ENHANCING HUMAN COMMUNICATION/INTERACTION THROUGH VIRTUAL REALITY

In what ways can combining 360° videos technology with remote communication technology offer new or optimised modes of human communication?

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Abstract. The increase in advancement of virtual reality (VR) in the gaming industry provides a promising potential, yet the use of VR in communications and interactions have yet to prove its worth into people’s everyday lives. Various technologies today provide a variety of “communication methods that transcends both space and time” (Charles, 2001). This research project identified a possible method of communicating and interacting with VR and 360° cameras. Furthermore, an immersive communication and interaction experience than the traditional 2D video and voice calls. Using a small budget, the project carried out attempts to imitate a larger concept and design which can aid in providing a means of identifying a new method of interaction between people. One of the key outcomes is to test the effectiveness of communication or interaction through VR and 360 panorama videos, by using the technologies such as the Samsung Gear VR, Arduino components, and 360° fly camera. Through testing and evaluating, the research project offers the limitations and the current ability of using such devices.

Keywords. Virtual Reality: Communication; Interaction; Telepresence; 360° view.

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1. Introduction: Research Aims and Motivations

The use of VR technologies and the potential it has with the use of 360° cameras can bring about a new method of social interaction and communication between people. Even though in today's society we are constantly surrounded by technology, the capability of being able to experience another person's environment has yet to be part of our daily lives.

This research evaluates the effectiveness of using the mixture of VR and 360° view videos. Also the figure of embodiment in a 360° space and also whether the VR headset assists further in enhancing the experience as it shuts out the user into the 'virtual' space.

This is a step to a new method of 'virtually' being in another person's environment. The methodology of the research aims to find out the limitations to what can be achieved in this domain.

Currently there are services and programs which display 360° videos in virtual reality, however the cost is currently too great for everyone to have access to. Using VR technology and 360° panoramas is method of this research project, and whether the technology can be used as a medium to enhance the interaction with other people.

2. Research Observations and Objectives

This research takes a step forward into finding the gap of where the technology stands and whether the virtual space and the perception of a person figure intensify the level of communication and interaction. Through various technology used, the research project also aims to test the limitations of whether live communication is possible, and the effectiveness of a panorama view used as a communication medium.

3. Research Questions

Enhancing human communication and interaction through virtual reality and 360° views

- What is the effectiveness of combining 360 videos technology with remote communication technology offer new or optimised modes of human communication?

4. Methodology

If the budget was not a problem, having two users with virtual reality headsets to be able to see one another in the same virtual environment would be optimal, although since the headset covers most of the facial features of the user, an external 360° camera is present in both the VR users to record them with the VR headsets. Although the facial features of each other would not be seen since the VR headset is yet to be able to do that, testing the value of the having the human figure would allow the understanding of effectiveness of whether the interaction would be higher than of the traditional interaction methods of 2D Video and voice calls.

Having a 360° camera attached to a stand would allow the user to also view their position in reality whilst also being in the other person's environment. In the 'virtual space', the users would be able to view each other's environment through the 360° camera that is on the stand, and the user would have half of the 360° panorama view (180° each) for their environment, and half of the other person's environment. This way, the users can see both sides of the space in one 'virtual' space. This concept is a possible situation to test and evaluate to see how effective the panorama view and the virtual headsets provide as a means to enhance the long distance interaction.

