

Shapelandia: Using the LEAP Motion in the Development of a Gesture-Based Game

Jeau Gigataras
Ateneo de Manila University
jeaueg@gmail.com

Dickson Lua
Ateneo de Manila University
dicksonlua94@yahoo.com

Chelsea Manzano
Ateneo de Manila University
chelsea.manzano@gmail.com

ABSTRACT

In this paper, a gesture-based interface is presented through the development of a game. The device chosen is LEAP Motion, which tracks the user's fingers and hands within a given area. Capabilities of the device will be shown and proof of user experience will be based on a user test.

Keywords

LEAP Motion, *Shapelandia*, Tangram, Gesture-based interface, Kezeile

1. INTRODUCTION

Gesture-based interfaces are becoming widespread. Many people have already used gesture-based interfaces in the form of game consoles such as Nintendo's Wii, Microsoft's Kinect and even smart phones. The development of this game demonstrates the capabilities of one such interface.

A gesture is defined as a motion of the body that contains information [1]. Some common, every day examples of gestures would be a handshake, a nod, a wave, or even a smile. The information and meaning of the gesture depends on the gesture itself and how it is performed.

Based on this definition, gesture-based interfaces are interfaces which track the user's movements and convert them into information that controls a computer.

The main difference between gesture-based interfaces from the typical graphical user interfaces is the medium being used for interaction. GUIs require people to use a keyboard and mouse to control the computer. Gesture-based interfaces detect user hand, arm, face, and body movements and interpret these as instructions that direct the computer towards accomplishing a goal [9].

There are advantages and disadvantages to the use of gesture-based interfaces. Some of these advantages include the idea that gesture-based interfaces allow the player to focus more on the task instead of the input device, as well as the idea that the nature of gesture interaction tends to be more engaging [9].

It has been shown that while device-based interactions (e.g. mouse) score higher on perceived performance and pragmatic quality, the hedonic quality and fun of embodied interactions (e.g. Wii) were rated higher than non-embodied interactions (e.g. mouse) [9]. However, while, gesture-based interfaces allow the user to be able to control the computer more naturally, there is the

issue of accuracy and precision to which the device can detect the user's movements. This is less of an issue with the device that has been chosen, as such, a game which will successfully integrate LEAP, smoothly detect the user's movements, and provide a more engaging experience demonstrate the device's capabilities.

LEAP Motion uses a combination of LED lights and camera sensors to detect an area of approximately 8 cubic meters above the device [2] (refer to Figure 1). Its software detects up to 2 hands and 10 fingers and translates the data into information on your computer. By programming the device, users are then able to create software to entertain, to educate, and to further explore



Figure 1. Leap Motion [8]

LEAP's capabilities.

The main difference of LEAP from Kinect and other gesture-based interfaces is the precision with which it detects hand gestures, as it has 0.1 millimeter sensitivity for each of your 10 fingers, a 150 degree field of view, and can track movements at 200 frames per second [2]. With this in mind, the successful integration of the game with the device and the smooth and engaging control of the game through the program are what showcase the device's capabilities.

A few examples of existing games for LEAP Motion include *Verticus*, an action adventure game, *Kyoto*, which is an interactive ambient puzzle game, and *Dropchord*, a music-driven, score

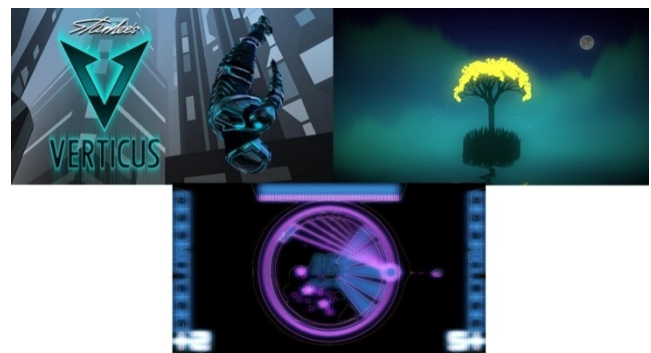


Figure 2. Verticus, Kyoto, and Dropchord [10]

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challenge game [10] (refer to Figure 2).

2. GOAL

The goal of this paper is to develop a gesture-based game that capitalizes on the features of the LEAP Motion device. There are two questions that this paper tries to answer, one is “How do you design a game that makes authentic use of gestures as input commands?”, and two, “How satisfying is the gaming experience?”

