RGBDToolkit Workshop - James George & Alexander Porter July 13-14th 2013
As transcribed by Ellen Pearlman

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Session 1: Background to RGBDToolkit
From 2009, Alexander and James, concern about safety in subways, think about public surveillance and safety. Heard a story about science fiction surveillance company to Lockheed Martin. First one not going to tv's going into boxes that were analyzing the images with artificial intelligence saying threat detected, go here. Lawsuit MTA to Lockheed Martin, didn't function as promised, but if it did function, what would it be like.

Bruce Sterling, a "media designer" gave a Vimeo keynote, crabby old technocrat. He described the cameras of the future. October 2010, Bruce Sterling, Vimeo Awards Keynote. Sent as a computational problem out into the cloud. Is it a good idea that everyone sees everything from every angle. Around the same time the Kinect came out as a video device, packed with all of these sensors. The Xbox was an aging console, but they put a depth sensor in it. Amazing images coming out of the Kinect.

This image was not meant for a human to consume, but a machine to consume. Ominscent cameras, where things are headed, mixed all the ideas together, to imagine what that system could look like, the surveillance system that never existed. No one seemed to care that they were doing this. Could we use technologies that were developed by the military for artistic purposes. How do you take something that was intended for one thing and make a community around it.

Two renderings of a data set from two different angles. Discovered a new type of portraiture with the language of computers, polygons, explore the idea of people who wanted to push the medium and explore the potential. There was a core technical problem. When you have 2 cameras, one an SLR and another camera, its not a two dimensional problem, it's a 3D problem of 2 cones intersection in space. Can we push it in another way and calibrate this together.

The OpenFrameWorks community. Art & Code3D, hosted by the Studio for Creative Inquiry . JG brought it to that conference. Algorithms were written for this and shared with the world. You can reinvent what is being presented.

Clouds Interactive Documentary, Beta Preview/ Jonathan Minard. Features this community. Thinking about how filmmaking is changing, and conversations are like social networks, and you don't have to have a linear presentation. Can bring it into Unity and other real time environments.

Then they showed it to Bruce Sterling, and Bruce Sterling said a lash up, 2 different cameras united with rubber bands, 2 data streams and mash them up, a lot of game devices have pretty short life spans of a pet mouse, and the other a life span of a cat.

Now they are in radioactive and will end up in a radioactive heap in China. Something beyond fetishizing these individual tools. What is about it that is intriguing.

Session 2: Calibration

Checkerboard, computers good at finding edges, 5 x 7 show both cameras, if you know where the checkerboard lives in 3d space, calibration, the process of adjustment, and you lock it down and get a set of numbers between this lens and that lens. The first step is calibration, and you use that afterwards, and then you visualize. We will find ways of holding it. Usually we do it with natural light, because the sensors see in the infra red range. There is actually very little infra red light.

The best way is to be in front of a large window with light coming in from the sun. Too much infrared light the sensor can't be seen at all. The Kinect was designed to work in living rooms, so that is the best place to use it.

First section, solve the problem of 2 cameras, calibration is pre-production. Establish and identify the relationship with the camera. Pretend that both originated from the same point. Since they come from slightly different angles they see things from different perspectives. We use the checkerboard that is recognizable by both color and depth camera.

Get lens intrinsics, or profile for the lens, even Photoshop uses lens intrinsics. That is a product of the lens. Pointing the lens. What we are doing is capturing separately. We are capturing 2 streams simultaneously. Later we merge the 2 screens in software.

The first thing is you want the checkerboard to be flush straight, flat and well lit. Make sure your exposure on your camera is good, not too dark, or light. If you download the application, leave it intact, and move it into your applications folder. The RGBD toolkit.

Start with video camera independently. Fire it up. Adjusting, white balance. Take images of this, and you want to cover the frame, start close, don't put shadow on it. Make sure every time you move the camera you refocus it. The point is to show the checkerboard in as many different positions as possible. The way these lens and camera are used, each is completely different. Wait a moment and stop, . Record, pause, stop. Record, pause, stop, move it back, do about nine of them. The easiest mistake is going too far away, as opposed to going too close, a little bit of depth. This is no really right answer.

