Spring 2013 Haptics Class Project Paper presented at the
University of South Florida, April 29, 2013

Dual Kinect Haptic Network Gaming

N. Bonilla, A. Manasrah, and T. Ramakrishnan
Department of Mechanical Engineering
University of South Florida
Tampa, FL, 33620, U.S.A.

Abstract— **The gaming community is full of hardcore gamers that not only play video games but they live a full experience while doing it. The gaming companies are always trying to innovate in this field to bring a more interactive experience to the users. Observing the tendencies of the market the smartest move is the virtual reality experience. Right now the main gaming systems allow the users the ability to control what is happening on screen with the movement of their bodies, done differently in each system. But thinking like a gamer the next logical step would be to bring that experience into another dimension and add a force feedback that would allow the user to fully experience what is going on in the game. The best example is with fighting games; those are two player interactive games where the users hit each other in the virtual world in order to win the combat. Haptic feedback was given at the controller and many attempts have been made to give the feedback on the body as well. The system presented in this paper has a two Kinect network interface that allow users to virtually fight each other. The haptic interaction for this research is done using a couple of vibro-motor vests that allow the users to feel the punch connect to and by the opponent. This is done by strategically placing the vibro-motors in the vest. Testing of the system was conducted to thirteen users and to get feedback data a short questionnaire was collected from the users. The data showed that the users preferred the game with force feedback and that the vest was comfortable and easy to wear; but that the system needs some work in terms of responsiveness. This project is of high interest for true hardcore gamer or anyone that likes new technology. This type of gaming networks with haptic feedback will improve the realism of the gaming environment and may well broaden the gaming community.**
Keywords:Kinect, force feedback, network.

I. Introduction

In the mid to late 1970s a new industry was born, computers. With the launch of personal computers and entertainment arcade games the computing industry gained its momentum and it has not stop since then. It has only exponentially improved all of its components and added new ones to make the experience more enjoyable to the users.

Nowadays computers are an essential part of our lives. They are used for everything. Currently one of the most common and popular uses of the computer is for gaming. Since the beginning gaming has not been limited to computers or arcades; game consoles were created with the purpose of home entertainment. But this type of system became popular back in 1983 with the launch of the Nintendo Entertainment System (NES). Now, 30 years later and in what it is consider being the eighth generation of video game consoles we have state of the art technology in our homes.

The biggest revolution in the video game industry was with the seventh generation back in 2006 when Nintendo launched the Wii system which had the innovative feature that the wireless controller was a handheld pointing device that detects three-dimensional movement, making it the first of its kind. As a response in September 2010 the Playstation 3 Move controller was launched by SONY which is very similar to the Wii controller the only difference is the use of a camera for motion capture. Later that same year, November, Microsoft launched the Kinect, figure1, for the XBOX 360 console. This device allows the user to control and interact with the console without video game controllers. This new system has voice and movement recognition that allows the user to be the game controller.

Fig. 1. Kinect system (Source:Google.com)

Going on that same line the next sensible step to be taken in the gaming industry should be games with force feedback. Although this has been used in the controllers of the Playstation and XBOX we would like to take it to the next level. A gaming vest with haptic force feedback was created at Penn State University [1] back in 2010 and presented in a Haptics Symposium in Massachusetts. This vest involves the gamer to experience the force feedback of a live action game such as a shooting game while playing the game. The drawback of this device is that is only one user with one computer. We however make an interactive gaming experience involving two players while using two Kinect systems.

II. Background

As engineers we are very curious about the world around us and we are always trying to find the best way to interact with it. Haptics is a virtual form to interact with the world. Taking this into consideration and also considering the ever changing gaming industry we got inspired to create a more realistic gaming experience. Having hardcore gaming friends, and knowing about gaming ourselves we decided to combine our hobby with our field of study and create a device both innovative and enjoyable.

Doing some research of the topic we came across a couple of papers that are trying to make the virtual world more realistic. There is a jacket to improve movie viewing [2] that have pre-set force feedback to enhance the emotions while watching a movie. The Penn State vest, previously mentioned, only gives force feedback of the game that you are controlling with keyboard input, and there are haptics shoes [3] [4] that simulate different terrains.

What we have accomplished is having real-time force feedback while interacting with another person in a fighting game. Also this project uses a two Kinect interface to create online gaming with this system; which has never been done before. The final intention of this project is to give a more realistic experience to the users while playing video games, like [5] [6]. Beyond gaming other applications for this vest could be for movie/tv viewing [7], training/rehabilitation, and even social networking [8].

