Real World Flight Simulation Rendering Technologies

William Harvey
Unitec, Auckland
wharvey@unitec.ac.nz

Recent technological advances in the area of personal desktop computer Flight Simulation Software to represent real-world geographical and Topographical terrain, textures and land-objects have led to interesting developments in the field of Aviation and Flight Training. This has resulted in the Aviation Sector overseas looking at this technology as an effective training tool, and perhaps as a new method to log instrument flying hours for student pilots.
I will be looking specifically at some emerging geographical terrain and land-object personal Flight Simulation Software currently being developed by software developers. This will consider the terrain, textures and other land-objects to determine how accurate and useful the sceneries are for real VFR flying. I will focus on the 3D-Graphical rendering processes and the quality and accuracy of the Simulated Terrain and Geographical Landmarks in the United States, England and New Zealand. My methodology will attempt to highlight the technologies as mentioned in the reference material, making a comparison to actual terrain; and in the conclusion to offer some thoughts in summary.

1. INTRODUCTION

Microsoft Flight Simulator 2004 is used as the flight simulation platform in this study, and the scenery within the simulator is built upon a basic framework that represents the height of the ground at any point in the world. This provides the 3-dimensional relief model of hills, mountains, valleys, cliffs, depressions, plateaux and so forth upon which all other scenery objects and ground textures are placed. JustFlight, one of the largest flight simulator developers and publishers of digital aviation products states that "The vast majority of the area of the default relief model in flight simulator is set at 1.22 kilometres (1,223 metres) between each reference point, so this means that there is no relief detail changes under 1.22 kilometres." (JustFlight, 2004). Since the scenery grid between each reference point is so huge, it unfortunately is not detailed enough to render the virtual flight simulator terrain realistic enough compared to the actual scenery for real visual flight rules (VFR) flight. As a consequence, many software developers are creating add-on software to replace and enhance the default scenery.

2. GEOGRAPHICAL TERRAIN AND LAND-OBJECT SOFTWARE

Microsoft has created a layering system to render the default scenery and terrain. These layers can be divided as follows:

2.1 The Landclass Layer

Initially the parameters differentiating the land and ocean areas are identified on a flat surface. This layer includes the data elevation model (DEM) with altitude data. (Scenery Design Org., 2004).

2.2 The Mesh Layer

On top of the landclass layer another layer containing a wire-frame grid is placed and is based on geographical data gained from satellite imagery that determines the topographical shapes and dimensions of the land areas. A 3 dimensional map is created shaping the terrain with hills, valleys, riverbeds, etc. This grid is then rendered with the image files into a mesh for ground areas. The default terrain uses generic coloured squares that are then tiled to cover the land areas. A further scenery layer is then placed on top of the grid containing generic objects such as trees, generic buildings, roads, etc. The smaller the squares within this grid, the more accurate the geographical data will be.

2. 3 The Objects Layer

Within this layer containing airports, buildings and other landmarks, Microsoft includes a feature named *Autogen*. This was first introduced with Flight Simulator 2002 and populates the ground surface with these generic objects (buildings, trees, power lines, etc.). Finally, to complete the scenery, specific objects such as airports, runways, Instrument Lighting Beacons, etc are placed on top of all the layers.

Kane Milne, in his review of the default flight simulator scenery, mentions that

> "… these aren't just randomly placed. Data is stored in scenery files that tells the Autogen system where towns, forests and farmlands are, and the system places the appropriate objects there to suit. It doesn't recreate cities and towns to their exact layout at all, but it does make areas of terrain recognisable, and makes the entire experience of flight much more involving seeing more than just green tiles passing underneath you." (Gameplanet, 2004)

3. REPLACEMENT SCENERY TECHNOLOGIES

A technique utilising high quality aerial photography and satellite imagery is used to create photorealistic scenery for the simulator. According to FlightSim Central this is only a "snapshot in time" and the scenery for a particular area portrays the scenery only as it was when the picture was taken. This means that to make allowances for the seasons, or time of day, recreating seasonal terrain changes, separate imagery have to be created for each season. The scenery itself carries the marks of the land as well as things like shadows, which do not move with the sun. They state that photorealistic quality refers to the

> "technique of using samples of photographic textures to represent the landscape over a wide area. For example, a single photograph of a set of fields may be used to display fields in many different locations in a flight simulator." (FlightSim Central,2004)

However, to create a more realistic scenery environment, the simulator uses actual photographs of each location to display the scenery at that location within the flight simulator. The resulting difference is that all visible features in the real-world landscape are displayed in their true location in the flight simulator. Examples of geographical areas which have been remodelled for VFR flying in the simulator are the United States, England and Wales, and some areas of New Zealand.

