SCALING ISSUES IN LARGE NETWORKS OF SMALL SENSORS: ENERGY AND COMMUNICATION MANAGEMENT

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Abstract- We discuss five scaling-related issues in robotics and robotic systems. They are unified by an understanding of the fundamental engineering constraints imposed by the essentially fixed fundamental strength of materials and the essentially fixed practical density at which energy can be stored. These constraints have profound effects on when big bodies are in danger of collapsing under their own weight and when small bodies are in danger of running out of fuel. The section on strength provides a review of the lesson that small is strong, big is weak. The section on speed relates design and scale to inherent speed capability, including a discussion of why humanoid robots walk in unnatural-looking ways. The section on energy reinforces the realization that stored energy scales as the cube of a body's characteristic linear dimension, whereas its baseline power requirement usually scales as a lower power, e.g., the square of that dimension, so running time and range usually decrease cripplingly rapidly with size. The section on power shows how baseline power – and its dependence on speed – in combination with stored energy determines a body's running time and range. The section on communication discusses scale-related communication quality and duration, especially in systems that are simultaneously large and small, e.g., in networks composed of a very large number of very small robot-like nodes.