Robotic Car Race for Attracting High School Students to Engineering and Engineering Technology

Abstract

This paper describes the development of a remote-controlled robotic racecar competition designed to attract local high school STEM students to engineering and engineering technology. The competition takes about five hours to complete and includes a lecture on the Engineering Technology Program and a facilities tour.

Introduction

Robotics is an excellent way to interest young students in science and technology. This paper describes a remote-controlled robotic racecar competition designed to attract local high school students to engineering and engineering technology. In this competition students build and pilot a remote-controlled racecar around a figure-8 track. As part of the activity they learn to make tradeoffs between top speed and acceleration and climbing ability as they navigate hairpin turns and inclined ramps. The students are also introduced to the Engineering Technology program at Drexel University. As part of their introduction they meet and interact with current undergraduate students and tour laboratory and computer facilities. The competition, lab tours, awards ceremony, and lunch together take about five hours.

The goal of the competition is to attract more high-quality students to Drexel and to increase the Engineering Technology Program's name recognition in the surrounding school districts and academic community.

The Competition

The competition takes place on a figure-8 track about 18' on a side. Part of the course in shown in Figure 1. The central feature is a 2'-wide crossover bridge built from plywood. The bridge has 6' ramps and a 2'-long deck section. Building the car with sufficient torque to climb the approach ramp while still achieving high top speed is one of the key challenges for the students. The starting line can be seen toward the upper left of the figure. The course is outlined with duct tape and flag posts mark the turning points.

Students begin the competition with a short lecture on torque and gear ratios. They are also shown short videos of the course and starting sequence. Next, they are given car kits and challenged to build the fastest car for the course. The kits comprise parts from VEX robotics.[1] VEX was chosen because they are relatively inexpensive and popular among high school students interested in robotics.

Students compete in teams of three or four students. To save time, the teams are provided with preassembled chassis and an assortment of candidate drive wheels and drivetrain gears, shown in Figure 2, together with the necessary drive motor, axles, bushings, and mounting collars. The assembled car, with one possible gear and wheel combination, is shown in Figure 3. The car is about 15” long and 6½” wide. The design uses a universal wheel in the front; steering is accomplished by using a servo motor to spin this wheel slowly left or right, turning the car in the desired direction.

Figure 1. Central part of the course with bridge. The starting line and race starter may be seen in the upper left.

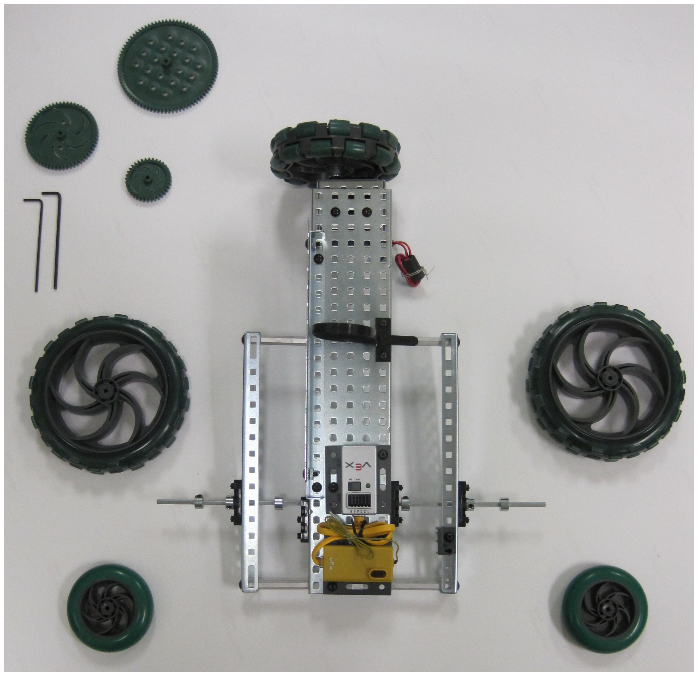

Figure 2. Racecar chassis (top view) with several of the available choices of drive wheels and gears.

