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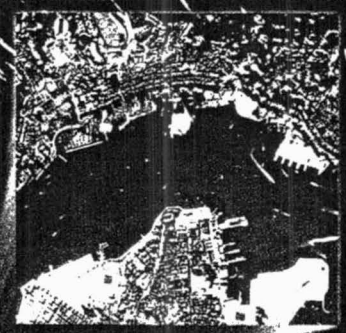

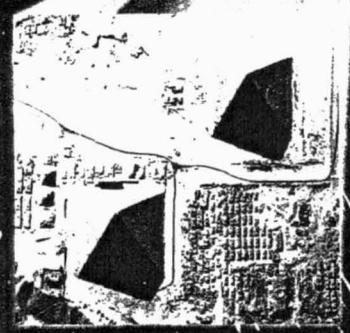

Global Snapshots

Mapping our world with down to earth technology in space imaging

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C O N T E N T S

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About APSCC

The Asia-Pacific Satellite Communications Council (APSCC) is an international organization whose aim is to promote satellite communications in the Asia-Pacific Region. As of March 2002 APSCC had 93 member organizations and companies from 30 countries. APSCC activities include an Intensive Training Course, Study Group activities, and an Experts Meeting, covering various areas of satellite communications ranging from technologies, systems and services to policies and regulatory matters. The APSCC Conference and Exhibition is a biennial event to exchange views and ideas on satellite communications as well as international cooperation. The APSCC publications including the Newsletter and Directory contribute towards the promotion of the satellite communications industry. APSCC membership is open to public or private organizations related to satellite communications.

Coping with Copious Content:

Problems and Solutions in the Management of Land-Imaging Satellite Data

In low-lying southwest Florida, a water management official uses land-imaging satellite data to construct possible high-water flood scenarios, complete with visually accurate depictions of water overtaking buildings. In Georgia, climate researchers are using the same type of data to plot the relationship between urban development and microclimate change. And in Indiana, a fan of the television show Survivor has directed a land-imaging satellite to Africa, where it took overhead snapshots of the show's production camp, which usually lies off-screen, hidden from viewers.

From crucial assessments of natural disaster preparedness to applications that have no purpose besides fun, remotely sensed data is being tapped more and more as an effective, compelling way of communicating Earth information. At any time in the next five years, there will be from fifteen to twenty land-imaging satellites in the Earth's orbit, steadily accumulating heaps of visual information that will swell databases worldwide. The images captured by these satellites are useful in a variety of industries, from real estate to insurance to travel, among plenty of others. However, as the longevity of the land-imaging satellites increases and as the resolution of the images they capture becomes ever finer, the databases designed to store their output will quickly balloon to very large sizes. Managing this high volume of imagery presents a significant challenge for interface developers. The TerraFly project is an attempt to create an elegant, user-friendly method of accessing this ever increasing-and ever more popular-geospatial data.

Launching New Worldviews

Satellites launched to record images of the planet's surface have been around for 30 years.

They have quietly circled the Earth, logging visual overhead snapshots from around the globe, eventually re-entering the atmosphere and burning up before hitting the ground. Most of the data these satellites have collected has consisted of low-resolution images intended for non-commercial purposes, especially in the fields of planning, land management, and military intelligence and strategy. The first generation of these satellites produced images with resolutions of 10 to 30 meters; these resolutions were sufficient for large-scale planning endeavors but not particularly useful to the majority of consumers and professionals, whose economic interests tended to be bound up with land areas of a smaller scale.

This all changed in 1999, when Space Imaging, Inc., launched its IKONOS-2 satellite. Traveling around the north-south axis of the planet approximately fourteen times per day, at a speed of seven kilometers per second, IKONOS can be directed immediately to any particular place upon customer request. It integrates real-time cloud cover data to determine the likelihood of image acquisition success at locations across the globe, and it can deliver imagery data (utilizing the latest compression techniques) both to Space Imaging's main data collection center in Colorado and to regional centers worldwide.

