FLORIDA HURRICANE ALLIANCE
QUARTERLY REPORT FORM

PROJECT TITLE: **An Interactive 3D Visualization and Animation System for Hurricane Impacts**

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PERFORMANCE PERIOD: July 1, 2005 through September 30, 2005

Percentage of Work Completed: 45%

Project Proceeding on Schedule: [X] Yes [ ] No

Cost Status: [X] Cost Unchanged [ ] Under Budget [ ] Over Budget

Describe milestones achieved during this quarter:

The following is a list of the major research and development accomplishments made in the past quarter:

1. Investigated into finding possible ways for the automated generation of digital city models for on-demand faster and more efficient hurricane and storm surge flood impact animations.
2. Enhanced the water wake effect animation to incorporate realistic wake effect and water splash textures around moving vehicles.
3. Enhanced the Key Biscayne Animation by adding the following animation sequences and models
    1. Toll plaza
    2. Rickenbacker Causeway Bridge
    3. Newer and more improved automobile ***.3DS** models

1. Automated Digital City Generation Study

The priority for this development period was to research and study the possible ways of implementing an automated digital city model for faster and more efficient on-demand hurricane and storm surge flooding animations. In the April-June quarterly report, we implemented a methodology for triangulating the walls of a building footprint obtained via the **LIDAR** data. The goal of the triangulation methodology was to overcome our system's reliance on **3D Studio Max** [1] and to generate faster and more efficient building models using the **LIDAR** data footprint and textures obtained via digital camera images. These models were to supplement the generation of an automated digital city animation. However, due to certain implementation and computation overhead concerns discussed later in this report, we further investigated and researched

additional possibilities for the automated digital city generation. The following three methodologies were investigated during this quarter.

1. Enhancing the current triangulation methodology for supporting automated texture addition and enhancement
2. Development of textured building component database/library for the generation of building models
3. Development of a generalized **.3DS** building model library/database

1.1 Enhancement of the current triangulation methodology

The first methodology is related to extending the current implementation of the triangulation methodology to incorporate the texture addition and enhancement capability. The major drawback with this methodology is that a precise and accurate mapping between the building textures and triangulated walls is almost impossible. We use **OpenGL** [2] functions to generate the triangulated building walls as shown in Figure 1 and add texture onto these walls. However, this approach is appropriate for the case where a wall has the same texture or it does not have any windows, doors, etc. This approach falters for the case where we have doors or windows, or have multiple textures across a wall. The main reasons behind the faltering of this approach are the lack of an appropriate mapping methodology among the building wall triangulations and the corresponding textures. Currently, it is almost impossible to map a wall texture including windows, doors, etc. accurately and precisely to its corresponding triangulation. The building structures and textures differ from each other and our current framework and resources lack the support for meticulous and accurate mapping of the textures across each wall of the building footprint obtained via the **LIDAR** data.

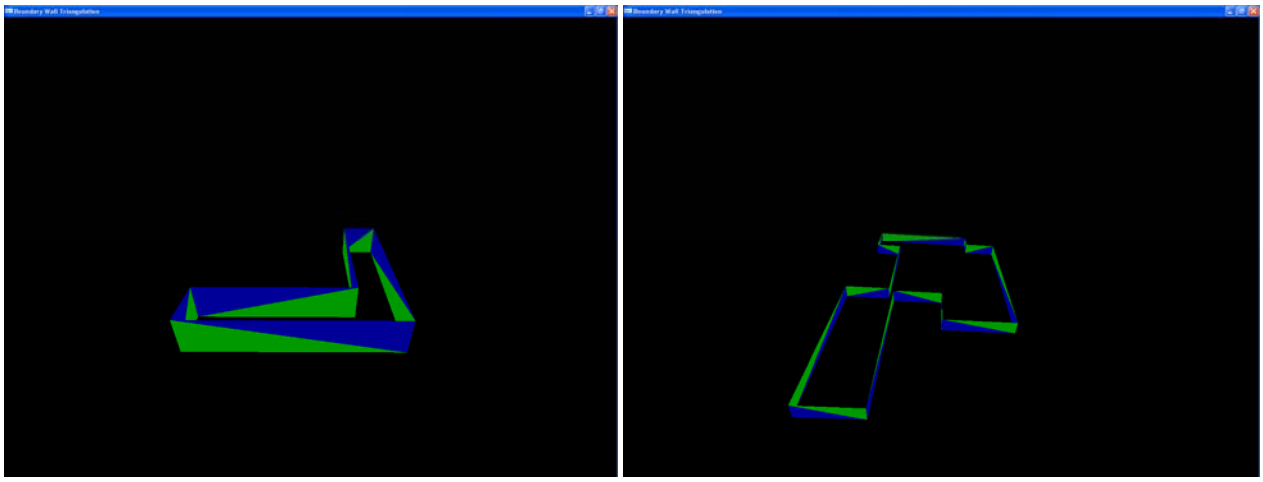

Figure 1. Building footprint triangulation with wall colors

1.2 Development of a textured building component database/library

The development of a textured building component database/library was another methodology investigated by our group. The key concept behind this approach is to create a **.3DS** based component library/database consisting of different structural components of a building, e.g. roof sheathing, walls with different textures, different roof types, etc. that can be connected to each other using the **LIDAR** data footprint information to generate a 3D building model. The creation of a

