Implementation of Vector Algebra and The Hybrid Pseudo Random Number Generator in Android Game of Kuaci

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Abstract. Kuaci is a game property made of plastic and has various unique shapes. Two to ten people usually play Kuaci game in turn. The game starts with determining how many Kuaci will be at stake, and then each player puts the Kuaci into a box. At a distance of one foot from the box, a first straight line is made, and at a distance of two meters from the first line, the second line is created. From the second line, the kuaci master is thrown to the first line to determine the turn. The player's turn is sorted from the closest one to the first line to the furthest from the first line. The first player tosses the Kuaci master into the box until the Kuaci master and the regular pieces located inside the box are out, then from the place where the Kuaci was thrown, the player aims at the opponent to eliminate it. If other players have been eliminated, then the player has won the game. The game was built on Android smartphone that has recently become the biggest contributor to the technological development of the traditional games. The authors implemented Vector Algebra in determining the direction of the computer player Kuaci master and The Hybrid Pseudo Random Number Generator on the determination of the throwing power of the computer player Kuaci master so the computer player can balance the game with the user. These methods implementation is to assure the user to play the game without eliminating the essence of the game such as managing the strategy to defeat the opponent. As a result, the performance of the opponent's Kuaci master can run according to the difficulty of each game.

1. Introduction

Games are becoming more popular among the people today. A game is an activity that one engages in for amusement or fun. \cite{1}. The game is classified into two types, namely Modern and Traditional games. The modern game implements technological aspect in the application \cite{2}. While the traditional game is the product of the culture itself which in it, contains many educational values because in the activities of the game gives a learning point with a sense of fun, happy, cheerful in children who play it. Also, the game is played in groups, resulting in the sense of social activities between friends, and the game equipment of traditional games is relatively simple \cite{3}. In principle, the names of traditional games vary in each region. This causes the difficulties in finding the origin and the creator of the game. Examples are congklak, hide and seek, kuaci, and so on.
Kuaci is game equipment made of plastic and has numerous appealing shapes. Kuaci game is typically played by 2-10 people in turn. The game starts when the players set the number of Kuaci to be bet. Each player places the approved number of Kuaci pieces into a box. At a distance of one foot from the box is made a first straight line. Then a second line was drawn at a distance of two meters from the first line. From the second line, the Kuaci master is thrown to the first line to determine the turn. The turns are sorted from the closest one to the first line to the furthest. The first player throws the Kuaci master into the box until the Kuaci master and regular pieces located inside the box are out, then from the place where the Kuaci was thrown, the player targets the opponent's Kuaci master to eliminate. If all players have been eliminated, then the game ends.

Unfortunately, the Kuaci game and other traditional games become less popular in the present day. The technological advance on modern game is one of the biggest contributors to the factors of the traditional game being forgotten. With a total population of 259.1 million people in Indonesia, mobile phone users in Indonesia reached at the number of 326.1 million which means one person has more than two mobile phones and 43% of the population have a smartphone [4]. This proves that smartphones have become a necessity and people spend more of their leisure time playing with their smartphones, such as playing modern games. However, with the support of these technological developments, the traditional games can be transformed into the modern games on the smartphone without losing the essence of the game, such as sharpening and set a strategy to defeat the opponent.

It takes the skill of target shooting and ability to estimate distances in Kuaci game against the computer player. So, the implementation of the compatible method and algorithm to determine the movement direction of the player is mandatory so the computer player can balance the game with the human player. Therefore, the Kuaci game can be adapted into Android-based games using Vector Algebra and The Hybrid Pseudo Random Number Generator. Both of these methods will be applied to determine the direction and power of each Kuaci that will be thrown by the computer player.

The rapid development of technology is one of the biggest contributors to the traditional games, like Kuaci, to be left out. However, the traditional games can be developed using the technological developments, so it can be played on the smartphone without eliminating the essence of the game, such as sharpening and set a strategy to defeat the opponent.

There has been no previous research on Kuaci games, but there have been several studies on the implementation of the Vector Algorithm method in various games and the application of The Hybrid Pseudo Random Number Generator. Among those studies, research has been performed by applying Algebra Vectors in determining the position of a player during dribbling, passing and shooting at a basketball game [5]. Another research is the implementation of Vector Algebra on Page Rank Algorithm in determining the relevance of a site as well as the importance index of the information contained in it [6]. Further research is the utilization of Vector Algebra to obtain the limit of the binary pattern of an image during tracing [7]. Another research is the application of the Pseudo Random Number Generator Hybrid algorithm in a cryptographic system [8].

2. Methodology

The application design of the Kuaci game consists of three variables that underlie the application. Some of these functions include the user interface as the interface of the device screen, the data model object as the execution of the movements including the direction and power on the Game Arena page, and the game logic as the deck of the game. The general architecture of the method is shown in Figure 1.

2.1. Analysis of Object Model

Analysis of Object Model serves as the execution of the movements of the movement including the direction and strength of the Kuaci to be displayed on the game. Vector algebra will be applied as a method to determine the Kuaci motion direction of the computer player. The coordinate point of the computer player's Kuaci position and the Kuaci position coordinate of the human player will be set as the input for the operation of the vector algebra. The result of the vector algebra is the direction of the
next Kuaci movement of the computer player. The description of Vector Algebra on the direction of Kuaci movement will be discussed later on, while the Hybrid Pseudo Random Number Generator algorithm will be applied to the power of the Kuaci movement.

