Kinect Gestural Interaction for a Collaboration Game

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Abstract

Competition between players seems to be integrated in most video games in the video game industry. Yet, collaboration features can carry new game experiences that can interest some players. This thesis discusses some distinct Kinect and Wii Remote interactions, and relates them to if they can enhance collaboration though a casual collaboration game called *Geometry Friends*. Natural gestures, collaboration sense, gesture recognition, gesture exhaustion and space issues are some of the aspects compared between all interaction tested.

Keywords: Kinect, Nintendo Wii, *Geometry Friends*, Collaboration, Gesture Interaction, Gesture Recognition

1 Introduction

Video games are continuously evolving and so does the mechanisms to play them. New interactions with games, such as gestural interactions, brings new forms of how to play games and at the same time bringing a lot of new revolution games to the market.

Many research has been exploring different approaches to play video games. But one feature still remains in most video games: competition. Yet, competition is not the only option that video games have. In collaboration games, the players may now play together to overcome challenges instead of fighting each other.

Many new forms of playing video games were introduced in the past years, but it is still unknown which is the best interaction mechanism to play them, and what are their limitations. Regarding this, can an interaction change, like changing a Wii Remote interaction to a Kinect interaction, can also change the collaboration feeling of *Geometry Friends*? Can natural/playability factors affect this collaboration feeling? For these problems, research about measures, problems, advantages and disadvantages that Wii Remote has when comparing with Kinect was been explored. Different interactions types were implemented and tested using the Microsoft Kinect and the Nintendo Wii Remote. All interaction tests were expected to gather information about natural gestures, collaboration sense and playability. The final goal of this dissertation was to have a proper comparison table that manifest advantages and disadvantages of each interaction tested. All these interactions are compared and discussed in this article results.

Figure 1: Players playing *Geometry Friends*

2 *Geometry Friends*

Geometry Friends [1] is a casual game that attains collaboration. The game runs in a two dimensional world with a physics engine. The game is played by two players, wherein each player control a geometric shape, a circle or a rectangle. Each geometric shape has distinct possible actions (Figure 2).

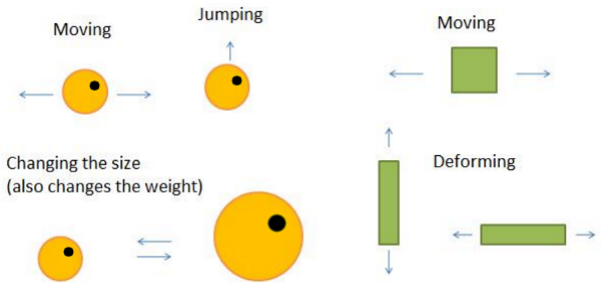

Figure 2: *Geometry Friends* game actions [1]

The circle is able to move sideways (left or right), jump and morph. Morphing the circle shape means increasing or decreasing its size, consequently increasing or decreasing its weight. Like the circle, the rectangle can also move to both sides and morph, but the morph ability works differently. Using the morph ability, the square can stretch or contract its shape, always maintaining the same area.

Geometry Friends will have a set of different levels to challenge the players. In order to complete each level, players must catch all purple collectible diamonds scattered across the level (an level example can be seen in Figure 3). Since *Geometry Friends* is a collaboration game, most diamonds can not be possible to reach without the cooperation of both players.

