Experimental Bipedal Walking Robots

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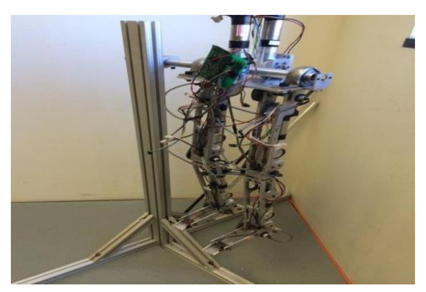
Abstract

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

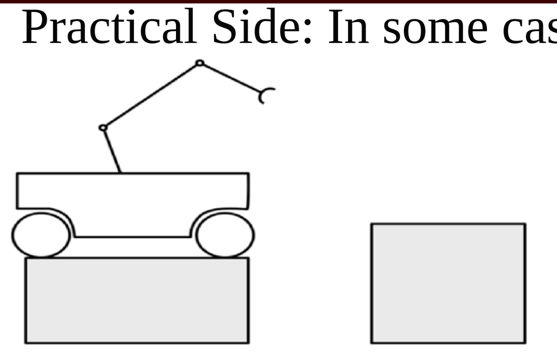
Over the past few years, science and engineering have greatly advanced the field of robotics. The continued growth in computing power and the continuing miniaturization of computer components has pushed previous limits to new levels. There is a growing interest in developing robots able to more fully interact 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 undeveloped terrain. Although there is on going research in other means of locomotion, the bipedal design has numerous advantages for a robot designed to interact with humans. [1]

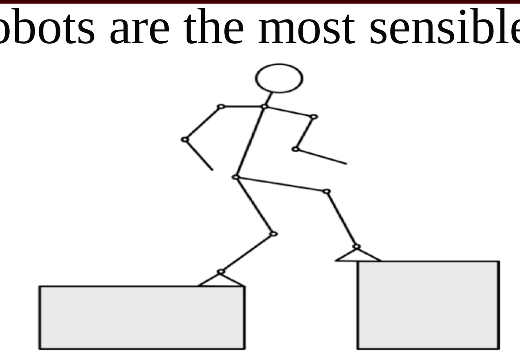

AMBER 1


AMBER 2

Motivations

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



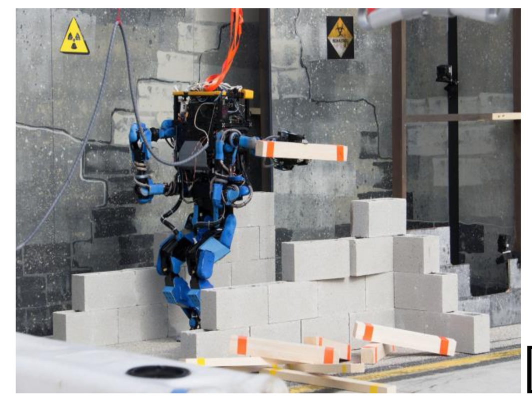


Adaptability: bipedal robots can work in environment designed for humans (safety tasks) and expand their capabilities by using machines that humans use.
Collaboration: bipedal robot motion is easy for human to understand and predict. [2]

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 the Robotics and Automation course for grades 11- 12 and with Virginia's Computer and Technology Education Tasks and Competencies for the Technology of Robotics Design Course for grades 9-11.

Applications


[5]

Bipedal robots may be used in the inspection of dangerous environments with unpredictable ground debri

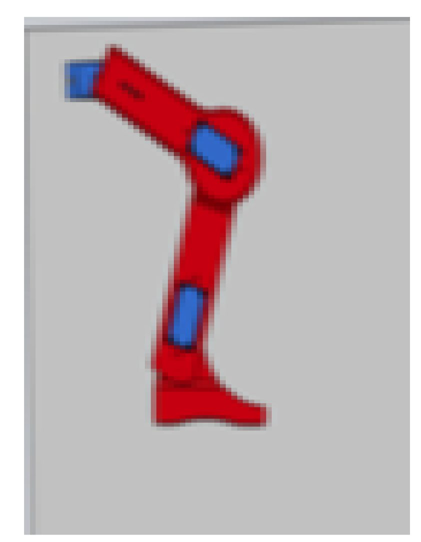
Research from the study of bipedal robots is being applied to prosthetics research.


[4]

Agricultural work because a walking robot does less damage to the ground than a wheeled robot, and is also capable to step over obstacles and move in complicated, non- smooth terrain. [3]

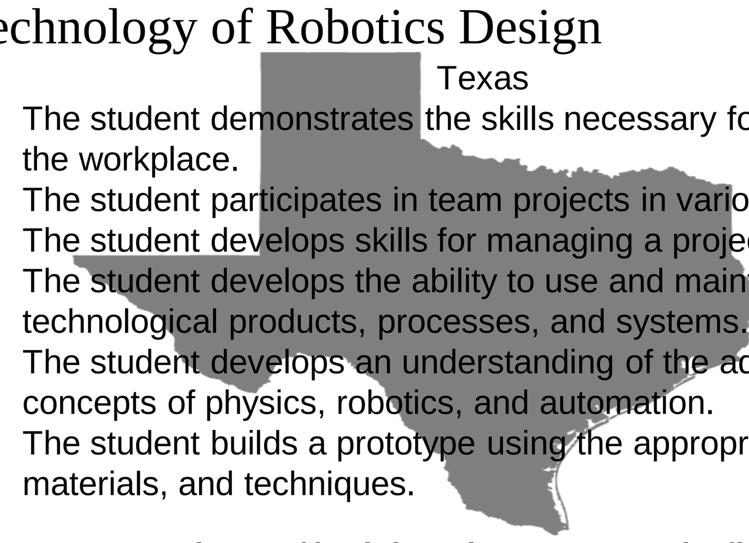
Methodology

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 programing 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 Polypropylene. 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.

