

CRYPTOCOINOPOLY: A Real Time Online Multiplayer Board Game

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Abstract—With the insurgence of cryptocurrency and the thriving business of mobile games, games related to cryptocurrency have gained enormous interests in recent years. This paper presents a real time online multiplayer board game, Cryptocoinopoly, which is a hybrid of the existing Cryptocoinopoly board game and Monopoly. Unity (a cross-platform game engine) has been used in the development process together with Photon Unity Networking (PUN), which is a Unity package for creating online multiplayer games. At the abstract level, Cryptocoinopoly is represented by Remote Database, Game Server, Network, Application (Game), Local Database and Client components. Notable functions such as allowing users to play the game with multiple people and for no matter how many rounds they desire; allowing users to invest into the cryptocurrency market at any time and allowing users to trade their assets with other players have been successfully implemented. Functionality testing and debugging have been conducted under constrained conditions with limited resources due to the on-going Covid-19 situation. Despite the challenges, all functional and non-functional requirements of the prototype have been fulfilled.

Keywords—multiplayer board game; cryptocurrency; mobile game; unity

I. INTRODUCTION

With the insurgence of cryptocurrency and the thriving business of mobile games, games related to cryptocurrency have gained enormous interests in recent years. There are many Monopoly-like board games such as Business Game: Monopolist [1] and Europoly available in the market today. However, there are some rules which are rarely obeyed, and some new features that should be updated for a better player experience. For instance, these games still include the rule of

auctioning the land if the player has decided to not buy it upon landing on it, which is not commonly followed these days. Cryptocoinopoly was created by network users by modifying the existing game of Monopoly to incorporate Cryptocurrency market. The game is available on GitHub, but it requires players to print and play with a physical board.

Our version of Cryptocoinopoly is a hybrid of the existing Cryptocoinopoly board game and Monopoly. Players can experience classic land trading and modern cryptocurrency market in a single game. The game introduces a cryptocurrency market that simulates the real-world cryptocurrency market where players can invest in anytime. Therefore, player don't have to put all their eggs in one basket. While buying more properties, players can also invest in the cryptocurrency market to maximise their profit by investing in different cryptocurrencies that would react differently on the same event. As a result, players can build a more balanced and diversified portfolio by spreading their assets across various financial instruments. Furthermore, the game was simplified by integrating Chance cards into the Community Chest.

II. LITERATURE REVIEW

Due to the rapid advancement of technology and networking, it is fair to say that the significance of software engineering in daily life increases with the dependency of human on technology. This indicates that the human lifestyle had been affected in many aspects such as education, working, living, learning and entertainment. One of the important entertainments in our daily lives are video games. Game is a software application in which one or more players make decisions by controlling game objects and resources, in the pursuit of its goal [2]. Video games are extremely popular among people of all ages, as we are living in an era of

advanced technology where Wi-Fi is available anywhere. Anyone can easily install video games on their consoles, hardware devices, and cell phones. As more and more people like to play games, more are also motivated to design their own games. Developing video games is an intricate task as developing video games requires collaborative effort from everyone in a team.

In recent years, evolution in smart technologies are changing the ways we play games, such as in [3], a game set has been used for a real world engineering problem. Since 2012, the market percentage for mobile games have shown an increase by 39% [4]. By providing entertaining games that are easily accessible, the proportion of users playing video games on smartphones, tablets, and etc. have shown a significant increase as compared to their PC (Personal Computer) and console counterparts. This trend indicates that, nowadays, majority of users favour mobile games that can be enjoyed on the go, and thus, highlighting the potential for mobile gaming in the near future. Classic and new board game applications are estimated to have a continuous upward trend in the future based on the current statistics.

According to the Mobile Operating System Market Share Worldwide in October 2020, Android [5] has the highest market share among all the other operating systems, making up a total of 72.92%. This project is developed using Unity [6] because the engine itself supports game building on more than 25 different platforms including Android, iOS, Windows and MacOS. Besides that, Unity has an intuitive interface. While writing a code in Unity, you can define the behaviours of an object by simply attaching a script to it. This allows quick testing, prototyping, and balancing while the game is being built.

