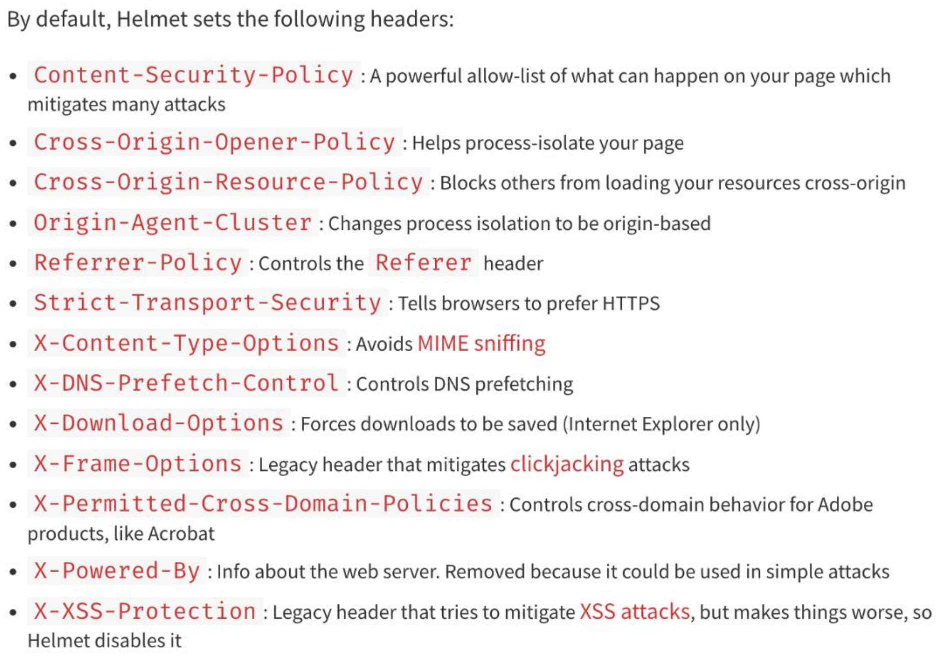
```
import allowedOrigins from './allowedOrigins.js';

const corsOptions = {
  origin: (origin, callback) => {
    if (allowedOrigins.indexOf(origin) !== -1 || !origin) {
      callback(null, true);
    } else {
      callback(new Error('Not allowed by CORS ' + origin));
    }
  },
  optionsSuccessStatus: 200,
};

export default corsOptions;
```



```
const allowedOrigins = [
  'https://elevenhero.games',
  'https://www.elevenhero.games',
  'https://elevenhero-dashboard.netlify.app',
];

export default allowedOrigins;
```

3.1.3. Helmet.js - Node security package

Helmet.js is a popular security package for Node.js applications such as ElevenHero. It provides critical middleware functions to improve application security by setting various HTTP headers. These headers aid in the prevention of common web vulnerabilities like cross-site scripting (XSS), clickjacking, MIME sniffing, and other malicious activities. ElevenHero ensures that these security headers are properly configured and automatically added to the server's HTTP responses by integrating Helmet.js into the application. This proactive security approach strengthens the application against potential attacks, making it more resilient and less vulnerable to known security vulnerabilities.



By default, Helmet sets the following headers:

- `Content-Security-Policy` : A powerful allow-list of what can happen on your page which mitigates many attacks
- `Cross-Origin-Opener-Policy` : Helps process-isolate your page
- `Cross-Origin-Resource-Policy` : Blocks others from loading your resources cross-origin
- `Origin-Agent-Cluster` : Changes process isolation to be origin-based
- `Referrer-Policy` : Controls the `Referer` header
- `Strict-Transport-Security` : Tells browsers to prefer HTTPS
- `X-Content-Type-Options` : Avoids MIME sniffing
- `X-DNS-Prefetch-Control` : Controls DNS prefetching
- `X-Download-Options` : Forces downloads to be saved (Internet Explorer only)
- `X-Frame-Options` : Legacy header that mitigates clickjacking attacks
- `X-Permitted-Cross-Domain-Policies` : Controls cross-domain behavior for Adobe products, like Acrobat
- `X-Powered-By` : Info about the web server. Removed because it could be used in simple attacks
- `X-XSS-Protection` : Legacy header that tries to mitigate XSS attacks, but makes things worse, so Helmet disables it

3.1.4. Prevent NoSQL Injection

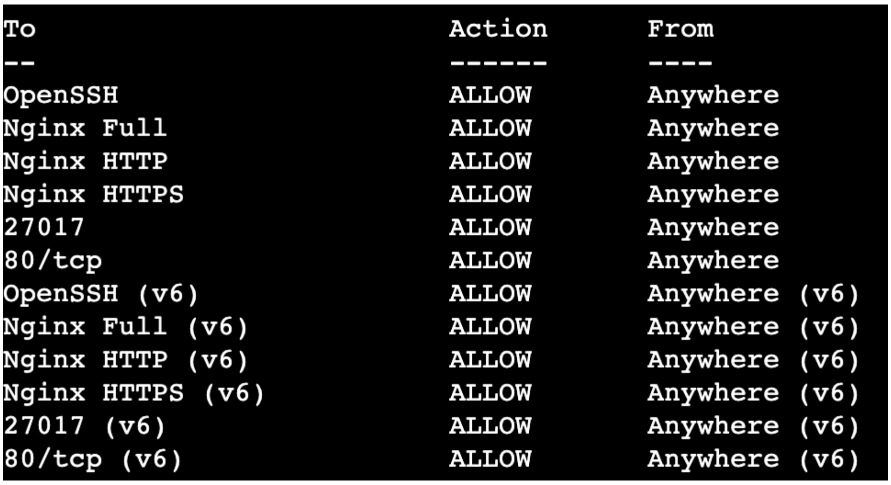
ElevenHero uses the "express-mongo-sanitize" library to prevent NoSQL injection attacks. This library aids in the sanitization of MongoDB user inputs and queries by automatically detecting and removing any potentially malicious or unauthorized characters that could be used for injection. ElevenHero mitigates the risk of NoSQL injection vulnerabilities by sanitizing user inputs, ensuring that only safe and valid data is passed to database queries. This proactive approach helps to maintain the application's data's integrity and security and protects against potential data breaches or unauthorized database access.

