BranchClash: A Fully On-Chain Tower Defense Blockchain Game with New Collaboration Mechanism

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ABSTRACT

Mainstream blockchain games have drawn criticism for prioritizing economic systems over gameplay experience. Influenced by these economically-centered games, existing research on blockchain games predominantly focuses on the financial sector. We have developed BranchClash, a fully on-chain tower defense game on the Sepolia testnet of Ethereum. It introduces chain collaboration, a novel non-economically-centered game mechanism inspired by blockchain technology. BranchClash aims to expand unique game mechanics in blockchain games and explore innovative cooperative modes within the decentralized ecosystem.

CCS CONCEPTS

• **Human-centered computing** → *Collaborative interaction.*

KEYWORDS

blockchain game, game mechanism, collaboration

1 INTRODUCTION

Blockchain games are a specific genre of video games that are developed as decentralized applications (DApps) [3]. These games play a vital role in the current Web 3.0 ecosystem based on blockchain technology [11]. In the field of traditional video game research, games are commonly deemed as microcosms of the real world

[5, 10]. Players within video games are not only influenced by the real world [4, 14, 15], but also possess the capacity to impact their real-life experiences [1, 2, 16].

However, the scope of research on blockchain games is currently constrained by the market and projects. Following the success of CryptoKitties[1], mainstream blockchain games have predominantly focused on the play-to-earn (P2E) model [6]. The core gameplay mechanics of these games revolve around breeding and selling higher-priced non-fungible tokens (NFTs). Furthermore, many of them are not fully decentralized, failing to inherit the decentralized properties of the blockchain, as exemplified by the well-known AXIE INFINITY [2]. These games rely on developer-controlled services instead of operating independently through smart contracts. which are primarily used for minting or transferring NFTs.
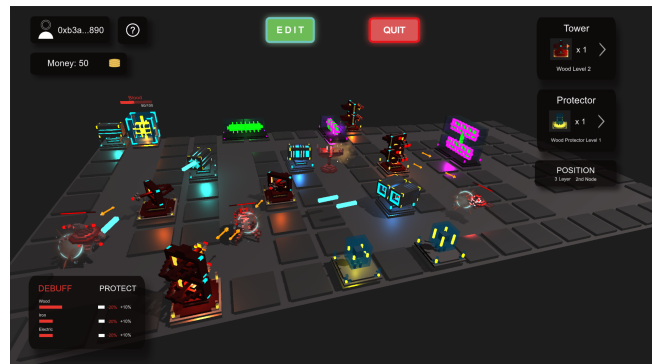

Figure 1: The interior of tower defense level

Additionally, blockchain casinos are another common form of blockchain games that have migrated from traditional online casinos to take advantage of anonymity and transparency. Conversely, only a few blockchain games deviate from economic-centric to explore the unique game mechanics, such as Dark Forest [3]. These alternative games have piqued the interest of researchers in exploring decentralized social structures [8, 17]. However, affected by the

[1]https://www.cryptokitties.co/
[2]https://axieinfinity.com/
[3]https://zkga.me/

economically-centered blockchain games market with the disadvantage of simple user behavior and poor gameplay [9], related academic researches lack a diverse foundation and predominantly revolves around economic systems [7, 12, 13].

We have developed BranchClash, a fully on-chain tower defense game that incorporates an innovative game mechanism called "chain collaboration". The game is deployed on the Sepolia testnet of Ethereum to avoid gameplay costs. BranchClash relies on a smart contract as its independent core, with a Unity-developed website (www.branchclash.com) as the graphical user interface and a server as the data cache. The interface of the tower defense level interior is shown in Figure 1. BranchClash expands on the limited gameplay mechanisms typically found in blockchain games and presents a novel cooperative model within the decentralized ecosystem. Through playing this game, we hope to highlight blockchain games' potential beyond economic aspects.