Monopoly allows the players to perform multiple actions on the property or tile they land on. Player can buy properties, and charge other players rent when they land on a property. The more properties the player acquires, the higher chances that the player will earn more money. The Game of Life is like Monopoly, but it only allows players to choose their life path. Meanwhile, it also teaches the player money concepts such as the importance of career and income. In Puerto Rico, the goal is to teach players about cash management and the importance of investments. Players experience how investments could positively or negatively impacted by various changes in the market which is beyond their control.

However, nowadays, people tend to have multiple income streams and there are many types of investments available such as cryptocurrency trading [7]. Therefore, merely investing in properties is not enough to let player learn how to manage their assets efficiently. It was observed that Monopoly and other similar games lacked an investment market. Thus, we had decided to incorporate a cryptocurrency market into our H-Cryptocoinopoly.

III. CRYPTOCOINOPOLY OVERVIEW

The main aim of this work is to create a online multiplayer board game, which is similar to the existing game of Monopoly. Cryptocoinopoly was based on the economic concept of monopoly, where a specific enterprise was the only supplier or owner of a particular good and had full control of

its market in a particular instance. The game itself is playable by 2 to 6 players moving around the board to buy, sell or trade the properties with in-game money or with cryptocurrency, developing properties with mining rigs and farms, landing on specific blocks for Community Chest cards, and collecting rent from opponents. The general assumptions made were that players are already familiar with the current Monopoly rules and that they have a Wi-Fi connection for an online multiplayer game. Furthermore, Cryptocoinopoly targets audiences from all age ranges as long as they are literate in English.

The technique of gamification [8] has been used in this work, which is a process of integrating game mechanics into existing things to better stimulate people's natural desires, participation, commitment, and loyalty. It introduces game design elements into non-game applications, often used in competition, scores, achievements, game rules, status, self-expression, and many other game mechanisms to encourage user actions and make non-game applications more interesting and vivid.

IV. CRYPTOCOINOPOLY DESIGN SPECIFICATIONS

In this section, the design specifications of Cryptocoinopoly is elaborated.

A. System Design

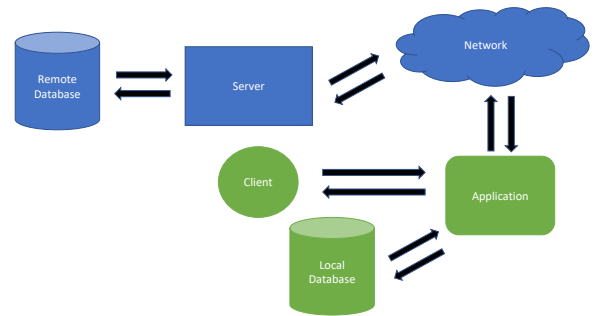


Figure 1. Cryptocoinopoly system architecture.

At the abstract level, Cryptocoinopoly is represented by 6 main components: Remote Database, Game Server, Network, Application (Game), Local Database and Client as shown in Fig 1.

- Remote Database: All players' data are stored here and can be accessed by other players via the Game Server.
- Game Server: The server used in this game is Photon Unity Networking (PUN). It hosts and handles all the server events such as connection, disconnection, room creation, room joining, etc. It also handles events such as turn switching and host transferring.
- Network: Connects the game to the remote server.
- Application (Game): The game interface that players directly interact with. It retrieves data from the remote database and stores it in the local database. It displays data from the local database.

- Local Database: Stores data that is currently used by the player.
- Client: The player that is using the application.

B. Game References

The Cryptocoinopoly's game rules have a reference on the current popular board game Monopoly's game rules (howdoyouplayit, n.d.) and the existing Cryptocoinopoly [7] which can be found online with additional mechanics such as a virtual tradable cryptocurrency market. The names of Cryptocoinopoly's properties were referenced from the names of existing cryptocurrencies in the real time market as the theme of the game is built around cryptocurrency, whereas the names of cryptocurrencies in the virtual cryptocurrency market were named by our team.

C. Game Design

1) *Game Category*: Cryptocoinopoly is a mobile 2D multiplayer online board game which can be played by 2 to 6 players in one room. A 2D game means that the game is being built with two-dimensional geometry, by having the game objects to appear as sprite objects on the surface of the game. Multiplayer online games which are also known as Massively Multiplayer Online Game (MMO or MMOG) can support multiple players playing the game on the internet at the same time [9]. Boardgames are games that have a central board for players to interact with each other during the gameplay by having tokens or avatars being placed on the board to represent the players.