3.1.5. Secure the database

ElevenHero uses secure credentials to improve the security of the MongoDB database. This entails creating one-of-a-kind and secure usernames and passwords for accessing the MongoDB instance. ElevenHero ensures that only authorized users can connect to the database and perform operations by establishing strong authentication credentials. This safeguard protects sensitive database data and prevents unauthorized access. ElevenHero also adheres to best practices such as regularly updating credentials, implementing role-based access control, and enforcing secure connection protocols to further strengthen the MongoDB database's security.

3.1.6 Server Firewall (UFW)

ElevenHero employs the Uncomplicated Firewall (UFW) utility to improve server security. UFW makes it simple to manage firewall rules on the server. ElevenHero has set up UFW to accept incoming traffic on critical ports like 80 (for Nginx), MongoDB routes, and OpenSSH. ElevenHero reduces potential security risks and unauthorized access attempts by carefully defining and restricting access to these specific ports. UFW serves as an extra layer of defense, effectively controlling network traffic and assisting in the protection of the server and its services from potential threats.



```
To                         Action      From
--                         ------      ----
OpenSSH                    ALLOW       Anywhere
Nginx Full                 ALLOW       Anywhere
Nginx HTTP                 ALLOW       Anywhere
Nginx HTTPS                ALLOW       Anywhere
27017                      ALLOW       Anywhere
80/tcp                     ALLOW       Anywhere
OpenSSH (v6)               ALLOW       Anywhere (v6)
Nginx Full (v6)            ALLOW       Anywhere (v6)
Nginx HTTP (v6)            ALLOW       Anywhere (v6)
Nginx HTTPS (v6)           ALLOW       Anywhere (v6)
27017 (v6)                 ALLOW       Anywhere (v6)
80/tcp (v6)                ALLOW       Anywhere (v6)
```

3.1.7 Secure Nginx with Let’s Encrypt

ElevenHero has implemented Let's Encrypt SSL/TLS certificates for Nginx to ensure secure communication over HTTPS. This procedure entails using tools such as Certbot to obtain and renew SSL certificates automatically. Let's Encrypt improves the security and privacy of user interactions with ElevenHero's website by encrypting data transmitted between clients and the server. The Nginx server is configured to support secure HTTPS connections using Let's Encrypt's automated certificate management, providing users with a trusted and encrypted browsing experience.

4. CONCLUSIONS

In order to give players an immersive and compelling gaming experience, this senior project has explored the creative application of blockchain technology and NFTs in the creation of a Football Manager game. Different facets of software engineering have been addressed throughout the project, including frontend and backend development, network system design, security considerations, and user interface design.

To serve players with a seamless and satisfying gaming experience, the frontend development team concentrated on creating a user-friendly and aesthetically pleasing interface. Player attributes, match simulations, database management, and overall game logic were all handled by the backend development. The network system design enabled multiplayer interactions and real-time gameplay, encouraging player cooperation and rivalry.

Security was prioritized in this project to protect sensitive user data and ensure the game's integrity. To protect user information and prevent unauthorized access, measures such as JWT authentication, CORS and allowed origins, Helmet.js for node security, NoSQL injection prevention, database security, and implementing a server firewall (UFW) were implemented.

The addition of NFTs and blockchain technology to the game added a layer of transparency, immutability, ownership, and rarity. The NFT cards that represented individual players gave the players a sense of ownership by allowing them to collect, trade, and manage these digital assets. The randomness and uniqueness of each NFT card's attributes added to the game's authenticity and rarity.

This project demonstrated the potential applications of NFTs in the gaming industry, specifically in football management simulation. This project demonstrated how cutting-edge technologies such as NFTs and blockchain can be incorporated into established gaming frameworks, providing players with a unique and cutting-edge gaming experience.

Throughout the course of this senior project, various computer science skills and knowledge were applied, such as image processing, software engineering, UI design, web development, backend development, and more. This project not only added to the field of computer engineering, but it also demonstrated the practical application of learned concepts and technologies.

Finally, this senior project achieved its goal of creating a Football Manager game that fully utilizes NFTs, providing players with an engaging and immersive gaming experience. The integration of NFTs and blockchain technology, as well as the implementation of robust security measures, frontend and backend development, and network system design, has resulted in a unique and innovative gaming platform that challenges traditional gaming frameworks.

5. REFERENCES

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https://www.npmjs.com/package/helmet

https://helmetjs.github.io/

6.CURRICULUM VITAE

Emre ÇİL was born on November 28, 2001 in Istanbul. He completed his primary, middle, and high school education in Istanbul. In the year 2019, he enrolled in the Department of Computer Engineering at Akdeniz University.