III. Coding Process

The final game system will include two Kinect devices working in two different computers connected to the same network via a router. The programming of the Kinect devices is done in C Sharp. A server was created in each system in order to receive the points. Similarly two clients were created to send the data points created by the user and later be interpreted by the Kinect. The server is a project linked to the Kinect project; however the client code is embedded in the Kinect code already.

By comparing the data points of the opponent the system will determine if a hit was acquired. If so the data is sent to the Phidgets,figure 2, USB sensing and control board that will set off the necessary vibro-motors,figure 3. Giving like that a force feedback to the user, as done before by [9] [10]. To give a sense of the player that is making the hit, a beeping sound was added to the code. Different frequencies were used to be able to differentiate between users.

IV. Hardware

To create a proper haptic interface between users a vest with vibro-motors, figure 4, was prepared for testing. To attach the motors to the vest velcro patches were created. One motor was attached to the right hand, fighting hand, of the user. Meanwhile the other three motor were attached to the chest area of the vest in the left side.

The vests are extra-large reflective safety vests, chosen like that to fit most potential users. Since the vibro-motors are attached to the vest the system needs to be close to the chest in order to be felt. To solve this problem adjusting straps were put in the chest and the waist of the vest. The straps resulted very effective to keep the system in place.

V. Set-Up

To finalize the set-up of the system the connection presented in figure 5 needs to be completed. The Kinect system is connected to the computer as well as the phidget board. The chest vibro-motors will be connected to the phidget board and the hand motor will be connected to the other phidget board as shown in the diagram. This connection is the same for both sides.

Fig. 2. Phidget sensing and control board (Source:Google.com)

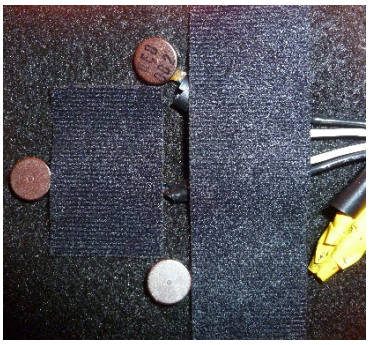

Fig. 3. Vibro-motors

Fig. 4. Vibro-motor vest

The connection allows the users to see the video feedback from the other player. While feeling the connected punch in the right hand vibro-motor and the received punch in the chest area. Meanwhile, at exactly the same time the opponent will be feeling the chest and then the right hand vibro-motor go off as the interaction between player progresses.

VI. Testing

The connection presented in the previous section was set-up in a room for testing. After making sure that everything was working fine testing began. The game was presented as a boxing game to the potential users. The testing consisted of dressing two people with the vibro-motor vests and made them virtually fight each other, as shown in figure 6. As it

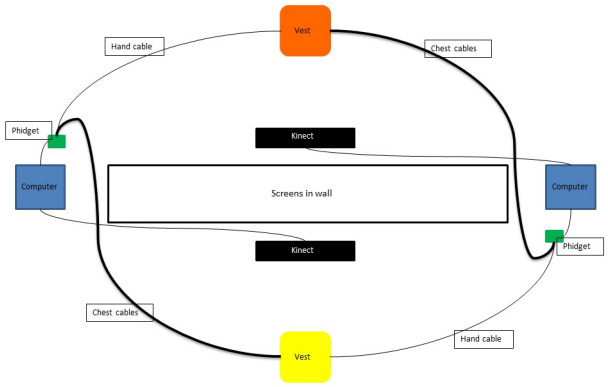

Fig. 5. Connection diagram

Fig. 6. User test.

can be seen each user will stand in front of a Kinect and on screen is the image of the opponent. The user just needs to move to where the opponent is located to connect a punch. Once a punch is connected a beeping sound will be heard and both the user and opponent will experience vibro-feedback. One will feel the feedback in the right hand and the other in the chest, respectively.

After the user was done testing our system a questionnaire was handed to each of them in order to improve the system. Our target audience is mostly college students of every level; mostly between the ages of 20 and 36. Thirteen (13) questionnaires were collected during the trials; two female and eleven male. Each questionnaire asked for gender and age for statistical purposes only.