2) *Game View*: Cryptocoinopoly is created by using the Unity Development Platform. It implements 2-dimensional geometry graphics. The overall view of the game is the board, which is the map of the game. Its board image is placed on a two-dimensional plane and the player's avatars, mining rigs, mining farms, and cards are shown in 2-dimension as well. Besides that, a virtual cryptocurrency market is designed for the virtual cryptocurrency trading mechanic of the game. The market would automatically control the prices of the cryptocurrency every round throughout the game triggered at the end of each round. In addition, cards from the Community Chest that can affect their prices such as virtual global market news, effect cards, etc are also designed according to their functions.

3) *Game Animations and Sound Effects*: Cryptocoinopoly is comprised of animations and sound effects throughout the whole gameplay. Sound effects play when certain events in the game occur, such as rolling the dice, pressing on a button, etc. An animation would be played when a player moves around the board or when it is idle, an hourglass depicting the timer rotates.

D. Game Features

1) *Cryptocurrency Market*: Aside from the usual features provided by Monopoly, a cryptocurrency Market which simulates the real-life cryptocurrency market is implemented.

Players can access the cryptocurrency market to buy or sell cryptocurrencies be it their turn or other players' turn. At the end of each round, a random event will be triggered to affect the cryptocurrencies' prices. Besides that, there are 6 events available in the Community Chest to trigger cryptocurrency events.

2) *In-game Chats*: There is a "chat" button that will display a chat panel when pressed. Players can use the chat panel to communicate with each other. Besides that, whenever there is an event during the game such as a trade request or whenever a player rejects or accepts a trade request. A dialog message will be sent back to the trade sender to notify the sender whether the trade is accepted or rejected.

3) *Community Chest*: Community Chest contains a total of 20 events such as announcements and cryptocurrency's news, that can be triggered in the game. The original Chance is merged with Community Chest, providing more randomness to the game. The Community Chest events can be triggered by drawing cards whenever a player lands on a Community Chest tile. The card drawn will be shown to all the players

4) *Cryptocurrency Market*: Another significant feature in our game is that players shall be able to invest into the cryptocurrency market at any time. This feature keeps players engaged as there will be random events throughout the game that will either increase or decrease the price of the cryptocurrencies that the players can invest into, to give them an advantage over one another. As players can invest into the market, they are also able to withdraw the money they have invested along with any profit or loss they have from investing.

5) *Trading*: Players are also allowed to trade their assets with other players. Assets include property and player's money. To do so, a player simply press the trade button indicated by a "handshake" icon, then select the player that they want to trade with and indicate which property and amount of money they would like to trade and vice versa. After submitting the request, the other player selected will be given the option to accept or decline the offer.

V. CRYPTOCOINOPOLY IMPLEMENTATION

A. Developing Environment

The development environment consists of two parts: local and public. Local represents the game being installed on the mobile device whereas public represents the server which facilitates the transfer of data between the mobile devices. Unity is used as this game development platform allows us to build cross-platform applications and monitor the real time changes during the development process. The coding language used in Unity is C#, which is developed by Microsoft, and is similar to C and Java.

B. Photon Unity Networking (PUN)

Cryptocoinopoly uses PUN to host a remote server and connect multiple players at once. PUN has a tight Unity

integration which allows users to easily develop and launch multiplayer games. A free license which provides for a maximum of 20 connections is used for the game. Photon Chat is also employed to allow in-game chat between players.

Host Creates Room: The player creates the room by setting its room number, maximum number of players and rounds. After creating the room, the player is identified by the server as the master client. When all the players have entered the room, the room is closed, and the master client is allowed to start the game.

```
// When connected at the first time
public void OnConnected()
{
    // Print state connected
    print("***** Connected");
    connectionState.text = "Connected";

    // Chat connects to their room number channel
    this.chatClient.Subscribe(new string[] { roomNo.ToString() });
    // Print connected in the chat
    DialogText.text = "Connected\n\n";
    // Set status to online
    this.chatClient.SetOnlineStatus(ChatUserStatus.Online);
    // Set Player ID
    GameDisconnectObj.GetComponent<GameDisconnect>().InitialiseCurrPlayerID();
    // Set Sprite Icons
    gameControl.GetComponent<GameControl>().SetSpriteIcon();

    //Limit fps
    QualitySettings.vSyncCount = 0;
    Application.targetFrameRate = 60;
}
```

Figure 2. In-game chat source code.

