Augmented Reality

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Introduction
To augment reality is to alter the view of the physical world through use of computer-generated sensory and image processing. It is the combination of reality and virtual reality, and acts as a technological extension to our own vision. The uses of augmented reality range from displaying critical information about a patient during surgery, to showing which the highest rated restaurant in a food court is. Information being overlaid on top of reality in real-time could drastically improve the efficiency and effectiveness of almost any every-day activity. This technology is still at its breaking through point and has much progress to make. This document will only skim the surface of augmented reality technology, but still make an effective use of the technology on a small rover.

History
- Around 1957, Morton Heilig designs a machine that immerses the user in the full range of sensory stimulation while watching short films. It was essentially a booth that someone sat in and was flooded with senses that would help to make the user feel like they were actually inside the movie. Unfortunately, Heilig was unable to build his patent due to lack of funding,
- In the 1970’s, Myron Krueger established the Videoplace. This laboratory created a low-grade virtual reality environment using cameras and projectors. The users would have their silhouettes captured in an artificial reality environment, and transferred to other rooms with the same devices. Users could interact with objects, but without any feedback.

- In 1992 L.B. Rosenberg creates the theory of Virtual Fixtures. This concept involves the help of computers to correct any error in the task of a user. The simplest analogy being a ruler helping to draw a straight line.

- In 1993 Loral WDL demonstrates augmented reality equipped vehicles.

- In 1994 Julie Martin creates a theatrical production called “Dancing In Cyberspace”. It used graphics computers to let the dancers manipulate objects in a virtual world.

- In 1999 Hirokazu Kato created ARToolkit. This is the first widely used software to solve both the problems of augmented reality, which is tracking and object interaction.

- 2011 LASTER Technologies develops ski goggles that incorporate augmented reality. Also, Total Immersion develops the software D’Fusion.

**D’Fusion**

*Source: Total Immersion website*

1. The user presents an image to a webcam that is used as a connector to the real world
2. The image is recognized in the real-time video flow captured from the webcam
3. A 3D computer-generated object is then superimposed on the image as seen in the captured video
4. The user can then interact with the 3D object, in real-time, by moving the image in the real world
Augmented Reality Engine:
- A calibrating tool (D'Fusion Camera Calibration) to calibrate camera and sensors
- An authoring tool embedded in Autodesk Maya and 3ds Max (D'Fusion Exporter for Maya, D'Fusion Exporter for 3ds Max and D'Fusion 3D Viewer) to produce 3D content, preview it, and export it for D'Fusion's real-time engine
- An authoring tool (D'Fusion Studio) to design your scenarios, and define behaviors and interactions that can be script-controlled using the Lua scripting language
- A scenario engine (D'Fusion @Home, D'Fusion Mobile) to manage the real-time show
- A physics engine (based on the Bullet engine) to improve natural interactions and rendering
- A rendering engine (based on the Ogre3D engine) to smoothly merge computer-generated objects with the real world through a real-time video stream
- A debugger to ensure a smooth development process
- An open framework, to easily add your own plug-ins and match your specific needs
Materials

- Rover
- Easycap video converter
- Spycamera
- Blender and D’fusion software

Procedure

The first step to giving the rover an augmented reality is to first give it a reality. This involves installing the camera both physically on the rover, and intangibly using drivers for the camera. Since the USB driver for the receiver is not a “video capture device”, a video converter must be used. This converter will take the analog video from the camera receiver, and convert it to a usable digital format through USB. If using windows 7, the automatic driver retrieval will not work for the Easycap converter. This driver will work to access the cameras.

Next we must install blender and the necessary resources to export the proper file. It is important to note that Blender version 2.62 must be installed, not the newest one. There is a newer beta version of the specialty exporter that should work with the newer versions of blender, but the trusted older version used in this demonstration only works with Blender 2.62. After installing blender, the Ogre exporter needs to be installed. Both the old version and the beta versions of the exporter can be found here. There are two methods of installing these add-ons. The first method is to use blenders interface. Under user-prefs, click add-ons, click ‘install-add-on’, and select io_export_ogreDotScene.py. The second method is to copy io_export_ogreDotScene.py to your blender installation under blender/2.59/scripts/addons_contrib/. Once the add-on has successfully been implemented, there should be a new option under file/export/ called Ogre3d(.scene and .mesh). This add-on will export the 3d model as the correct .mesh file needed for D’fusion to operate. For this exporter to work, it requires OgreCommandLineTools. This should be installed to the C:/ directory. You may also need to install OgreMeshy to the C:/ directory for the exporter to work. The next step involves making your 3d rock for the rover.
Creating a 3D object using Blender

Blender is a very useful program for creating 3D objects to use for our augmented reality program. It is probably useful to watch the “getting started” videos on the cg cookie website: Get started with Blender

For our rock, we delete the default box mesh, and add a new mesh (icosphere).