You want to shoot HD, 24 frames per second. Your zoom, tape it so you don't accidently move it. PAL should work, the Kinect shoots at 30 frames per second, but actually the frames shoot at different FPS, if you shoot at a lower reate, it gives you a better way to match.

Take the video files and dump them into your laptop. Normally it loads with a working folder, but you can set your own folder. The way we visualize it, white represents close to the camera, and black is far away. Resolution breaks down far away. The quality decreases, the father you are away, it decreases. You can turn on Rainbow or point cloud . W – A goes forward F-A, only in point cloud. ?

Set your working directory. Click on the upper right hand. Make new folder, RGB Folder, it is like a CF card. Make sure you shoot to a space that has a lot of space. External hard drive. You can sit on Working drive.

This is just getting to know how to work the lenses. There is a self-calibrate Depth Camera, its not good just a wall, need different depth levels. . It will freeze for a little while, and now it says self-calibrate. The principal point should be 320 x 240. , field of view, field of view will vary from device to device, 570 or 575. If you remove any images which are not calibrated well, then you have to reload them. If total average is .2 or so as an average, that is good.

Clock on the drive that the files downloaded to, sort by dates. Go through the images. Take all the movie files, drag them to the application and literally drop them into square on the right, the window freezes, they don't have to be in any particular order. . By scrubbing over the image, it replicates the animated gif. Note the Error numbers, it tells you how well it worked. Think of Google translate from English to Chinese to English. It reimagines the checkerboard. The model of the lens is the foreign language and converting it back it the reprojection rate. Perhaps there are issues with the capture. . The total error rate should be is less than 2. If you have a bad image, get rid of it, and then move all the images back into the right hand side. One bad image will mess it up. So if there is one or two bad, get rid of them, and so that all the images should be low.

All images are in the box green, good to go.

Now the Kinect. They re on the near infrared spectrum. It is projecting a specific patter on dots on the screen. It interprets these dots as depth. 2 laser pointers at different angles. If you get weird data or dots that are not yours, see wgi else is there, it could get weird.

Now turn the Kinect on the checkerboard. We need to illuminate the checkerboard with infra red light. It is a bridge between color image and depth map. It does not have to be in live view mode, you just need to be able to record it.

Calibrate Lenses. Locating the color information on that depth map. Go from Calibrate lenses to calibrate correspondence. We need what the kinect sees to see the dots on the checkerboard. . We want to diffuse the high density laser patters with soft diffusion. . Get the Kinect a little closer to the checkerboard. You want to move it around for 4 shots and focus each time. Diffuse the IR. Double up the toilet paper. Move the camera around so you get your red dots. The algorithm, mash the 2

lens together. Normally it is looking for dots, but when you cover up the IR with a diffuser you see the red spots. You wind up with a checkerboard in space.

With the screw you are trying to make the Kinect as flat as possible. The way to test it is turn on live view mode, you see it in live view mode. Wants the color image to encase the depth image..

Recommend 24 mm lens for camera
No glare Checkerboard in middle of frame. Jackie clicks internal Ir, then clicks the left more image, then there are 2 of the same. Then move the checkerboard again, take a short image. Click the depth, click the depth, look for the red dots, click internal IR after you see the red dots, move the checkerboard further, take off the diffuser. Saying here are the 3D points I am looking at at a certain perspective, where is the camera in the world that it can line up. . When you take the short video it is taken, click the left most image, cover the checkerboard with diffuser, get the red tos, click and its ok. , Take a short video, click that one, click left most image, put diaper on, now click the middle one internal IR, get your card out and drag them into the right hand . Download the files,

You need to put a diffuser on the lens, a plastic bag, toilet paper, this is where the natural light really helps, your whole scene will be infused with natural light. What we are looking for is even illumination. We are also looking for even infra red illumination. At home go to a window, place your checkerboard by the window.

