Sensor Networks in Border Security Applications

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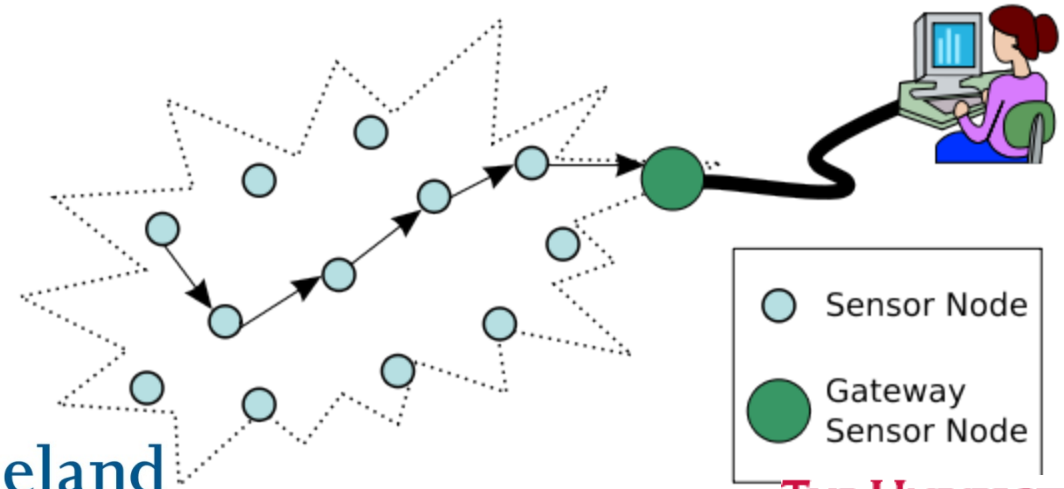
Border Control Challenges

- Very large areas require some level of surveillance.
  - Automation is crucial.
- Sensor networks emerge as a natural solution technology.



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Sensor Networks

- Specially distributed autonomous devices.
  - Sensing + CPU + radio.
- Cooperatively monitor physical or environmental conditions.
  - Temperature, sound, vibrations, video capture, surveillance, etc.
- From 100's to 100,000s nodes.
- Challenges:
  - Communication protocols, collaborative problem solving power, reliability, survivability, interoperability, security…
  - "Situational awareness" through fusion.
  - Network/sensor heterogeneity, generational legacies.

Acoustic Surveillance

- Acoustic networks acquire and classify speech, footsteps, vehicle sounds…
- Develop acoustic characterization and tracking for border surveillance.

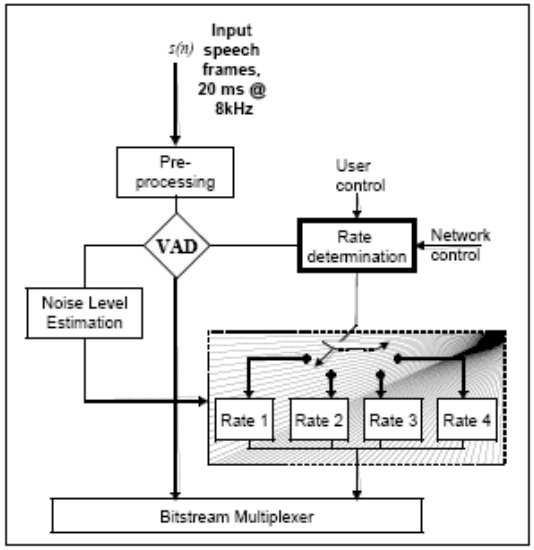

Fig. 2. Multirate sensor, voice activity detector (VAD), and transmission system for the audio monitoring system.

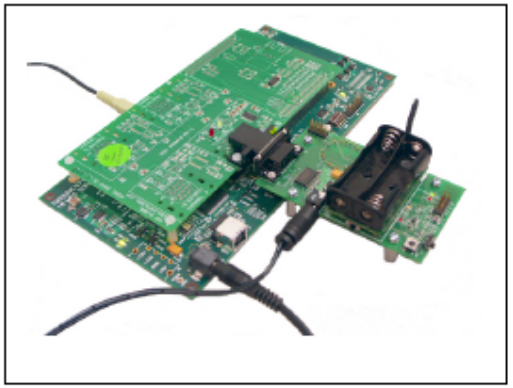

Fig. 3. Prototype interface of sensor mote with a DSP DSK board used for sound activity experiments.

Low Frequency Sensing (through foliage, walls, etc.)

- Walls, vegetation and terrain limit the effectiveness traditional surveillance.
- Low frequency sensing (Hz – kHz – MHz) “sees through” the barriers.
- Need to overcome limited resolution & sensitivity.

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LWIR Polarimetry

- Day and night time surveillance.
- Decreasing cost (LWIR 8-12 μm) may make future deployment feasible.
- Creating adequate SW support is a challenge.

