Visualizing Waikiki

Integrating GIS into Driving Simulation Scenarios

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Highway Driving Simulator (HDS)

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OUTLINE

Background
  - HDS Features
  - HDS Activities Types
  - What GIS is, and Why Do we need it?

Scenario Elements
  - Roadway geometry, Buildings, Trees, Signs, Signals (Lights + Ped), Traffic,
    GUI requirements, Data Collection

GIS Tools

Questions?
Highway Driving Simulator

New Car Cab 2013 Ford Fusion December 2015
HDS FEATURES

- The Highway Driving Simulator now has 18 Video Channels covering 200 degrees FOV front overlapping for a full 360 degrees with LCD based rear view mirrors.

- 3x Barco SIM10 4K front projectors, each at 4096x2400 resolution with cylindrical warping, edge blending, Auto-Alignment (Color and intensity)

- Multi-Display Operators Console

- 3 Rear View panels (replacing mirrors) 1024x800 resolution each

- 6 Degrees of Motion platform for Pitch, Roll, Yaw, Heave, Sway and Surge

- Audio rendering of Engine, Road, and Wind sounds independently

- A full data capture and replay capability including EyeTracking
Operators Console
4K PROJECTORS
HDS Types of Activities

- Visualization projects to demonstrate how new infrastructure will “look” – articulate the benefits of roadway safety investments

- Behavioral research for safety to understand how the driving environment affects driving performance and what changes can be made to improve safety
What is GIS?

“A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data.” Source: Wikipedia

“GIS lets us visualize, question, analyze, and interpret data to understand relationships, patterns, and trends.” Source: esri website

GIS data and GIS applications have become ubiquitous in everyday use and coverage of many data types are of high quality and accuracy.
GIS Data Layers

- Hydrography
- Elevation
- Cadastral
- Digital Orthoimagery
- Governmental Units
- Transportation
- Geodetic Control

Data source:
- Street data
- Buildings data
- Vegetation data
- Integrated data

Data layers

Source: GAO
GIS Data Resources from FHWA

https://www.gis.fhwa.dot.gov/gisData.asp

- GIS Data
- FHWA Data Resources
- GIS Software
- Other Federal Agencies
- GIS Applications
- Resources
- GIS-Related Organizations
- Other Federal Agencies
- GIS in Transportation
- FHWA Data Resources:
  - Transportation Planning Program Process: A website providing contact information for transportation professionals, highway network reports, and transportation GIS resources for the U.S. and Mexico. Most files are available in ASCII format, but the U.S. state boundaries are available in SHAPE format. From the homepage, click on "Data Management" to search for data on the site in spreadsheet and presentation formats.
  - National Bridge Inventory (NBI): FHWA offers a record of federal bridges across the U.S. From the homepage, click on "Tables of Frequently Requested NBI Information" to locate spreadsheet data.
  - National Highway Planning Network (NHPN): The NHPN is a database containing the features representing 400 miles of current and planned highways in the U.S. The NHPN consists of interstates, principal arterials, and rural minor streets. Files are available in ASCII format.
- GIS Data Application:
  - GeoCommunity Data Catalog: GeoCommunity Data Catalog provides access to data cataloged by the National Geospatial Data Center. Users can search for data in inventory and create their own GeoCommunity Data Catalog download files.
  - Data.gov: Explore geospatial data and resources, including an interactive map of substandard bridge information, maps of air quality across the U.S., data on water resources, and more.
  - GeoData.gov: A website providing access to Federal geospatial data on all roads and parking lots for use with geographic information systems. This information is available for use by other federal agencies, states, local governments, and the public.
  - National Agricultural Imagery Program (NAIP): NAIP products include spatial data that is useful for agricultural planning and management.
  - National Wetlands Inventory (NWI): NWI produces and provides spatial information on the characteristics, extent, and status of the Nation’s wetlands and other wetland-like habitats.
  - National Park Service (NPS): NPS GIS sites provide access to data, training opportunities, and detailed descriptions of modeling applications occurring nationally.
  - National Forest Service (NFS): NFS GIS site provides access to data, training opportunities, and detailed descriptions of modeling applications occurring nationally.