3.1 The United States of America

According to the creators of FS Terrain, a replacement scenery mesh covering the entire continental US have been created using Space Shuttle data "to dramatically increase the surface detail by up to 16 times with reference points between 76 and 38 metres. Featureless areas are transformed; mountains soar and valleys plunge." (Justflight, 2004) JustFlight claims that the FS Terrain relief model is set at a high resolution of 76.4 metres between each reference point.

Aerosoft Australia is creating photorealistic scenery that replaces the default US textures. This is called MegaScenery and is released according to different geographical locations, utilising large-scale satellite photos. Aerosoft state that these satellite images creates a resolution of 5 meters per pixel, which *is* good enough to accurately reflect real terrain, making it suitable for real VFR flying. They claim that it creates "real rivers, real lakes, real mountains, real farmland, real towns and real cities. Just what you'd be seeing if you were really up there." Aeronautical maps and charts needed to fly in these areas are supplied with the software, for both VFR and IFR Day And Night. They further claim that it is also possible to use real aeronautical charts to fly any VFR route within the scenery areas covered. Aerosoft state that:

> "MegaScenery also uses high resolution Digital Elevation Model data, that's accurate within feet, to provide you with accurate elevation data across the entire area covered. Mountain flying is unlike anything you've ever experienced to the point where you can identify even the slightest ridge or mound and reference it on your aeronautical chart." (Aerosoft, 2004)

The scenery defines the areas defined as water *as water*. This means that water effects are seen with waves and ripples, and only floatplanes are able to land on any body of water within the area covered whereas other planes will sink.

3.2 New Zealand

Various flight simulator enthusiasts, most notably Robin Corn from Windowlight, Christian Stock from GeograpX, and Massey Aviation are designing realistic scenery for New Zealand. They are developing the new scenery using satellite imagery of New Zealand, replacing the default scenery. Students from Massey Aviation developed a new landclass system correcting placement of rivers, roads, lakes for New Zealand. Stock has developed high resolution 40m and a lower resolution 150m mesh replacement files for the entire geographical area of New Zealand. This corrects the default mesh scenery. It is on top of this new layer that the scenery by Corn is placed, using the satellite imagery with custom New Zealand textures. These do not yet cover all of New Zealand, and only covers selected areas. Additionally, the students at Massey Aviation have been developing add-on scenery objects for New Zealand airports and these are then placed on top of the previous layers.

Reviewing the Godzone scenery created by Corn, one of the major entertainment software suppliers in New Zealand, GamePlanet, states that

> "each scenery set covers a limited area. For instance, the Taranaki scenery is 30x40 square kilometres. Beyond that, the default game textures kick in and there is a distinct and sometimes ungainly crossover. This detracts from the natural flow of the landscape unfortunately, and can also have an effect on realism. But within the bounds of the scenery is an environment that is 100% New Zealand as we know it." (GamePlanet, 2003)

3.3 England

According to Flightsim Central the development of the photographic scenery for Great Britain is the result of

> "a collaboration between Getmapping PLC and Visual Flight to develop add-on scenery for Microsoft Flight Simulator 2002 using … continuous seamless aerial photographic image of the UK"

The authors of the scenery mention that the photographic scenery uses Getmapping's Millennium Map™ aerial photography which is based on images shot from aircraft flying at around 5,000ft." They further state that …

> "the photographic scenery is made by draping high quality aerial photography over a 3D model of the terrain so that it can be used by Microsoft Flight Simulator to display it as it might be seen from a plane in real-life. The photographic scenery recreates VFR flying in which navigation is by linear features such as motorways and railways, and reporting points are based on prominent visual features in the landscape. The resulting photographic quality and seamless coverage cannot currently be matched by satellite imagery." (JustFlight, 2004)

