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Weather Station Website for Pace University Environmental Center

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Abstract

This project developed a fully functional website for the Davis Vantage Pro Wireless Weather Station located in the Pace University Environmental Center. The primary goal is to upload local weather information automatically to a website every 15 minutes. This is accomplished by using Virtual Weather Station by Ambient Weather, used by Pace University, to populate a configuration file housed on the web server. The configuration file is loaded to the database weather table currently on the web server using a Data Transformation Service (DTS) job. A SQL Agent job runs in the background every fifteen minutes to initiate the DTS job.

1. Introduction

The Pace University Graduate Program in the Department of Environmental Science owns and operates a Davis Vantage Pro Wireless Weather Station located in the Pace University Environmental Center at the Pleasantville campus. The Weather Station gathers and analyzes local weather conditions in the Pleasantville region. Ambient Weather's Virtual Weather Station (VWS) software provides readings such as precipitation, barometric pressure (humidity), wind speed, temperature, which is collected on the Weather Station's local computer hard drive and then analyzed by researchers. The VWS software also provides 30-day historical trends of weather conditions and has a feature that predicts local future weather outlooks.

A previous website design was developed by students in the Spring of 2005. The website gathered data using a comma-delimited file produced by *Weather Link* software on the server. The students designed a Data Transformation Service (DTS) job to push the data from the comma-delimited file and load it onto the Utopia CSIS server database. This was accomplished using File Transfer Protocol (FTP). Although the initial design of the web page and the application was successful there was a major design flaw. The data could not automatically update from the comma-delimited file received on the Weather Station local hard drive to the utopia server [1]. Accurate weather conditions and predictions would have to be loaded into the database using a manual FTP process which was difficult and time consuming. Eventually the inefficiency of the manual load process led to the failure of the website [1].

2 Relevance in the Context of Other Research and Design

2.1 A Brief History of Meteorology

Weather and climate tracking has been analyzed and researched for thousands of years. The early Egyptians, Greeks and Romans developed sophisticated and elaborate sundials to accurately predict sunrise and sunset [2] while predictions of weather were completely based on observation. It was not until the invention of the barometer by inventor Envangelsta Torrecelli in 1643 that actual weather measurements could be done. The hygrometer (1644) and the mercury thermometer (1714) allowed metrology to become a bona fide science based on objective and measurable calculations [3].

French scientist Laurent Lavoisier, in 1765, developed the first daily measurements of wind speed, air pressure and moisture content. However a massive storm in 1854 that caused the sinking of a French warship and eight merchant vessels off the Crimean coast changed the way the science of meteorology was approached. It was discovered that the storm was formed two days earlier than the prediction and as a result the French government started the first storm warning tracking service [3].

It was also in the 1800s that the Paris Observatory developed the first weather maps. This was accomplished through the advent of a revolutionary technological breakthrough, the telegraph, invented by Samuel Morse. The telegraph allowed for greater communication of every kind and thus allowed much greater distribution of weather prediction.

It was after the end of World War I that meteorology took a great step forward. Lewis Richardson (1881-1953), a British meteorologist, declared that since meteorology follows laws and principles of physics that future weather predictions could be measured using mathematical formulas. His mathematical calculations created by a series of differential equations were the first metrics that accurately predicted the weather. However due to the enormous complexity of the formulas weather could only be calculated in six-hour intervals and many times a weather system and condition would pass before the calculation could be achieved. Computer technology has been a tremendous support in allowing Richardson's calculations to be solved quickly. The formulas basically are utilized in the following manner. Meteorologists divide the earth into a grid with grid points 80 km apart. Measurements of weather are taken at twenty levels of atmosphere above a square of grid points. Computers from more then 35,000 observation stations around the globe then analyze the data and a weather prediction is accounted for every fifteen minutes. Modern meteorology owes a big acknowledgement to Richardson. The formulas that he developed at the start of the 20th century are the formulas guiding weather prediction and analysis today [3][4].

Accuracy for weather prediction correlates with technology. As Internet and World Wide Web technologies grow so must the need for better accuracy and more frequent predictions of weather conditions. Advancements in satellite technology and Doppler instrumentation have been useful in measuring greater accuracy. The 21st century has seen a great change in the way individuals can access daily weather conditions. Today daily weather conditions and predictions can be accessed through such devices as satellite radio, palm pilots, pagers, blackberries and cell phones.

2.2 Modern Research Techniques for Weather Analysis

The focus of this project is to automate the transfer of weather data from the local Weather Station computer to the Weather Station database on the Utopia CSIS server. Resources in the automation of weather data from the weather station to the database for a particular website is sparse and mostly confidential, however there are a few descriptions of how weather data is made available to public viewing and how it is updated. The similarities between these websites do overlap although there are some fundamental differences in how data is displayed and stored. We will be focusing on two websites: Weather Channel (http://www.weather.com) and Wunderground (http://www.wunderground.com).