IKONOS is capable of obtaining images of the Earth at resolutions down to one meter, and it has yielded a correspondingly huge amount of data-its archive is equipped to hold 100 terabytes of imagery, which is about three times as much "book data" as is housed in the entire U.S. Library of Congress.

Take into account the several other major sources of satellite data-most notably Orbimage's Orbview 1 and 2 satellites (with number three launching soon)-as well as the substantial amount of digitally orthorectified aerial imagery available from the U.S. Geological Survey (USGS), and the volume of overhead imagery available for any one point on Earth becomes truly extraordinary. With recently launched satellites achieving resolutions down to .6 meters, and with over fifteen more launches planned in the next four years (half

of them high-resolution satellites), the efficient management of geospatial data will become ever more important.

This task takes on a new relevance for the general public when considered vis-a-vis the growth of the Internet that has occurred over the past ten years. The expansion of Internet access to more and more people worldwide has allowed the possible market for land-imaging data to grow exponentially. Previously, the main impediment to connecting consumers with this data was the absence of an easy-to-use interface: bulky and expensive GIS programs have allowed well-funded enterprises (such as governments and universities) to access the data, but those with limited resources have been left with few options. With the arrival of widespread Internet access, the means have been put in place to allow for the development of a fairly priced portal aimed at both professionals and the general public.

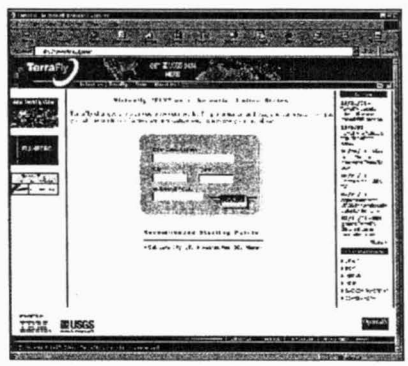
It is at the juncture of these two developments-the proliferation of high-resolution land-imaging data and the increasing availability of Internet access-that TerraFly has come about.

TerraFly: An Interface to the World

TerraFly is a Web-based interactive fly-over vehicle designed to aid in the visualization of high-resolution overhead imagery via Internet. Presently, it delivers high-resolution imagery of the entire United States and selected cities and regions elsewhere on the globe (with increased international coverage coming soon). It manages its content through database and file system technologies developed specifically for the purpose by the High-Performance Database Research Center (HPDRC) at Florida International University; this is used in combination with commercial database technologies. The end-user accesses the TerraFly databases via a friendly graphical interface, which is currently available at no cost on the Web.

The cornerstones of the TerraFly service are its portability, its unique fly-over feature, and its ability to integrate multiple sets of data into customizable, multi-layered products. These features, described below, set TerraFly apart from the other applications currently available to access similar data.

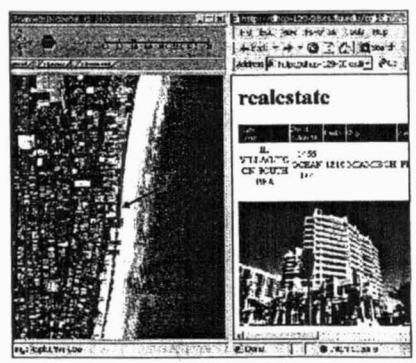
• ***Portability.*** **TerraFly is an entirely Web-based service requiring no software or image files to be loaded onto the end-user's computer. This allows those with standard-power computers and Internet connection to access the large databases of images without taxing their own system's resources.**



The TerraFly website provides a street address lookup entry point into the TerraFly application

• ***Fly-Over Feature.*** TerraFly's unique "fly-over" feature allows users who are interested in specific regions or neighborhoods to start at one particular geographic point and then navigate through adjoining land areas. This navigation is seamless, as TerraFly automatically loads and aligns adjacent imagery datasets while the user "flies" over the area (either by using a compass control or by simply navigating the image with a mouse).

