A traditional bekel game using leap motion controller

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Abstract. Bekel game is a traditional game originated from West Java. The game requires seeds and ball to play. The number of seeds to be played is around 6-10 seeds. The game is played by throwing the ball upwards then taking the seeds one at a time, two at a time and so on until the seeds are taken at once. The rule of the Bekel game is the ball can only bounce once on the floor. However, Bekel traditional game is rarely played nowadays as the rapid development of technology on modern games. Therefore, required a modern technology to be used to play bekel in game application. In this research, authors built the bekel traditional game application using Leap Motion Controller as a tool to play the game. Using this tool, players can interact in game applications with hand gestures read by Leap Motion sensors. This research has proved that the existed traditional game applications can be developed with Leap Motion Controller technology.

1. Introduction

Bekel game is one of the traditional game originated from West Java province, Indonesia. In West Java, Bekel game is better known by the name beklen which means bekel. The word beklen or bekel is thought to be originated from the Dutch language “bikkelen” which means fighting spirit.

Bekel game uses colorful balls made of rubber and special seeds made of brass or also called Bekel seeds. The procedure of this game begins by throwing the ball upwards then spread the seeds on the floor. The seeds can be taken one at a time or taken at once. If the seeds have been successfully taken entirely then it will proceed to the next stage by taking two seeds at a time, then continue with three seeds and so on until the seeds are taken at once in a single try.

Bekel game has an effect to children based on the way of playing which requires skills and agility to play the game. The importance of Bekel game for children is to provide an active form of learning that includes mind, body, and spirit and provides opportunities to practice new skills and functions [1]. However, Bekel game nowadays is rarely played. Many factors make this traditional game abandoned.

One of them is because of the modern game technology that does not take place and is not constrained by time, nor does it have to wait for others to play[2]. In the end many children will turn to a modern game that uses technology such as games on computers, smart phones, or play-stations.

Leap Motion Controller is a sensor device that aims to translate hand gestures into computer commands [3]. Leap Motion Controller in the form of a small Universal Serial Bus (USB) prefesial device is designed to be placed on a physical desktop, facing up and using two monochromatic IR cameras and three infrared LEDs that observe a hemisphere-shaped surface on top with a range of about 1 centimeter [4].

Leap Motion Controller is designed to detect hand gestures up to the finger accurately. These
gestures will be read by the sensor as inputs on the computer to execute the given commands. Similar to a mouse and keyboard, but Leap Motion Controller device does not require physical contact to use it. In Bekel game application, this hand gesture will make the users as if they are interacting with the objects that exist in the game.

In this research, the authors intend to build a game application that takes the theme of Bekel traditional game with a little adjustment to be able to run on the Leap Motion Controller.

Bekel is a traditional game which rarely played nowadays as the rapid development of technology on modern games. There are also game applications that take the theme of the traditional game developed on computer technology and smart phones. However, only a few who developed the game applications by utilizing modern technological devices that is able to optimize the application, especially on the game applications. Therefore, required a development on traditional games applications using modern technological devices.

Some of the previous research that became the reference source of this research is the research conducted by Ovy Rizky in 2015 which build an Android based Bekel traditional game using free fall method as motion method on the ball and using random function to randomize the seeds on bekel game [5].

In 2015, Farhan Luthfi built a 3-D human anatomy application using Leap Motion Controller. The research applied Leap Motion Controller technology as a tool to display the anatomy of the human body. The hand gestures are read by Leap Motion to rotate, grasp, and shift the object of human anatomy and display the name of human anatomy the parts [6].

In 2014, Ok-Hue Cho built a game application of the honey bee dance for children using Leap Motion Controller. In this game, players follow the bee dance moves by the lines contained in the game interface using the players hand gestures on Leap Motion Controller. Hand gestures performed on the game is good for brain development of children [7].

In 2015, Martin Ebner and Norbert Spot built a game-based learning application for children using Leap Motion Controller. The application applies basic elementary math lessons to be combined with game play on the game. The questions will be displayed when the player finds a case on the game. The player will answer the question by moving his hand on the Leap Motion Controller on the object that has the answer of the question [8].