Weather Channel

The Weather Channel website is the most popular website for checking daily weather conditions and predictions. The website features up to the minute status of weather conditions and features a 10-day prediction forecast. The information collected is from satellite and radar imagery fed into many weather stations and then fed to the database directly. The Weather Channel Website features many interesting tools including travel weather, driving conditions and offers educational tools for understanding basic meteorology. Its fault however is that the information that users are allowed to view is just that, information. Data cannot be stored for any reason, historical or otherwise, and many of the locales searched for in the same region give the exact same weather conditions for all the locales. Also, as with most commercial websites the interface is crowded with pop-up ads and advertisements. For these purposes of weather data collection, http://www.weather.com is not an effective research tool. The website is also receiving its information through expensive satellites and radar technology which are out of the scope and over the budget of the research necessary to automate the data process [5][6].

Wunderground

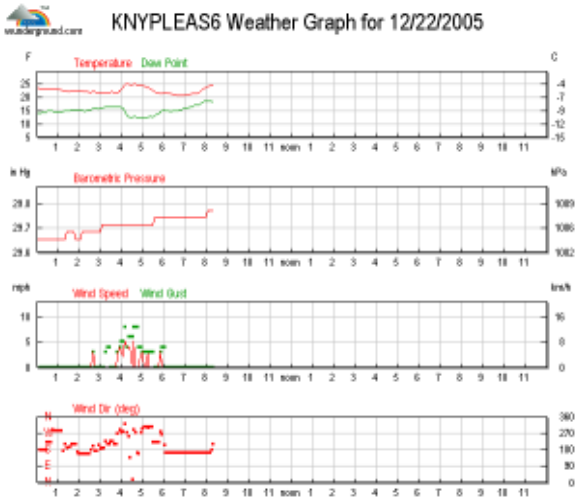

Figure1. Graph of weather data produced by wunderground.com

Simpler and less convoluted then the Weather Channel Website, Wunderground does allow for users to retrieve data for limited storage purposes. Data is transmitted through a comma-delimited file and researches can use this data on their own weather stations. However they do not provide researchers and developers the means for transmitting data from the weather station to the server database in order to build a website. This is what the previous student research team had problems with. Although data could be gathered it could only be displayed through manual intervention. As with the Weather Channel website, Wunderground uses expensive satellite imagery feeds, Doppler radar and expensive automated FTP processing to load the data onto the websites [6][7].

What can be done in the scope of this project to build an automated process for getting weather data from the *Virtual Weather Station* software to display accurately on the website? Automated FTP tools such as Automated FTP Premium [8] may help but product cost could be expensive, $150.00 - $200.00, and appropriate licensing will need to be applied. Most weather station websites use an automated FTP or HTML process for this usage. The methodology described in this paper will hopefully discredit the claim that automated FTP is the only way the process will work at no cost to the customer.

2.3 Comparison of University Weather Stations and Designs

A number of universities conduct weather research and operate weather stations similar to the Pace University Environmental Center. The University of Wisconsin-Madison Automatic Weather Station (AWS) Project, run by the Antarctic Metrological Research Center is designed to research metrological conditions in Antarctica using weather stations in many locations around the continent [9]. The National Technical University of Athens has a weather station that uses analog and digital sensors to transmit weather data from Athens across radio waves to the computer in the lab 1km away. Data is displayed in tabular form, maps and also satellite imagery [10]. The University of Michigan-Ann Arbor ‘s weather lab features a comprehensive listing of links to weather related FTP, gopher telnet and Internet sites [11]. Finally the University of Ohio Agricultural Research and Development Center (OARDC) collects average temperature, humidity and other weather related data in a database on a daily basis from populated agricultural areas around the state. The database also collects crop frost dates for farmers and agriculturalists. Historical data and trends date back to 1986 [12].

A major focus for this project is to accomplish what the other universities have been able to do. The goal is to produce a visually appealing and thorough website for our client and the Pace University community.

3. Competitive Software Analysis

Three software packages were analyzed during the two elaboration phases of this project. The original weather software that the project team inherited was Davis Weather Link. During the spring term, our original client’s requirements were to transition to Weather Display Live. However after seeing the software first hand, our client opted to go with a product called Virtual Weather Station by Ambient Weather. Table 1. describes the main features of the three software packages.

Name	Davis Weather Link	Weather Display Live	Ambient Weather
Cost	NA	$99.99	$99.99
Version	Discontinued	V10	v12p09
Wunderground Support?	Yes	Yes	Yes
FTP Uploads	Yes	Yes	Yes
Flash Web Interface	No	Yes	Yes (add-on support)
Dynamic Graphs	No	Yes	No
Web cam Support	No	Yes	Yes
Online Support Forums	No	Yes	Yes
Webpage Creation Support	Yes	Yes	Yes
Customized jpg Creation	No	No	Yes
Email Alerts Support	No	No	Yes
Automatic Reboot	No	No	Yes
Client Interface Usability [1-5, 5 highest]	3	2	4
Software Stability	3	3	4

Table 1. Comparison of Weather Software Packages

Although the project team liked the interactive interface provided by Weather Display Live, our client found the interface busy and confusing. The traditional weather graphs produced by Ambient Weather more closely matched the original software, Weather Link, previously used. Since the original software is discontinued, the VWS software was the best choice to transition to.

