

DO ROBOTS FEEL? A ROBOTICS-ORIENTED ENGINEERING ANALYSIS OF THE BOUNDARY BETWEEN COMPUTATION AND EMOTION

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Abstract: *Modern robotic systems increasingly simulate emotional behavior using sensor fusion, control algorithms, and adaptive policies. This paper investigates these systems from a robotics engineering perspective, focusing on architecture, embodiment, and control loops. It argues that robotic “emotion” is a behavioral simulation resulting from data-driven computation and control, rather than an intrinsic affective state. The engineering boundary between computation and emotion is defined by the absence of biological homeostasis and intrinsic vulnerability.*

Keywords: *Robotics; Cyber-Physical Systems; Affective Computing; Embodied AI; Autonomous Systems; Human-Robot Interaction; Control Systems*

1. Introduction

Emotion-aware robotics are increasingly deployed in:

- social robots (e.g., Pepper, Softbank Humanoid Robot),
- assistive healthcare platforms,
- human-robot interaction interfaces.

Robots can detect speech sentiment, facial expressions, and physiological signals, then adapt motor or verbal outputs. From an engineering perspective, the question is **not whether robots appear emotional**, but whether emotions exist as intrinsic states within the robot.

2. Robotic Architecture

A robotics-oriented affective system typically includes:

2.1 Sensor Subsystem

- RGB-D cameras
- Microphones
- Tactile arrays
- IMUs
- Force-torque sensors

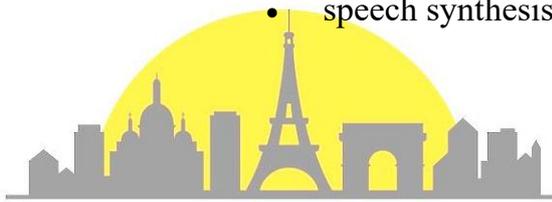
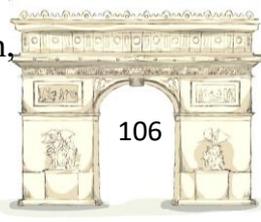
2.2 Perception Layer

Signal processing and neural inference models convert raw sensor data into structured representations (e.g., emotion classification probabilities).

2.3 Control Layer

Emotion-linked responses are mapped to:

- trajectory planning modules,
- motor torque control,
- speech synthesis modulation,



- gesture generation.

Behavior arises from a closed-loop control function:

$$u(t) = f(x(t), r(t), \theta)$$

Where:

- $x(t)$ = robot state
- $r(t)$ = input/reference
- θ = learned parameters

No component corresponds to a subjective emotional state.

3. Embodiment vs Biological Systems

Humans experience emotion through:

- autonomic nervous system activation
- endocrine and metabolic feedback
- survival-driven learning

Robots have embodiment constraints:

- battery charge, actuator limits, structural stress
- managed through protective protocols and supervisory control
- absence of subjective experience or existential risk

Even advanced humanoid like Atlas (Boston Dynamics) achieve dynamic adaptation via real-time control and optimization—not emotion.

4. Simulation of Emotion

Robotic “emotion” can be modeled as:

$$E_{sim} = g(S, C, P)$$

Where:

- S = sensor input
- C = context/model
- P = policy/action mapping

The output simulates affective behavior but does not generate intrinsic regulation.

Robotic emotion is:

- A representational abstraction
- A behavioral interface mechanism
- A social interaction tool

But not a self-generated regulatory phenomenon.

5. Engineering Boundary

The distinction between computation and emotion in robotics:

Feature	Human	Robot
Regulation	Biochemical, survival-driven	Algorithmic, control-driven
Experience	Phenomenological	Absent
Adaptation	Ecological, homeostatic	Computational, task-oriented
Vulnerability	Existential	Operational (system constraints)



6. Conclusion

Robots do not feel; they simulate adaptive emotional behavior through control and computation. The engineering boundary is determined by the lack of intrinsic regulation, homeostatic feedback, and embodied vulnerability. Future research may explore intrinsic motivation systems, homeostatic robotics, and adaptive cyber-physical architectures, but affective experience remains uniquely biological.

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