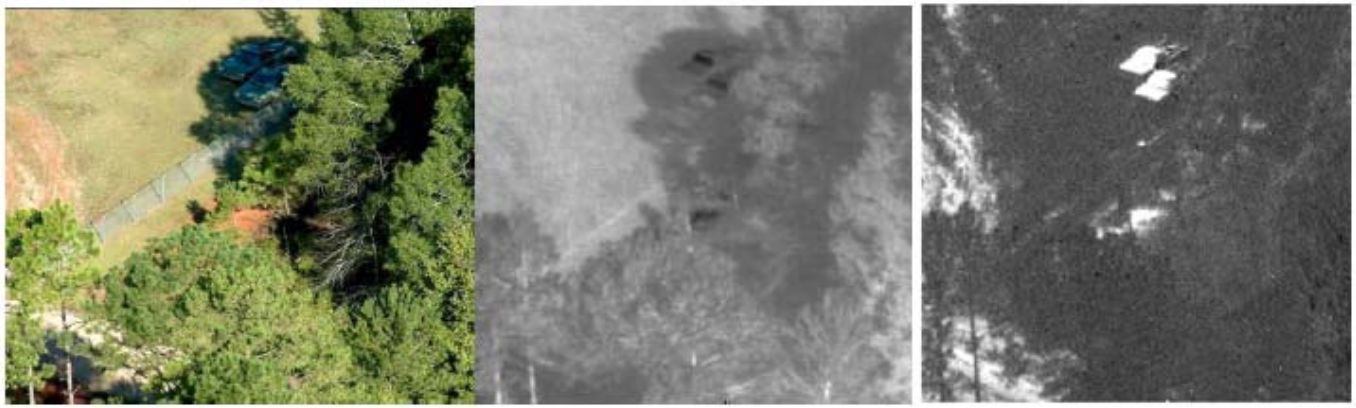


Figure 1: Visible picture of two pickup trucks in shade (top), long-wave IR intensity image om left), and long-wave IR polarization image (bottom right). Strong contrast in the rization image shows advantages for enhanced target detection.

Fusion and Intelligent Monitoring

- Sensor network deployments may suffer from unacceptable false positive rates.
- Developing robust anomaly detection algorithms for heterogeneous networks.
- Bayesian reasoning over uncertain data.

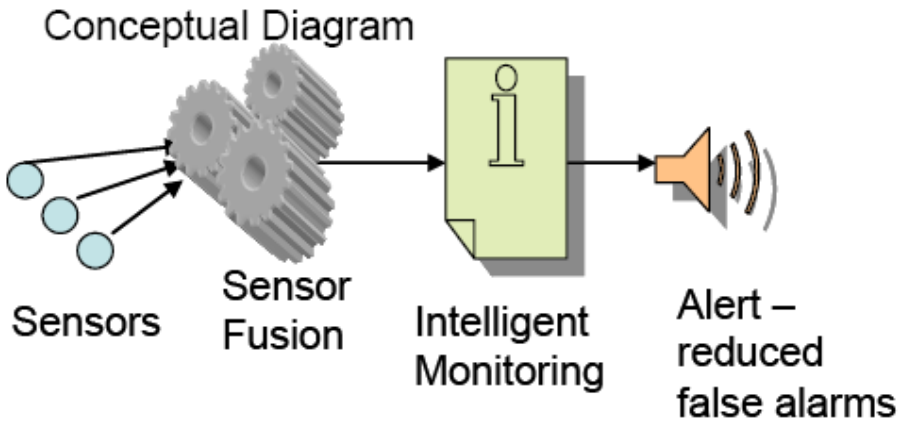
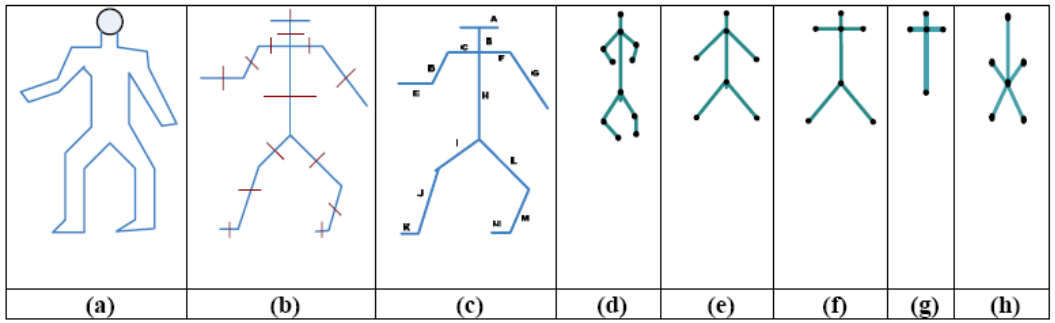


