32.5L: *Late-News Paper:* Video Virtual Window Camera and Display System

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Abstract
A system has been developed utilizing a directly coupled, high-resolution camera and display which provides an effective "video virtual window" which approximates the resolution of the human visual system. When viewed at a distance of approximately 0.5 meter, the system provides a full motion video experience equivalent to direct viewing of the scene by a human observer when the Fov of the camera and display are matched by selection of the appropriate lens. This paper and presentation describes the architecture and implementation of the camera system which was developed to provide the video stream, as well as the interfaces and transmission bandwidths required to achieve the objective. The implications of this concept, as well as ideas for improving its practicality are also introduced

1. Background
Imaging Solutions Group of NY (ISG) has developed the world's highest resolution video imaging system by integrating ISG's 8.3 M pixel video camera with IBM's T221 digital display. This system creates the first world-class, eye-matched, tactical imaging capability, an order of magnitude better than current camera based imaging systems and arguably equivalent to looking through a window. The IBM display provides enough pixels to meet the eye's 20/20 vision requirements at a normal viewing distance and the SVI prototype ultra high resolution video sensor provides enough full color (24 bit) pixels, at video rate (30 fps), to almost fill the IBM display. This integrated capability will itself serve as a demonstration of next-generation state-of-practice for commercial-off-the-shelf imaging technology. The ISG camera and IBM display can also serve as the "bookends" of a test bed that examines network architectures, services, and protocols for next-generation imaging systems and services.

The Camera was originally developed under contract for the US Navy Naval Undersea Warfare Center Division, Newport and the NASA Ames Research Center

2. Technical Approach
The camera was developed to provide the following capabilities and features:

- Silicon Video Inc. 8.5Mpixel CMOS 'COTS 'Image Sensor
- ISGs' real-time, Hardware-Based Color and Image Processing for true 30 fps real time video, demonstration level automatic and manual image processing and color processing control.
- Multiple image interfaces for maximum demo and research flexibility:
  a. DVI Digital Monitor Interface (4) for direct connection to the IBM T221 9.2 Mpixel LCD Monitor.
  b. SMPTE 292 Standard Recording Interface – For real time recording of video data.
  c. 1394 Interface for system control. Also allows single frame capture to the control PC.
- ISG Camera Control Software and User Interface. Allows direct control of sensor parameters and image processing features through a graphical user interface. Windows 2000 based.
- Packaging. Simple, enclosed metal enclosure with 35mm lens mount, and standard tripod external mounting fixture.
- Optical lens. ~35-135 mm zoom capability.
- Power: 115V 60 Hz

3. Demonstration Environment

Figure 1 Details the Demonstration Environment.

4. Camera Electronics Architecture
Figure 2 is a representation of the camera Electronics Architecture. The camera utilizes FPGAs (Field Programmable Gate Arrays) which implement a hardware image processing pipeline.

5. Impact
The demonstration of an Eye-Matched, Video Virtual Window is a significant new capability which can have applications in many arenas including Military and Aerospace, Surveillance and Security, as well as Entertainment Imaging. The capability to capture and display the large amount of data provided by the camera brings up many issues for transmission and storage of data streams of this nature.

Devices of this type illustrate the need for the concept of a user managed scalable video transport and presentation (SVTP) architecture that recognizes the camera and display as emerging smart digital network devices. Some of the key concepts of SVTP are :

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- Enable the user to dynamically tailor the end-to-end system performance to the task requirements,
- Rethink end-to-end the collection, distribution, presentation, and perception architecture,
- Redistribute processing across the architecture to improve performance,
- Consider the sensor and display components smart, managed, network devices, and
- Employ smart compression changing only relevant content that the user can see.

Some of the technologies and techniques which will be investigated as enablers to manage the data within an SVTP architecture include:

Sub Sampled Chroma - Sub-sampled chroma mode (SSC), takes advantage of the bandwidth savings that can be generated by conveying raw Bayer data to the reconstruction device. This mode, however, is non-standard so although it can save considerable channel bandwidth it also eliminates many COTS components that could otherwise be integrated into a full image communications system. Additionally, this mode of operation presents new challenges for color balancing, up sampling, and enhancement schemes.

Bandwidth Savings Through Spatial-Temporal Trade-Offs – The QuadHD video sensor produces 2.98 Giga bits per sec. When the camera is operated in the standard mode (STD) the camera produces 5.97 Giga bits per sec, when it is operated in the sub-sampled chroma mode (SSC) its data production rate is equivalent to the sensor data production rate. Both of these rates surpass the abilities of today's wired and RF networks. There are several methods that will be explored and evaluated to address this problem using Spatial-Temporal Trade-Offs.

Emerging Compression Technologies – JPEG2000 and its variants. New, emerging compression schemes. Combinations of existing MPEG standards.

6. References

[1] Chaum, Erik, "Emerging Tactical Imaging Challenges and Opportunities" Presentation, 2003