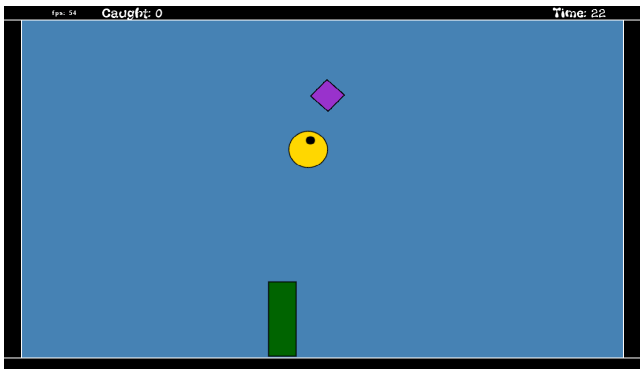

Figure 3: *GeometryFriends* Level Example

3 Related Work

3.1 Collaboration

Most of individual games have a winner and a loser, but in fact anyone has to lose in video games. The collaboration games are based in the approach wherein the only way to win is for everyone to win. Still, collaboration features in games can bring along many pitfalls. For example, the producer of the *Legend of Zelda: Four Swords Adventures* (2004), Eiji Aonuma, stated that "although it is a game that four players have to cooperate to solve puzzles, when you play it, you actually end up competing a lot more in that game than you do cooperating" [2]. Behaving competitively in a collaborative scenario is exactly what should not happen in a collaborative game. To counter problems of competitiveness, a collaborative game should give players a certain tension, so that they can perceive both individually utility and team utility [3].

In *Wolfenstein: Enemy Territory* (2003), a player can play the game as a solo soldier and even win the game singlehandedly, if skillful enough. That is what collaboration games should avoid. These games should prevent players to win games alone, thus giving the fell that they need his partners to win the game. After players perform their actions, they must be able to identify payoffs back to their decisions and these payoffs have to engage the players with satisfying results (if performed correctly) so that they care about the outcome of the game [3]. This pitfall applies to all games, but it is particularly important for collaborative games. If players do not care about the outcome of their choices, they will not fell motivated to collaborate with other players. 'Replayability' of the game is another major problem that can any game can have and collaboration games can have and may influences collaboration.

3.2 Gestural interaction

Video games are controlled by their input controls (e.g. motion controls) and these input controls are controlled by the players. This means that changing game input controls changes the way the players play the game [4]. In fact, many different interaction have been explored in many different Kinect and Wii games. Exam-

ples of these are "touch" interactions [5, 6] like in *Kinect Sports* Menus; hand interactions [7–11] such as *The Gunstringer* [12] or *Child of Eden*; full-body interactions [13–16] as in *Dance Central*; and even, yet not commonly used, collaboration interactions [6] and object interactions [17] like in *Geek Run* [1]. It is remarkable that all these interaction comes with a common statement of playing games naturally as one could imagine it to do it in real life. Players can add skills to their natural abilities, likewise they need to learn new skills in order to adapt to a given environment in their human life. If new skills are to be introduced to players in order to play the game, these new skills should be naturally learned by players or otherwise they may refuse to learn the desirable skill [18].

3.3 Kinect SDK vs OpenNI vs Wii

Many application exist for Kinect (a lot from www.kinecthacks.net), but many rely upon Kinect SDK or OpenNI, so these ones were chosen for implementation. Both SDKs (Kinect SDK and OpenNI) can track 20 joints of the human body and can track two players simultaneous (with a little lag times in the mere milliseconds) [19]. However, OpenNI's tracking system requires the players to hold a calibration pose until it can truly identify and begin tracking all the players body joints. This is not necessarily with the Kinect SDK since it uses a specialized system that compares known images of humans with the Kinect data received [20], allowing to quickly (less than a second in most cases) generate all body joints. This is great in a walk in/walk out situation, witch could not the granted by the OpenNI, since if some player would walk out of the Kinect range, that player would have to do the calibration pose again. Because of this, the Kinect SDK was chosen for further implementation and testing for all interactions done.

Comparing with the Wii platform [21], the Kinect has an impressive body tracking algorithms and unique controller-free experience, which is great for casual gaming parties and workouts since it also promotes natural user interface [22]. Yet, it requires a lot of room to play[23], hard-core gamers may not feel so much satisfied with insufficient precision[24], an it requires to do standing poses which can lead to gesture exhaustion[25].

4 Solution

For motion control gaming consoles, many studies and research have already compare Kinect and Wii [26][27], as is here done. But most comparisons accord to some specific interaction and most of all is a single-player research. What we want to research here, is to find out if Kinect can be compared with Wii in collaboration games.

After investigating how several researchers solved their motion control [10, 14, 17, 26, 28, 29], collaboration issues [3, 6], it was developed several interaction for Kinect to compare with the currently Wii interaction.