library consisting of different textured structural components of a building is possible. However, the assembling of these components is a major concern. Different buildings within a city have different architectural and structural models along with a variety of textural styles. This approach allows for the generation of a 3D building model using the .3DS library components. However, since our ultimate goal is to ensure the functionality and usability for a personal computer at home or work; using multiple **.3DS** components with each component requiring space in memory will pose a major drawback by increasing the computational costs for the automated digital city generation process and requiring the use of additional resources for the faster and more efficient generation. The increased computational costs along with the required additional resources such as additional memory and faster processors will be infeasible and against the overall aim of this project. The animation will not be supported over the majority of the basic personal computers at work or home and hence would serve no useful purpose other than increasing computational and overhead costs.

1.3 Development of a .3DS building models database/library

The development of a **.3DS** building model library/database was another approach investigated by our group. The key concept behind this approach is the creation of a library of different **.3DS** building models as shown in Figure 2 to be used by our **VTP** [3] based framework. The library will be based on manually created 3D Studio Max based generalized **.3DS** building models. This approach will attempt to match the **xml** representation of the **LIDAR** data building footprint and retrieve the closest matching **.3DS** building model. This methodology can use **OpenGL** Scaling functions and the **.3DS** models can be scaled to our **VTP** based animation environment. Currently, this approach is the most suitable for our current framework as it will help in the faster and more efficient generation of a digital city animation while keeping the computational costs to a minimal level. The VTP framework will only be responsible for rendering the **.3DS** models and will not be involved in cumbersome computations for determining the coordinates for each structural component of a building model.

Figure 2. 3D Studio Max based .3DS Building model

The above approach will provide the support for efficient digital city damage animation using VTP's **lib3DS** library. The building models will be animated to represent hurricane and storm surge related damages using the **lib3ds** API function calls. This approach of a **.3DS** model library is currently the most suitable approach for our framework. Future implementations and research efforts will focus on overcoming the reliance on 3D Studio Max and the generation of a fully automated digital city animation.

2. Water Wake effect enhancement

A major portion of the implementation phase was dedicated to the enhancement of the Key Biscayne traffic evacuation animation. The scenario has been enhanced to include animations for the water wake effect around moving vehicles under rainy or hurricane related storm surge conditions. The water wake effect is generated around the vehicles during or just after a rain and over wet roads. The water wake effect animation scenario presented in the April-June quarterly report used **OpenGL** based 3D lines to represent the wake effect associated with each tire of a vehicle as shown in Figure 3. The enhancement to the water wake effect uses **.3DS** models for animating the water wake effect around moving vehicles as shown in Figure 4. Since the traffic animation includes a traffic blockage under storm surge related flood conditions, the wake effect is invisible during the storm surge flooding as shown in Figure 5. The wake effect animation further helps in enhancing the realism and appeal of the 3D hurricane visualization and animation environment.