2 GAME MECHANISM

In the "chain collaboration" game mechanism, players, analogous to blockchain miners, create new levels based on the levels of predecessors, similar to creating blocks on a blockchain.
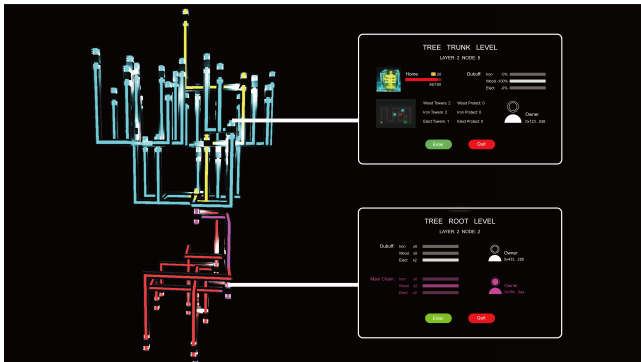

Figure 2: Two different modes on the main interface

As shown in Figure 2, BranchClash depicts two distinct modes: the blue Tree Trunk Mode (representing tower defense) and the red Tree Root Mode (representing debuffs that decrease the success rate of the trunk level). These modes correspond to two different groups of players. On the main interface, each glowing cube represents a level, similar to a block of the blockchain. These levels form a tree-like structure consisting of multiple chains that originate from the same initial level. Each player must select an existing level and inherit all its attributes, including tower layout, money, and debuffs, to play the next difficulty level. The experience of this process will add a new level to the branch, analogous to the addition of a block to a blockchain. Therefore, when players engage with each level, they are collaborating with all the strategies created by the players on the same chain to complete level challenges.

To enhance player freedom and promote a dynamic gaming experience, BranchClash encourages the concept of forking. When multiple players choose to play the same level, it results in the formation of multiple chains. The longest one in the whole game will be identified as the main chain. Players should design levels that offer optimal solutions or possess unique qualities to attract a larger player base and extend the length of their chain. Levels and

their creators on the main chain are awarded special colors as visual distinction. Additionally, debuffs implemented in levels on the main chain of the root will affect the levels at the corresponding height on the trunk. The interplay between two player groups, trunk and root, continuously influences the status of their respective main chains. As a result, players are motivated to devise diverse strategies to secure an advantage of their chain.

"Chain collaboration" requires players to cooperate with other players on the same chain, while competing against players from different branches or modes, aiming to extend their own chain.

3 TECHNOLOGY

As a fully on-chain game, the entire mechanisms of this demo are reliant on the smart contract. Each level of the game is stored in a mapping format within the contract on blockchain, where the key represents the level sequence, and the value is a struct that contains all the level information. The smart contract provides 'Write Functions' for creating levels, adding or upgrading towers, and performing numerical calculations. Additionally, it offers 'Read Functions' that allow players to view string-based outputs, such as tower defense layouts, level relationships, and remaining health points. By interacting with the smart contract, players can perform all game operations. Hard-core players can even extensively download tower defense layouts created by other players using the Ethereum API to analyze and optimize their own strategies.
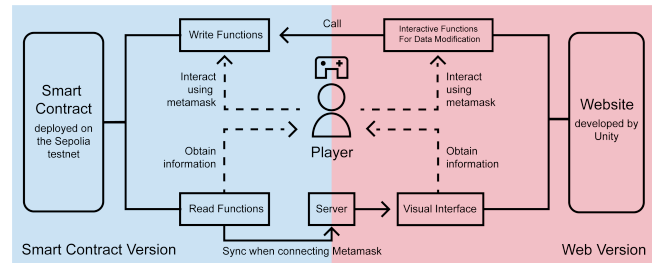

Figure 3: Smart contract version and web version

Although the smart contract fulfills all the operational requirements of the game, we have leveraged Unity to develop a web version, aiming to enhance players' gaming experience. As shown in Figure 3, the web version serves as a graphical user interface for the smart contract. On the website, all operations related to modifying game data directly call the corresponding 'Write Functions' of the smart contract through Metamask extension. The visual display on the website is generated using information retrieved from the smart contract's 'Read Functions'. Furthermore, to mitigate the low access speed of on-chain information, we employ a centralized server as the data cache, which does not involve any modification operations to the game data. This server stores the data obtained from the 'Read Functions' and synchronizes the on-chain information whenever a player connects to Metamask. By adopting this approach, players can avoid the long waiting time caused by loading all the on-chain information from scratch.

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