Solar Energy Collection and Management for Networked Infomechanical Systems

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NIMS

Introduction: Networked Infomechanical Systems (NIMS)

What is NIMS?

- NIMS is a sensor node which explores and monitors the surrounding environment
- The NIMS architecture consists of static sensors, mobile nodes, and smart infrastructure which is completely integrated into one cooperative system
- The NIMS node will sense, sample and be adaptive

  Sensing:
  1. Light
  2. Humidity
  3. Temperature
  4. Pictures

Sampling:
1. Water
2. Eddie Flux (CO_2)
3. Soil

Adaptive:
- Nodes that adjust operations to respond to events
- Horizontal and Vertical Movement
- Some Applications are natural environment, remote locations, public health, biomedical, homeland security

The NIMS Node

Problem Description: Remote Energy Aware Articulated Sensor Networks

System Requirements

- NIMS nodes must be autonomous sensing systems that can be placed in remote locations
- The remote location of the node requires the system to be independent of an utility grid and therefore, an alternative energy source must be considered
- The Node consumes 30W of Power

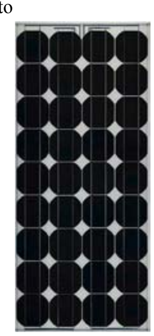
Design Challenges

- Limited Energy
- Ability to run the node and store excess energy for 24-hour periods
- Remote location
- Environmental factors
- Mounting issues

Proposed Solution: Solar Energy Harvesting

Why is Solar Harvesting is Necessary?

- The remote location does not allow a utility grid to power the node
- Batteries only have a finite lifetime without being recharged
- Solar energy harvesting and storage allow the node to be run on a 24 hour basis



Stand-Alone Photovoltaic System

- A stand-alone photovoltaic system allows the node to be powered in a remote location for extended periods of time.
- The system does not have to be connected to a utility grid. Using solar cells as an alternative energy also helps the sensing nodes to remain autonomous.
- Excess energy from the system can be stored in a battery bank, which can be sized to meet the nodes requirements

$$\text{Battery Bank Capacity} = \left[\left(\frac{\text{Load Power}}{\text{Battery Voltage}}\right) \times systemlossfactor \times UsageHours\right] \times StorageDays$$

- The panels can be fixed at an angle to maximize the day light resources

  •Angle of inclination = latitude – 15 degrees (Summer)

  • Angle of inclination = latitude + 15 degrees (Winter)

Mounting of Solar Panels

- The Solar Array is placed above the tree canopy so it can receive the most sunlight
- The solar panels are hung below the NIMS node main support cable
- The solar panels then can be fixed at any angle by adjusting the length of the support wires
- The power cabling then can be lowered to the forest floor where the battery bank is located

Energy Harvested

- Measured energy harvested in a day was found to be 509 Watt-hrs (1,832,400J)
- Assuming there are 5 peak hours of sunlight in day, the maximum theoretical amount of energy collected would be 750 Watt-hours (2,700,000J) using the Siemens SP75 solar panels
- Summer peak hours range from 5 – 7 hours in day [at Wind River]
- Winter peak hours range from 3 -4 hours in a day [at Wind River].

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