Figure 3. Water Wake effect Animation using OpenGL 3D lines

Figure 4. Water Wake Effect Animation using .3DS models

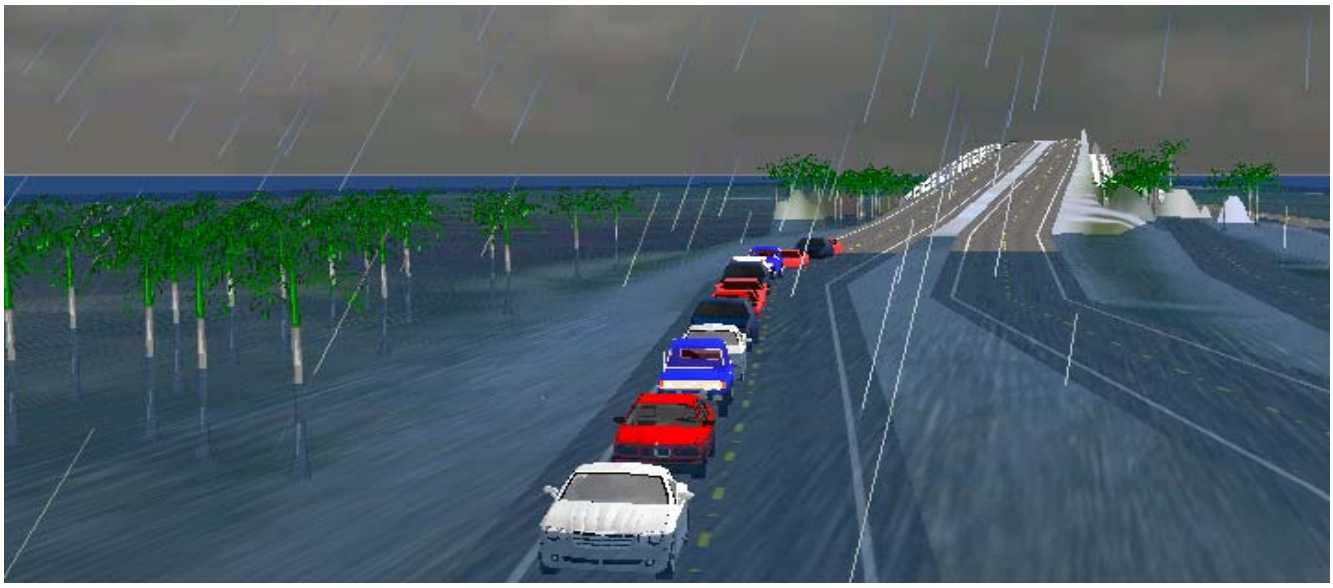

Figure 5. Wake Effect Animation under Storm Surge Flooding

3. Other Enhancements to the Key Biscayne animation environment

Other key enhancements to the Key Biscayne animation environment during this period included the following:

3.1 Toll plaza

The addition of the toll plaza and the vehicles evacuating alongside the toll plaza is another important feature of this development quarter. The Key Biscayne Rickenbacker causeway has a toll plaza at its western end that collects toll from the vehicles coming in Key Biscayne. Under hurricane conditions and mandatory evacuation orders, the tolls are suspended with no traffic coming in to Key Biscayne. We enhanced the Key Biscayne animation scenario by adding the toll plaza and animating the evacuation alongside the toll plaza. The toll plaza is shown in Figure 6. The toll plaza further adds to the Key Biscayne scenario's realism and appeal.

Figure 6. Vehicles evacuating alongside the toll plaza

3.2 Rickenbacker Causeway Bridge

The Key Biscayne animation scenario earlier used the elevation data to represent the bridge. Another major addition to the Key Biscayne animation scenario was the Key Biscayne Causeway Bridge. The bridge model has been generated using 3D Studio Max. The animation scenario includes both the old and the new Key Biscayne Rickenbacker Causeway Bridges to ensure that the animation is realistic. Both the old and new bridges are shown in Figure 7.

Figure 7. Key Biscayne Causeway Bridges (Old on the right and New on the left)

3.3 New and improved automobile .3DS models

In addition to all the above developments, enhancements, and implementations, the automobile **.3DS** models were also improved. New car models such as Chrysler Crossfire has been added to our animation environment to animate the diverse and up to date range of vehicles. Moreover, the old version of **.3DS** models like BMW, Ferrari, etc. have been improved to show more details, thus adding to the system's appeal and realism. The car models are shown in Figure 8.

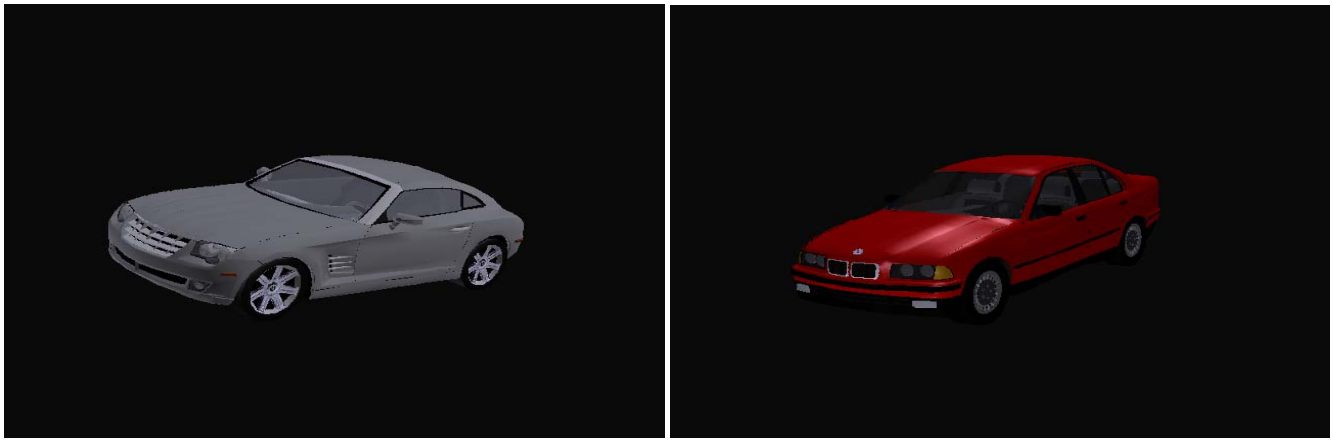

Figure 8. Improved .3DS models

Provide a schedule for the remainder of work to project completion:

We plan to work on the following tasks in the next development period.

1. Implement the automated digital city generation using a .3DS building model based library.
2. Investigate further into possible ways of automating the entire digital city generation process by overcoming the reliance on 3D Studio Max
3. Research, collection, and possible implementation of LIDAR based elevation grids for additional coastal locations across south eastern Florida.
4. Improve the Toll plaza **.3DS** model to provide a detailed and more realistic model.
5. Add road signs and Light Polls on the bridge

Describe problems or circumstances affecting completion date, milestones, scope of work, and cost:

Additional Comments/Elaboration:

References:

[1] http://www.discreet.com

[2] http://www.**opengl**.org

[3] http://www.vterrain.org/