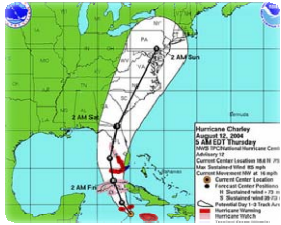# Hurricane Visualization Project supported by the Department of Homeland Security

Dr. Aidong Lu/ Lane Harrison
Iris D. Jones

Charley's Track:

Fig.1. This map from the National Hurricane Center depicts the track of Hurricane Charley. After making landfall in Cuba, the storm continued to the north and then to the northeast to make landfall on the southwest coast of Florida.

Fig.2. This map from the National Hurricane Center shows the eye of the storm and its strength making its way across the land of Florida.
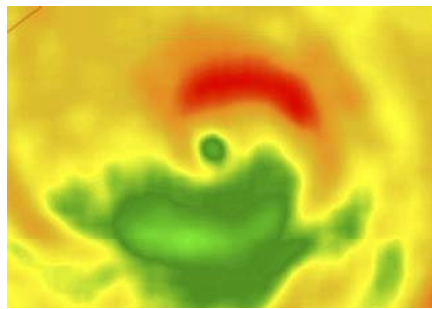

Fig.7. Rapid Intensification occurs when the minimum sea- level atmospheric pressure of a tropical cyclone decreases drastically in a short period of time. The rapid intensification of Charley's vortex was unstable during the eye wall contraction while the vortex became stable after Charley reached its peak intensity.
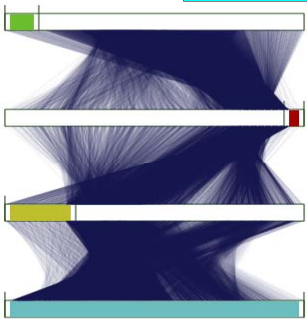
Results:

Fig.5. Parallel coordinates plot showing the first 30,000 values for Mean Sea Level, Surface Temperature, U Wind, and V Wind in that order.
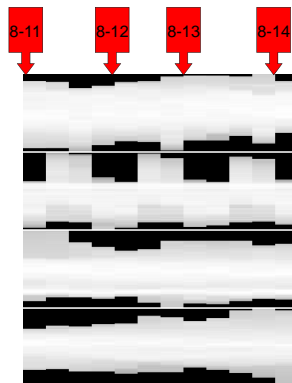
Fig.6. The surface temperature fluctuates with the hours of the day starting at 8am-2am each day. The maximum for the peak hours of the day seems to be decreasing slightly as the hurricane makes landfall on August 13., the Sea Level Pressure increases.

Abstract:

This project involves many aspects of the research process. These aspects include a literature review of relevant multivariate time-varying visualization papers, developing a program to access and manipulate the scientific data, and producing preliminary visualization results. The project consists of visualizing natural disasters, specifically data from a simulation of Hurricane Charley in 2004.

Introduction:

Hurricane Charley unexpectedly strengthened to a category 4 storm as it made landfall in Florida on August 13, 2004. This miscommunication ended up costing billions in damage, as hurricane Charley "rapidly intensified" into the most powerful storm to hit Florida since 1992.

Charley originated from a tropical wave and developed into a tropical depression. The depression strengthened to a tropical storm in the eastern Caribbean, and became a hurricane on the 11th near Jamaica. The hurricane turned northeastward and accelerated toward the southwest coast of Florida as it began to intensify rapidly; making landfall with maximum winds near 150 M.P.H.

In this project we are trying to answer the question, "How can we visualize the Multivariate Time-Varying data and reveal data relations on 3D space?" The results of this project focus on visualizing multivariate time-varying data, which cannot be directly rendered since humans can only see at most three dimensions.

Related Work:

Tri-Space Visualization Interface for Analyzing Time-varying Multivariate Volume Data

Presents a user interface for visualizing multivariate time varying data. The interface visualizes three categories of data that varies in different dimensional spaces. Tri-Space analyses time varying multivariate volume data. The interface consists of three components:

1. Correlations between variables in a parallel coordinates plot.
2. Time histograms of data. The user usually identifies time steps and specifies time varying features. This shows how the circulation of data changes over the time sequence. Histograms are a view of time-varying data, showing the data falling in different ranges.
3. A volume rendering of the data.

Importance-Driven Time- Varying Data Visualization

This paper introduces the temporal behaviors exhibited by time-varying volume data. Time-varying data can be categorized by different temporal behaviors. Each category shows different values over different time steps:
-	The first category of time-varying data is regular; the rate of change varies in space and time.
-	The second is periodic, meaning the data has recurring patterns at different times.
-	The third category of time-varying data is turbulent. A variety of data with change or variation in a quantity over time distributed over a wide range of spatial and temporal scales.

Experimental Set-up:

Our goal is to develop a feature extraction visualization method that can intuitively show why hurricane Charley strengthened. For example, reasons could be a temperature change or it may be the surface temperature of the soil that may relate to the strength of the hurricane. Researchers have collected data on the hurricane and input them into a scientific model. The model has 81 variables such as wind direction/pressure, temperature, and speed. This project also involves time varying data, because all the 3D data changes with time. We have 81 variables, for 1 variable at 1 time step there are up to 1, 576, 752 data values.

Visualization Process:

The process of understanding data begins with:
- Acquire- Obtains the data from a file on a disk
- Parse- Provides some structure for the data's meaning
- Filter- Removes all but the data of interest
- Mine- A way to discern patterns or place the data into a mathematical context
- Represent- Choose a basic visual model
- Refine- Make things clear and more visual
- Interact- Manipulates the data to determine what features are visible.

Results:

My results consist of background research on Hurricane Charley and reading papers that introduced me to different types of visualizations, which led me to learn how to use a simple visualization tool to familiarize myself with existing visualization techniques. Also, learning the 7-step process to visualize data. I filtered information that is needed to complete this project that I will give to the team. I was able to provide important information relating to the project goal and gained a better understanding of basic concepts in programming.

Conclusion/Future Work:

Future work will concentrate on using statistical methods with current MVTV visualization techniques to extract interesting features of the data (rapid intensification) of hurricane Charley.
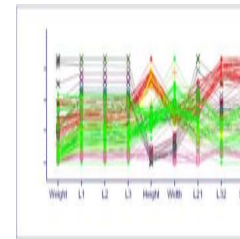

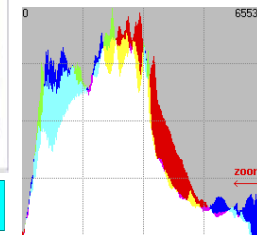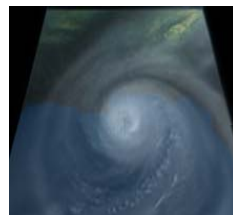Fig.3. Example of a Parallel Coordinates plot

Fig.4. Example of a Histogram

Fig.5. Example of Volume Rendering