- Other Federal Agencies:
  - U.S. Census Bureau: The Census Bureau is responsible for producing a wide range of statistical data about the U.S. population and economy.
  - U.S. Environmental Protection Agency (EPA): The EPA’s GIS website offers links to a geospatial data clearinghouse, software downloads, and other resources.
  - U.S. Geological Survey (USGS): USGS website provides information about the physical landscape of the United States. The site offers data for high-quality, downloadable data layers and the National Map, a tool for maintaining consistent national GIS data.
  - Federal Geographic Data Committee (FGDC): The FGDC is a group of federal agencies that work together to provide access to geospatial data.
Using GIS in Simulation & Visualization

What Data can we get from GIS?
- Elevation Data
- Street Data (Open Roads compliant)
- Vegetation Data (Parks, specific trees along streets, vegetation level)
- Building Data (Based on footprint, stories, style, use procedural generation rules)
- Some city based “furniture”

Advantages of GIS
- Modelling existing “Real World” locations
- Fit CAD Designs to “Real world” locations
- For Public Understanding and Involvement (Hey That’s my House!)
- Comparisons of Real World Data matching Simulator Data
- Many Cities and communities are generating the GIS Database layers for us

Challenges
- Real-Time simulation must run fast at over 60 fps
- Many GIS end products are for either proprietary or geared for presentation only (images / videos)
- Only certain file formats can be used in 3D model environment
GIS Modeling Tools

Google Earth™
- Not fully GIS, but more of a viewer (data layers restricted and defined by developer)
- Elevation Data
- Imagery (satellite and aerial)
- Map Based Data
- Street View, 360 images based on location along major roads and some foot paths
- Some Building Data from larger cities

ArcGIS™
- Full GIS Database
- Actual Database Engine
- Requires expert knowledge to use

Esris CityEngine™
- Easy to use Interface
- Parametric based scripting to generate large areas quickly
- Includes all GIS data layers from ArcGIS

Autodesk InfraWorks 360™
- More Gear to Infrastructure Design Engineers and Quickly Generating Data Visualizations
- Also allows for scripting interpolation of data layers
- Large number of Export formats geared toward 3D Modeling
Examples Using InfraWorks 360

Select ROI
Textured / Shaded Views
Google Earth

• Advantages
  o More true representation with data
    • Buildings are vetted by Google and not just generated
    • Constant corrections fixes are added
  o Includes 3D point cloud data for some vegetation / Tree layers
  o Imagery and Elevation Data is fairly high resolution
  o Data source and resolution is defined
  o Tightly integrated with Street View

• Disadvantages
  o Much of the data can’t be easily exported (other than elevation and imagery)
  o Does not work directly with other GIS data bases
Trees
Procedural Solutions

- Can quickly build model based on parameter lookups and substitutions
- For example, using just the footprint, the number of floors and an architectural style, we can approximate many buildings
- Trees and Street Furniture can also be built procedural
- ESRI City Engine may be best if doing a lot of procedural modeling.
Challenges

- InfraWorks and ESRI City Engine data is not precise
- Need to make changes based on Google Street View or own surveys
- Point data is still hard to work with
- Level of expertise requirements are high for all the applications and engineering areas (Takes a while to learn)
- Large data sizes can be “clunky” to work with
- Need to control Level of Detail (LOD) switching for real-time, few good tools exist to automatically generate LOD in the GIS world
- Tools are always evolving
ONLINE RESOURCES

Federal Highway Administration
Office of Safety Research and Development

Human Factors Program

http://www.fhwa.dot.gov/research/tfhrc/labs/humanfactors/
Questions?

THANK YOU!