3. GAME CONCEPT

Shapelandia: Origins is a puzzle game in which the player finds himself in the ruined kingdom of *Shapelandia* and helps the *Shapelandians* rebuild their world. The puzzle part of the game is based on the tangram puzzle which is reputed to have originated from China during the Song Dynasty [3]. The objective of the game is to form a specific shape using the pieces that you have based on an outline or form which is shown to the player. Tangram literally means “ingenious puzzle figure of seven pieces” and this version of the game follows the basic rules [3] [4].

The rules of *Shapelandia* are as follows:

- All given pieces must be used
- All pieces must be inside the board
- All pieces must fit inside the outline
- Pieces may be rotated or flipped to complete the puzzle

Players may choose from two game modes, which are Story and Classic. In Story Mode, players follow the main character Kezeile in his quest to rebuild the world of *Shapelandia*. There will be no scoring mechanism in the game, and the goal will simply be solving the puzzles or progressing through the story. In Classic Mode, players can choose which level they want to play, unlocking the next level by solving a previous one. The levels for both Classic and Story Mode will be preset, with 30 plot-related puzzles for Story Mode, and 30 normal tangram puzzles for Classic Mode.

In Story Mode, players choose the levels that are presented on a map. The levels are listed on a map, where players can replay levels they’ve unlocked, or unlock the next level through solving the previous one. Upon selecting a level, the broken pieces of the *Shapelandian* artifacts are shown to the player, along with an outline of what it originally looked like.

To solve a level, a player must be able to move the pieces and arrange them so that it resembles the outline that is shown to them. The game continually checks if they have formed the outlined shape using all pieces; as soon as they put all the pieces in the right position, they will be notified that they have solved the puzzle. By solving the puzzles, the player will be able to recreate things that were broken in *Shapelandia*, helping them rebuild their world by solving one puzzle at a time.

The Story Mode has an ending, while Classic Mode both offer numerous puzzles for the player to solve. While the puzzles may not be unlimited, players can replay them if they want to. The game can be played by people ages 15 and above, but seeing as how the target audience range from high-school to college students, the game will hopefully provide enough of a challenge and entertainment for it to be considered a brain teaser.

4. LOOK AND FEEL

4.1 Solving Puzzles

A 2D view will be used when solving the puzzles of the game. Each frame of the game is visually updated to reflect the

movement of the player’s hands, and effects will be added to show selection, de-selection, flip, and rotation of a piece. Aside from this, there will also be visual cues for completion of a puzzle, along with a scene by scene presentation of the plot for *Shapelandia*.

In order to solve the puzzles, players are able to select and deselect pieces, along with the option of rotating and flipping them. In accordance with the device, selection of the tile is detected upon pressing the spacebar of the keyboard, with the condition that it selects the tile the cursor is currently located at. If there is no tile on top of the cursor, then nothing is selected. De-selection occurs when the player presses the spacebar one more time.

To move the tile, a starting coordinate is tracked each time a piece is selected, and for each time that the finger moves, the tile will move as well. For as long as the tile is selected, it will move with the position of the finger.

To rotate the tile, the player can simply move his finger in a circular motion. As long as the tile is selected, the fingers and hands of the player will be detected and as such, the gesture that is being performed by the player will also be tracked. By having LEAP Motion detect the circle gesture, the player will then be able to rotate the tile by 45 degrees either clockwise or counter-clockwise (refer to Figure 3).

To flip the tile, the player can perform a swipe using his hand. By performing a quick horizontal motion with his finger, the player can flip the tile horizontally and then rotate as needed in order to be able to solve the puzzles where a flip is required (refer to Figure 3).

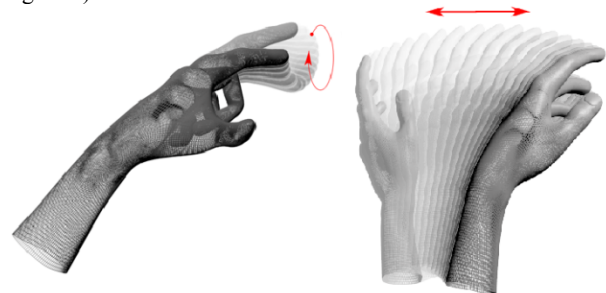


Figure 3. Circle Gesture and Swipe Gesture [11]

Since the target audiences are high school and college students, the game will employ 2D graphics for the tangram and use a cartoonish look for the game that is in line with the plot. For a preliminary look and feel of the game, an image of the game menu can be seen below (refer to Figure 4).

