Overview: Video sensing

- Feng, W., Kaiser, E., Feng, W. C., and Baillif, M. L. Panoptes: scalable low-power video sensor networking technologies
  - Built a video sensor platform
    - Experiences in encoding video, power management, programming and controlling those video cameras

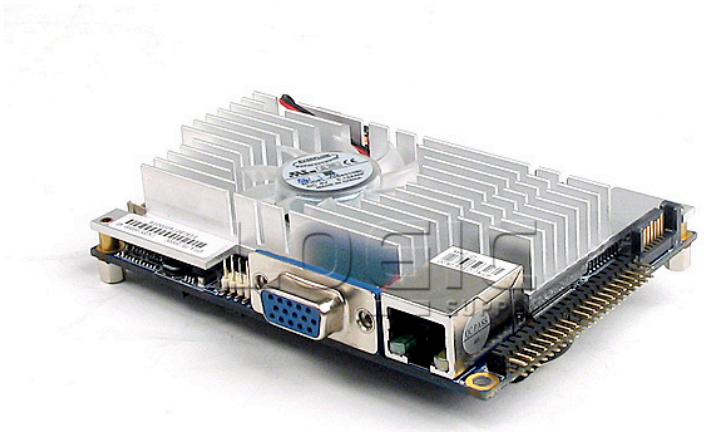
- Feng, W., Bulusu, N., and Feng, W. **Dissecting the video sensing landscape.** In Proceedings of the international Workshop on Network and Operating Systems Support For Digital Audio and Video (Stevenson, Washington, USA, June 13 - 14, 2005). NOSSDAV '05

Applications

- Environmental monitoring: 1200 sensors along Oregon coast to monitor the evolution of sandbars underneath the water's surface
  - Coordinate sensors to capture events such as rip-currents
- Advanced health care delivery: causes for onset of dementia by recording the movements of patients
- Little sister sensor networking application
- Monitor oil pipe lines in red sea

Panopte: Platform

- Used an Intel 206 MHz ARM, 5.5W
  - 802.11b wireless PCMCIA, 4”x7”
  - Logitech USB1 camera
    - Camera compresses images, use CPU to decompress
  - Work at JHU was building integrated CCD-processor chips
  - Pico-ATX from VIA - 10cmx7.2cm, 1 GHz processor, 1GB memory, USB 2.0, 13W



Deployment challenges:

- How to physically build these things and deploy them. Video sensors need to be clean. For example, Panopte monitors Oregon coast. Need to worry about misting, gunk, bird dropping etc. Not always possible to go clean them every day
  - Maintaining is a problem. Oregon coast is fairly long. If things break, then have to send a student up and down the coast. Assuming 1500 camera for the entire coast, you would probably spend all your time cleaning and fixing gear
  - Energy is a concern but not much. Wind is plentiful though wind-wanes can be a bird killer. Birds may also sit on those vanes!! Solar energy is not a viable option because of bird droppings!!

Hardware challenges

- How do we get data from the sensor to the main board
  - Perhaps integrate them directly onto the motherboard PCI or some such bus
  - Use PCMCIA or some such interface
    - Highly energy inefficient
  - Use Firewire or USB 2.0 (operates at 400 MHz and 480 MHz respectively). Requires CPU power to consume this data
  - Use USB 1.1 (12 Mbps theoretical max)
    - Cameras compress objects. Require software to decompress them and then recompress them
      - Panopte uses JPEG because MPEG was too CPU intensive
      - Hardware MPEG encoder will be nice. The VIA board only has a decoder to play DVD/HDTV etc

Buffer management

- Once captured:
  - we could stream all objects in real time. Makes sensors simple but requires good and continous network availability
    - Requires massive infrastructure. Imaging streaming video from 1300 camera to a central site for processing
  - Preprocess, buffer and only transmit some information
    - Preprocessing should be flexible. We may require good quality when we are interested in some event
    - Buffer management is important because buffer space is finite, have to decide reclamation policy
      - Could transcode some objects to save space

Adaptive functionality

- One can build sensors that are static and keep performing the same task
  - Interesting applications require flexibility. For example, the events of interest might change. Require a flexible programming, debugging interface that can manage lots of embedded platforms
    - Panopte uses a Python based platform that allows for reconfiguring the sensors on the fly

User interface

- How would you show the video to the users?
  - How do you filter to show the objects of interest?
    - Panopte lets users specify regions of interest

Cascade

- Programming component of the Panopte system
  - High level composable filtering and adaptation infrastructure
  - Efilters - error filters
  - Dfilters - scalar data filters
  - Vfilter - video data filters
  - Ufilter - integration filter
- Filters can be written in optimized language
  - Cascade is written in Python
- How do they compare with Active Sensor networks