360 Meeting Camera: Engineering Principles

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I pledge my honor that I have abided by the ***Stevens Honor System.***

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Section I - Team Responsibilities

Andrew Bean

Having a significant amount of experience with programming, I will be able to assist the team in developing algorithms for motion detection, camera movement, panoramic stitching of video stream as well as other minor facets. Possessing a sufficient amount of experience in coding environments and embedded systems I will be able to help the group achieve hardware/software interfacing. In addition to this, I am also an Electrical Engineering major and will be able to assist in the wiring setup and fabrication of the multi-camera design. My major efforts will be devoted towards the programming side of the project, but hopefully I will be able to assist in all aspects where I can.

Jeff Nicholls

As one of the Electrical Engineers in the group, I will be working on more of the physical side of the project. Developing a 360 degree camera for low cost and easy use will be the biggest challenge. To have the lowest cost possible, the team should design as much as the project as they can and not purchase outside companies products. I will also be working on how the device will be connecting with the computer. For fastest and the best results, hardwiring is the way to go. Possibilities include using the USB or FireWire ports, as the VGA, HDMI, and Display ports are for output displays only. Unfortunately FireWire ports do not exist on many computers at all. Thus the most viable option for hard wiring would be USB connection. For convenience of the user however, wireless connection would be optimal so this option must be looked into as well. Lastly, I will be helping with designing a layout of the program that will make it user friendly. This is more of general input so the Computer Engineers of the group will be mostly responsible for the software of this product.

Sarah Prall

In this project I will do my best to contribute as much as possible. My strengths are not in programming or software so I would most likely focus on the actual physical product. I would be able to help with the wiring and the building of the camera. I will also help the group keep up on things in a timely manner and keep everything organized. Overall, I will help out with as much as I can.

Ed Paulosky

My contribution would be software development and video analysis. I have vast experience in software design and development and would lead the software development team whos primary goal will be to develop a way to recognize and adjust faces of the individuals conferencing so that their is minimal distortion.

Section II - Research

3D with Kinect

Those who originally conceived the Microsoft Xbox 360 Kinect device could not have foreseen its widespread applicability. One of the areas in which it truly has made a difference is research and experimentation in computer vision, a division of artificial intelligence that aims at object recognition, image reconstruction algorithms and more. Use of the Kinect as a 3D sensor due to its low cost, reliability and its human pose recognition system have proven invaluable for many researchers. The Kinects 3D measuring system consists of an IR projector and camera, used for depth, and also an RGB camera to texture the 3D landscape. In this particular article, researchers have aimed at modeling the Kinect as a multi-view system and providing a particular calibration method for using the device for 3D measurements. Combining the Kinects built-in capabilities with Structure from Motion and Multi-View Stereo, the group was able to improve reconstruction significantly. This information and system model could prove extremely useful in the groups object recognition algorithms, since there must be a way to identify items and people in the conference area or meeting place. However, the most difficult part is doing this in real time and being able to process a video stream simultaneously. The task is daunting, but the information provided in this article places us on the right path.

Dual camera intelligent sensor for high definition 360 degrees surveillance

This paper incorporates an omnidirectional imaging device and a pan tilt zoom (PTZ) camera in order to perform 360-degree surveillance. The systems tracking abilities seem impressive and would greatly aid our plan to have the camera be able to track a person moving while talking. Their use of a catadioptric sensor may be slightly more convoluted than is necessary for our project, but it is an efficient manner for projecting 360 degrees of image. The projection of this proposed camera is overhead, as is common in most surveillance system. It is certainly plausible that this system could be adapted to the groups plan for an eye-level projection, however the latter is far more difficult. The paper also discusses calibration, which will be very useful for those in the group with little knowledge of camera geometry and optics. But perhaps the most important section of the report refers to target tracking, which is a big facet of our initial design. In order to keep the viewer focused on the person speaking, the design must be able to adapt to movement in the environment and have a selection process for which movements to react to. The combination of a multi-view camera into a single one could also prove useful.

Camera Motion Detection for Conversation Scenes in Movies

An interesting application of Motion Detection, this report focuses on using a pan, tilt, zoom camera to more efficiently analyze conversation scenes in movies. The instant applicability to a real time conference room conversation made this paper strongly appealing to the groups project. The use of the RANSAC feature points matching algorithm, including Harris corner detection, is a popular and common method in modern computer vision experimentation and application. The algorithm detects features in order to analyze video and then determines the appropriate motion the camera should take to focus in on who is talking, etc. The last and most important aspect of this research is the attempt at constructing a visual attention model. This system could be adapted to ours and would allow us to treat many different meeting room scenarios with the same model. Overall, feature matching with improved performance using RANSAC is pivotal to the groups finals design.

Masters 3D

The field of live video combination was very limited, but is slowly growing. The biggest trend is having live video feed and displaying a 3D feed. Starting in 2010, the Masters Golf Tournament has been broadcasted in 3D. With their success, companies have decided to jump on the bandwagon and start displaying their videos in 3D. There is some video combination necessary to produce this 3D feed. Unfortunately the 3D aspect does not specifically relate to this project but some steps to make this successful do relate to this project, the video combination. The way the cameras are set up for 3D video makes for easy video combination. The process of creating 3D video starts off with the physical camera set up. The camera contains 2 lenses that are slightly and specifically offset to simulate the system of the human eyes.

MakingView Brings 360-Degree Video Full-Circle With The Mountable ViewCam Camera

A similar idea can be applied to creating a 360 view camera. With multiple lenses positioned in specific ways, a full 360 view can be rendered with slight combination processes. Being said, there are already 360 degree video cameras that have been produced, tested, and presented successful video. A company called MakingView, from Norway, created a camera called the ViewCam which was tested by Red Bull. Red Bull tested and displayed a video of a mountain biker riding down a hill providing a 360 degree view for the entirety of the video. The video and other information can be seen on the website. To make the ViewCam useful to Red Bull, MakingView designed the camera to be extremely light, specifically just over 21 ounces. From this and other reasons, we can assume this product is expensive and not geared towards the general public.

