Reward Function

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Reward Function - Part 1

The reward function is defined as:

$$\xi_j = S_j P_j e^{\left(\frac{(t_j^E) - t_j^R}{\sigma}\right)^2} + (P_j^D)(d_j)(g(k))$$

Where:

- S_j indicates if task j is performed (1) or not (0).
- P_j indicates if task j is downloaded (1) or not (0).
- t_j^E is the task j actual execution time.
- t_j^R is the task j requested time.

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Reward Function - Part 2

Continuing with the reward function parameters:

- α is the weight factor for SoC (State of Charge) goodness w.r.t task execution, where:

  $\alpha < 1 \Rightarrow$ more weight to performance and battery health

  $\alpha = 1 \Rightarrow$ same weight to P_j and R

  $\alpha > 1 \Rightarrow$ more weight to R

- E_{max} is the maximum charge (safety limit).

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Reward Function - Part 3

E_L is the minimum charge (safety limit).

N is the number of sampling points between ground station power.

δ is the dispersion in time from requested of execution (gaussian weight).

The modification for the function $g(k)$ is as follows:

$$g(k) = \begin{cases} 1 & \text{if } k = 1 \\ 0.5 & \text{if } k = 2 \\ 0.25 & \text{if } k = 3 \\ 0 & \text{if } k \geq 4 \end{cases}$$

Overall Performance Metric

$$\xi = \sum_{j=1}^{J} \xi_j + \frac{\alpha}{N} \sum_{i=1}^{N} \left(\frac{E_i - E_L}{E_{max} - E_L} \right)$$

This equation defines the overall performance metric (ξ) for a nanosatellite, which may include considerations of energy efficiency, task management, and operational longevity.

Task Efficiency

$$\sum_{j=1}^{J} \xi_j$$

The first term sums the efficiencies (ξ_j) of individual tasks or subsystems (j) within the nanosatellite, reflecting how well each task performs relative to its energy consumption and operational objectives.

Energy Efficiency

$$\frac{\alpha}{N}\sum_{i=1}^{N}\left(\frac{E_i - E_L}{E_{max} - E_L}\right)$$

The second term represents the average, normalized measure of the battery's state of charge, weighted by α. It assesses the energy efficiency by considering the battery charge levels (E_i) at N different sampling points, bounded by the safety limits (E_{max} and E_L).

Notebook