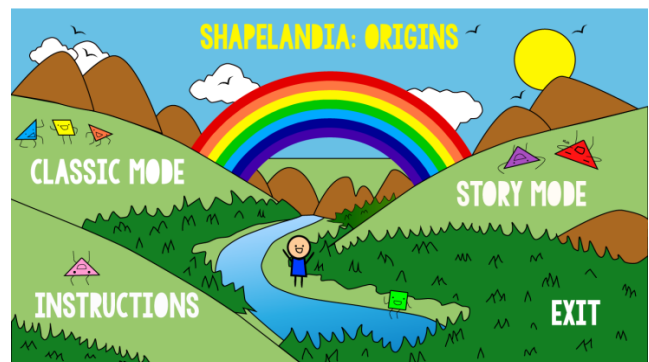


Figure 4. *Shapelandia's* Menu

4.2 Storyline

The storyline of *Shapelandia* follows the adventures of Kezeile.

Kezeile wakes up in *Shapelandia*, and it is dark around him. Looking to the distance, he sees a group of shapes running towards him. They ask him to help them rebuild their homes, and give him a piece of the rubble. He rebuilds a kettle, 2 houses, a boat, and a plane from levels 1 – 5 [5] [6].

After helping the *Shapelandians* rebuild their village, the *Shapelandians* talk to Kezeile to request further assistance. He rebuilds a cat, a dog, a fish, a kangaroo, and a rabbit from levels 6 – 10 [5].

Now that Kezeile has done what he can for the village, the Shape Elder talks to Kezeile to help him find out why he is in *Shapelandia*. He rebuilds a flower, 2 bridges, a mockingbird, and a mountain from levels 11 – 15 [5] [7].

After arriving at the mountain, Kezeile meets a wise man who tells him what he must do. He rebuilds a boy, a nurse, a fisherman, a woman, and an old man from levels 16 – 20 [5] [6].

After solving the puzzles, Kezeile starts to recover his memories and remembers a fragment of his life. He goes on a rage upon remembering his ex-girlfriend and *Shapelandia* starts to break. He rebuilds his memories from levels 21 – 25 and once he solves the puzzles, a picture of his past shows up [6].

The mountain breaks just as Kezeile remembers the events leading to his accident. He clutches to the edge of the mountain, and is about to fall. Fearing for his life, he hears a voice inside his head, and sees that it is the Wise Man. He rebuilds 2 men, a book, a key, and a heart from levels 26 – 30 [5] [6].

After he rebuilds himself, Kezeile learns an important lesson. Everyone who he has cared about, and everything that matters to him, have always been there for him; if he had looked past the difficulties that he was facing at that time and remembered how much he mattered to other people, how good of a person he was, and saw the things that really mattered, then he wouldn't have tried to kill himself.

4.3 Game Levels

The puzzles constitute the 30 levels of Classic Mode and the 30 levels of Story Mode. Levels 1-10 are displayed in order, from left to right, and top to bottom (refer to Figures 5 and 6).

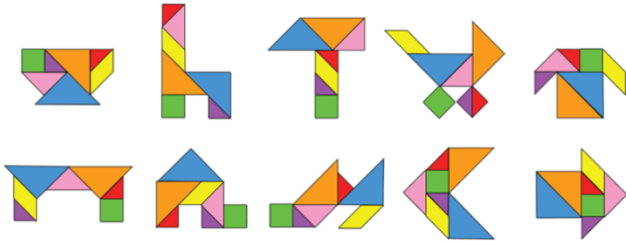


Figure 5. Classic Mode (Levels 1 - 10)

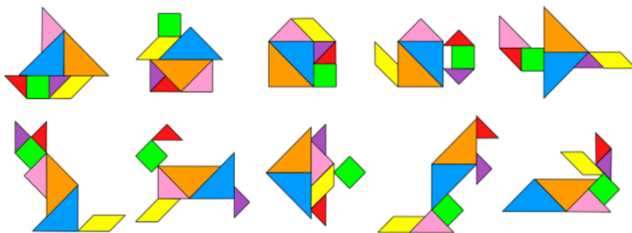


Figure 6. Story Mode (Levels 1 - 10)

4.4 Storyboard

The storyboard shows the images for the cut scenes. It covers the cut scenes stated and follows the dialogue based on the storyline (refer to Figure 7). To show the dialogue better, a few screenshots of the cutscenes can be seen below (refer to Figure 8).