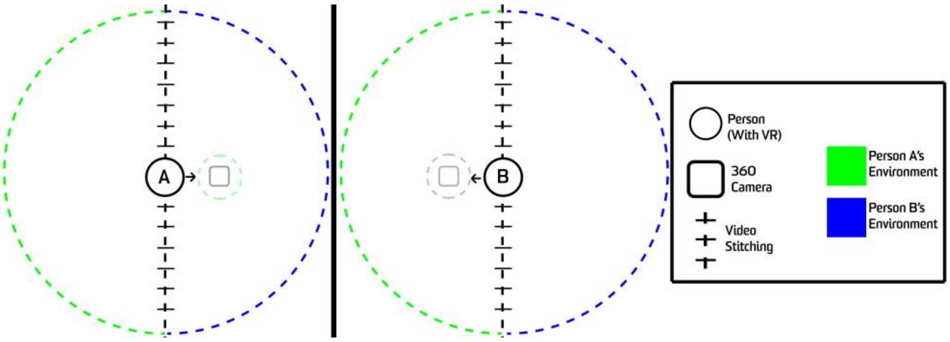

***Figure 1. Plan view diagram of the larger concept*.**

In the diagram, the thick line represents the two different environments. The 360° camera that each person is facing is in their real environment and not part of the virtual space that they are looking at. Person A will be facing the camera in front of them, whilst viewing Person B’s camera view. Vice versa with Person B. Each person through the VR headset is able to view the other person’s camera, and when look back, they will be looking at their own camera view of their environment.

In terms of the physical prototyping, the testing of this idea came down to using only one person in the VR environment, and also what was compatible with the 360° camera. Initially, the project tested the capability of using the 360° fly camera with YouTube 360°, but was suggested by the “fly” (Camera’s application) to use Facebook 360° feature. Testing the camera with the Facebook was compatible with the Samsung Gear VR to test out the video quality of the stream. Tweaking the settings to suit the desired video output was needed to be applied. A factor that may cause the VR user to feel slightly disconnected in the experience is the Frame Rates Per Second (FPS) of the experience; having higher FPS provides a higher quality feedback to the user and a higher simulation experience. Testing the differences also provided information on the current ability of the phone and network speed capabilities with 360° views and VR.

5. Background Research

VR was once viewed as a machine that was a destination to what communication could mean in a virtual space (Biocca, 1995) and has moved and changed a lot since. The nature of virtual space is researched in this project, to determine whether the technology poses any potential in becoming an additional tool in communicating and interacting with others.

The article Communication in the Age of Virtual Reality by Frank Biocca looks into the concept of Virtual Reality as a communication medium, and how it was viewed as the “ultimate” interaction between human and computers. It explores the concept of VR and how it is not just merely a technology, but an emerging communication system. This a step further than the “interpersonal channels which involve a face to face exchange to a technological advanced level of communication” (Rogers,1986). It promotes the idea that the way humans communicate with each other is determined by the communication technology that is available and used at the time. Since this research project attempts to use virtual reality and 360° panoramas as the communication tool, it questions how effective it is today and the whether it can be applied to our daily lives.

The value of the human figure embodiment in 360° panoramas and VR would be different to the traditional face-to-face communication, as you don’t get the opportunity to get “instant feedback and quite difficult to read the atmosphere between you and the person” (Ray Land 2004). However, having the human figure inside the VR experience would have some effect on how we perceive that figure. A discussion of the concept of a ‘virtual environment’ has defined “virtualisation as the process by which a human viewer interprets a patterned sensory impression to be an extended object in an environment other than that in which it physically exists” (Sanchez-Vives, 2004). What contributes further to the value of the human embodiment is the field of view that the headset provides. Having a wider view that contains both the human figure and their environment together provides a more convincing experience.

The concept of telepresence was first introduced by Marvin Minsky in 1980, and described the “feeling that a human operator may have while interacting via a tele operator system” (Sanchez-Vives, 2004). Having the human to view the perspective of a machine and manipulate its parts at the same time would allow the user to feel as if they are actually there in that environment is what the telepresence was conceptualised by Minsky.

Capturing 360° panoramas is accomplished through capturing “multiple images and stitching them together into one seamless wide angle image. The input images were transformed to a planar surface, and then the stitching points are calculated with an image registration algorithm, lastly, the overlap regions of the images are merged to smooth out the differences near the stitching points” (Patrick Pan, 2011). To take things further, “the portion of the video in the direction of view is dynamically extracted and presented to the display in response to the user’s head orientation. The challenges encountered in this process span issues in camera calibration, image processing, compression, networking, computer graphics, and high-performance computing” (Thomas Pinatric 2000).

With the developed design of the fish eye lens design such as the 360° fly camera used in the project, the 360° panorama view is recorded without the need to stitch the images together, and the recordings are the actual video footage rather than images overlapping. Fish eye lens were previously used in recording "forest stand hemispheres for radiation-ecological analysis" (Manojit Sarkar, 1993). The lens magnifies the closer objects, whilst shrinking further objects in the distance. The fisheye view is typically focused largely in one area and shrinking the other areas to the side as shown below in the diagram.