4.1 Four different Kinect interactions to compare vs Wii

Since non-button interactions have arrived, game developers start wondering about different interactions that can be used [12]. Unlike Wii Remote, Kinect offers a non-linear control base. The Wii Remote however, needs to necessarily use a Wii Remote control to play Wii video games. This feature open a wide variety of possibilities resulting in proposing four different Kinect Interaction proposes to compare with the current Wii interaction. The Wii Interaction will not be changed from the currently *Geometry Friends* Wii interaction, that was already implemented.

4.1.1 Hand Interaction Proposed Solution

Hand Interaction is the more basic form of interaction with the Kinect platform. Since hands are the basic utility for human life, it can deliver great utility for gaming. From the existing Kinect games that uses hands as the main or only interaction for the game, it is remarkable that most of them use both hands to interact instead of just one. Examples of these games are *Child of Eden* or *The Gunstringer* that makes use of both hands.

Regarding these studies .[8, 9, 12, 16], it was decided to use similar gesture as *The Gunstringer*

[1] http://geekrun.ch/ (last accessed November 19th, 2013)

game have. Seeing *The Gunstringer* gestures example, it is remarkable that the right hand is used to do the more active actions while the left hand is used to do moves that are less used. While the left, right and jump move (all done by the left hand) are the less used actions in *The Gunstringer*, in *Geometry Friends* these are the most used. For this reason, the left, right and jump move was considered by the right hand to do it, instead of the left hand.

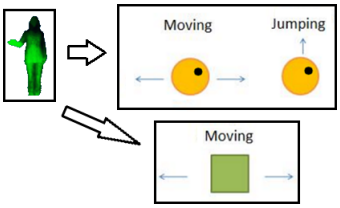

Figure 4: Hand Interaction Movement

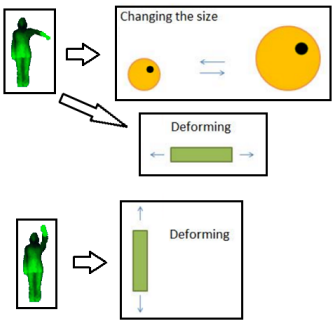

Figure 5: Hand Interaction Transformations

4.1.2 Full-Body Interaction Proposed Solution

Instead of tracking one particular point such as hands, full-body interaction is more focused on gesture using different body parts as one gesture. The proposed gestures for square and circle movement were the player's head and body (Figure 6), since this gesture have been greatly evaluated in many 3D environment applications [15, 16]. Since movement did not require player's hands, both hands was used for transformations.

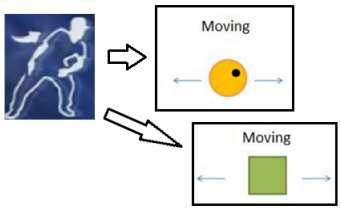

Figure 6: Full-Body Interaction Movement

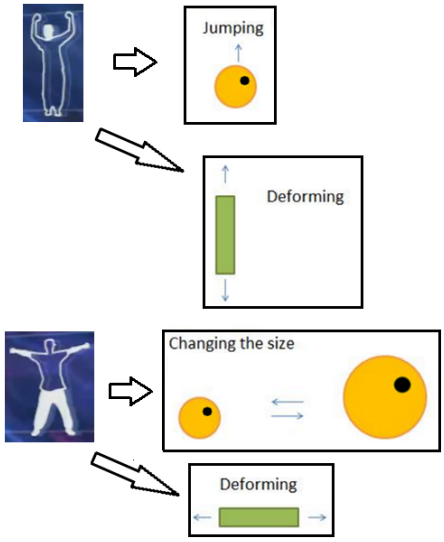

Figure 7: Full-Body Interaction Transformations

4.1.3 Collaboration Interaction Proposed Solution

The collaboration interaction was meant to bring gestures of both players together as one. However, the movement of both circle and the square was proposed to be single based gesture, stating the important role of 'who I am'. The distance between players was used for the square transformation (Figure 8). Collaboration with hand gestures was used for the ball enlarge and jump.