The dots identify the corners of the red checkerboard. It finds the dots. With this one, we do something more narrow band a little more closely. This is an introduction to RGB filmmaking. You need to capture them at the same time.

You need to make sure the alignment between the 2 cameras is optimal, and they are seeing the same scene. They are loosing data otherwise. We are trying to make them parallel.

Try and put it where you are filming. Use the live view mode in your camera, and use the laptop to see what the camera is seeing. . Put the checkerboard at the top of the frame. The mounts can pivot. The bottom one is a pivot, you can loosen it, and you can loosen the top one quite a bit and you can adjust it up and down. Put the checkerboard right at the top, put it inside the grey bar.

Drag the files one at a time in the correct order. The colored dots respond to the different colors The neon dots are the checkerboard points position in 3D points

Confirm the bottom is a good match, put it right at the bottom, it should look perfect, it means on the depth map is there is color. Once set, tighten the screws. It is a description of the relationship between the two cameras. If you change any of the parts, i.e., lenses, baseplate, you have to recalibrate. **WASD** are the keys to move it,

How do you know its bleeding color?

You can aim it at an object so you know it is the top boundary, but the vertical is a constraint.

We do 4 of these sets and we are good to go. One after the other, push it, let it roll, cut, but don't move depth image, the IR image and the color image. Operate the image refocus. Click on the little box and that is how it saves it. Vary the angle just a little, left to right. It says at the bottom Regenerate RGB/depth correspondence.

Roll the camera, cut. Now we have the images and put them into the folder, they correspondence to the 4 boxes.

Make a calibration folder
Drag them into associated squares.

An easy mistake to make is drag it into the wrong places.

Left image from the Kinect, right image from the camera, and it should regenerate, click regenerate, and it might work or might not work, one of the checkerboards might throw it off, you can click the IGONORE button on one of them.

You can look at the calibration, and the color or the grey scale is from the SLR camera.
Sometimes there will be a little bit of spill. The little dots floating in space is where the Kinect saw the checkerboards.

If the first time you try it it doesn't work, don't worry, there is a little bit of randomness, it doesn't matter whether it works .

Session 3: Shoot, align and visualizer
So far we capture them separately. Just like when you are recording external audio we need a way to synchronize them. We have a depth camera and a color camera,

So now (have a USB extender) . Get all the normal camera settings, lighting is still important, framing is still important, hot lights are bad to shoot with they interfere with infrared, hot lights, led lights kino flow lights are good they don't interfere with the visible spectrum.

Start closer in time, in record there is a red rectangle button, wave , and you can finish with a clap, then cut.

It says in record, take 07 13 ,etc. You can rename your take. It writes a folder, the grey bar drops, it records uncompressed, and then it takes a while to compress. It

makes a calibration folder, a depth folder, and a color folder that is empty. Need to drop the video folder we just shot into the video folder. . Having your date set on your camera with date and time, you can sort by it and it really works. At this point done with the capture folder, and now into the visualizer folder.

When you open up the new app you have to set the folder to the folder you are recording in. Pick the top level with the calibration and the take. FILE STRUCTUE. Call the top level a media bin, one media bin for one shoot day. Within each one you have a calibration folder. And the take number, all you take will fall in there, each will have depth and color folder.

But you can see the timing is all wrong. The color image is moving but the depth is staying still. . So there is a field at the bottom called synchronize. . There is a zoom like final cut zoom, it is like a final cut zoom, , you can zoom to the begging, you can look for the first and then the second clap. Hold your mouse with the video, move it frame by frame find the moment right at the clap. . Once they re both where you want it to be click set color depth time. . There will be an offset of a few milliseconds. The algorithm knows the fraction of the color second happens, and it finds the match in the color frame. . It is normal that alignments don't quite work.