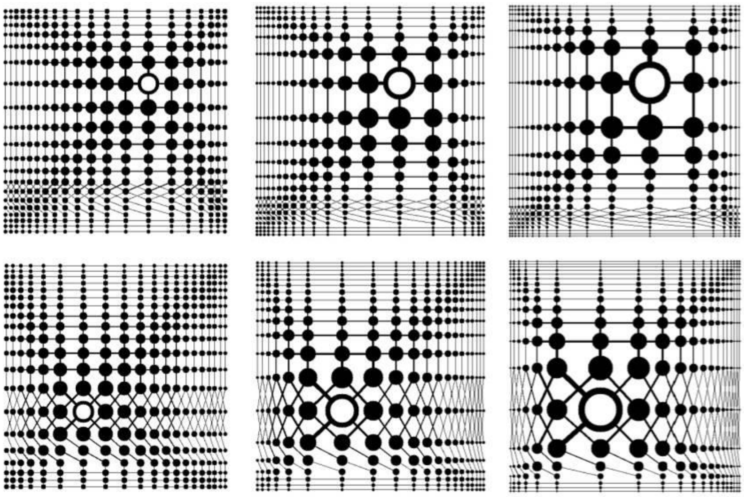

Figure 2. Fisheye lens differences of looking at different points of the screen which is enlarged compared to the unfocused areas which are smaller (taken from Manojit Sarkar, 1993).

6. Case Study

The physical prototype focuses on allowing one person to experience another's environment in virtual reality and have the two to switch back and forth when needed. Since the users are not in a symmetrical relationship of experiencing each other's environment, one user with the VR headset would be able to experience a 360° view of the other person on the other end, and the person without the headset would be able to move around with a moving stand with the 360° camera on top. The project contains the use of a remote control car as the moving stand which follows the user that is without the VR headset. The remote control car base is attached to an Arduino circuit board in which the board is also powering a servo motor. The servo motor is attached to a platform which will be the base for the 360° fly camera, and will rotate with the servo motor, which in turn will move the 360° camera on top.

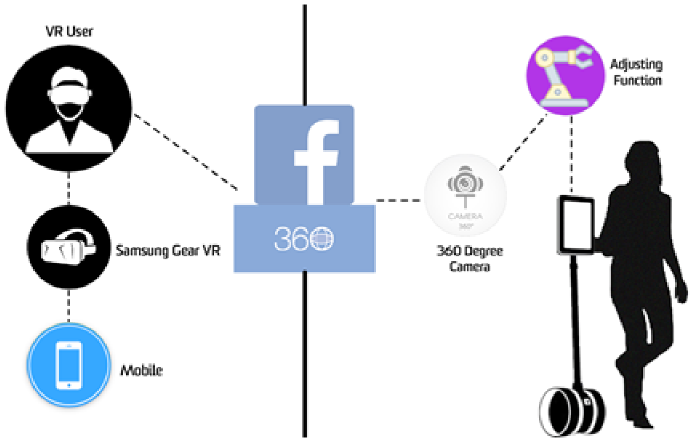

***Figure 3. Concept of how the components are connected*.**

The motor is used with the Arduino board as it will act as a user input to control the view of angle of the 360° camera. This input is added for the additional option of not having to always rotate your head constantly, especially if you are sitting down and using the VR. This also allows any age group (in particular the elderly) to feel more comfortable looking around without a lot of effort to experience the 360° view. This user input would also allow for the VR user to feel a higher level of embodiment within the experience, and with this additional input of the rotating platform, it generates a higher level of connectivity with the other person's environment than having no control of the movement of the 360° camera.

The 360° camera is placed on top of a platform that is connected to the servo motor, and the user would be able to control the servo motor through a device such as a phone and Bluetooth connectivity.