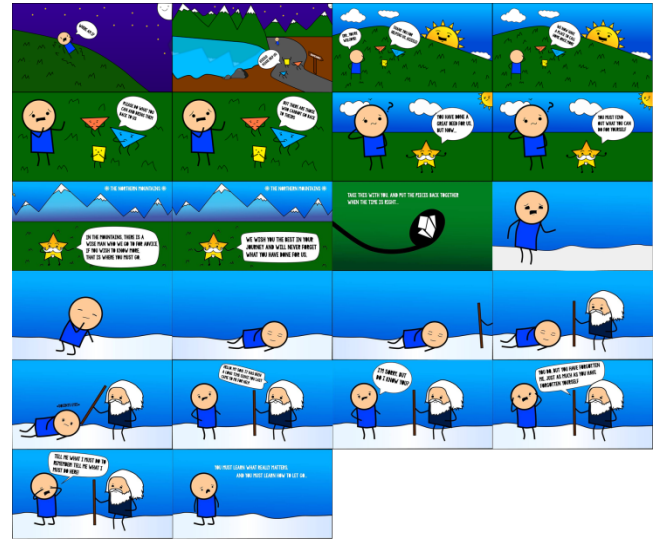


Figure 7. Storyboard Scenes (1-22)



Figure 8. Scene 2.4, 3.1, 3.5 (top to bottom)

5. IMPLEMENTATION

5.1 Programs

There are mainly five programs that were used for the development of *Shapelandia: The Origins*. These five are Java (a programming language), Adobe Illustrator, Adobe Photoshop, and LEAP Motion (which is the gesture-based interface that was used).

Java was mainly used for the source code of the program. Its library and documentation were referred to during coding but the creation of the game and mapping of the levels are original.

Adobe Illustrator and Adobe Photoshop were used primarily for the graphics of the whole game, from the game menu to the cut scenes involved.

LEAP Motion is the device that was used to track the player's hands. It can be programmed using the Java language, and plans of using it are further elaborated in the next section.

5.2 LEAP Integration

LEAP Motion will be used to track the gestures and the hand movements of the user which will serve as game controls.

The LEAP software analyzes the objects observed in the device field of view. It recognizes hands, fingers, and tools, reporting both discrete positions, gestures, and motion. As the Leap tracks hands, fingers, and tools in its field of view, it provides updates as a set, or frame, of data. Each frame contains lists of the basic tracking data, such as hands, fingers, and tools, as well as recognized gestures and factors describing the overall motion in the scene. The reported values will then be used to determine what corresponding method or command the program will do. For example, using the x, y, and z coordinates of the finger detected by LEAP, the program will know if a certain puzzle piece is selected by the user. If the point is on top of a tile and the player presses spacebar, it is selected. If the piece was in a chosen state and the player moved, then the frame will be updated along with the player's movements. The circle gesture of the user will tell the program to rotate the puzzle piece while the swipe gesture will tell the program to flip the puzzle piece.

5.3 Game Interaction

The user interacts with the game through LEAP Motion as soon as the game starts. From the game menu itself, the cursor moves according to the user's hand, but in order to choose the game mode and display their selection better, the color of the hill changes to a bright green, as seen when the player hovers the cursor over it (refer to Figure 9).



Figure 9. Game Menu with highlighted Story Mode

While solving the puzzles, the cursor becomes smaller when a tile is selected using the spacebar on the keyboard, though a better alternative might be to change the cursor's color or load a different image for the cursor while it is selected. As you can see, the cursor here is smaller while the blue tile is selected and bigger when there is no tile selected yet (refer to Figures 9 and 10).



Figure 9. Blue Tile selected with smaller cursor displayed



Figure 10. No Tile selected with bigger cursor displayed

Aside from this, the user is notified about puzzle completion by having the game show a semi-transparent black screen with the words "Puzzle Completed" on it. Players are supposed to respond by clicking on "Next Puzzle" (refer to Figure 11) to proceed to the next level in either story or classic mode.



