

Physical AI and the Humanoid Race

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Physical AI refers to intelligent systems that extend beyond the digital world to perceive, reason, and act in the physical environment through embodied machines. Recent advances in large language models, vision-language-action models, multimodal sensing, high-performance actuators, edge computing, digital twins, and large-scale robot learning are rapidly accelerating its development. These technologies are expected to transform manufacturing, logistics, construction, healthcare, caregiving, and domestic services while reshaping labor, industrial structures, and human–robot collaboration. Humanoid robots, in particular, are evolving beyond preprogrammed motions and demonstrations of locomotion toward general-purpose machines capable of understanding natural-language instructions, adapting to unfamiliar environments, and performing diverse tasks. The emerging “humanoid race” includes Tesla’s Optimus, which combines AI, manufacturing expertise, and mass-production ambitions; Figure AI’s humanoids based on vision-language-action models; Boston Dynamics’ Atlas, which extends advanced dynamic robotics into industrial applications; and Unitree’s rapidly commercialized, cost-competitive platforms. This talk examines the technological foundations and development strategies of these leading humanoid robots. It highlights how competition is shifting from hardware performance alone toward learning data, foundation models, manufacturability, and real-world reliability. Finally, it considers the opportunities, limitations, and societal changes that Physical AI and humanoid robots will bring to future industries and everyday life.

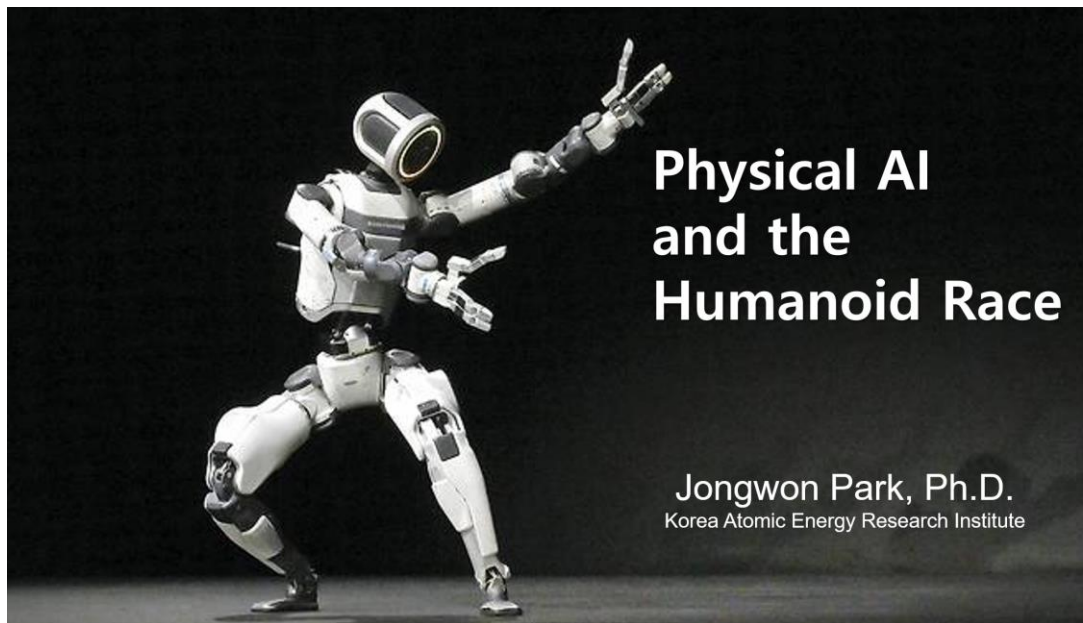


Fig. 1. Physical AI and the Humanoid Race