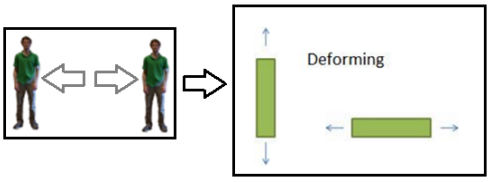

Figure 8: Collaboration Interaction Square Transformations

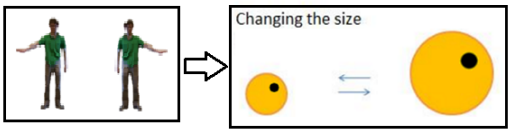

Figure 9: Collaboration Interaction Enlarge Transformations

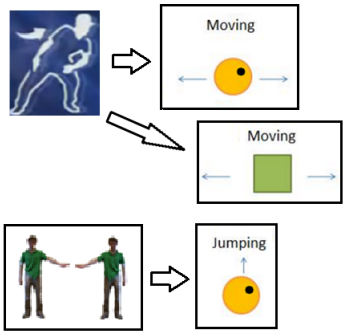

Figure 10: Collaboration Interaction Full-Body Proposal

4.1.4 Tangible Interaction Proposed Solution

The tangible interaction uses the Kinect as a form of bringing life to real life objects. Although these objects have no controller chip added to communicate with Kinect, they represented the main interaction with the Kinect game. The choice of which object to choose was rather easy and logical, as *Geometry Friends* has already polygons to choose from. Yet, since the polygons in the game use transformation actions, this would be rather hard to transpose it as real life object actions, especially for the square transformations. With the help of two green rectangle objects (thus each rectangle representing half of the square), the square transformation problems were done for. Repeating the procedure of the collaboration interaction, the closer the two squares are (the minimum would be at clashing both rectangles) the thinner the square in the game would be and vice-versa.

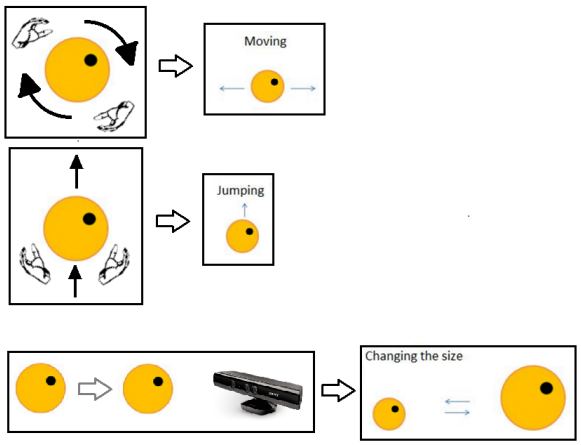

Figure 11: Circle Interaction

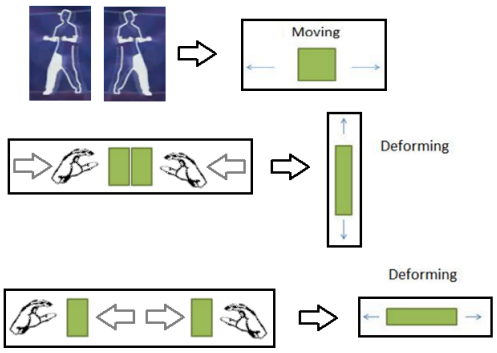

Figure 12: Square Interaction

4.2 Menu Interaction Proposed Solution

As said before, the menus were evaluated too. *Geometry Friends* has two different menus, one with line words: main menus; and another using big buttons: level select menus. In the level select menus it was used the menu navigation of the *Kinect Sports*, while the main menus was used as the *Dance Central* menu navigation. There was a little gap in the collaboration interaction although, where the second player used its right hand as a select action instead of the *Kinect Sports* and the *Dance Central* select actions. In the objects interaction, the circle was the cursor instead of the player right hand.

5 Evaluation

Participants will be randomly chosen for each proposed solution, but since this will be tested for a collaboration game there will be needed two participants for each test. The mean of all tests gathered was around six tests for each interaction, gathering 12 participants for each interaction. The only restriction was that each participant can only be part of one of the proposed solutions. This way, the participants will not confuse or compare the controls from a previous experience. Each test conducted to the participants had three sections. There was a natural-interaction section, a gesture recognition accuracy section, and a collaboration sense section. Every step of the participants was recorder, using video capture of the game using *Fraps* [2] and an another video capture with a normal camera to record the players entire gameplay.