We then add a modifier called displacement to the rock. This will displace the vertices of the icosphere which will give us a random shape to work with.

After this you can smooth the edges by using the a subdivision modifier with 5-6 subdivisions on the object. **Note:** if you plan on adding a texture to create your rock, you should add the modifier, but do not click apply. This will cause issues when unwrapping the object for texturing.
We then use the texturing method used in this youtube video: Rock texture tutorial. The only difference is we take the rock as a reddish/orangish color to make it resemble a rock from Mars.

**Note:** texturing is affected by the lighting on the object. this can be avoided if you use normal mapping (instead of using full render that was used on this object) like explained in the above tutorial video.

We can also use the sculpting method using Alphas and different sculpting brushes. This method is much more difficult and is harder to make the rock look more realistic. However, you don’t have to bother with loading the texture file into the D’fusion program. The object itself is modified. **Note:** For this method, you must click apply on the subdivision modifier so that the planes of the object will be subdivided very small so that you can sculpt each plane of the object.

Other useful videos for learning how to create your own rocks and texturing:
Useful tutorials on creating different objects: CG Cookie
Multi-textures and sculpting: Damaged pillar tutorial
Creating your Augmented Reality

After exporting the 3d object using the Ogre exporter, this portion takes your 3d object created in blender, and digitally places it on top of a tangible picture of your choosing. The D’fusion website offers a very in depth and easy to understand tutorial, so we will use that as a reference and explain what to change or do differently.

Here is the [tutorial](#).

**Step 1 and 2**

The project name could be whatever you desire, but the options selected should all be the same as the tutorial.

**Step 3 and 4**

Select the USB2.0ATV driver, which is the receiver for the rover’s onboard camera.

**Step 5**

Instead of importing their DemoRobot folder, select the folder that the 3d object was exported to. Drag the .mesh file into the 3d view instead of their DemoRobot.scene file. The positioning should be the same as their demo, so use their numbers. This is our rock without the texture, more on how to texture it later.

**Step 6**

There is no need to open the animation window, since the rock will not be animated. The “robot_manager” files created could be renamed as “rock_manager”, and select “entity” as the owner. The rock_manager.lua script will not have any animation, so instead of their 4 lines of code ours will be:

```lua
local rock = scenette(getCurrentScriptOwner())
```
Step 7
The tutorial .zip file they ask you to download contains the “tracking.lua” file needed to make the image tracking function correctly. If not done so already, this file should be downloaded and added to the project.

Step 8
When creating the .bat file make sure to change the name “my_scenario.dpd” to the name of your project, also keep the quotation marks around the entire line.

Texture
Since the blender exporting does not include the texture, we need to add it through D’Fusion. To do this, we must create a new lua script and wrap a JPEG around the 3d object. Import the JPEG as by going to add>2d elements>texture. Name this new texture as texture1. Next add a lua script to the scene by going to add>script. Put this code inside the script file.

```lua
local scene = getCurrentScene()
local me = Entity(scene:getObjectByName("entity"))
local mat0 = Material(me:getMaterial(0))
local tex1 = Texture(scene:getObjectByName("texture1"))
mat0:setTexture(tex1)
```

This should wrap your object in the texture of your choosing.

Conclusion
Augmented reality can help in everyday life with many aspects. With AR we are able to simulate more accurately what a rover mission on mars would look like. The plaques for our mission can be replaced completely with 3D objects that look like mars rocks. Some issues that we encountered with our project, is that the camera quality was not perfect so if the plaque was too far away it wouldn’t be able to pick up the image on the plaque clearly enough to create the 3D object on top of it. We also encountered a few problems with the exporting of the 3D object. This was easily fixed by changing our 3D modeling program from version 2.63 to 2.62. We can improve this project by creating multiple rocks for our project and multiple images to put the rocks onto (We found a few links that explain using multiple 3D objects instead of just one object). There is also a way to create a background landscape that we can fill with red sand/dirt.