There is a texture alignment tab. If you think about protection mapping you make the geometry line up so it looks like it is animated on the 3d image. You are scooting the texture on top of the depth. . A few settings to move that on. X texture rotate and Y texture rotate. The best place to look is the face that is what people look for. . The timeline works like Aftereffects. Usually at the end there is a little fudge step. . You can keyframe the texture map. There are other ways of fudging the texture, Mostly you will use texture rotate, the first two . Kinect thinks in 2D image. To separate levels, you need to cut the polygons with scissors, and you keyframe it down so it looks cool. , If you go all the way down it takes surfaces with no differences. Z is scale. Moving the scale stretches the scale up and down. These are all animatable. Wireframe mode, or pointcloud. – draw point grid, rendering, , If the points are too dense, you can go to the geometry and remove. A huge part is selecting and removing. By adding negative space . It gets at the cores aesthetic of RGBD. A mesh

Beta phase, identifying bugs, soon, once you get the concept its self. Types of geometry distortion, wave distort, amplitude, like and oscillicope, change speed or frequency, dense or wide, the geometry, you can animate them on both accesses, animate both X and Y, where this stuff gets interesting, in combination of variables. You see how it combines. Click it in there, if you don't see anything, look at the check boxes and make sure it is turned on. Can use QuickTime or aftereffects to build a video. Obj export, or a combined format. If you want to watch a processing sketch that uses your sketch, it lets you easily combine the format. The hue value is depth, and then you can color each point. It cares the synchronization and the calibration, and you can take it into unity and Maya, trying to make it so the data can go into environments that work for you. Each png is the combined. If you want to scrape videos. It is easier to use what the Kinect naturally capture. It exports those

combined images so you don't have to worry about it. It exports the obj frame and vectors they don't' print mtl files. More like video and 3D where every image is a new frame and its pretty heavy. With all data they are 5 to 12 meg, you simplify, it is 500k. The images can not be used as a normal map, it is not a pure displacement map, based on the Z you can change x and y.

So now go into record mode. Make sure you are pathed correctly in a media bin or something. Calibration and others into same file. Start record on both and then clap as it is rolling.

Record, clap, do something, end. Then bring the media from the camera into the color folder. Depth folder is Kinect.

Launch RGB visualizer, create a new composition from the take. F key will do full screen.

Go to downloads, visualizer, July 12, 2013

First synchronize the data. Find the clap with the green line in the color and a red line in set color depth time and then video and depth come up in aqua camera point in left hand box (black)

Hit texture alignment and you get all these other fields. And its x texture translate to line up the 2 images. Move the blue line keyframe.

So now play with other effects.

Synchronize in synchronize. You can click on the very bottom brown, and start it again. Find the moment right before the hands clap. ITS IMPORTANT TO SYNCHRONIZE TO THE FRAME. The Arrow keys nudge in synchronize. Touch the thumbnail once you activate. So then you hit set color depth..

So blow it up, and go to texture alignment zoom in on a face. And that fixes everything. When the video plays back the alignment will drift, but when they pause, it aligns back again. Moving the image with the WSD.

Set camera point, sets where you look at the video. Set camera point is moving a 3D camera move in space, keyframing your camera in space. If you select the camera and move up and down, / lock to track, move everything, Shift L, lock to track, you are not free to move as you move back. Save comp. Hit the little R. Say start, it will go really slow. Called render bin, same one frame for every frame for every video.

Take off draw mesh, draw point grid, . Use render point. Turn on scan lines, horizontal lines or vertical lines, in geometry, simplify, . All up on line.

Camera moves principles of animation. You can fly around with the keys we used. Timeline lets you scrub though scene. You can create a camera point for a moment in time and pick a point in space. . Click set camera point SHIFT T is the hot key. Then scrub forward somewhere else. Create another point, set camera oint or SHIFT T. In order to preview this, an alternate mode, called lock to track, what this does is takes these 2 camera points. Lock to track is on the side with the black, You can copy and past them. You can repeat the action, drag them around, make it quicker. You can move these close together, You can soften the movements and the arc.

Export as video. Way to do that, choose the size you want, render 10 80, click save copy, click R, bring up a render cue on the side, click start render. Where does it actually write to. It write to the render bin. The original tape, but with the same export format, in that folder, .png's saved out to sequence. It is all alpha and transparent you can combine it. Use quick time pro or mpeg stream quick. The frame number is 404, you can resynch your audio. 1 frame per original source.

