Project Proposal Abstract
CSc 190 - Senior Project
Department of Computer Science
School of Engineering and Computer Science
California State University, Sacramento

Project Name (short title): I-SCAN

Project Name (full title): I-SCAN: Multi-source Video-on-Demand for Bandwidth Constrained Applications

Sponsor/User of Project (full name and address, phone and Email):

Organization Name:	NASA, Dryden Flight Research Center
Contact Person's Name:	Larry Freudinger
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Description of Sponsoring Organization (product/services provided):

NASA Advanced Test Technologies is working towards the development of Over-the-Horizon airborne sensor-web communications and infrastructure for Earth Science Applications. An example of an application of this technology would be a UAV, flying anywhere in the world, on a scientific observation mission. This craft is out of range of high bandwidth communications, namely a direct link with the ground station at its base of origin. However, by developing a "global test range" capability, the aircraft is able to not only broadcast telemetry and onboard scientific sensor data over the internet in near real-time, but also those same sensors can be reconfigured from anywhere in the world via the internet.

Short Description of Project:

Problem Statement: NASA Advanced Test Technologies has a need for a network computing solution to manage multiple digital video sources over network links with low bandwidth.

Software Needs: Distributed Web Application, Distributed Caching System, Real-Time Configuration Capablities, Java VM Compliant.

Operational Environment: Portable to both Windows XP and Linux Environments.

Team Members:
Dan Marconett - - Project Manager
Skylar Bemus
Ryan Jarvinen
Samuel Johnson
Dan Potter

Project Approval:
Signature: _____
Date Approved: _____

National Aeronautics and Space Administration

Dryden Flight Research Center
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I-Scan

Multisource Video-on-Demand for Bandwidth-Constrained Applications

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I-Scan Project Description

Release: Preliminary Draft
RELEASE FOR COMMENT

Approved By:

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ESCD OTH Lead

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AERO Institute representative

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Summary

In this project we concern ourselves with the construction of a network-computing solution to manage multiple video sources over bandwidth-constrained network links.

Images from digital cameras are two-dimensional recordings of a small part of a three-dimensional world that varies in time (four dimensions). Video cameras extend the recording into the time dimension but are still constrained by camera location and orientation. Multiple imagers acquiring data synchronized in time can be combined with the time variation of location and orientation to reconstruct the time variation of three-dimensional space. Knowledge of the time variation of three-dimensional space is the essential starting point for the effective use of video observation in decision-support systems. Because all decisions are inherently time-constrained, there exists a need to incorporate this knowledge into online, near real-time environments.

Practical applications involving many image sources must deal with relatively significant bandwidth constraints. Sometimes these constraints are due to wireless communication links. An example of this type of problem is one or more high resolution imagers on an aircraft such as a NASA airborne science platform. In this case, the network link may be less than a 56 kbit/sec modem link. Moreover, links may not be continuous due to intermittent or scheduled outages.

Alternatively, bandwidth constraints result from trying to integrate many webcams together to create (if on the ground) an intelligent video security system or a futuristic three-dimensional video teleconferencing center or, alternatively, even a synthetic vision system for vehicles (aircraft, cars, robots, etc). In these examples, even gigabit/sec network links can quickly saturate. Some existing cameras provide useful tricks for bandwidth conservation, but a general solution requires greater control over bandwidth consumption.

NASA has been instrumental in developing a middleware tool called Ring Buffered Network Bus, a distributed network caching solution designed for network computing on time-varying distributed data sources. This tool is in use by NASA and others for a variety of network-centric applications, including managing distributed video sources in Grid computing applications. NASA and others have built on this core technology to establish a critical mass of experience and components to make a general solution possible. Thus, the project proposed here is for the CSUS team to interact with knowledgeable professionals to design and implement a useful video sensor web using this technology.

A rough outline of the initially conceived solution approach is as follows: one or more webcams provide data into a locally-running RBNB DataTurbine server. Time-skew and thumbnailer compression plug-ins are among local processing capabilities. More complex configurations or widely distributed configurations might involve multiple RBNB servers routed together to form a distributed database of video sources. Metadata regarding camera specifications, orientation, and position are also logged and are allowed to change over time. Provisions must be designed for interactive (command/control) communication with the camera itself although, as will often be the case, cameras will only be passive producers of data.

An online configuration tool will be used to assemble components, resulting in web-based management and monitoring applications for the distributed system. The monitoring application will include fused images that leverage knowledge of camera location and orientation.

Acceptance testing might include one or more of these scenarios (sample applications):

Scenario 1: Airborne High Resolution Nadir camera. A single high resolution camera generating multiple multi-megabyte images as the aircraft flies constructs overlapping views of the Earth. This test will simulate the ability to query and view an entire multi-gigabyte image database on the aircraft over a datalink of perhaps 28.8kbit/sec. In other words, this test allows the viewer to pan and zoom a large image database as it is being acquired.

Scenario 2: Pan/Tilt/Zoom 3-dimensional space. This test scenario involves a fairly large number of stationary webcams viewing a finite space like a lab or conference room. The capability demonstrated here is analogous to a combination of TiVo and those 360-degree virtual tour packages you see on real estate websites.

Scenario 3: Residential home security. This test would be similar to Scenario 2, but with outward-looking cameras instead of inward-looking. The goal could be to establish 360 degree binocular vision with a network of inexpensive cameras.

Successful demonstration of these three scenarios would establish the application as an extensible platform for developing or deploying super-sampled imagers, hyper-stereo imaging, and automated object recognition and target tracking in a network computing environment.

Platform requirements

This application shall be hosted on the Java virtual machine as a platform and shall be tested on both Linux and Microsoft XP Operating systems.

Sponsors

The project sponsor is NASA Dryden Flight Research Center in collaboration with the Aerospace Education, Research and Operations Institute (AERO Institute).

The Technical Monitor is Lawrence C. Freudinger l.freudinger@dfrc.nasa.gov, phone (661) 276-3542. Mr. Freudinger leads NASA Dryden's Test Systems Directorate in the development of advanced network-oriented test technologies and is the project lead for an over-the-horizon airborne systems networking project serving the Earth science communities.

Industry collaborators for this project are tentatively identified as Matt Miller of Creare, Inc (systems integrators and developers or RBNB DataTurbine software), and Dave Ward of SemQuest, Inc. (developer of integrated circuits specializing in imager applications).