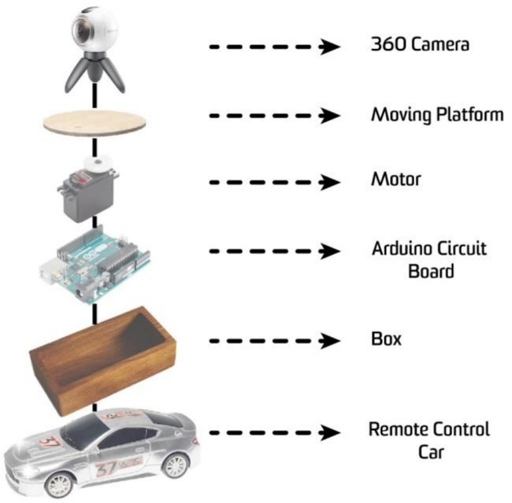

Figure 4. Concept diagram of the prototype.

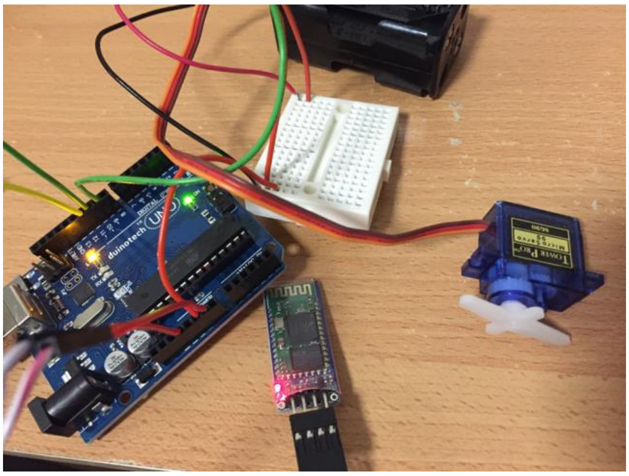

Figure 5. Arduino components. Servo motor and the Bluetooth HC-06 module.

To view the panorama view of a person's environment, the 360° fly camera is compatible to view in VR through Samsung's Gear VR headset. This is possible through the 360° video view function on Facebook. The Samsung Gear VR additionally has an application to view the 360 experience and to view it within the VR headset. By using this method, the capability to view the 360 degree VR experience is possible.

Figure 6. Project setup. Samsung Gear VR with Remote control car with the Arduino components inside, and the rotating platform on top of the car for the 360° camera to sit on top.

7. Significance of Research

Virtual view generation for 3D digital video by Saied Moezzi explores VR and how it was initially tested was through “multiple recordings at different perspectives and transferred into computer 3D graphics” (Saied Moezzi 1997). It attempted to record real life events and environments like this project research but through “older methods of capturing images”. The system that Moezzi used was through the “Multiple Perspective Interactive Video (MPI-Video), an infrastructure for the analysis and management of, and interactive access to, multiple video cameras monitoring such as a dynamically evolving scene in a football game” (Saied Moezzi 1997).

To create the 360° views, Moezzi’s team used image warping approaches, such as using an uncalibrated camera to scan the stationary scene and finding the transform points on the camera image plane of the virtual view. In terms of the model based methods of recording 3D objects, the project consisted of 17 cameras surrounding the area. The main aim of this project was to “record images at different angles on one object and generates a low polygon 3d model which moves according to actual footage of the object" (Saied Moezzi 1997). The virtual view in this case was merely the distinction of colours and identifying the various parts of the object. A diagram is shown below to demonstrate.

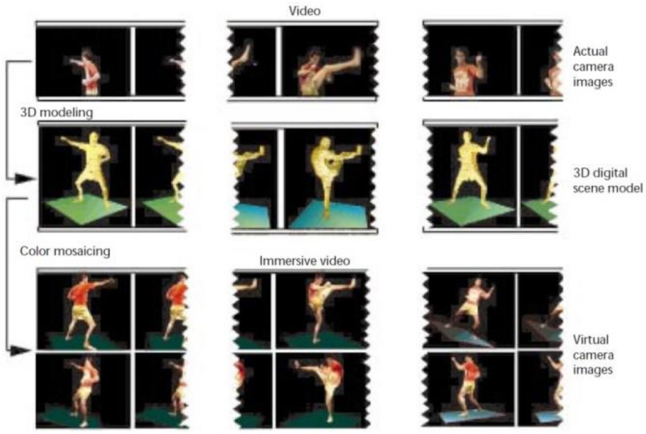

Figure 7. Process of 2D images to 3D virtual objects (taken from Saied Moezzi, 1997)

This project presents the history of the process of making virtual images, and how the angles of recording were used. Similarly, this research project records 360° view images through the fish lens of the 360fly camera, and the images are automatically pinpointed into a spherical shape rather than trying to make it look like a 3D model of the surrounding environment. A project on telepresence and video conferencing in an office also looks into using a wide angled view to communicate and interact with other people. Video conferencing usually provides a back and forth interactive video and audio communication between two or more points. Telepresence "creates an illusion to make the user feel as though they are in the same room as the other person on the other end of the call" (Davis, 2008).