The questionnaire was divided in three parts. The first part was about the gaming while using the vest. The users had to rate the vibro-motor vest in seven categories in a scale from 1 to 4; 1 being the lowest. The categories for the vest were: comfort, wearability, sensitivity, visualization, responsiveness, ease of use, and gameplay. The intention of this part is to know what this project needs to be improved on.

The second part was to compare the gaming experience between the current game experience without force feedback and the game experience with the vest which includes force feedback. The factors to be compare were: visualization, responsiveness, ease of use, and overall gaming experience. To be able to make a correct comparison the user needed to have experience with Kinect gaming without force feedback; for this reason only eleven (11) responses are used for the analysis. Two of the testers were not familiar with the current gaming systems and were instructed to leave this part in blank. The intention behind comparing these two gaming experiences is to know if the potential users of a system like this would actually like it; if the addition of force feedback to the gaming experience is a convenient move in the gaming industry.

The third and last part of the questionnaire consisted of three open ended questions. Just like in part one (1) of the questionnaire the intention of this part is to know what this project needs to be improved on and also which things do not need any improvement since they work fine. The first question was asking for the most enjoyable part of the experience. The second inquired about the least enjoyable thing of the game. And the last one requested the users to input suggestions on improving the project. At the end there was also some space for additional comments about any part the system. This was an excellent part to get specific feedback from the users since ten (10) out of the thirteen users wrote something in the questions to help us improve the project in the future.

VII. Results

Two type of analysis were done from the data collected during testing. A statistical analysis from the whole general data was performed to see if there is any statistical significance in the data. The second study performed with the data was a percentage analysis from each of the factors from part one and two, explained in the Testing section, to clearly view the users preferences of the system. Finally, the users answers to the open ended questions were analyzed to reinforce the tendencies of the answers of part one and two of the given questionnaire. To complete the statistical analysis ANOVA was use. Two different analysis were created to study the data from part one and part two of the questionnaire separately. Figure 7 above presents the results of part one,

Analysis of Variance

Source	Sum Sq.	d.f.	Mean Sq.	F	Prob>F
gender	2.9469	1	2.94694	16.01	0.0001
factors	2.1538	6	0.35897	1.95	0.0826
age range	2.0242	2	1.01212	5.5	0.0058
Error	14.9128	81	0.18411		
Total	21.5385	90			

Fig. 7. Statistical analysis part one.

gaming experience while using the vest. From the figure it can be see that gender and age range are statistically significant for the study. Meaning that the two females gave better scores than the men, see figure 8; and that the three users between the ages of 25 and 29 rated the system better than the seven between the range ages of 20 and 24 and the three users above 30 years of age, refer figure 9. A

reason for the gender inclination of the response might be that female tends to be more sensitive to external stimuli than male [11]. For the age range there are two possible reasons: for the users between 20 and 24 the system might not be as precise as they would like since they are the biggest gaming audience; and for the users over 30 the explanation might be that they simply dont enjoy gaming at all. Above; figure 10 presents the results of part two, the

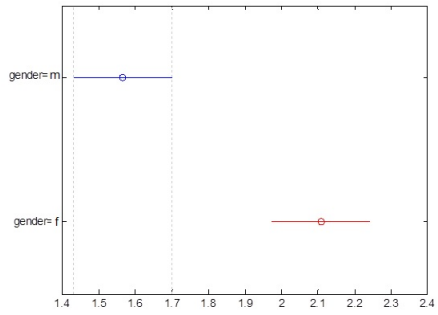

Fig. 8. Statistical significance of gender part one

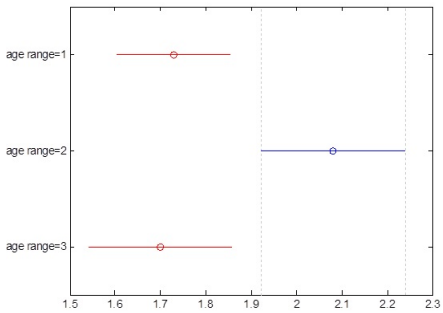

Fig. 9. Statistical significance age range part one

Analysis of Variance

Source	Sum Sq.	d.f.	Mean Sq.	F	Prob>F
gender	0.12857	1	0.12857	0.87	0.3569
factors	0.25	3	0.08333	0.56	0.6422
age range	1.42222	2	0.71111	4.81	0.0139
Error	5.46667	37	0.14775		
Total	7.15909	43			