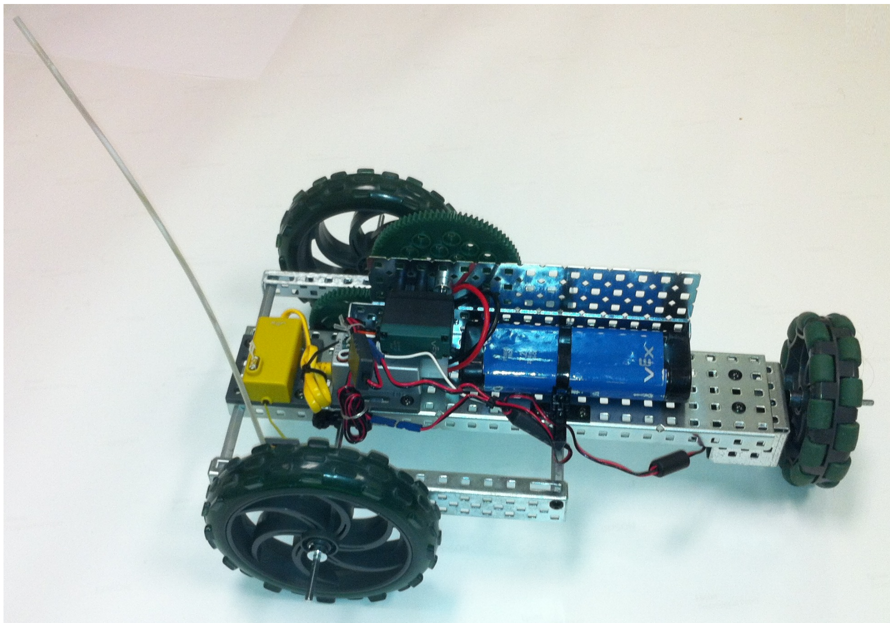

Figure 3. Assembled racecar. The car is 15" long by 6½" wide.

Once their car is completed the students select a designated driver. Teams can evaluate their car's performance on test ramps and around the course; they can then iterate their design as necessary. The students have two hours to finalize their car's design and practice the course.

Each race consists of one lap around the course. The teams compete sequentially for lowest elapsed time and each team gets three tries at the course. The best single-lap time wins. Teams are disqualified for failing to appear in the staging area or for taking more than five minutes to complete the course.

The bridge was designed to assemble and disassemble quickly, so that the two ramps can be used separately by groups of students to test their car's climbing ability, then quickly assembled for the race. The bridge design is in three sections—two ramps and a deck. The ramps are 2' wide by 6' long, cut from a 4'x 8' x 11/16" plywood panel. The bridge piers are 15" x 24" x 11/16" plywood and are attached to the ramps by hinges so that the entire assembly can be stored easily in a space about 5" thick. The bridge rails are made from 1" x 2" pine strips.

Figure 4 shows details of how the bridge is assembled. Figure 4 a. shows the three sections before assembly. 4" L-brackets are attached to the deck, which is then attached to the ramps using ¼ x 20 flat-head screws and wing nuts (Figure 4 b.). Figure 4 c. shows the pier folded under the ramp for storage. The bridge assembles and disassembles in less than 5 minutes and requires two people.

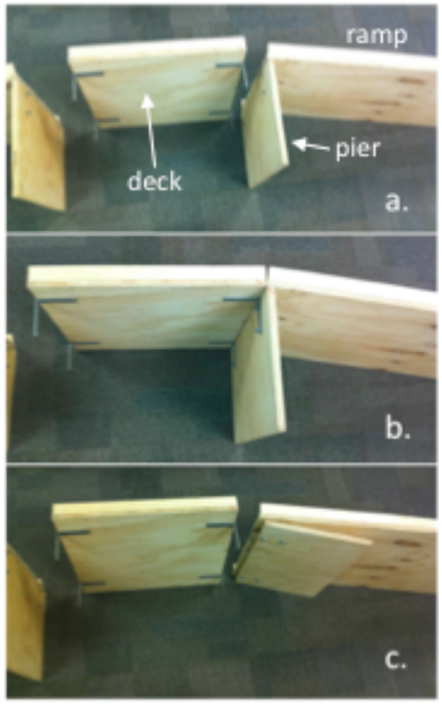

Figure 4. Details of the bridge: a. Three sections disassembled; b. center section attached to one ramp; c. Ramp wall folded for storage.

To make the race more realistic a drag race starting format is used. This format requires a drag race “Christmas Tree,” seen on the right in Figure 5. The sequence starts when the car is “staged” by rolling it toward the starting line until it breaks a laser beam. This position is indicated by the four yellow lights at the top of the tree. Next, the race starter presses a starting button which sequentially flashes three rows of yellow lights from top to bottom at ½ second intervals. Audible cues are also provided. Finally, ½ second after the last row of yellow light flashes, a row of green lights flashes and stays on for the remainder of the race. If a car starts prematurely unblocking the laser beam the bottom row of red lights turns on and the car is disqualified.