4. Methodology

The automated process to update the weather station data is comprised of two main parts:

1. The VWS software which outputs a comma delimited file every 15 minutes
2. The DTS Job that imports the comma delimited file from the weather station PC every 15 minutes to the SQL server

Figure 2 shows a screenshot of the DTS job to automatically import the data.

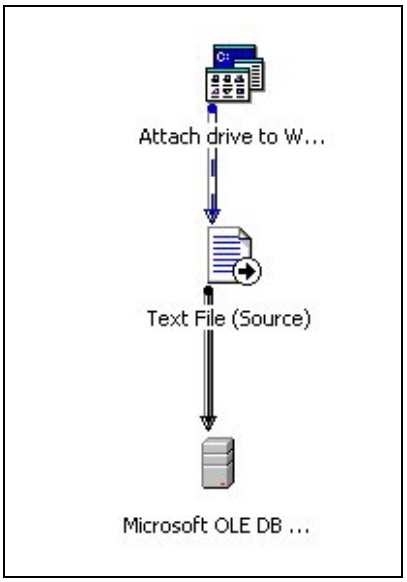

Figure 2. Transformation Flow

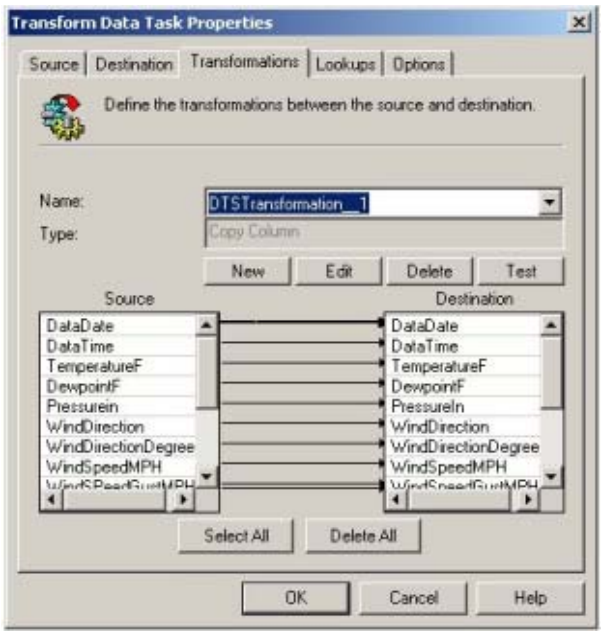

Figure 3. Data Transformation from text to DB

Figure 3. depicts the process of moving the data from the comma delimited flat file to the data fields in the SQL Server. By adding a header row to the text file, the DTS job will automatically map the comma delimited fields from the data file, transform and copy the data into a temporary table and then import into the SQL Server database.

Additionally, data transformations and data manipulation can also be added to the transformation by using various scripting languages such as VBScript. No VBscript tasks are currently being used, but will help facilitate improvements to the data model for future work assignments.

As the data flows to the SQL Server, recent images of data readings are sent directly to the website. The data is ftp'd to the webserver in fifteen-minute increments. The user then has the option of viewing recent data that is provided by the images or viewing tabular data by mining against the SQL database.

In addition to the feed to the SQL Server that provides data mining, the *VWS* software also automates the upload of the images directly to the web server. The interval in which the site is updated, as well as the data uploaded, is configurable by the VWS software.

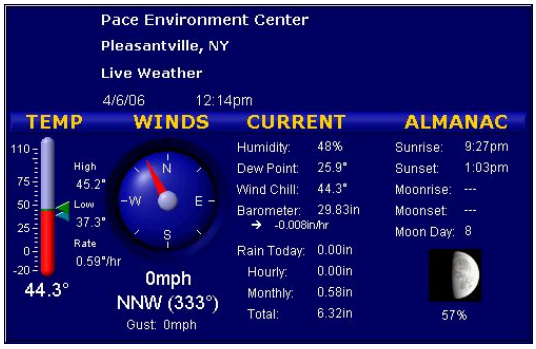

Figure 4. Image Produced by the VWS Software

4. Result

The process to import the data into the Weather DB was initially going to be a push system. This would make the weather station PC responsible for syncing data with the DB server. By using a pull method the weather station PC can continue to take readings and dump flat files locally, independent of the data import process. By using simple read-only access drive mapping to the weather station PC, we eliminate the complications of using an FTP process and setting up additional IDs and passwords to maintain. We also eliminate the need for having to host an FTP server on the SQL server, which only adds to the complexity of the support for the Utopia environment.

5. Conclusion

Since the data is imported directly from the weather station PC to the MS SQL Server, we effectively remove the constraint of what server the site is hosted upon. This allows the weather station website to be moved easily to another server within the Pace University infrastructure.

5.1 Recommendations for Future Work

Our recommendations for the continuation of this project are as follows

- Adding a lightning detection module
- Adding a weather station in the NYC campus
- Adding a webcam
- Providing email alerts for severe weather conditions

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