Fig. 10. Statistical analysis part two

comparison of the gaming experience between the one with force feedback and the one without force feedback. From the figure it can be seen that only age range is statistically significant for the study since the probability of occurring if less than 0.05. Meaning that the only user that filled this part of the questionnaire from that age range prefers gaming without force feedback, see figure 11. For the age range again this can mean that users over 30 simply dont enjoy gaming or that they prefer traditional gaming best. In other words, users above 30 like playing video games using controller while sitting comfortably in front of the television. For the

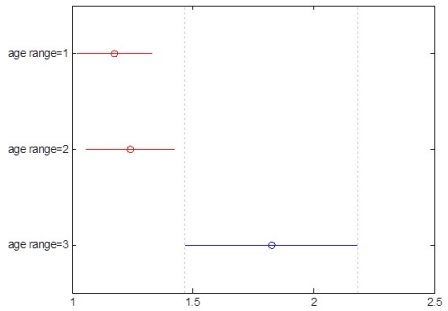

Fig. 11. Statistical significance age range part two

percentage analysis, each of the factors presented in part one and part two of the questionnaire were study separately using Microsoft Excel software. For the results in part one the number of users that selected three or four were counted and then divided by the total number of responses. Finally, to obtain a percentage of the people that agree with that statement the number was multiply by one hundred (100). The results, figure 12, show that the majority of the users found the vest to be comfortable and easy to wear. They also thought that the visuals of the game and the overall experience were good; and that the system was slightly easy to use in general. Meanwhile sensitivity and responsiveness were below fifty percent. This can be explained since first, for sensitivity, most of the users were male and as mentioned before female tend to be more sensitive than those of the opposite sex. Also in the middle of the testing process one of the cables broke in the soldered area; which was a drawback for the user to get the full experience. In terms of responsiveness one of the computers was slower, in processing, than the other which made the game lag sometimes preventing like that the information to go through. For the results in part two the number of users that selected

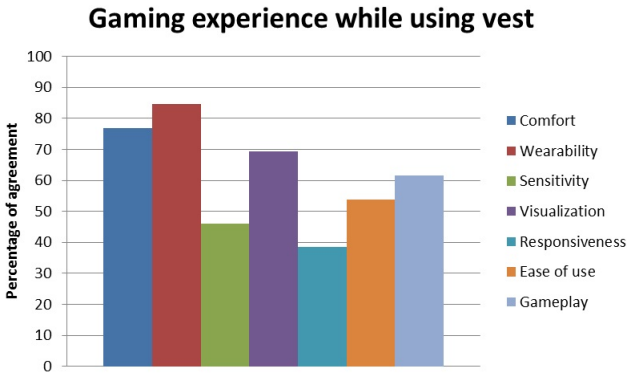

Fig. 12. Percentage analysis part one

the with force feedback experience were counted and as before then divided by the total number of responses. And then again to obtain the percentage of the people that agree with that statement the number was multiply by one hundred (100). The resulted number was then subtracted to one

hundred and the percentage of people that preferred each of the factors without force feedback was obtained. The results, figure 13, show that more than seventy percent of the users found the gaming experience to be enhanced by the use of the force feedback in each and every one of the factors in this part. Even responsiveness, which in part one got thirty-eight percent, was preferred with force feedback that without it receiving eighty-two percent of the votes of the users. But still being the overall gaming experience the one receiving the most approval from the users with ninety-two percent. This tendency can be explained as gamer wanting to experience the games in another dimension. Since most of our users were the targeted audience of video games they were able to compare the experience this project provided to the one currently delivered by conventional consoles. With this study it is safe to say that users would like to feel what is going on in the game by the means of haptics and force feedback. The last part of the questionnaire was mostly for