The input of the Hybrid Pseudo Random Number Generator algorithm is in the millisecond of the running time in the system, so it is unlikely to generate the same random number. Ultimately, the results of the vector algebra and the Hybrid Pseudo Random Number Generator will be associated with the accuracy of each difficulty level. The strength of the game was set randomly to avoid the tendency of Kuaci strength to have the same value at every throw.

**Figure 1.** The general architecture of the proposed method

**2.1.1. Description of Vector Algebra on the Direction of Kuaci Movement**

When the kuaci of the computer player is going to shoot the human player's Kuaci to eliminate the opposing Kuaci, the coordinates of the human player Kuaci is expressed by \((x_1, y_1, z_1)\). Where the value of \(z_1\) is considered as 1 because the object is a two-dimensional object while the coordinates of the computer player’s Kuaci position is declared with \((x_2, y_2, z_2)\) where the value of \(z_2\) is also considered to be worth 1.

The direction of the Kuaci movement of the computer player to target the Kuaci of the human player is expressed by \(r\). The \(XX\) and \(YY\) values are required to determine the value of \(r\). The values can be obtained through the formula:

\[
XX = x_1 - x_2
\]

Where \(x_1\) is the x coordinate point of the human player and \(x_2\) is the x coordinate point of the computer player, and:

\[
YY = y_1 - y_2
\]
Where \( y_1 \) is the y coordinate point of the human player and \( y_2 \) is the y coordinate point of the computer player. Then, the value of \( r \) can be computed using the following equation:

\[
r = \sqrt{XX^2 + YY^2}
\]

For different conditions, when the computer player throws the Kuaci master into the box to release the regular pieces, the direction is no longer having only one object but six objects. To determine the value of \( XX \), then the coordinates of each piece which be the subject to the throw will be averaged and searched for its midpoint.

When the midpoint is obtained then operate using the formula \( r \) that has been stated earlier to obtain the direction of Kuaci movement. Illustration of the computer player is about to throw the Kuaci master into the box to release the regular pieces is shown in Figure 3.

\[\text{Figure 3. Illustration of Kuaci Position when targeting the box}\]

2.1.2. Description of the Hybrid Pseudo Random Number Generator in the Power of Kuaci Movements

In Kuaci game, the throwing power of the computer player is obtained using the Hybrid Pseudo Random Number Generator algorithm with the purpose of the throwing force for not likely to be the same every time the throw is executed. The input of this algorithm is the maximum and minimum limit values and the current time (in millisecond) of the game, so it is improbable to generate the same random number.

2.1.3. The accuracy of Kuaci Movements

The accuracy of the Kuaci movements describes how accurate the computer player decides the steps taken in each throw. The effect of the accuracy of the shooting direction lies in the early
conditions of the game in choosing the difficulty level. The throwing accuracy of the computer player is different at every level.

2.2. Game Logic

Game logic on Kuaci game applies the item checking function in each game to determine the players’ activities during the game. Game logic is based on the basic flow of the Kuaci game.

2.2.1. Basic Flow of Kuaci Game

The game plot begins with the player throwing each Kuaci master into the second line to determine the turns. Based on this, the application will display the game screen with the results of each player throw. It continues under the rules of the Kuaci game which have been previously described.

2.2.2. Item Checking

Item checking is a function used as a trigger between interrelated items, such as The Kuaci pieces. Item checking applies the if-else and else-if structure to execute a statement if one of the expressions provides true value and also includes another alternative if the expression evaluated gives an incorrect value. In other words, item checking is the game rule that determines whether the player is winning or losing. The structures of the if-else and else-if function consisting of some of the basic rules of the Kuaci game as follows:

1. If the regular pieces of Kuaci in the box are out and managed to shoot the opponent's Kuaci, then the score increases and the opponent can only play the remaining Kuaci pieces.
2. If the pieces are drawn out of the box but unsuccessfully targeting the opponent's Kuaci, then the score remains, and the Kuaci pieces are put back into the box.
3. If the Kuaci master of the opposing player gets into the box, then the player wins the boom.
4. If the Master piece of the player gets into the box, then the player loses the boom.
5. If the regular pieces in the box run out, the game is won by the highest scorer.

2.3. User Interface

The result of this research is the movement of the Kuaci including the direction and strength of the Kuaci on the Game Arena page of the system interface.

3. Experimental Results

In this phase, a test was conducted to see how reliable and valid the computer player is, against the human player in each game difficulty level. The reliability and effectiveness of the application are viewed from the number of times the computer player beats the human player in the gameplay.

The test was performed on 10 participants who played the Kuaci game in every level of difficulty. The results of the application reliability and effectiveness are shown in Table 1.

| No | Difficulty Level | Number of Winning | Number of Losing |
|----|------------------|-------------------|-----------------|
| 1  | Easy             | 2                 | 8               |
| 2  | Normal           | 4                 | 6               |
| 3  | Hard             | 7                 | 3               |

From the test results, it can be seen that the strongest computer player to beat is on the hard level with the victory percentage of 70%.

Furthermore, the winning rate of the computer player in normal mode reached 40% while in easy level, the computer player only obtained winning percentage of 20%. Based on the test, the computer
player for each level is considered properly executed. Based on Table 1, the winning rate of the computer player can be seen in Figure 4.

![Figure 4](diagram.png)

**Figure 4.** Diagram of the reliability and effectiveness of the computer player

4. Conclusion

Based on the results of the following conclusions can be drawn are:

1. The Kuaci app works well on Android smartphones
2. The performance of Vector Algebra and Pseudo Random Number Generator Hybrid are satisfactory to determine the direction and power of the computer player's Kuaci in the Kuaci game.
3. The computer player runs following the difficulty levels where the highest level is the hardest one to beat.

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