• ***Data Integration.*** TerraFly's ability to merge supplemental information (such as street names, neighborhood demographics, assessed property values, nearby amenities, environmental data, etc.) with its databases of overhead images makes it a viable service for the delivery of data-rich, high-quality content. This content can be tailored to anyone whose professional interests involve land, such as realtors, travel industry professionals, environmental scientists, farmers, and insurers, to name but a few. TerraFly is currently developing integrated data products to serve each of these industries; a fully functioning prototype of the real estate product is already available for realtors working in greater Miami, Florida. Real Estate overlays on TerraFly are clickable and show the property's brochure.



In addition to providing integrated data products, TerraFly also serves as one of the only sources of purchasable small-size remote sensing images available anywhere. Previously, those interested in purchasing overhead imagery of their neighborhood, town, farm, or property had no choice but to purchase the entire dataset in which their land of interest could be only a small portion-at a rather substantial cost for the whole dataset. TerraFly allows small businesspeople and interested consumers to buy overhead images of almost any definable size, at a much more palatable price which is determined in proportion to the size of the desired view.

The Challenge of Data Integration

The schedule of upcoming land-imaging satellite launches is jam-packed: eighteen will be set into orbit over the next four years, eight of which will be capable of producing detailed images at resolutions of one meter or less. Though this will be a boon to all those interested in such data, the spatial data sets these satellites build will come in many different formats from a variety of sources: governments around the globe will be launching satellites, along with U.S. commercial endeavors and multinational partnerships.

TerraFly deftly handles this variety of image sources with a technically sophisticated data delivery program, which is transparent to the end-user. The images that together constitute the comprehensive "fly-over" experience are merged by an algorithmic calculation that determines matching coordinates for adjacent images and aligns them precisely. The result is a unique true-to-scale overhead environment in which all the discrepancies among overhead images-from the full gamut of imagery sources-are neatly ironed out into a seamless whole.

While this seamless integration is itself useful (for instance, it allows for clean overhead views of an area that is covered by several adjacent dataset), it is essential for TerraFly's trademark "fly-over" feature. TerraFly's flight function is powered by a predictive flight and direction module, which facilitates the efficient delivery of data to end-users. It does this by tracking the direction in which the user is "flying," then pre-loading the data that logically follows in this direction as well as the area immediately adjacent to it (in order to respond quickly to common minor adjustments of flight path). Simultaneously, the program keeps buffered some amount of data sufficient to respond to demands for flight in arbitrary, unpredicted directions. This novel and effective method of data delivery ensures an optimal smoothness to the TerraFly experience.

TerraFly currently has patents pending for both of the above technologies. Their research and development was supported by the National Aeronautics and Space Administration (NASA) and the National Science Foundation (NSF). IBM and the USGS supplied TerraFly with equipment, software, and data.

Conclusion

Currently, companies offering airplane-based photography dominate the market for overhead imagery. However, given the huge amount of high-resolution imagery that satellites will be acquiring over the next several years, many of the tasks previously accomplished by plane-based systems may be done just as well-and more cost effectively-by satellite. The challenge is to make all of this data available to consumers in an intuitive and useful format.

TerraFly attempts to meet this challenge in as elegant a manner as possible by utilizing the latest Web and database technologies. It has received accolades from a variety of sources-including the Yahoo! Top pick of the week, USA Today newspaper's weekly tech pick, and the journals Science and Nature. As databases of Earth information continue to grow, TerraFly will demonstrate the crucial role that research advances in database technologies can play in bringing high-quality, remotely sensed data directly to end-users around the globe.

By Douglas Muller, Gary Tie-Shue, Martha Gutierrez, Naphtali Rishe

TerraFly is a project of the High-Performance Database Research Center (HPDRC) and its constituent NASA Regional Applications Center (RAC) at Florida International University (FIU) in Miami, Florida. The HPDRC and RAC comprise 100 researchers working under the direction of Dr. Naphtali Rishe. The U.S. government (NASA, NSF, and DOI) and industry partners have funded TerraFly and the Center's related work on database technology, the Internet, and data visualization at $27 million. TerraFly is available on the Web at http://www.terrafly.com.