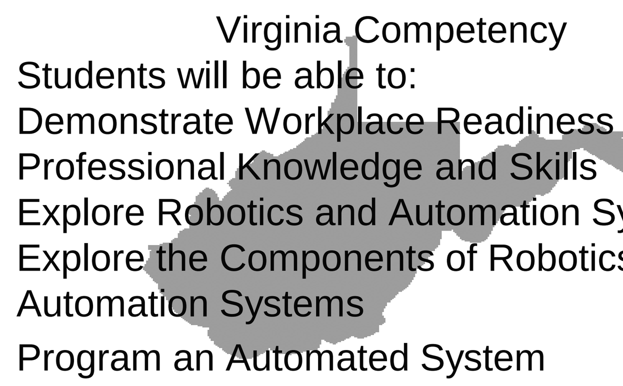


Correlations

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



Texas
The student demonstrates the skills necessary for success in the workplace.
The student participates in team projects in various roles.
The student develops skills for managing a project.
The student develops the ability to use and maintain technological products, processes, and systems.
The student develops an understanding of the advanced concepts of physics, robotics, and automation.
The student builds a prototype using the appropriate tools, materials, and techniques.



Virginia Competency
Students will be able to:
Demonstrate Workplace Readiness Skills:
Professional Knowledge and Skills
Explore Robotics and Automation Systems
Explore the Components of Robotics and Automation Systems
Program an Automated System

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

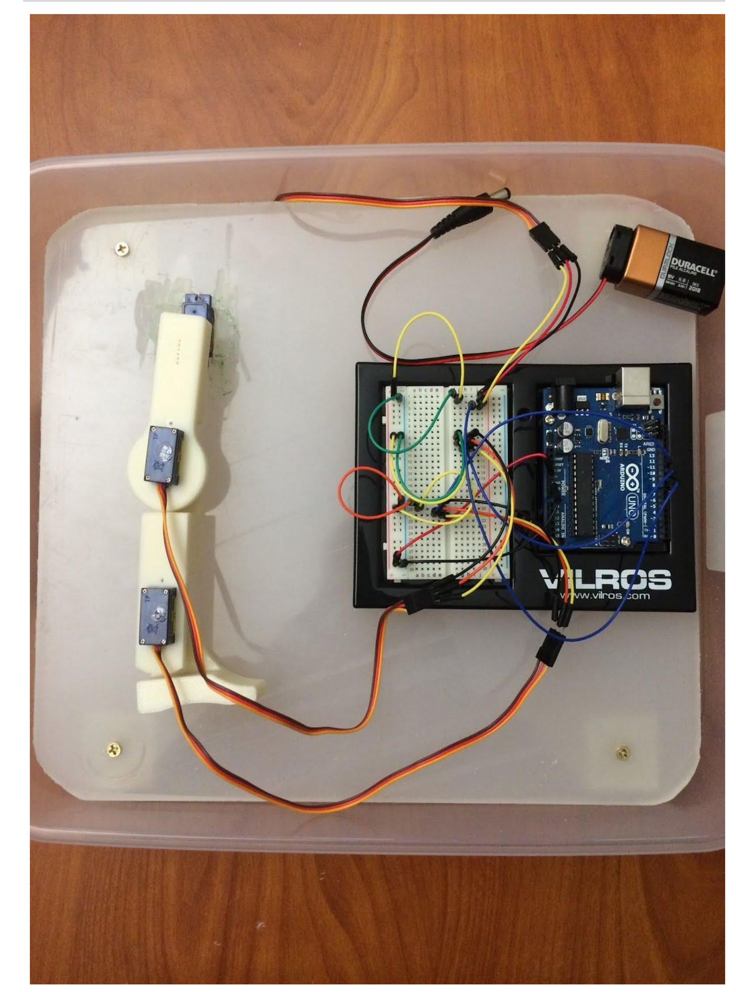
Lesson and Activities

These are lesson 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. Lesson Plan
90 minute lesson

Pre assessment
Is this a robot?
What is a robot?
Human senses compared to robot sensors
Difference between a motor and a servo
Wiring and reading a wiring diagram
Programming languages
Post assessment

Design, Build and Program a Bipedal Robotic Object Activity
9 - 90 minute classes total time 810 minutes
Class 1 - 90 minutes
What is a bipedal robot
Bipedal robot online scavenger hunt
Class 2 - 90 minutes
Review of bipedal robot
Task challenge - build and program an original bipedal robot
Unpack grading rubric
Brainstorming discussion
How to work as a team - class sets norms
Class 3 - 90 minutes
Engineering design process: Introduction
Engineering Design Process team progress sheet
Class 4-5 - 180 minutes
Robot construction and testing
Class 6 - 90 minutes
Progress check with peer feedback
Class 7-8 - 180 minutes
Iteration of design process
Class 9 - 90 minutes
Task Challenge Assessment using grading rubric
Extension activity: If a group presents early they can work on of adding sensors for obstacle detection.


R.E.T.R.O. Model


Bipedal EV3

Reference and Acknowledgement

1. http://web.stevens.edu/msrobotics/SMRDC2010/muecke06r.pdf
2. Oriolo: Autonomous and Mobile Robotics- Biped Robots (by A. Paolillo and M. Vendittelli.
3. http://profmason.com/wp-content/uploads/2009/09/bipedal- overview.pdf
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5. http://www.darpa.mil/NewsEvents/Releases/2014/03/21.aspx

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