[2] http://www.fraps.com/ (last accessed November 19th, 2013)

The first section consisted in asking participants to perform the movements as they felt was more natural. This was done before providing instruction to the participants. After this section, the participants were informed about the game controls, thus playing the rest of the game as proposed. At the end, a questionnaire was made to participants in order to gather information about playability aspects, but mostly of how was his/her sense of collaboration about the game. The playability questions gathered information about gesture recognition feeling, difficulty of the gestures, the environment physical space problems and gesture exhaustion too. In the other hand, collaboration questions gathered information about the collaboration sense of the interaction and aspects of the collaboration sense of the game itself as pleasure of winning, the repeatability of the game, the feeling of being losing or the need of playing alone.

Before the game itself starts, players have to past through the menus to start playing. So, the menus interactions were evaluated too. Yet, they were not included in the natural-interaction section, meaning that players were aware of the menu instructions when navigating the menus. Furthermore, there will be some additional question in the questionnaire regarding the menu interaction difficulty and collaboration sense.

6 Results

6.1 Menus Interaction results

Away from the in game experience, this subsection describes the results of the menus experience. As earlier explained in this document, this experience will not count with a natural factor and only one questions was done to evaluate the collaboration sense factor. What is to be more judge here is the playability factor, which gathers the Kinect fidelity to recognize gestures and the gesture difficulty relatively this last one with the time spent to complete the task, the number of errors committed and finally some few question answering results. For last, it is to note that the hand interaction and the full-body interaction used the same menu interaction which then will be evaluated together. Table 1 resume all the main menu interaction results that were tested.

Main menu Interactions	Collaboration Sense Factor	Playability Factor		**Final Result**
		Gesture Difficulty	Gesture Recognition	
Hand/Full-Body	62,88%	49,01%	98,00%	**68,19%**
Collaboration	83,33%	81,94%	100,00%	**87,15%**
Object	50,00%	11,11%	76,92%	**47,01%**
Wii	70,83%	76,39%	100,00%	**79,51%**

Table 1: Summary of all Main Menu Results

Comparing the different menus interaction, the one that achieve the most collaboration sense factor was the collaboration gesture with a 83,33% value. This value was expected since this interaction is the only one that needs a second players to navigate though the menus. Apart from this menu interaction, all others revealed distinguishable values, almost in 10% intervals, with 70,83%, 62,88% and 50% corresponding respectively to the Wii interaction, the hand/full-body interaction and the object interaction.

Considering now the playability factor, the Kinect accuracy revealed a perfectly 100% gesture recognition from the collaboration menu interaction, and a 98% for the hand/full-body menu interaction. For the gesture difficulty metric, only the hand/full-body menu interaction revealed some side downs for some players indicating that most players understand and used this interaction perfectly, but some of them (mostly, the female players) had some hardship to fully pass the menu navigation. Yet, it it to remark that this only happened in the main menu interaction, since all different interactions revealed a perfectly and remarkable 100% value for the level select menus (the reason why Table 1 only gather the main menu results). With all downsides from the hand/full-body main menu interaction, the gesture difficulty meter estimate a 49,01% evaluation. The object interaction has only tested by female players, and thus reveals a very disappointing evaluation. This may not be because of the sex factor, but it clearly reveals that was the worst main menu interaction, since even the hand/full-body interaction had better result. The collaboration interaction was the best scored here with a 81,94% evaluation, winning the 76,39% evaluation of the Wii interaction.

With an overview of all menu interaction results, it clearly highlight the collaboration main menu interaction with an outstanding 87,15% evaluation, winning against the Wii interaction with a 7% difference. The hand/full-body and

the object interaction reflected a rather bad interaction to choose with many playability problems. Nevertheless, it is not to forget that if the main menu interface has changed to a big buttons interface like the level select menus, all interactions are evaluated equally in playability (all have 100%). This will put the hand/body, object and Wii interaction in closer terms. Yet, the collaboration interaction would always have the trophy here, because of the outstanding difference in the collaboration sense.

6.2 'In game' Results

This subsection will finalize the results section with an overall fun factor results gathered from every results indicated in the past subsections. To make things clearly and understandable, table 2 relates all overall results for every factor evaluated. The fun factor has separated from the three main factors of this dissertation (natural, playability and collaboration sense) so that is does not influence the dissertation objective, making it clear the final percentage results without the fun factor.