2. Methodology
The steps performed in Bekel game application development will be illustrated in general architecture. The steps start from user interface as the interface on the device screen, followed by the leap motion system as the observation of hand and finger gestures using Leap Motion Controller, object data model as the executioner of the ball motions and seed position randomization in the game arena displayed on the screen, game logic that determines the flow of the game, and the database that has been connected to the computer as a scorecard in the game when the game ends. The entire process of application development will be displayed on the user interface.

The general architecture implemented in the development of Bekel game application using Leap Motion Controller can be seen in Figure 1.
Figure 1. General architecture of Bekel game application

2.1. Hand gestures leap motion sensor
Leap Motion Controller is useful as a sensor that observes hand gestures when the hand is placed on the Leap Motion tool. The gestures are observed and displayed on user interface in the form of 3D objects. The data of hand gestures will be processed in leap motion service then will be sent to Unity application. The data will be received by Unity and will be run in accordance with their respective codes. The ball grasping gesture will be used in Bekel game for the object hand to grasp the ball.

2.1.1. Ball grasping gesture
To grasp the ball, initially the player’s hand position is placed on the Leap Motion Controller tool so the hand model is visible on the game interface. Next is to point the hand near the ball on the floor. Make a grasping gesture on the ball so that the ball sticks in the hand. The grasping gesture uses GrabStrength property from Hand class. The ball can be grasped with the fingers and palm of the hand or simply grasped with the fingers alone. The details on GrabStrength can be seen in Figure 2.

Figure 2. GrabStrength; (a) GrabStrength 0.0; (b) GrabStrength 0.1[9]

2.2. Object data model analysis of ball and seeds
In the previous chapter it has been explained how basic the restitution coefficient of collision and random function. The restitution coefficient of collision will be applied as a reflection method on the
ball object to the floor and hand objects. Initially the ball will be given maximum and minimum speed when it is in the air. Then the ball is given a restitution coefficient that has been determined as the resilience level of the ball bounce. When the ball has reached its maximum height, it will fall to the floor or to the hand of the collision function to determine the type of collision on the floor and hands. The collision types used are partial resilient collision and non-resilient collision. The partial resilient collision is applied when the ball falls to the floor while non-resilient collision is applied when the ball falls on the hand.

2.2.1. Logic description of ball object bounce using Restitution Coefficient

In Unity, there are engines that can perform simulation of physical objects such as bouncing ball engine called engine physic. The working principle is that engine physic will do style specification to object based on user input in every iteration. Thus, the generated output is the result of a computational physics engine. In this game application, ball object is given engine physic in the form of ball bounce. The ball bounce will be inputted to the value of the restitution coefficient so that the ball can bounce off the ball speed when the ball falls.

Pseudo code of the proposed method for ball bounce can be seen in Figure 3.

begin
float maxspeed = 20.0;
float minspeed = -20.0;
float highball = 0.0;
int gravityball;
float bounce;

if (ball = grab) {
    if(ball = throw){
        gravityball = 1;
        if(speedball == maxspeed){
            highball += 1;
        } else if (speedball == minspeed){
            highball += 1;
        } else{
            ballreturn = true;
            highball -= 1;
        }
    } if(ballreturn == true){
        if(ballreturn = floor){
            bounce = 0.9;
        } else if (ballreturn == hand){
            bounce = 0.8;
        }
    }
}
end

Figure 3. Pseudo code of ball object bounce logic

2.2.2. Seed randomization description

In Bekel traditional game, seeds will be spread when the ball has been thrown. The seeds will be spread in random position. In Bekel game application, the position of the seeds will be randomized as game variations. The coordinate variable is an array type with a length of 3 so that there are 3 possibilities of seeds appearing at the specified coordinates. Each value in the coordinates (x, y, z) will be assigned a different value. Therefore, the Random.Range function is used to randomize list the array from the smallest to the largest. This is done so that the beans displayed are not in the same position.

