Types of projects to facilitate the teaching of educational robotics

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Introduction

Educational robotics as an instructional technology helps to unify the diversity of computing and technical topics into a single cohesive unit. Delivered as a problem based learning unit, different types of robotic projects can be extensively used to demonstrate individual design and construction technology using specific hardware and software development tools. These projects are to be carried out as third year or Honours level programs. The contributions from these projects as part of educational robotics in an instructional technology curriculum are significant.

Construction kits

All the projects described in this paper are designed using construction kits manufactured by *Lego* (2002) and *Fischertechnik* (2002). The main advantages of using these kits are accessibility, flexibility and reusability. The *Lego Mindstorms* kit consists of *Lego*'s range of building and electronic components. Included in the kit is a specially developed micro controller called the RCX, encased to look like a large *Lego* brick. The *Fischertechnik* range of construction kits for robotics has been used by heavy industries as a prototyping tool for the design of industrial robots. Robots built from these construction kits can be programmed and controlled from a computer.

Robot categories

Robots can be basically categorised into two main categories: industrial robots and autonomous robots. Industrial robots are static. With the exception of articulated joints like grippers, elbows and turn-tables, these robots do not move from the location it has been originally positioned. The controllers are normally situated apart from the actual robot, linked by physical communication cables. Autonomous robots are independent free-roaming robots. In most cases, these robots either have wheels, tractors or legs to facilitate mobility. The controllers can be found onboard the actual robot's construction.

Types of projects

The different types of projects are classified as simple, intermediate or advanced. This classification is determined either on the complexity of its construction or on the programming techniques required to control the construction. Only in rare cases are both construction and software rated at an advanced level.

Type 1 – Industrial robots (static robots)
These robots normally have a pneumatically operated arm with three degrees of movement: turn left or right; tilt up or down; and a gripper that opens or closes. As its name suggests these robots are used in manufacturing industries to move heavy loads in a pre-determined three-dimensional space. The programming techniques used are simple repetitive linear programming. Construction: Advanced. Programming: Simple.

Type 2 – Walking robots (mobile robots)
Walking robots are perhaps one of the most challenging robotic constructions that can be undertaken. The project covers bipeds (two-legged), quadpod (four-legged), six-legged and hexapods (eight-legged) robots. The software development is however quite basic as it only requires sequential programming to control the movement of each leg in sequence. Construction: Advanced. Programming: Simple.

Type 3 – Competitive robots (mobile robots)
Competitive robotic projects are probably the most popular forms of robot application. This category covers soccer robots, robot maze and search-and-rescue robots. The objective of these competitions are respectively to: score the most goals; traverse a maze in the quickest time; and gathering the most number of objects from pre-determined space. The construction is fairly simple consisting of wheeled vehicles. However, its programming involves some of the most advanced techniques available using fuzzy logic, neural networks and genetic algorithms. Construction: Simple. Programming: Advanced.

Figure 1. (Left) A *Lego* mobile robot in the form of a prototype car modified to hold an RCX with three motors and four sensors to control steering. (Right) A *Fischertechnik* industrial robot arm with articulated joints.

Type 4 – All-terrain explorer (mobile robots)
This project involves the construction of mobile robots that can explore and navigate their way through uncharted space, avoiding and extracting themselves from obstacles. Most of these vehicles are either wheeled or tracked with novel methods of manoeuvring. Its programming involves an advanced level of intelligent systems technology. Construction: Intermediate/Advanced. Programming: Intermediate/Advanced.

Type 5 – Cooperative-collective robots (static and mobile robots)
This project involves a collection of robots. Their main purpose is to explore an uncharted space collectively, communicating and data-logging its finding with other robots in the collective. Basically a main static robot would act as the main station, controlling smaller but more mobile robots as an extension of itself. This project is perhaps the most challenging in both aspects of robotics construction and programming. Construction: Intermediate/Advanced. Programming: Advanced.

References

Fischertechnik (2002) [Online] Available: http://www1.tpgi.com.au/users/p8king/ [2002, April 28].
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