In Game Interactions	Natural Factor	Playability Factor	Collaboration Sense Factor	**Final Result**	Fun Factor	**Final Result With Fun Answers**
Hand	51,92%	65,67%	75,75%	**64,45%**	54,44%	**61,95%**
Full-Body	61,54%	69,50%	87,43%	**72,82%**	68,52%	**71,75%**
Collaboration	44,23%	62,59%	84,98%	**63,93%**	84,26%	**69,01%**
Object	91,67%	58,90%	79,17%	**76,58%**	88,89%	**79,66%**
Wii	69,45%	69,27%	83,40%	**74,04%**	84,72%	**76,71%**

Table 2: Summary of all Factor Results

From this table, we can see that the object interaction has the better final result with or without the fun factor. This was expected since this interaction is especially designed for only this game particularly. Yet, without the fun factor, the difference is not so great as expected, since only a 2,54% difference from the Wii interaction and a 3,76% difference from the full-body interaction is detected. It fact, the object interaction only wins here, because of the high natural factor, since the playability factor is the worst between all interaction and the collaboration sense is the second worst. In the same theory, the Wii interaction achieves the second place though the good natural factor too.

Comparing between the different Kinect interactions tested, the full-body interaction is clearly the winner in here. Yet, with the fun factor the full-body interaction became very close to the collaboration interaction (1,74% difference). The lost in the collaboration sense (not expected) reveals less reasons why this interaction should be highlighted, since it has expected with the collaboration need of the interaction gestures, the collaboration interaction will come up with a better collaboration sense. The hand interaction was expected to achieve a better playability factor too, however it reveals a lost when comparing with the full-body interaction as the collaboration interaction lost in the collaboration sense factor. Furthermore, the full-body interaction revealed a much better natural than the other two Kinect interactions. It is also remarkable that the full-body interaction has the better playability and collaboration sense evaluation from all interaction tested.

In overall, the object and the Wii interaction revealed a good and better natural factor than all Kinect interaction done, and as concluded in the natural sub-chapter, the Kinect console reinforcement of many natural interactions possibilities are hard (yet, surely not impossible) to enhance in a non real-life environment or non-avatar control. Yet, only an nearly 8% difference differs from the full-body interaction and the Wii interaction. If a natural factor was not evaluated here, the Kinect full-body interaction would have the best score here, and even the object interaction would be surpassed by all other interactions. However, with the fun factor appreciation, the full-body interaction have a clearly downside here to the collaboration, object and Wii interactions which both had superior evaluation. Finally, it is clear in table 2 that the hand had the worst collaboration sense factor and fun factor of all interactions.

7 Conclusions

To make a good structure of a collaboration game is not an easy task. Even if the objective of the game is for everyone to win, it does not mean that a collaboration feeling is achieved. It has revealed that the *Geometry Friends* can achieve true collaboration sense and this sense can vary with an interaction change. It was not found a direct interrelation between the playability and the collaboration sense of the different interac-

tion, meaning that problems like gestures recognition and gesture exhaustion does not have a directly interrelate with collaboration sense of the players neither have a true interrelate with fun too. Playability is a factor to surely be taken seriously it the gestural and motion control industry, but not the only important feature. For example, the introduction of the second player use for the menus navigation, surely has helped and persuasive the players in the gesture difficulty evaluation. It can not be forgotten that the idea of collaboration or cooperation modes in games are to reach a better performance than in a single-player mode, not equal or worst.

A change of the interaction can truly change the perspective about the game. Yet, participants proclaimed difference problem issues about the game, such as being to hard, taking to much time to complete a level, repeatability, etc. It was also acknowledged that players needed more time to accustom to the *Geometry Friends* physics and overall gameplay with the Kinect interactions. This means a proper change in the game interaction should come with a change of the game itself. If the game is non real-life environment or non-avatar control, players tend to have difficulties to get used to the virtual game. This relationship can be seen when comparing the natural results with the gesture difficulty of the three Kinect skeleton interactions. This concludes that some more tutorials and difficulty changes should be evaluated to be changed when changing the game interaction to a gestural interaction.

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