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Transit Time

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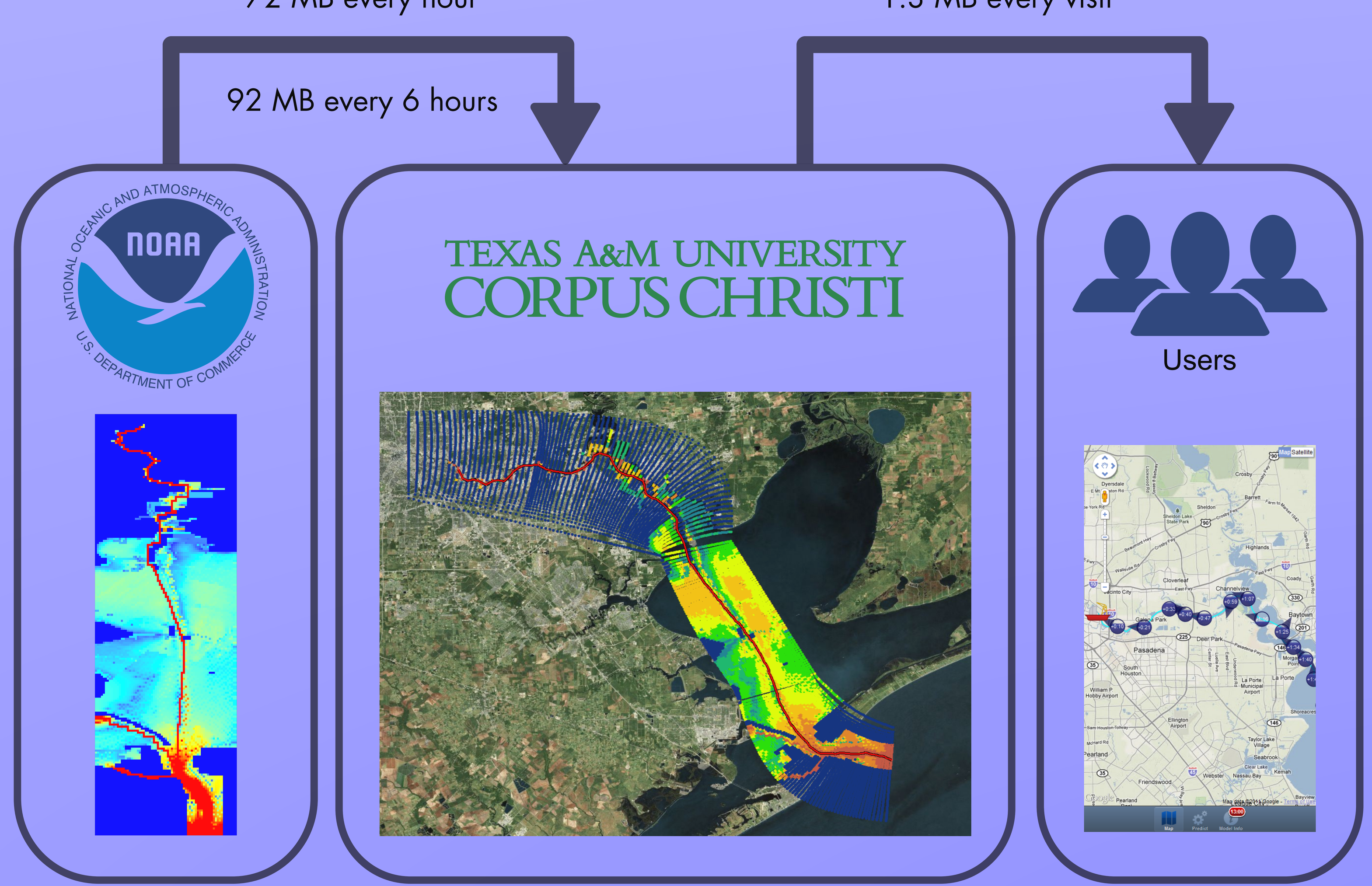
Summary

The Houston-Galveston ship channel is the second largest port by tonnage in the U.S. and is used by over 350 vessels daily. These vessels are piloted along the channel by ship pilots who rely on available atmospheric and oceanic information. Hydrodynamic predictions from the National Oceanographic and Atmospheric Administration (NOAA) PORTS models are available online in the NetCDF format. Although this file format is familiar to coastal researchers, few methods exist to bring these predictions to a broader base of users, and none that leverage the capabilities of mobile platforms, such as georeferencing. This project's goal is to use mobile technologies to make these predictions easily accessible to the Houston-Galveston ship pilots. Several technologies were selected in order for the application to be computationally efficient and to behave similarly to a native application while being run in a web browser. Perl and the Perl Data Library is used to filter and convert NetCDF files on the server, while JavaScript calculates the ship transit model and drives the Sencha Touch interface using Google Maps and HTML5 to draw dynamic markers. The selection of these technologies allows the application to work on any Webkit based browser such as those included in modern smartphones. Hydrodynamic predictions are combined with information provided by the pilot to predict ship travel along the channel. The app includes several displays including currents and water levels at the present or a future time and predictions along the channel at the predicted time of the ship's passage.