Figure 11. Puzzle Completed with Next Puzzle Option

Once they click “Next Puzzle”, the game moves on to the storyboard, where players can then click on “Click to Continue” to go to the next scene until they reach the next puzzle to be solved (refer to Figure 12).



Figure 12. Storyboard Scene with click to continue

Additionally, a tutorial is included in the first five levels of story mode, where users are taught how to play the game. In the first level, players are taught to hold the spacebar to select the piece and move it to the correct position, all other puzzle pieces already in their correct position, so the player only has to move one puzzle piece. In the second level, players are taught how to rotate a tile, while flipping a tile is taught in the third level. The fourth level asks the player to put three tiles in the correct position through a combination of moving the tile, rotating the tile, and flipping it; and finally, the fifth level lets the player solve the puzzle using 7 pieces, although clues using faded out colors of where the pieces are supposed to be are shown (refer to Figure 13).

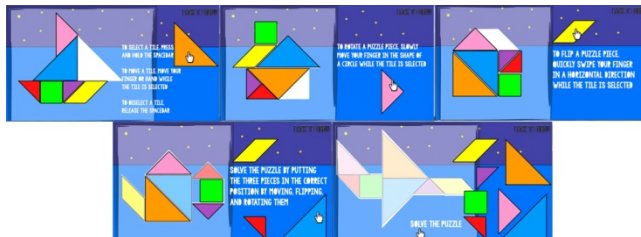


Figure 13. Story Levels 1-5 (Tutorial)

6. TESTING

6.1 Test Plan

The goal of the test was to determine how well LEAP Motion performed as a gesture-based interface in *Shapelandia: Origins* from the viewpoint of the players. To put it concretely, the test aims to answer whether or not players thought the gameplay was smooth (responsive, no delays, moderately easy) and whether or not they felt that a tangram puzzle game like *Shapelandia: Origins* was a good way of demonstrating LEAP Motion’s capabilities.

Given the goal, 5 people were asked to test the game. The qualifications for being a tester are the following: The tester has to be 15 – 25 years old, with prior experience in using a gesture-based interface, such as Wii or Kinect to be able to play LEAP Motion; and, to be able to tell us how *Shapelandia: Origins* fares as a puzzle game using LEAP Motion, the tester also needs to have prior experience playing a puzzle game. If there is no prior experience of using a gesture-based interface, the transition to LEAP Motion might be too hard and will affect the results.

Prior to testing the game, the tester was given a short orientation through an overview of LEAP Motion. Following this, they were asked to rest their elbow on something stable, such as an armrest or a table, at which point the game was run and Story Mode was chosen, which is when the test officially starts.

The test starts when the tester enters Story Mode and is given full control of the device. The tester will initially be guided to choose Story Mode and continue onwards to the tutorial, which he or she will then have to complete alone. The test ends when they are done with the 5 levels covered in the tutorial, as the 5th level is one where they have to completely solve a puzzle with all puzzle pieces out. If the tester gives up while the test is ongoing, the test is ended and the questionnaire is given to them. On the other hand, if they want to solve more levels, they will be allowed to continue.

After playing the game, a questionnaire was given to the testers. It contains questions such as how bored, aesthetically pleasing, frustrating, fun, or challenging the game was. In addition to this, questions pertaining to their experience with LEAP Motion versus other gesture-based interfaces were also asked, along with how *Shapelandia: Origins* does in comparison to other puzzles, how well LEAP Motion fits the game, and whether or not they have other devices in mind for the game or other applications in mind for LEAP Motion.

The questionnaire contains the following questions:

1. Please tick only one answer per row and answer all the questions (refer to Figure 14).
2. What puzzles have you played before?
3. What gesture-based interfaces have you used?
4. How does LEAP compare to other gesture-based interfaces such as Wii, Kinect, or other similar devices?
5. How does the game compare to other puzzles you’ve played before? Rate from 1 – 10 (with 10 being the highest) and explain why.
6. Does LEAP Motion fit *Shapelandia: Origins*? Rate from 1 – 10 (with 10 being the highest) and explain why.
7. Do you have other devices in mind for *Shapelandia* or other applications for LEAP Motion?