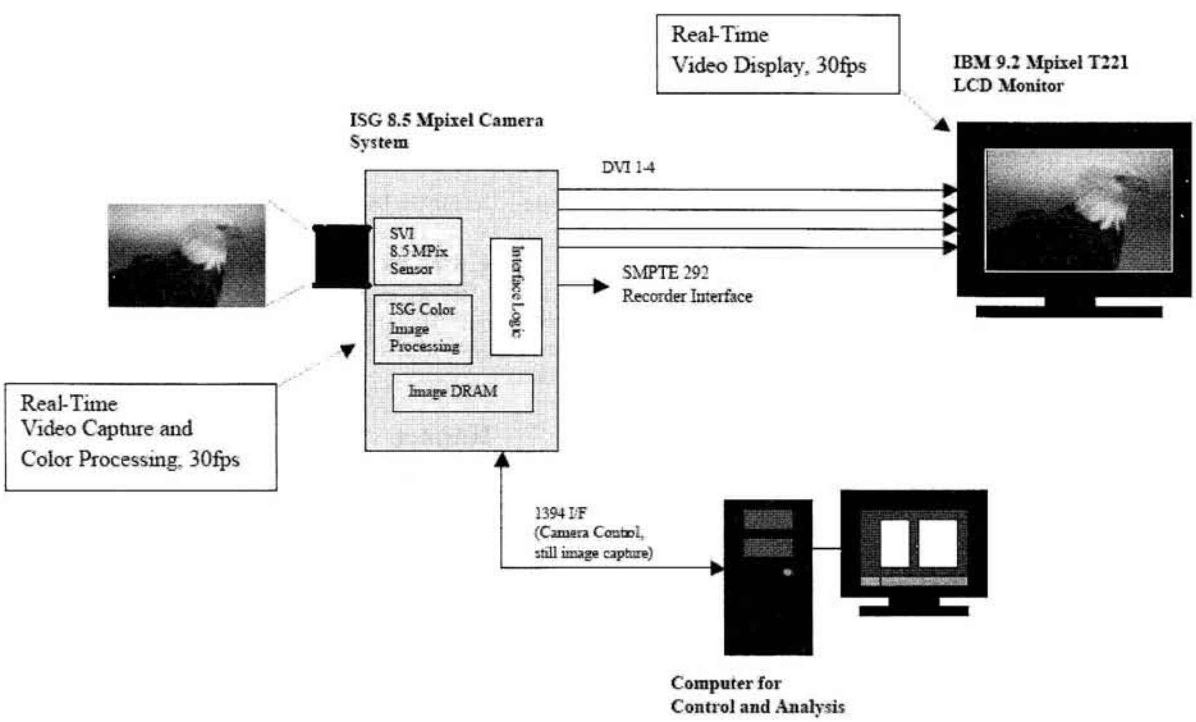

Figure 1 – Demonstration Environment

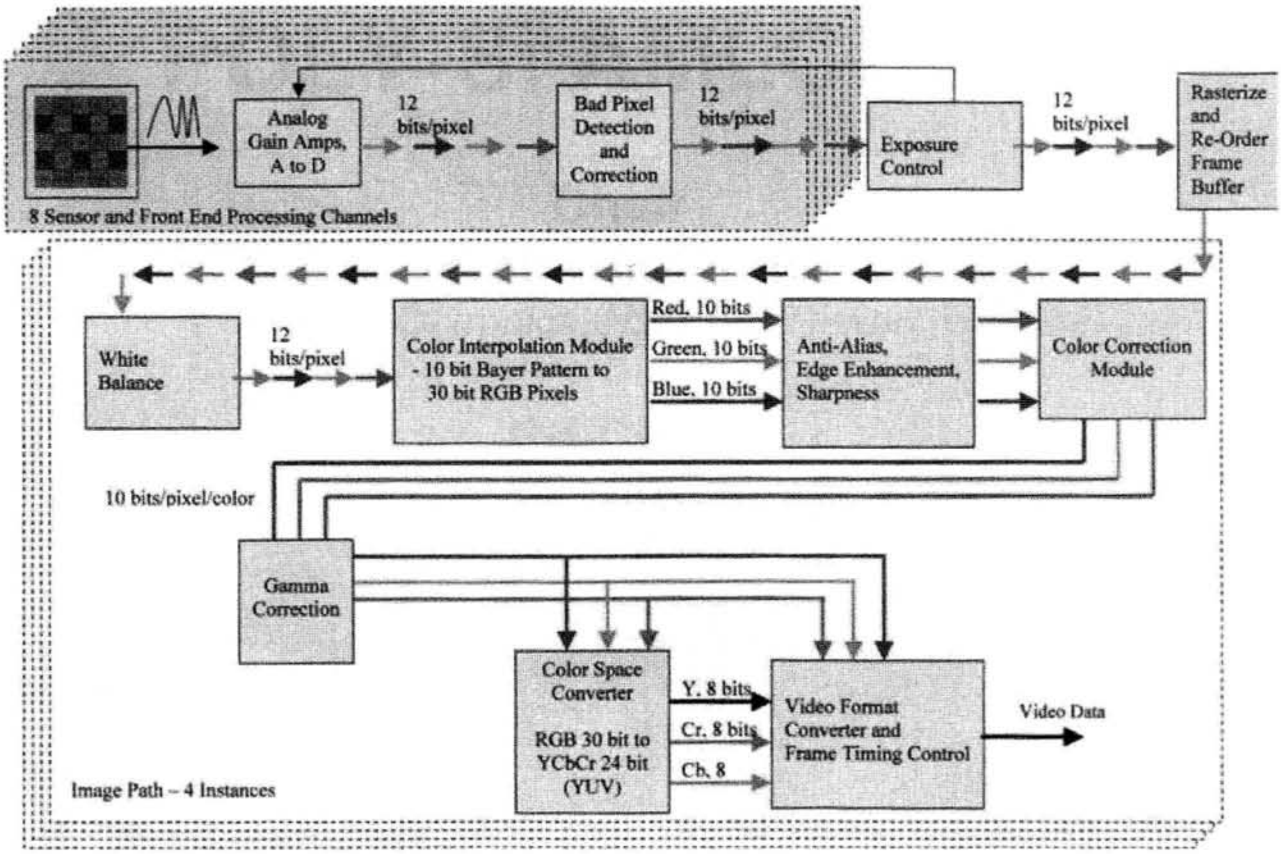

Figure 2 – Camera Electronics Architecture