If you want to render, save composition, the button of the clip, and the little R/. , . YOU can render as other types.

Png is saving out your alignments and toolkit.

How do I convert png to QuickTime.

Take the first one open a new sequence as a video, the frame rent is 24 fps. . Based on how you export =. They stich.

Sunday July 14, 2013

Session 4: Recap on calibration
Prime Sense 1.08 Carmine
http://www.primesense.com/developers/get-your-sensor/

AcusAction XTionPro Live u/b for $159. Install the drivers.

Working Directory in first calibration set ' calibrate lens

Focus Kinect on checkerboard
Make sure everything is nice and tight does not wobble
Make sure views of camera and depth are similar

In depth view hit "Depth Camera Self Calibrate" turns green, tells you Field of view, principal point and it should be 320 x 240

Take the calibration videos. Big frame, then step back, then left, center, right, then step back, then left, center, right, do this in your video, not the depth center.

Import the movies into Load RGB Calibration Images on right side of application, drag and drop, they take a minute.

Error lower than 0.2, it comes up green if it works.

Then go to calibrate correspondence at top of dialogue box. It says no correspondence to visualize at first.

Do a cycle where need one depth image, one internal IR (red dots) and one external rgb

Do this cycle of all 3 four times

First click in left box, not much happens. The checkerboard should be in the left, then click in the middle box. Put your hand or a tissue over the camera so its just red dots. Then use the video camera to film the checkerboard in the left side. Repeat for 4 levels of depth.

Take the movie files from the normal video and drag and drop them into third box on the right, for the video

If ever it crashes, take out the old stuff, which is usually corrupted

Keys to move, W, A, S, D

You can see the multicolored point clouds.

Part 2, now you film something.

Session 5: The visualizer in depth
(See video at https://vimeo.com/70924774)
Set camera point, you get a blue mark a key frame, set a camera point. Can move the camera now. Right when the camera happens, can zoom in on the clap., If want more granularity, can zoom in like slider in Final Cut. Set a camera point there. Hit Shift L locks to track. Hit play, will execute the camera check. Drag the key frame from here to here. Hit Sift L to unlock, it means camera can move again freely, once it is locked it is for moving again, move far in the future, sweeps in and goes out the other side. , Can make it be more dramatic, unlock the track, zoom way out, delete what was there before, set it again, now will have really dramatic out. You make a wave

through space, turn on lock to track and stare at what you are lloking at. Shift L is the same as Lock to Track.

First start with clipping, delete the background. Z threshold min and z threshold max, scrub it, it isolates the foreground. Isolate the fan, everything from the background is gone. Get rid of the foreground can do the same thing. You can have the shadows. That is a geometry pad. Also a simplification, , turn off mesh, turn on wireframe. If you zoom in (it often gets slower, you frame rate might drop) what is actually being drawn is vertices, a grid position in space, 3D images, a distortion map. The simplification increases the distance between lines. This looks bad when you are far away, all the lines get so thick, so in the simplify pad, simplify x and Y, if you simplify Y it increases the space between each row, you introduce negative space and it is way faster. In the geometry tab that is simplification. Too dense turn up simplification, too sparse, turn down. X clipping removes the long polygons, That is in clipping, not geometry. You want to make people look like cardboard cutouts, you can turn on edge clipping. It is a maximum tolerance of how long things can get turned out. Sometimes it looks cool. In between you get striations. These effects are additive, If you draw a mesh you get both with the wireframe screen blended above it. The wireframe comes in as a little bit glowing.

You can clip the top, or the sides, get rid of stuff you don't like, maybe your camera was not covering the depth image you can clip it off, you can animate these, so if you scrub these, you can animate these to create cool wipes, in 2D like a door swinging open. Deleting all those, Rotation is pretty obvious, it lets you swing stuff in a circle, just spin the thing, it shifts the geometry in space, the rotation tab.