Pseudo code of randomized function on the beans can be seen in Figure 4.
2.3. Game logic

Game logic is based on the basic flow of Bekel game. Game logic of Bekel game application uses the item checking function at each stage of the game to decide the player’s activities during the game. Further explanation on game logic can be seen in the following sub-chapters.

2.3.1. Item checking

In Bekel game application, the item checking function is used as a trigger on interrelated game items in this case are the ball bounce, the number of seeds on the floor, the number of seeds taken and the number of lives available. The function will be executed when the ball is thrown up until the seeds appear on the floor.

On checking items are used if-else and else-if structures that have a function to execute a statement if one of the expressions gives true value and also provides another alternative if the expression gives the wrong value. Checking item is a rule that determines the player’s success or failure in the game. The if-else and else-if decision structures that include the basic rules of Bekel game can be seen as follows:

- If the amount of seed taken is in accordance with level of retrieval then the score increases. Else, life is reduced;
- If the ball bounces more than 1 time then the life decreases. Else, the game continues;
- If the life is up then the game ends. Else, the game continues;
- If the number of seeds taken is as numerous as the seeds used then the game succeeds. Else, level of retrieval increases.

While the structure else-if have a function to determine whether or not the game level increase. The flow of Bekel games becomes the basis of the else-if structure when taking the seeds. First the seeds are taken one by one until they run out. Then it will proceed to the next stage by taking two seeds at a time, then continue with three seeds and so on until the seeds are taken at once in accordance with the number of seeds used. The seeds can be taken at once in accordance with the number of seeds used in every level. If the seeds can’t be taken in accordance with the level of retrieval then the player life will be reduced.

2.4. Database

In the game application, the scores saved to the database are the 5 highest scores on each difficulty level of the game. The scorecard consists of 3 tables in the database where in table 1 is for easy difficulty level score, table 2 is for medium difficulty level score, and table 3 is for hard difficulty level score.
3. Result and analysis
The result of the built system development is as follows:

3.1. Main menu display
Main menu display is the initial display of the game application. The main menu display consists of the initial display, the difficulty level display, the seeds selection display. Initial display (a) is a display that first appears when a game application is run. The display contains "Play", "Scoreboard" and "Exit" menus. Difficulty level display (b) is the display when “Play” menu is chosen, the display contains the difficulty level selections of the game where there are 3 types of difficulty levels which are "Easy", "Normal", "Hard" and "Back". The seeds selection display is the display that will appear after choosing the difficulty level. There are 3 selections of the beans to be chose which are “Bekel Seeds”, “Kuwuk Seeds”, “Bottle Cup” and “Back”. Main menu display can be seen in Figure 5.

![Figure 5. Main menu display; (a) Initial display; (b) Difficulty level; (c) Seeds selection](image)

3.2. Scoreboard display
The scoreboard display will appear if the scoreboard button is clicked on the initial screen. The display has selection button to see the highest score on each difficulty level and there is also an arrow button to return to the menu. Scoreboard display can be seen in Figure 6.

![Figure 6. Scoreboard display](image)
3.3. Game arena display
The game arena display will appear after the difficulty level and the seeds are selected. It displays scores, levels, lives, info board as information boards to inform the number of seeds should be taken at each level, guide board as a signboard to inform the players about the shortcut keys on keyboard. Ball objects, seeds, and hands are displayed on the arena. Game arena display can be seen in Figure 7.

![Figure 7. Game arena display](image)

3.4. Animation display
Animation display is a display that will appear with a trigger on game logic. In the game application, there is a display of game over animation and succeed animation display. Trigger in game over animation is the player life, if the player’s life has run out then the game over animation will appear. There are 2 types of display on the game over animation display, first is when the seeds are taken not in accordance with the level of retrieval (a) this display will appear when the player runs out of life because taking the wrong number of seeds. the second display is when the ball bounces more than twice (b) this display will appear when the player runs out of life because the ball bounces twice. Trigger on succeed animation is when the seed can be taken entirely before the life runs out. There are 2 types of displays on the succeed animation. The first one is the display for succeeding a game level (c). This display appears when the players succeed in completing one level. The second one is the display for succeeding the entire levels (d). This display appears when the players succeed in completing the entire levels. Animation display can be seen in Figure 8.