GoPano Plus

Another company known as EyeSee360 created a similar product. Instead of having the product be self-standing, EyeSee360 created a lens that could be attached to some products. Originally their product was made and distributed strictly to the military. Just recently they have modified their product to be able to distribute to the general public. The simplest is a lens that attaches to an iPhone. This product is called the GoPano Micro and costs around 60. The specifications reveal the lens allows for decent quality, 1280x304, but could allow for improvement. These improvements however can be seen in another product EyeSee360 has produced, called the GoPano unsurprisingly. The GoPano produces much better quality video but for a high cost of 700. Something of this quality is ideal for the project, but it seems any 360 degree video camera that is produced with similar qualities has a high price. This high price is detrimental to this project because the main focus group is the general public and not just high operating businesses.

Thus we can conclude that the technology is there, but just needs to be modified to match the business plan of this project. As far as video playback, it seems this has been successful for all the companies. Unfortunately there have not been any attempts of streaming this video. Most likely this is due to the size of the video feed. The full 360 degree view usually incorporates 4 lenses, meaning the file size must be at least 4 times the size of a normal video. This makes it extremely challenging to stream a high quality video of the 360 degree view and not produce any lag or loss of frames. Currently the display method of the 360 degree video is a single frame similar to a single video feed. However, the video in this frame is interactive and can be rotated by clicking and dragging to the right or left to bring other parts of the video into the frame. For a viewing a meeting this may not be the best way of presenting the 360 degree video. This is because the

entire room is not shown at once, which is a goal of this project, and also makes the user have to be extremely interactive to just view different portions of the room. The user should not have to put any effort in viewing the majority of the room, similarly to as if they were in the room themselves. Thus a different viewing of the 360 degree view must be designed for this project to allow for effortless viewing and convenience of the user. Regardless there will most likely be the problem of too large of a file to stream live.

A Novel Dual Camera Intelligent Sensor for High Definition 360 Degrees Surveillance

A high definition 360 degree surveillance camera was researched and the functionalities of it were explained. This camera is able to track multiple objects in low and high resolution. It is a system based on how a catadioptric sensor works. The catadioptric sensor can contain different numbers of mirrors which can determine how the sensor works. The article says, for example, if it contains a single mirror than the image output will be reversed, whereas if the sensor contains a double mirror, the image output wont be reversed. I think this is important to keep in mind for our project. Knowing the specific properties of this type of sensor will help us develop the specific images that we would want for a conference room/ meeting setting. This article goes into a lot of depth on how to angle the camera to get the best panoramic image, which I wont explain. In conclusion, we may not be trying to build a security surveillance camera but this article is very helpful in learning how to get the best image from a camera like the one we are looking into. Knowing the details of how the sensor works will help us build a functioning 360 degree camera.

Omnidirectional Sensing and Combined Multiple Sensing

Here an Omnidirectional Sensing combined with multiple sensing. The article is on a new system called the HyperOmni Vision System. It is designed to have a hyperboloidal mirror and a TV camera in a spherical glass tube. A feature of the hyperboloidal mirror that is very important is that is has a focal point. This allows an image to be projected on any designated image plane. This helps the image to not me deformed and is easier for a person to see familiar objects in the images. This system described in the article uses two cameras on a mobile robot to obtain an image that they desire. They use the 360 degree camera to get the panoramic style image, but then they also use a local view camera to get a high resolution image. This could be an idea to consider with our product. If the panoramic image is anyways distorted or doesnt have the best quality, we could add a high resolution camera to our system so that we get both features; an overall picture and a very detailed image. Or we can use the multiple visual sensing sensor (MISS) also described in the article, which has the same function as the two cameras, but in one device. The article then went into detail of the azimuth angle, resolution, single center of projection and transformation of omnidirectional image to other image planes, which could be helpful later on in our project. Although for our project we wont be putting our camera on a robot necessarily, I think the concepts described in this article are related to the concepts we are going to have to consider in our project.

Ricoh Shows Off Camera That Captures a 360-Degree Photo in One Shot

The article discusses camera that can capture a 360 degree photo in one shot. It uses two lenses that each covers 180 degrees, then combines the two images to create a panoramic-style picture. I think the idea of using two lenses instead of one is very smart, and could reduce distortion in the pictures. This camera apparently only takes pictures, but the company is looking into making

it able to take videos, which would be exactly what we want for our project. Another interesting feature on this camera was that it was able to send the image directly to a smart phone or tablet. This could be incredibly useful for what we want in our project. If the video could be accessed directly from a smart phone or tablet, Im sure it would be used more often than if it couldnt be.

Head-size equalization for better visual perception of video conferencing

Video conferencing combines the technology of video-processing and streaming with the technology of cameras and video-capturing techniques. Research must be done in both hardware and software in order to find improvements to both processes. Ideally, we could create a device that captures a wide angle view (between 360 degrees and the average human field of view which is about 180 degrees) and can capture and manipulate faces in order to provide a better viewing experience. Wide angle camera lenses have been developed for awhile now and every year their field of view gets wider. We could develop or use an already existing wide angle lens. If we used multiple lenses in our product, we could then tie their views together through software to provide one unified picture. The problem with wide angle lenses though, is that distortion occurs for objects that are further away from the lens. We would need to develop software that can adjust the picture and reduce the distortion so that faces of people further away arent distorted. Research has been done on head-size equalization, where it takes the heads of users in view that are further away from the camera and manipulates them to a better size so that user can clearly recognize faces.

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