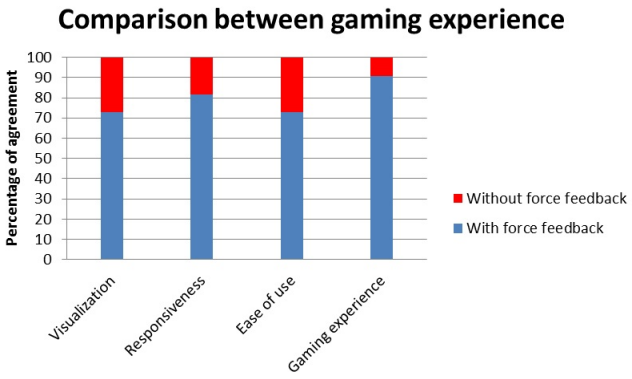

Fig. 13. Percentage analysis part two

the improvement of the researched project. The open ended questions lead to the discovery of the things that the users enjoyed the most while using the vibro-motor vest system. Some of the comments point out that it was a new, fun, and interactive new experience in gaming. That the punch was easily felt with the real-time interaction of another person while having the person right in front of them with the video feedback. On the other hand the negative comments, which will actually help improve the experience, address more the problems of the computing processing and responsiveness of the system. The users believed that if these problems are resolved the experience will greatly improve. For the improvement question in this part two suggestions stand out: add more contact points to make the game even more interactive and make the force feedback to be felt more like a punch instead of vibration. All of these comments are great feedback from the users that will allow the system to be greatly improved in future research.

VIII. Conclusion

The intention of this research was to prove that the next logical step for the gaming industry should be to add force feedback to the video games. For that, a vest with vibro-motors strategically placed was created. To get data a questionnaire was collected from each of the thirteen users during testing. Testing consisted of the users wearing the vest and using the system. From the analysis it was found that most of the users preferred to add force feedback to their gaming and that the vest was comfortable and easy to wear. The drawback of the system, according to the users, was the time response from the system for when the punch is connected and that the force feedback, which was a vibration, did not actually felt like a real punch. The users thought that if these two issues were resolved the system will be an excellent addition to video games; supporting like that this research believed of force feedback being the logical step for this industry.

In addition to resolve the issues found with this study for future work this system can have applications in other industries; other than that for video games. One industry that can benefit from a device like this would be the movie industry. To give movie goers a fourth dimension while experiencing a movie. The closest thing currently in the market for haptic feedback during movies is a moving chair which replicates the movements on screen to the chair; but this vest could allow each user to experience every single motion detail in the film. Another industry that can also take advantage of this type of system is social networking; to take human virtual interactions and turn the into a haptic reality.

References

[1] S. Palan, Tactile Gaming Vest (TVG), unpublished. In http://iroboticist.com/2010/03/26/tgv/

[2] F. Rydn, H. Chizeck, S. Kosari, H. King, and B. Hannaford, Using KinectTM and a Haptic Interface for Implementation of Real-Time Virtual Fixtures, unpublished.

[3] P. Lemmens, F. Crompvoets, D. Brokken, J. Eerenbeemd, and G. Vries, A body-conforming tactile jacket to enrich movie viewing, in Third Joint Eurohaptics Conference and Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems, March 18-20, 2009, pp. 7-12

[4] L. Turchet, P. Burelli, and S. Serafin, Haptic Feedback for Enhancing Realism of Walking Simuations, in IEEE Transactions on Haptics, vol. 6, No. 1, January-March 2013, pp. 35-45

[5] D. Chang, Haptics: Gamings New Sensation, in Computer, August 2002, pp. 84-86

[6] S. Jin, Effects of 3D Virtual Haptics Force Feedback on Brand Personality Perception: The mediating Role of Physical Presence in Advergames, in Cyberpsychology, Behavior, and Social Networking, vol. 13, No. 3, 2010, pp. 307-311

[7] D. Gaw, D. Morris, and K. Salisbury, Haptically Annoted Movies: Reaching Out and Touching the Silver Screen, unpublished. In http://techhouse.brown.edu/ dmorris/publications/haptic movies paper.pdf

[8] J. Rantala, R. Raisamo, J. Lylykangas, T. Ahmaniemi, J. Raisamo, J. Rantala, K. Mkel, K. Salminen, and V. Surakka. The Role of Gesture Types and Spatial Feedback in Haptic Communication, in IEEE Transactions on Haptics, vol. 4, No. 4, October-December 2011, pp. 295-306

[9] B. Shrewsbury, Providing Haptic Feedback Using Kinect, unpublished.

[10] W. Song, X. Guo, F. Jiang, S. Yang, G. Jiang, and Y. Shi, Teleoperation Humanoid Robot Control System Based on Kinect Sensor, in 4th International Conference on Intelligent Human-Machine Systems and Cybernetics, 2012, pp. 264-267

[11] R. Peters, E. Hackeman, and D. Goldreich, Diminutive Digits Discern Delicate Details: Fingertip Size and the Sex Difference in Tactile Spatial Acuity, in The Journal of Neuroscience, vol. 29, No. 50, December 16, 2009, pp. 15756-15761