![Figure 8. Animation display](image)
Figure 8. Animation display; (a) Taking the wrong number of seeds; (b) Ball bounced more than twice; (c) Succeed in completing a level; (d) Succeed in completing the entire levels

3.5. Hand gestures display

This display shows the hand gestures observed by Leap Motion Controller sensor when the player interacts on the objects as well as the buttons on the game application. The ball grasping gesture is show display is shown in Figure 9(a). The grasping gesture will be displayed on the game display when the user performs a grasping gesture on the Leap Motion Controller. Ball catching display is shown in Figure 9(b). The ball catching gestures will be displayed on the game display when the user performs a catching gesture on the Leap Motion Controller. Touching the seeds display is shown in Figure 9(c). Touching the seeds gesture will be displayed on the game display when the user directs the hand on Leap Motion Controller to the existing seeds on the game display. Clicking button display is shown in Figure 9(d). Clicking button gesture will be displayed on the game display when the user directs the hand on Leap Motion Controller to the existing button on the game display. Hand gestures display can be seen in Figure 9.

![Figure 9. Hand gestures display; (a) Ball grasping gesture; (b) Ball catching gesture; (c) Taking the seeds gesture; (d) Clicking button gesture](image)

3.6. Shortcut display

In the game arena, there is a guide board that gives instructions to show the shortcut keys on keyboard. Shortcut ESC display can be seen in Figure 10 (a). Shortcut ESC display will be displayed when the users press ESC button on keyboard. This display is used to inform the users that the game is on pause. Shortcut R display can be seen in Figure 10 (b). Shortcut R display will be displayed when the users press R button on keyboard. This display is used to inform the users whether they want to repeat the game or not. Shortcut B display can be seen in Figure 10 (c). Shortcut B display will be displayed when the users press B button on keyboard. This display is used to inform the users if they want to return to the initial display. Shortcut display can be seen in Figure 10.
3.7. Application testing
Authors conducted a questionnaire to 20 respondents, mostly information technology students with an age range of 20 to 26 years. The questionnaire contains polls regarding the interface conformity level, interaction and gestures as well as the satisfaction level of the game. The average score in the questionnaire will be made in graphical form. The graphic of average score of the game application conformity level is show in Figure 11(a). The average score of the game application conformity level is still below 4 because many respondents still have difficulties using gestures on the Leap Motion Controller so it is still difficult to use it. The graphic of game application satisfaction level is shown in Figure 11(b). The average score of respondent satisfaction on game application test is 4 because most of the users are satisfied with Bekel game application using Leap Motion Controller. The graphics of conformity and satisfaction levels can be seen in Figure 11.
3.8. Limitation of leap motion controller

The limitations on the use of Leap Motion Controller during game application testing are as follows:

- Leap Motion Controller has difficulty to maintain the accuracy and precision of detection when the palm is parallel facing vertical and when the palms is facing upwards;
- Low speed of data transfer from observation of Leap Motion Controller sensor to computer used. The cause of the low data transfer due to numerous ongoing process of the computer used or the lack of the used computer specifications.

4. Conclusion and future research

Conclusions that can be drawn from this research are as follows:

- Leap Motion Controller can be used as a tool in Bekel game application development.
- With the average score of 3.7 on conformity level of interactive application, most of users agree that the game is interactive. However, some of the users are disagree due to lack of the gestures features on the game application.
- With the average score of 3.75 on conformity level of the use of Leap Motion Controller tool because many users still have difficulties in playing the game application using Leap Motion Controller. The cause is that some users find it hard to use gestures proven by an average value of 3.7 in the use of gestures amenity.
- Leap Motion has limitation on maintaining the accuracy and precision of detection when the palm is parallel facing vertical and when the palms is facing upwards. Leap Motion also has limitations on low data transfer speeds from observation of Leap Motion Controller sensor to computer used.

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