The Christmas tree and detector are controlled by an Arduino Uno microcontroller board, which also tracks the elapsed time. Timing stops when the laser beam is again broken. The microcontroller board is interfaced to a laptop computer which displays elapsed time using a projector permanently placed in the room, as shown in Figure 6.

The total cost for five racecars, bridge, and Christmas tree was about $2,300. The VEX robot parts are regularly used by students for other projects and can be used for VEX competitions.

In the future we plan to include a short quiz to test the knowledge gained by the students in topics such as torque, gear ratios, acceleration, and top speed. Correct answers in the quiz will be rewarded as time subtracted from the team’s best elapsed time.

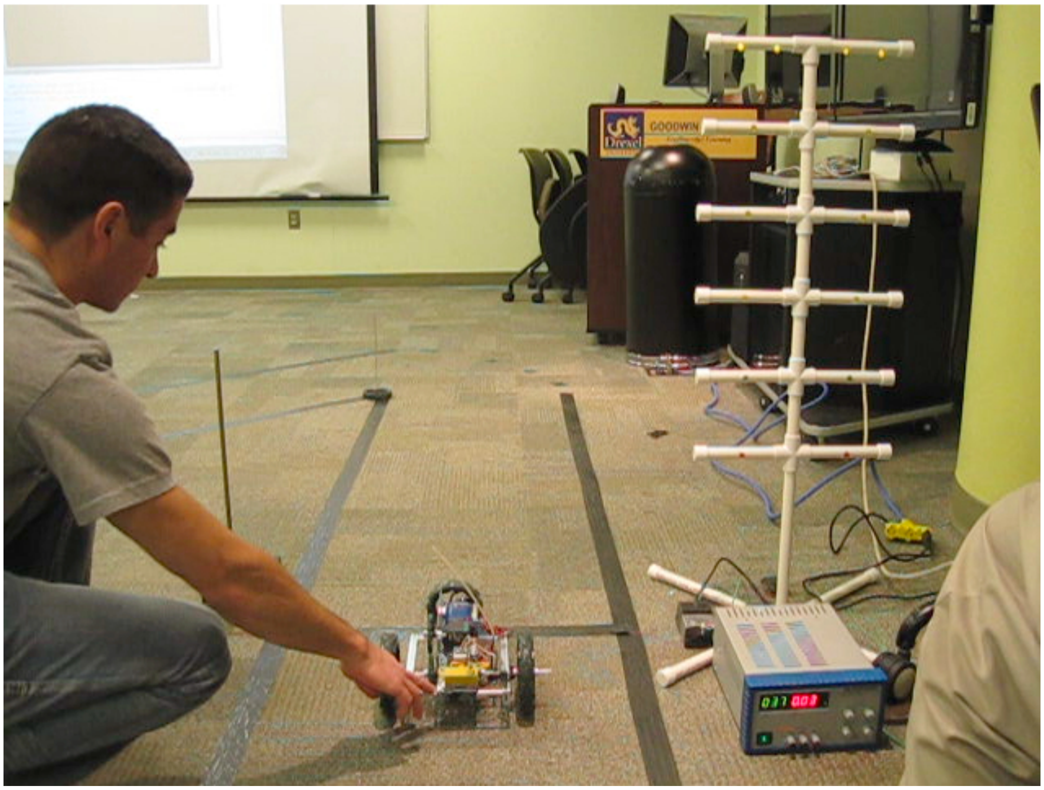

Figure 5. Drag race start. The "Christmas tree" on the right used in starting each race. The uppermost *staging* lights are on. The tree is 42½" high by 19" square at the base.

Figure 6. Elapsed time display.

Conclusions

This paper described the development of a one-day remote controlled robotic racecar competition designed to introduce local high school students to the Engineering Technology Program at Drexel University. The goal of the competition is to attract more high-quality students to Drexel and to increase the Engineering Technology Program's name recognition in the surrounding school districts and academic community. The competition provides an opportunity for prospective students to learn about the program, to interact with students currently enrolled in the program, and to tour the lab facilities.

Reference

1. http://www.vexrobotics.com/ (last accessed 3/6/12).