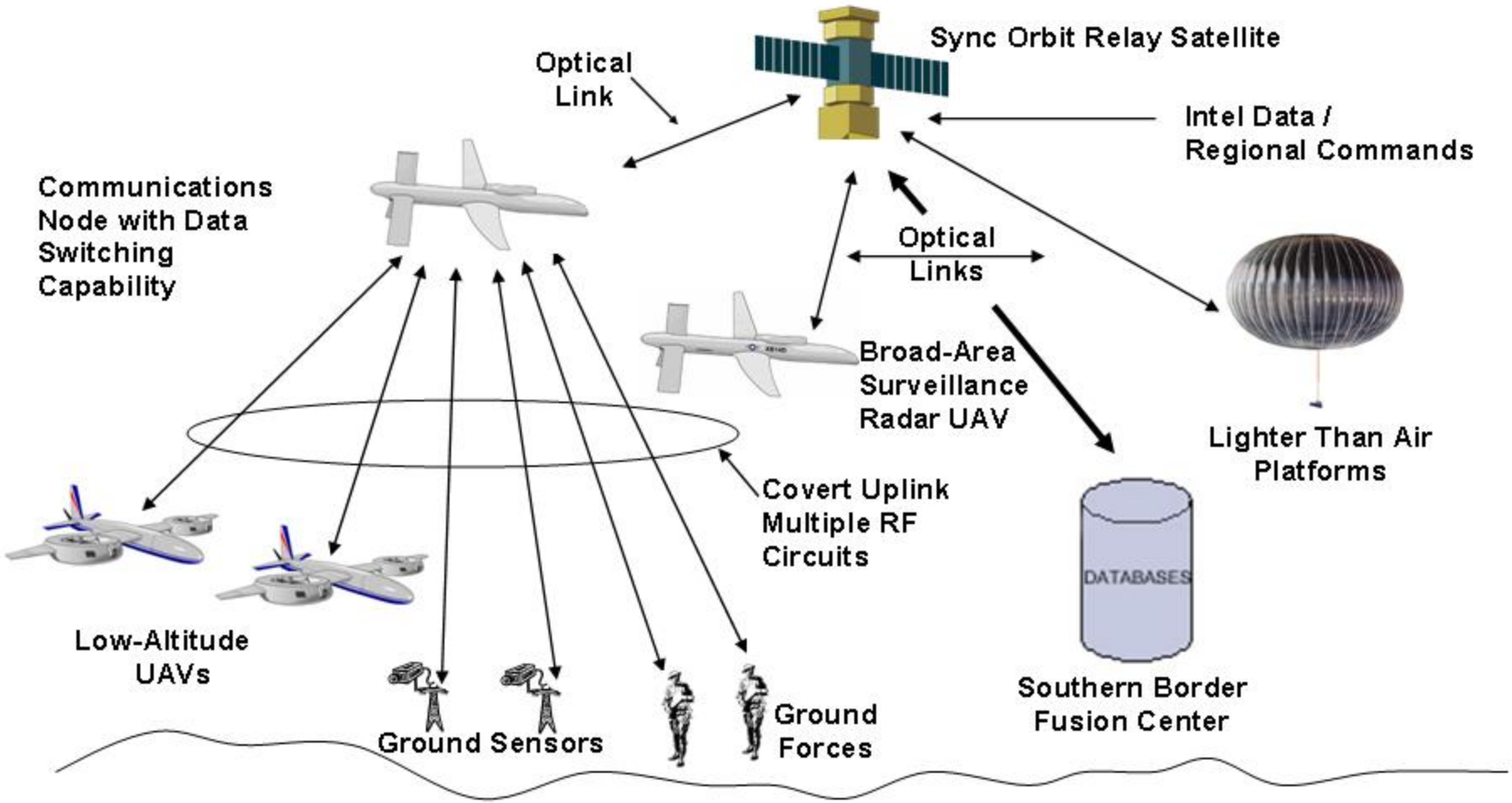
Figure 3. A conceptual diagram of sensor fusion and intelligent monitoring to achieve significantly reduced false alarm rate.

Pervasive biometrics

- Border surveillance grids enable the development of virtual biometric profiles.
- Opportunistic capture, soft/strong biometrics.
- Fusion, recognition, event correlation.



Regional Homeland Security: UAV Node Concept



Attributes:

- All entities: people, platforms, sensors are interconnected
- All entities can pull data in real time
- All entities have access (as appropriate) to relevant data at all times
- All entities are part of the Distributed Situation Awareness Network

Project 4 – Sensor Networks and C^3

- Extensive leveraging with ongoing sponsored projects at partner institutions.
- Conduct simulations, lab experiments and field tests for sensing and communication
- Deploy sensor networks along the southern and northern borders to test the feasibility of bi-national sensing of threats to mutual interests
- Conduct lab/field tests with diverse wireless systems