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Semantic Communication for Edge Intelligence: Theoretical Foundations and Implications on Protocols

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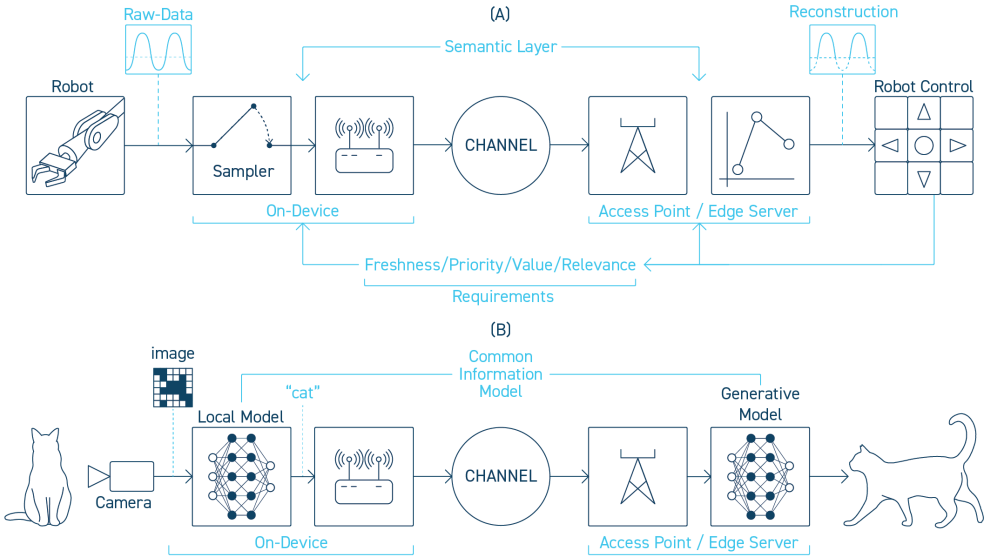
What flavor of semantic-based communications should be considered? How could the semantic-based techniques be integrated in communication protocols?



Two perspectives on semantic communication: a) goal-oriented communication: a semantic-aware architecture for robotic control that considers a unifi cation of the processes of information generation, communication, andusage; b) semantic operability: communicating a semantic concept corresponds to communicating the corresponding generative model. Once a concept is communicated, the destination has the ability to generate instances of that concept.

KEY FINDINGS

Despite the general intuition that semantic communication may contribute to more efficient system design, there have been only a few concrete attempts to implement aspects of it in practice. To help bridge this gap, in this work, we revisit the theoretical foundations of semantic communication and address the possible implications on the protocol and system design. The focus is on two perspectives of semantic communication: (i) a goal-oriented perspective, which unifies aspects of traffic generation, communication, andcontrol, and (ii) a semantic operability perspective, which extends the notion of data exchange through standardized interfaces (interoperability), to include the meaning or, more generally, the significance of data. In the context of (ii), we propose a system solution which adopts the information bottleneck as a design criterion that targets a reduction of the energy consumption and communication overhead while retaining the most relevant information for the end-to-end semantic task of interest. In a novel contribution, we sketch how aspects of privacy and physical layer security can be natively integrated in the learning framework. We discuss applications of the concepts in scenarios such as robotic control and health monitoring. We also investigate the relevance of neuromorphic computing, where processing is performed by spiking neural networks (SNNs), to provide support for energy-efficient, event-driven processing in the scenarios of interest.

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