Sync Cryptocurrencies: Hash tables are used to set the room's properties and keep data that is constantly updated, accessed by all players, and displayed throughout the game. For instance, the current prices of each cryptocurrency were

initialised and set when the room is created. When the price of any cryptocurrency is changed, the `OnRoomPropertiesUpdate()` function is called, and all players are able to access the latest change.

In-Game Chat: As shown in Fig. 2, Photon Chat is used to build the in-game chat. When the players enter the game scene, their chat will be connected to a channel with their room number as their channel name as shown in the picture below at the line `"this.chatClient.Subscribe (new string[] {roomNo.ToString() })"`. This is to prevent other game rooms using the same server to share the same chat channel.

C. Game Scene

The typical game scene is shown in Fig. 3, which splits between the board and the user interface that the players can interact with. An image of the board is displayed alongside the player pieces and the dice. When a property on the board is pressed on, a property card will be displayed to the user, showing the details of the property such as the rental price. The right side of the screen is separated into three sections, the top section displays the time left in the round, the price of the cryptocurrencies, rounds left in the game and the name of the current player's turn. The middle section shows the players' details, such as the name and the amount of money they hold. When the name is pressed, a popup containing the selected player's properties and the number of cryptocurrencies are displayed. The bottom section is where the player interacts with the game such as rolling the dice, purchasing cryptocurrencies, trading with other players, mortgaging properties, in-game chat and settings menu. A chat box is also located at the bottom, displaying the latest message.



Figure 3. Cryptocoinopoly game scene.

D. Testing

The testing of the game was done at regular intervals, namely when a new feature was added into the game. Test

cases featured detailed explanation on the user's actions and how the game should respond to those actions. Regression testing was conducted throughout the development of the

game to ensure that old features were not affected by new features. After all features were added, the game was tested again to ensure all bugs had been ironed out. Major bugs which affected the stability of the game were prioritized, followed by less impacting bugs.

The sample testing results of Functional and Non-Functional Requirements are shown in Table I.

TABLE I. SAMPLE FUNCTIONAL AND NON-FUNCTIONAL REQUIREMENTS TESTING RESULTS

Test Case No. (Functional Requirement No.)	<i>Functional Requirement</i>	<i>Result</i>
1	Host shall be able to decide the number of players and the number of rounds played when creating a room.	Pass
2	Players shall be randomly assigned an avatar upon joining a room.	Pass
3	Players shall be able to see their total amount of money, and the breakdown of properties and cryptocurrencies they have anytime during the game.	Pass
4	Player shall be able to leave or stay to spectate the game after he or she has declared bankruptcy.	Pass
5	Players shall be able to withdraw their money from the cryptocurrency market at any time.	Pass
6	Players shall act according to the words stated on the Community Chest card once drawn.	Pass
Test Case No. (Non-Functional Requirement No.)	<i>Non-Functional Requirement</i>	<i>Result</i>
1	The game shall be playable on Android mobile devices with versions OS 4.1 or later ARMv7 CPU with NEON support or Atom CPU OpenGL ES 2.0 or later.	Pass
2	The game shall be designed with 2-Dimensional graphics.	Pass
3	The game shall be a multiplayer game with a minimum of 2 players and a maximum of 6 players.	Pass
4	The game should be viewed and played in a horizontal manner.	Pass
5	The game should be viewed in the fixed side perspective only.	Pass

VI. CONCLUSION

In this paper we present Cryptocoinopoly, which is a real time online multiplayer board game. Such game is akin to the

game of Monopoly on a mobile device in the Android environment. We have successfully fulfilled every criterion stated by the functional requirements in the final version of our game. One of our most notable functional requirements is that the host shall be able to decide the number of players and the number of rounds played when creating a room. We have provided the option for the host to decide prior to creating a room, the number of expected players, up to a maximum of 6 players per room, and the number of rounds per game, up to a maximum of 80 rounds. This allows the user to play the game with multiple people and for however many rounds they desire.

Although the prototype is considered a success overall, further work is certainly required to disentangle the complexities in the development of the game. Firstly, suitable software design patterns should be used in designing the game. Secondly, more effort should be added in the documentation of the design patterns used which may be in the form of simple comments in the source code, in order to improve the readability and maintainability. Last but not least, the minimum of 3-level testing; unit testing, integration testing and system testing, should be conducted as part of the standard software quality assurance process.

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