Goal: A cross-platform mobile navigation application for the Houston-Galveston ship channel

Data Flow

NOAA's hydrodynamic model results are available to the public via an OPeNDAP server. Two types of output files are available: one for nowcasts and one for forecasts. The nowcast files contain hourly predictions for up to five hours and are updated hourly. The forecast files provide longer range predictions; they contain data for up to 48 hours and are updated every 6 hours. For this project NetCDF files are downloaded from the OPeNDAP server hourly for the 72 MB nowcast files and every six hours for the 92 MB forecast files. Once the data is downloaded, the data is processed and filtered on a TAMUCC server and formatted to be sent to the user's devices. To minimize latency, only the relevant arrays of filtered and processed model output are sent and all calculations pertaining to visualization and the ship transit are performed on the mobile devices.



Technologies

Preprocessing

Python
Scripting language used in conjunction with ArcGIS

ArcGIS
Mapping tool, used for selection of the channel

Server

Perl Dancer
A micro web application framework for the Perl programming language

Perl Data Language
Gives Perl the ability to compactly and speedily manipulate large N dimensional data arrays

Client

Sencha Touch
Mobile web app framework that provides a native look and feel on mobile devices

HTML5
Upcoming standard for website presentation with new capabilities such as canvas

JavaScript
A programming language used to provide interactive web applications

Sylvester
A vector and matrix math library for JavaScript

Model

At the core of the application is the ship transit model, which combines hydrodynamic model output and user input to predict a ship transit time between selected locations (presently only for the length of the Houston-Galveston ship channel.) Specifically the algorithm combines ship velocities and current forecasts at the predicted time of ship passage with the distance between grid points along the ship channel. In the present version of the application, the ship's velocity is provided by the pilot or captain, the fluid velocities at each point are provided by the hydrodynamic model, and the distances are precalculated. The information is combined as follows to compute transit time:

$$\Delta t = \sum_{i=0}^{n-1} \Delta t_i$$

$$\Delta t_i = \frac{\Delta x_i}{v_{ship} + \hat{v}_{ship} \cdot \vec{v}_{fluid}(t)}$$

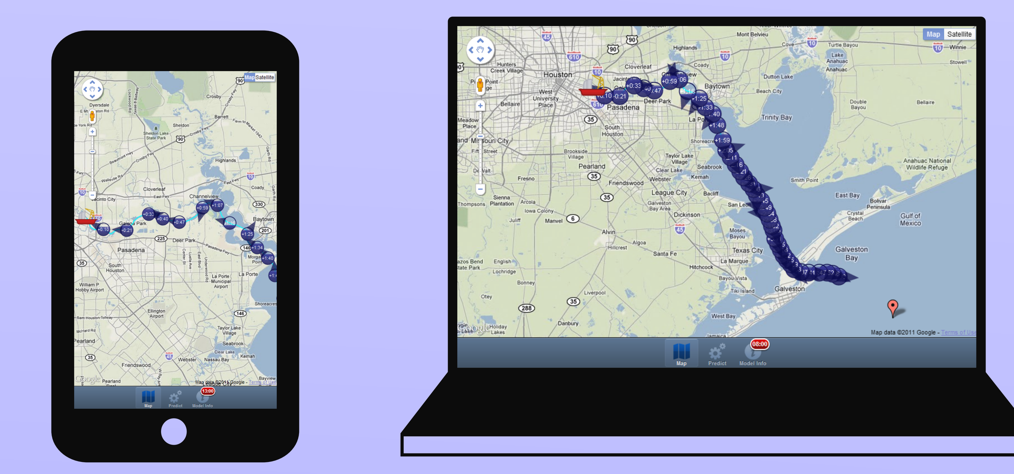
$$\vec{v}_{fluid}(t) = \frac{\vec{v}_i(t) + \vec{v}_{i+1}(t)}{2}$$

For each segment the distance between grid points is divided by the ship's velocity relative to land to obtain each incremental travel time. The ship's velocity relative to land is calculated by adding the ship's velocity to the effect of the predicted current along the ship's direction.

To find the predicted fluid velocity between two points, the endpoint velocities are averaged and the current is assumed to be constant between the two locations.

The App

The application is packaged as a web page, allowing it to be platform independent. This makes it accessible through any web browser with WebKit based browsers being the most compatible. To visualize the channel, the path was selected in ArcGIS and exported with directions and distances between each point using a Python script. This data is combined with the filtered model output on the server and sent to the user's device. The device then runs the ship model and calculates the predictions required to visualize the results which are drawn as markers on Google Maps using the canvas element, a part of the upcoming HTML5 web standard. These components are wrapped in a Sencha Touch interface, giving a native look and feel. Through HTML5, the application is also able to access the geolocation capabilities of the device to accordingly update the ship's position on the map.



Conclusions

A user-friendly mobile application was developed to provide hydrodynamic predictions in a simple and intuitive format for pilots and boaters navigating the Houston-Galveston ship channel. The application combines hydrodynamic predictions and user input to provide prediction of transit time as well as current and water level predictions at the time of the vessel passage.

The application is based on a combination of existing and emerging technologies; it is computationally efficient and portable to other locations covered by regularly updated hydrodynamic models.

During development, it was found that the various handheld computing devices tested were all able to handle the data processing and graphical tasks to compute transit predictions on the device itself. Using this combination of technologies allows for streamlined and user friendly access to hydrodynamic model predictions.

Future steps include extending the grid to the GP buoy, the location offshore of Galveston Bay where pilots and captains begin channel navigation. Other predictive fields will also be added to the application and other PORTS locations will be considered.

References

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Sylvester <sylvester.jcoglan.com>

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