Further to this they claim that "This photographic scenery shows not just every major city, but also every town, village, hamlet, wood, field, copse, stream, river, road, railway, canal, shopping centre, factory, in fact every visible feature in between – right down to individual streets and houses." (JustFlight,2004)

4. RELEVANCE TO REAL AVIATION

Flight Lieutenant Gair Bowbyes, a RAAF flight instructor based at Queensland states:

> "I have been a pilot with the RAAF (though originally from Dunedin) for some 13 years now. I have a background in Tactical transport, Special Forces and Fast Jet ops. I also started Flightsim with the very first version of Flightsim. It's what got me started. My background/interest in Flightsim as a tool has seen my involvement in Flightsim as a simulator for the PC9 in Western Australia (2FTS) and I have initiated flight sim inclusion in powerpoint mass briefs (videos and stills) to the students over the last 5 years that I have instructed as a QFI. Currently I am developing a CT/4 model for the use in FS2004 by students at BFTS Tamworth, and for a new series of Mass Briefs in the lecture package."

(Personal Communication, 18 March, 2004)

Brian Hesketh, a flying enthusiast based in England, writes:

> "Back in the late 1960s, I learned to fly at Barton airfield in the north of England in a Piper Colt and an Auster. I completed 30 hours, inc. 10 solo and never piloted a plane for decades thereafter. From about Flight Sim 4 onwards I have used a variety of PC-based flight simulators, usually flying single engine general aviation planes. A couple of years ago my wife

bought me an hour's flying lesson at Compton Abbas airfield in Dorset. I told the instructor I had flown years ago (I took my log-book) he was quite enthusiastic, and invited me to go through all the pre-flight checks, rather than join him when all was ready. He then took off and handled the radio (Bournemouth) and at 500' or so handed over to me, with a course I had suggested, flying to the coast at Swanage and then back north for about 15 mins or so of practice turns and so on. I was immediately at home in the cockpit and flew with very little direction or intervention from the instructor. (The aircraft was a Cessna 152 by the way)." (Personal Communication, 13 March, 2004)

5. CONCLUSION

It is obvious that to have any actual aviation use, simulator VFR flight would require scenery at a level of realism that is so accurate as to faithfully recreate actual flying environments so that real flight paths can be accurately simulated. Software developers are attempting to create technologies to reach a standard of realism that is as close to the actual real-world environment we live in as is possible. Although Microsoft Flight Simulator and the plethora of add-on enhancement products have been around for many decades and used by thousands of student pilots and desktop pilots for flight training and familiarisation, many aviation authorities and flight training centres have been slow to formally recognise the value for real flying. However, in the US, Britain and Australia aviation authorities and flying schools *are* now beginning to recognise the use of these technologies, and in some instances the use of Microsoft Flight Simulator has been incorporated into the flight training syllabuses.

In New Zealand the Civil Aviation Authority has *not* yet recognised the use of these products for VFR flight, nor have most flight training centres included these into pilot training. Many real pilots and student pilots suggest that there are indeed uses for these technologies, and informally many pilots do use the flight simulator to practice and familiarise themselves before undertaking actual flights. The issue could therefore be raised as to if formal recognition of these technologies for pilot training in New Zealand by the Civil Aviation Authority and pilot training centres can be considered.

REFERENCES

Flightsim Central VFR Photographic Scenery: England Vol. 1 Retrieved 22 April 2004 from: http://www.fscentral.com/photscenenwa.html

GameZone (2003) GodZone Scenery Review Retrieved 28 April 2004 from: http://www.gameplanet.co.nz/mag.dyn/Reviews/2708.html

GeographicX (2004) NZ Mesh for Microsoft Flight Simulator 2000/20002/2004 Retrieved 3 May 2004 from: http://www.geographx.co.nz/Products_MSFS.htm

JustFlight (2004) FS Terrain Retrieved 3May 2004 from: http://www.justflight.com/en/(i140debena0ynw45fkb3hnya)/index.aspx

Massey Aviation (2004) Special Topic Retrieved 2 May 2004 from:http://www.massey.ac.nz/%7Eavweb/papers/fltsimdesign/scenery1.html

SceneryDesign Org. (2004) Tutorial: Scenery Design the FS 2004 Way Retrieved 29 April from: http://www.scenerydesign.org/modules.php?name=News&file=article&sid=86