Telepresence has been used in the "Medical Intensive Care Unit" (Becevic, 2015) in addition to having robotics like the concept of this research project. The medical centre tested and evaluated the amount of use the patients had with the project and observed findings with the robotics. One of the main differences that was found through using the telepresence device and of the traditional videoconference systems in healthcare was that they assumed and interacted with the device as if it were a person. It was also observed that patients were quite adaptable to the new technologies, and this was the case as the patients who often come to the medical centre are already constantly in contact with technology and more so as the newer generation takes place. The observed results were tested from 26/10/13 to

20/12/13, and the robot was used for a total of 72 minutes, used throughout Monday to Thursday. The robot was only used in a total of 8 sessions with an average of 9 minutes each, which was the case as the robot was only used for additional questions for the physicians and not used as a main tool. The providers who used the robot indicated that during the hands on training, they wanted to control the robot through an iPad application. These observations show that the telepresence of the stand, and using technologies to communicate and interact, is not used as a primary option in the medical centre.

This is the same approach this research project has in terms of having the VR 360° view as an additional option in interacting with other people, and the robot would have the user to think that they are next to a person rather than a piece of technology. The users for this current project also have the option to control the robot and where it goes through the remote control car controller.

8. Evaluation of research project

Through the use of VR technologies in conjunction with the 360° cameras, the project did show potential in terms of being an additional interaction option to the traditional 2D video calling and voice calls. However due to applications and devices used, the live feedback was not possible, and the stream was able to be viewed when until the live video broadcast was ended. The perspective and the image quality on the other hand were decent and were not too hard on the eyes.

Figure 8. Inside view perspective of the quality of the 360° VR experience.

Depending on the position of the camera in terms of height, the results made a difference due to the fisheye lens design of the 360° fly camera. If the position of the camera was below the head level of a person, the human figure and the immersive interaction with that person and their environment did not feel realistic. However, having the 360° camera higher and closer to the head of the person allowed the VR experience to feel less like watching a video.

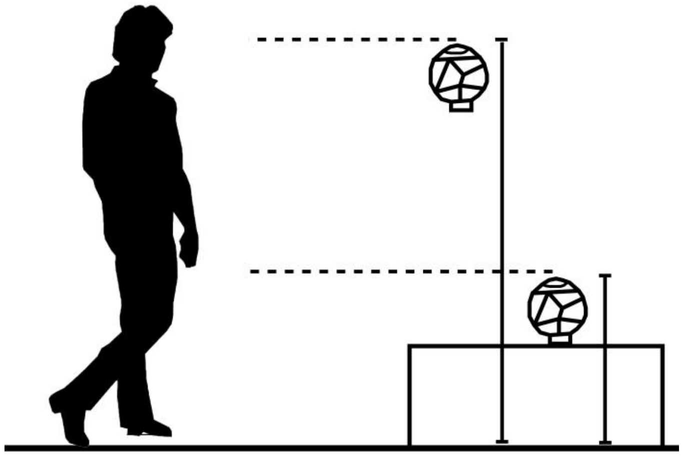

Figure 9. Having the 360° camera in level with the user on the other end provides a realistic view than of a view which has the user looking down on the VR user.

