Architectural Robotics: Unpacking the Humanoid

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Abstract
In most projections of intelligent environments, the design of the physical is neglected - a bystander to progress. Researchers routinely explore, *a posteriori,* augmenting the underlying architectural morphology with suites of sensors, processors, and associated intelligence. Additionally, numerous researchers introduce intelligence into the environment via self-contained mobile robots - mostly humanoids. In this extended abstract we offer an alternative vision in which the environmental design itself plays a more active role, assuming many of the tasks traditionally envisioned for robots ("unpacking the humanoid").

Keywords
Intelligent environments, architecture, robotics

ACM Classification Keywords
I.2.9 Robotics, H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. H.1.2 User/Machine Systems

Introduction
Two general approaches to endowing (built) environments with intelligence have emerged. In the

first (and most predominant) of these, a combination of sensors are attached to, or embedded within, the built environment. The sensor readings are combined with computational elements (often also embedded in the environment) to infer characteristics of, and events within, the environment, and respond to them in an "intelligent" manner beneficial to the occupants. The second general approach comes from robotics. In this vision, the intelligence lies within self-contained robots, brought into the environment and which may be modified with markers or sensors to assist the robot. The robots capabilities for mobility and manipulation (i.e. move mass) are used to supplement the equivalent skills of humans occupying the same environment. In either of the above two approaches to intelligent environments, the environment itself is, literally, a background element. The goal is to introduce intelligence into a physical (built) environment, neglecting the possibility of the architectural morphology playing a key role. Additionally, the intelligence introduced is largely an "add-on" to that of the humans in the environment, rather than being integrally connected with it.

An Alternative Vision

We envision a new class of robotic environments wherein (carefully selected parts of) the environment are designed with programmable movement capability. The collective intelligence of the environment would be correspondingly distributed. The idea is to capture the strengths of the static sensor-based environments ("watch, perceive, and advise") and the "robot-into-environment" strategy ("investigate, fetch and carry"), while mitigating the inherent weaknesses of each.

The core vision outlined here is not unique to the authors. For example the notion of distributed smart elements is well-espoused by Weiser in [3]. There have been numerous efforts promoting "adaptive Architecture", for example [2], [3]. The vision outlined in this paper, expanding the recent work of the authors [1], represents a natural extension. The innovation suggested here is the concept of "unpacking the robot" and distributing its functionality within the architectural framework. Which mass-moving capabilities should be "unpacked"? Humans tend to bring both intelligence and mobility into an environment. Humanoids are intended to replicate both capabilities. We argue that by considering the human faculty, and exploiting some of its core sensing, manipulation, and intelligence capabilities, many problems which currently appear daunting can be greatly simplified. Fpr more details, see www.cT-project.org.

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