Experimental Bipedal Walking Robots

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Research Experiences for Teachers Program (Summer 2014)
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Abstract
The number of research and development projects aimed at building and programming bipedal and humanoid robots has been increasing at a rapid rate during the last few years. In this project, we incorporated bipedal robotics research being done in the AMBER Lab at Texas A&M into the Robotics and Automation syllabus taught at the high school level.

Background
Over the past few years, science and engineering have greatly advanced the field of robotics. The continued growth in computing power and the continuing miniaturization of computer components has pushed previous limits to new levels. There is a growing interest in developing robots able to move more fully with humans and the environment. Wheeled and tracked robots are limited by the way we have engineered our cities and buildings and also when traveling on undevolved terrain. Although there is going research in other means of locomotion, the bipedal design has numerous advantages for a robot designed to interact with humans. [1]

Motivations
Practical Side: In some cases bipedal robots are the most sensible choice.

Adaptability: bipedal robots can work in environment designed for humans (safety tasks) and expand their capabilities by using machines that humans use. Collaboration: bipedal robot motion is easy for human to understand and predict. [2]

Research Objective
To gain knowledge about how the AMBER lab at Texas A&M is designing and building bipedal robots to walk continuously and robustly in 2D and to translate this information into a lesson and an activity. The lesson and activity will align with the Texas Essential Knowledge and Skills for High School level Robotics and Automation; Technology of Robotics Design.

Applications
Bipedal robots may be used in the inspection of dangerous environments with unpredictable ground debris.

Research from the study of bipedal robots is being applied to prosthetics research.

Methodology
Knowledge and concepts acquired in the A&M AMBER LAB were used to design and create R.E.T.R.O. for bipedal robot demonstration at high school level robotics and automation course using arduino kits. The prototype of R.E.T.R.O was first attempted using a wooden manikin and when that proved not to work, a second prototype was built using cardboard as the thigh, leg, foot and the ankle; Arduino kit components and Arduino programming were used to add movement to this model. After testing the concept, R.E.T.R.O. was then designed using Solidworks software based on the dimensions from the prototype. The designed R.E.T.R.O. was printed using a 3D printer. The servos and parts were connected and mounted to a sheet of Polyplyrene. The mounted leg was then programmed using Arduino. The lesson was written to work with R.E.T.R.O. and to give students an introduction to robotics. The activity was written to give students designing and programming experience with bipedal robots.

Correlations
This research correlates to the following Texas Essential Knowledge and Skills (TEKS) and Virginia tasks/Competencies for High School level Robotics and Automation:
Technology of Robotics Design

<table>
<thead>
<tr>
<th>Task</th>
<th>Virginia Competency</th>
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<tbody>
<tr>
<td>The student demonstrates the skills necessary for success in the workplace.</td>
<td>Students will be able to:</td>
</tr>
<tr>
<td>The student participates in team projects in a variety of roles.</td>
<td>Demonstrate Workplace Readiness Skills:</td>
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<tr>
<td>The student develops skills for managing a project.</td>
<td>Professional Knowledge and Skills:</td>
</tr>
<tr>
<td>The student develops the ability to use and maintain technological products, processes, and systems.</td>
<td>Explore Robotics and Automation Systems</td>
</tr>
<tr>
<td>The student develops the ability to understand the following advanced concepts of physics, robotics, and automation.</td>
<td>Explore the Components of Robotics and Automation Systems:</td>
</tr>
<tr>
<td>The student builds a prototype using the appropriate tools, materials, and techniques.</td>
<td>Program an Automated System</td>
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Lesson and Activities
These are lessons and activities in relation to the research topic: Walking with bipedal experimental robot with timelines that will be used at the high school level.

| R.E.T.R.O. Model | Bipedal EV3 |

Reference and Acknowledgement
2. Oriolo: Autonomous and Mobile Robotics- Biped Robots (by A. Paolillo and M. Vendettelli).

This material is based upon work supported by the Research Experiences for Teachers Program under National Science Foundation under Grant No. 1300779. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

http://eltdweb.tamu.edu/hsieh/ResExp-Teachers/Index.html