Robotics at American River College

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1 Purpose of this Document

The main purpose of this document is to introduce the reader to recent robotics development and explain how robotics can be a useful medium for various courses at American River College.

2 Recent Developments in Robotics

With the availability of low-cost electronics and mechanical parts, robotics gains much popularity in recent years. Games such as the Micromouse competitions, organized by the IEEE (Institute of Electrical and Electronics Engineers), have a long history. However, it is not until recent Battlebots competitions that robotics has gained recognition from the general public.

Besides the remotely-controlled and destructive Battlebots, another robo-competition has also gained much popularity recently. This is the mini-Sumo competition. Unlike Battlebots, which require a bit of investment and willingness to take injury risks, mini-Sumo robots are inexpensive and non-destructive.

In the educational toys market, Lego and K-nex both have robot kits that are complete with programmable brains as well as moving parts. While these toys are not cheap, they offer much flexibility and learning value.

There are even "practical" robots that vacuum and mow. Although lawn mowing robots are still much in development, carpet vacuuming robots do work and are relatively inexpensive even when compared to standard vacuum cleaners.

It is safe to conclude that robotics is becoming more popular and known to the general public. In fact, some compare today's robotics to computers in the late '70s. This means robotics is likely to boom in the next 10 years, creating business and job opportunities for many.

3 Incorporating Robotics in a Community College

Robotics is not an easy topic to teach because it involves many fields. Even with the smaller robots, a successful implementation requires expertise in electron-

ics, software and mechanical design. Furthermore, a class in robotics requires electronics equipment (such as multimeters), computer equipment (for software development) and tools to assemble and repair robots.

These requirements of teaching robotics mean departments must cooperate. Particularly, the CSIT and Electronics Technology departments have the resources, both in terms of professors and classrooms/labs, to conduct classes in robotics.

Although teaching robotics requires effort, the benefits are invaluable. One benefit is the increased enthusiasm of students. Instead of teaching concepts and ideas in an abstract form or through a series of "textbook experiments", students can now participate in projects that have "products" that performs some predefined operations. The competitive nature of mini-Sumo and other competition robots also improves students' interest.

On a more practical side, students will be better prepared for the industry as well as four-year universities. Project-based courses train students to think independently, communicate via verbal and written presentations as well as to cooperate with others. In addition, many employers appreciate students who have participated in a "product design" process because such students better understand how everything fits together.

Some may be concerned about the cost of robots. Although *commercial* robots often cost more than US$100, a "homemade" and non-profit autonomous educational robot can cost less than US$50. A minimally designed robot kit costs about US$25, but it can still serve as a teaching tool for most of the courses listed in the following subsections.

Needless to mention, if ARC becomes the first community college (at least in the state) to offer a program in robotics, it will become the leader in this area and gain prestige due to the leadership.

The following is a list of specific classes (most are not currently in the catalog) that can benefit from the incorporation of robotics.

3.1 Introduction to Embedded Controllers

Embedded controllers are everywhere, although most are not obvious. Even some pianos have embedded controllers to record and replay performances. Modern road signs, water meters, gas meters and other public utility equipment have embedded controllers. The brain of a robot is also an embedded controller! A robot has input devices (acting as its eyes and sensors) and output devices (to control motion and indicators). This is an Electronics Technology course that can be project-based so that the outcome is a small robot that runs some canned software.

3.2 Assembly Programming

Some of the low-cost robots do not have controllers that can run C programs. As a result, programs must be written in assembly language. CISP 319 offered by CSIT teaches assembly programming using a microcontroller unit that is

popular amongst robot builders. This course can be project-based so that the product is a small robot that behaves in a certain way and accomplishes some simple task.

3.3 Sensors, Motors and other Devices

The sensors, motors and other devices used on robots are also useful in many other applications. For example, quadrature encoders used on robots are commonly used in printers. The same applies to stepper motors, photo-sensors, contact switches and etc. This course can be project-based so that the product is a small robot that uses a number of devices discussed in the class. The robot can use a canned program so the course (offered by Electronics Technology) focuses on electronics.

3.4 Embedded Programming in C

Although simple embedded systems can be written in assembly, more complex ones are commonly written in C. This course teaches students the basic theories of embedded programming and how the C language is used to perform operations not found in a "regular desktop C program". The product of this course is a robot that has relatively complex behavior to accomplish a relatively complex task. This course is offered by CSIT, but it may need the resources of the labs of Electronics Technology.

3.5 Advanced Robotics Devices

Advanced circuits can enhance the performance of robots. For example, an energy-efficient chopper-drive circuit can improve the high-speed torque of a stepper motor without sacrificing battery life. LED pulsing techniques can improve the signal-to-noise ratio of photosensors *while* saving energy. A visible laser (used in pointers) and a matching LED makes a high resolution proximity/reflectance sensor. Other topics may include the design and implementation of high-current H-bridges (for controlling larger robots), the use of accelerometer for acceleration/deceleration computation and the incorporation of GPS for navigation. This course is probably best taught jointly by Electronics Technology and CSIT because there are electronics and software elements.

4 Conclusion

I personally believe that robotics, as an industry, is going to boom in the next decade (if it takes *that* long). In additional, I also think that can be used as a medium to teach the concepts, skills, knowledge and techniques that a community college has to teach in the first place. As a result, an early incorporation of robotics into programs of ARC will greatly benefit the students as well as the college, both in the short term and in the long run.

Cooperation between the CSIT and Electronics Technology department is the key to the success of a robotics-centric program. The sharing of classroom and lab resources is only the beginning of the benefits. The interaction of professors with different expertise and interests will strengthen both departments and benefit the students and college as a whole.

If you have any question or suggestion, please do not hesitate to contact me at auyeunt@arc.losrios.edu.