	Not at all	Slightly	Moderately	Fairly	Extremely
I felt bored					
It was aesthetically pleasing					
I felt frustrated					
I felt skillful					
I felt absorbed					
I thought it was fun					
I felt challenged					

Figure 14. Question Number One

6.2 Test Results

The 5 testers had ages ranging from 19 to 22. All of them had prior experiences with gesture-based interfaces such as Wii and Kinect, but others also had experience with the Interactive Gesture Camera and the Eye-toy. All of them have also played puzzle games before, ranging from puzzle games like tangram, chess, Rubik’s Cube, and Sudoku to Unblock Me, Flow, and Jigsaw.

The first question has to do with what they felt while they were playing the game, and an average of their answers show that they felt slightly bored (2/5), moderately frustrated (3.2/5), moderately skillful (3.6/5), moderately absorbed (3.4/5), moderately challenged (3/5), and thought that the game was moderately aesthetically pleasing (3.4/5), and moderately fun (3.2/5). For a breakdown of the averages, refer to Figure 15.

In comparison to other gesture-based interfaces, the testers felt that LEAP Motion was similar in some ways, but commented on how the detection was more sensitive and precise. One of them said that it depends on the environment, while another one said that it detects other things that ideally should not be detected. While Kinect does recognize more gestures or motions (not only the fingers) than LEAP, LEAP is more precise with finger detection.

The game itself averaged a score of 7.6 out of 10 from the ratings the 5 testers gave. From their comments, it could be said that *Shapelandia: Origins* is fun and challenging. Even if the controls were a bit frustrating or tiring, it does well as a puzzle game; however, one of the testers said that she liked the game Unblock Me better, and another one said that it was a good experience because the controls were new – as such, this brings about the question of whether or not the rating was influenced by it being the testers first encounter with LEAP Motion.

On the other hand, the testers thought that LEAP Motion fit *Shapelandia: Origins* well, giving it an average of 7.8 out of 10. One of the testers gave it a 10/10 with the reasoning that you only need your hands to play a puzzle game like tangram, while another one mentions that touch screen is better. Another one thinks that the combination is good, but thinks that there might be other devices more suited to the game.

In relation to that, two of the testers suggested touch screen devices for the game, with another saying that *Shapelandia* can be played without a gesture based camera. Other suggestions for LEAP Motion include Rubik's Cube and drawing or writing applications.

Questions:	T1	T2	T3	T4	T5	Average	Level
Bored	1	2	2	2	3	2	Slightly
Aesthetically Pleasing	5	3	2	4	3	3.4	Moderate
Frustrated	3	2	4	3	4	3.2	Moderate
Skillful	4	5	3	2	4	3.6	Fairly
Absorbed	4	3	3	4	3	3.4	Moderate
Fun	5	3	2	3	3	3.2	Moderate
Challenged	3	2	4	3	3	3	Moderate
Shapelandia Compared To Others	8	8	6	9	7	7.6	Fairly
LEAP Motion for Shapelandia	8	10	4	9	8	7.8	Fairly

Figure 15. Testers' Answers

7. CONCLUSION

In conclusion, *Shapelandia* is a game that makes authentic use of gestures as input commands by using the data that the gesture-based interface keeps track of. Since the game is 2D, the movement of the finger along the x and y coordinates was used in order to move the cursor around.

Certain controls were programmed and assigned to built-in gestures, such as using the swipe gesture to flip the selected tile horizontally and using the circle gesture to rotate. Initially, z-coordinate was used to select and deselect tiles and its implementation did work, however, this became a problem because of the sensitivity of LEAP Motion – for each instance where the finger forward or backward to select or deselect, the tile's x and y coordinates would move as well.

In terms of gaming experience, the testers found the game moderately good in all aspects (aesthetically pleasing, absorbing, fun, challenging) and felt fairly skillful, but deemed it slightly boring and moderately frustrating. The controls of LEAP Motion were appropriate for solving tangram puzzles, particularly the

precise motion detection, however, people still prefer touch screens because they are more used to it, and maybe because they also like having something solid to feel. While LEAP Motion works well with *Shapelandia: Origins*, it might be better to develop applications that are not as affected by sensitivity or applications which put less strain on players while performing the gestures or using the app.

As a suggestion, developing a drawing or writing application might be better instead of a game like *Shapelandia: Origins*, as a drawing or writing application might be able to utilize LEAP Motion's high level of precision and sensitivity better.

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