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NOVEL APPROACHES TO ROBOTICS EDUCATION

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Welcome to this special issue of *Computers in Education*, titled *Novel Approaches to Robotics Education*. The ability of robotics to captivate students is apparent – so much so that nearly every university offers at least one such course. However, I conjecture that 75% of the courses offered world-wide fit into one of two aging molds which I refer to as "Mindstorms-Mobile" and "Kinematic–Articulated". Over the last decade, robotics research has become incredibly diverse and instructional technology has evolved considerably begging the question: How should our educational approaches evolve accordingly?

The (Lego) "Mindstorms-Mobile" mold originated in the late 1990's. At the risk of over generalizing, these courses tend to focus on designing and programming mobile robots and rely less on advanced mathematics (i.e. no matrix algebra) – making them suited for Sophomores, Freshman, and even pre-college students. They are frequently used to generate interest in engineering careers and develop teamwork and communication skills. However, frequently they teach very little in the way of robotics-specific pedagogy.

Several papers in the issue focus on early curriculum robotics as a subject in its own right. *Ayanian, Keller, Cappelleri, and Kumar* present an impressive robotics summer school program for high school students which goes well beyond Mindstorms. *Jaksic and Spenser* breathe new life into the Mindstorm-mold and present a novel classroom project inspired by a contemporary challenge problem – the DARPA Urban Challenge.

The "Kinematic–Articulated" style course is a kinematics-driven treatment of serial-chain articulated robots targeted at senior-level undergraduates or first year master's students. The outline typically follows J. J. Craig's or R. P. Paul's classic texts from the early 1980's: coordinate transformations, forward and inverse kinematics, and Jacobians with a sprinkling of joint control, trajectory planning, or computer vision, depending on the instructor.

Other papers in the issue show how newly available hardware or software can facilitate the inclusion of topics traditionally assumed to be too difficult for such a course. *Bishop, Esposito* and *Piepmeier* explore how the availability of a new kit can facilitate the hands-on exploration of legged locomotion at the undergraduate level. *Shah, Tripathi, Lee and Krovi* explore a computer aided mathematics and visualization tool for teaching advanced kinematics of parallel and serial mechanisms. *Moll, Bordeaux* and *Kavraki* showcase an innovative open-source visualization and development suite used to teach state-of-the-art topics in robot motion planning.

At the meta-level, perhaps it is time to rethink not just *what* we teach but *how* we teach it. *Correll* and *Rus*, report on an interesting experiment in peer-to-peer learning. Members of their class collectively developed a complex robotic system, maintained a community wiki and source code repository. and co-authored a paper on their findings. From a curricular perspective, at most universities, the first course is typically an elective housed in the Mechanical or Electrical Engineering or Computer Science department. *Berry* considers the challenge of teaching a course, cross listed in all three departments, with no prerequisites; and *Cappelleri* wrestles with the challenge of creating an introductory course which balances the mobile and articulated approaches. An interesting new trend is the creation of Robotics degree programs. *Padir, Gennert, Fischer, Michalson, and Cobb* showcase the United State's first BS in Robotics program at Worcester Polytechnic Institute. Likewise, *Boutell, Berry, Fisher,* and *Chenoweth* report on their experiences with Rose-Hulman Institute of Technology's Robotics Minor program.

While I'd love to discuss these trends more, you will have to excuse me. I have to get started implementing some of these ideas in my own Fall course!

Joel M Esposito
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