Rendering tab. You specify the relative brightness's of the gemometry and some other things. There is a check box for all the features to turn something on and off. Check to make sure your alpha is on. If your point grid is at 0 you will see nothing. The density of point cloud is affected by this . Point size is pretty self evident. . When you are looking at things straight on it is like a grid. If you don't like a point grid you can turn on point random, you can control and key frame the amount through random point image., the alpha and are controlled.
Wireframe is normal wireframe and it is crosshatched, it is squares in triangles, If you don't like the cross hatch, wireframe alpha and wireframe thickness, you can turn it off and start with just horizontal lines. , Horizontal scan line alpha, horizontal scan line thickness. You can just turn on vertical lines and turn on the same thickness. You turn them both on you are back to the wireframe mesh without the cross feed. .

These are affected by the simplification. Turn on both lines and points, draw a point grid, turn the alpha up, wires with little dots. , if you just had one on you would get dotted lines. That is scan line.

That is all the points line and mesh techniques of visualization.

There is a tab, self-occlude, you want negative space with no background showing through, if you don't want people to look ghosty, turn self occlude on if you want someone to pop against the background.

Wave distort. Turn it on. It sends a sine wave trough the gemometry turn on wave amplitude, right now the frequency is low, it is one oscillator through the geometry, it can be animated. , turn the frequency and you can turn the oscillator on. These parameters can be touchy, shift and the parameter key, better than dragging, you can also change the height, alt E will expand that track and it does not have a hot key back, but you can change the size manually as well.. Turn down the amplitude of the first one , you can see the second one.

Warp distort. Added it now. The speed it moves, smooth random noise, Perlian noise, if it wobbles too fast, you can turn down the warp speed, if you want to turn down the warp you can do that. The warp density is how large. Perilian noise is big sweeping numbers, The density is how sweeping that noise is. Warp density make it warp slower, the stretched value affects the axis's, you can change the warp stretch off , it can look a little more under control. Up for x and down for Z.

Color is self explanatory, fade the meshes, best if background mesh is off, you can get a scan line look, fade in a little of the original material, . If you click a key frame, you can get the key frame color , this color can change, not RGB interpolation, but you can , you could go into GUI in the picture , you can replace it, it is unsupported but you can do it. You can get it from a specific color pallet. . You can change the background color the same way, but stay away from background colors.

Last but not least is depth of field simulation, turn on depth of field, it is a simulation that blends optics, white is focused, black is out of focus, the parameters are distance, how wide your focal range is, blur is your actual blur that gets mixed in. Turn on blur, move the blur low, turn on the assist, make the range a little bit slower, emphasize the geometry, emphasized on 3D optics, creating a new focal plane, that has nothing to do with the original focal optics. If you are bringing the data to Maya in 4 D a better depth of field effect.

You can change the frame height using frame feature. You can make it tall as well. This image is scaled to fit into the viewport. Default to 720 or 1080. Be careful you can crash it if you make an image too large

Render the scene, turn off depth of field, preview the camera move. Hit save composition, it is called Fan one (example(This allows other compositions, Render it, click start, step through frame by frame, it is rendering and saving it. Go into working directory, The rendering, it is the file writing out now. You set a background color it will become that color if it is not set it is alpha. Stop a render just hit

Export object fields, hit save. Copy to new. Save saves it copy to is save as. You can do create new comp, but that is back to default settings. You end up with a clean comp.

Export object files to use in may or 3D Max. Photo shop can preview the object fields Object file is a text based description of the file in 3D, they can be kind of big. Other sequences.

For QuickTime don't check any of the options, render out as you have seen it.

Let's export object fields into mesh lab. Turn on render object fields.

Other programs will let you generate a relightable surface.

Take it off the mount.

Close out of RGB Capture, go into visualizer
Import the clips from the movie into iMovie, export out as a QuickTime file.

The film made a file called Take. It is in your working directory

Calibration, find the folder Take, under take is color and depth. Take the video file, drag it into the color folder under Take

When you are in the visualizer, you have to load it in from the TOP level media bin you are using. Then load it in. Click on Take. Create New Composition from this scene

Make sure you are in synchronize on time line and temporal Alignment is clicked under video volume.