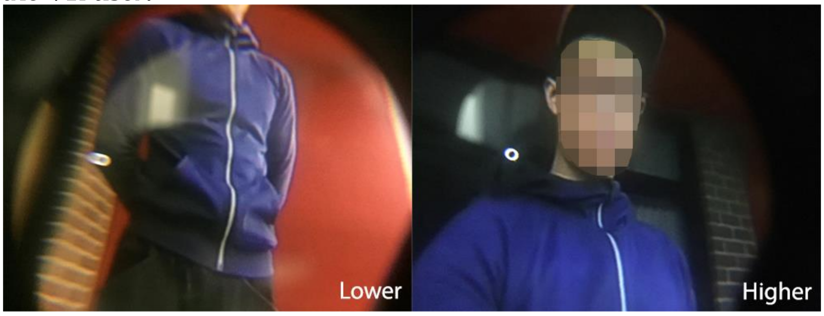

Figure 10. Differences of height of camera position. Left image shows the camera at a lower position and looking straight ahead, and the right image shows a higher position level.

The 360° view inside the VR headset also had the ability to view the top, unlike the traditional 360° panorama view with the top and bottom cut off. Since this is the case, the objects which are closer to the top seem further away, which is the reason why the positioning of the camera becomes important. Testing the camera at head level of the person next to the 360° camera provided a more convincing personification of a person, and felt more connected to what the other person would see in their environment. The rotating platform, which only rotated on the horizontal plane, did not need the vertical movement although the bottom part was cut off. This gave the sense of a ‘virtual’ body, and rather than having the bottom there, it would give the VR user the feeling of a floating head rather than connected to an object.

Figure 11. Image showing the bottom part of the 360° view cut off and blurred out.

The quality of the video streaming were able to be altered, but ultimately, the quality depended on the signal strength and internet speed of the phone service provider, as it used the mobile data to stream the video whilst using the Wi-Fi to connect to the 360° fly camera. The video quality would have been improved through a faster internet and upload speed. Furthermore, the option was limited to either promoting more FPS with less resolution, or higher resolution with lower FPS. This is the case as the mobile network internet speeds are not efficient enough to have both features to the stream.

As mentioned before in the research, the optimal and ideal concept consists of having both users to be in the same virtual space with two robotic stands and cameras. Therefore, the project can be improved with extra devices and components to have both users experiencing each other’s environment. The applications and programs available today are still lacking in terms of effectively stitching live stream video to VR but there are some available through using a high tech system (such as Vahana VR) at a costly price of about $3000. Although the research project does not reach live streaming capabilities, the position of the camera and the robotic stand can be improved by having an adjustable height to match the height of the person with the camera.

Having said this, the research project can still be of use in other areas than of live communication. Applications for this project can be used in understanding the architectural infrastructure through the recordings and what the place feels like through the 360 VR experience. Furthermore, managers and construction workers can communicate about the site without having to actually be there, and also discuss with other companies or industries around the world at the same time in the work site. The main difference is to simply end the live broadcast for it to be viewed straight after.

9. Conclusion

The use of VR technologies in conjunction with 360° cameras brought about the possibility to be used as a social interaction and an immersive experience between people. Even though in today's society are constantly surrounded by technology, yet the capability of being able to experience another person's environment is yet to be part of our daily lives. Through understanding the value of the human embodiment in the 'virtual space', it posed to be effective if the user is able to control parts of the machine in the remote environment. Live stream VR services and programs are available which attempt to stitch 360° videos to be viewed in virtual reality, however the cost of achieving the idea would be too great for everyone to have access to.

With having two users with VR headsets and having two robotic stands that would record and stitch together both VR user's environment would be the way the research project could have been carried out as an optimal approach. However, working with what is available to borrow as a student, the project consisted of focusing on one person's experience on another. The remote control car mimics the robotic stand, and the Arduino board and the servo motor mimics the telepresence aspect of the experience. The height position of the 360° camera became an important factor in providing a more immersive and a more realistic experience for the VR user. This is due to the fisheye lens design of the 360° fly camera that is used in the research project, which magnifies closer objects and shrinks further objects. The research project resulted in not having a live stream connection straight to the VR headset through the lower budget, but the capability of streaming the 360° video to the VR headset after the broadcast has ended, was achieved. However, the project could still test and evaluate the quality of the stream, the limitations and the standards of attempting to identify a cheaper method for people to be able to afford.

Overall, the research project takes a step towards finding an option for people to use in addition to the traditional communication and interaction methods of 2D video calls and voice calls. Enhancing human communication and interaction is definitely possible with a higher budget and with extended time to carry out further steps to optimise the visuals and improve the immersive experience for the VR user.

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