

Penn State Abington "Mini Grand Challenge" Robot Competition

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Abstract

An autonomous, outdoor, robot design competition, named the "Penn State Abington Mini Grand Challenge," was developed at the Penn State Abington campus to promote advances in robot technology. Robots must navigate unmarked paths, take off-road detours, and entertain spectators. The contest encourages the use of low-cost robot platforms and is suitable for research and education. An example of a low-cost robot platform has been designed to facilitate student participation in the contest. The robot platform consists of a modified electric car robot base, servo-controlled steering and motor drive, vision system, GPS, sonar, and a text-to-speech engine with a speaker for interaction with the contest spectators. The expected applications and outcomes of the robot platform and Mini Grand Challenge include curriculum enhancement, increased interest in undergraduate research, recruitment and retention, and K-12 outreach.

Introduction

The Abington Mini Grand Challenge requires autonomous robots (traveling at a speed between 2 and 5 mph) to follow unmarked sections of 8-foot wide pathways throughout the campus, and take off-road detours. Robots are also encouraged to interact with, and entertain, spectators who may be present

observing the robots. The contest is partly inspired by the DARPA Grand Challenge [1], and promotes advances in robot technology. However, the availability of a low-cost hardware and software platform will allow participants in the Mini Grand Challenge to focus on vision, navigation, and intelligent software solutions and reduce overall development and operation costs.

A low-cost, autonomous, outdoor mobile robot platform was designed to facilitate student participation in the Penn State Abington Mini Grand Challenge contest during the spring of 2005. The robot platform consists of a modified PowerWheels™ robot base, servo-controlled steering and drive, vision system, GPS interface, sonar, and text-to-speech engine with a speaker for interaction with the contest spectators. Control of the robot is accomplished by a laptop running Windows XP operating system, and MATLAB™ software.

This strategy has allowed lower-division undergraduate students to participate in the challenge at a level that would be impractical in the past. In our case, the ability to prototype and deploy algorithms directly in the MATLAB environment is a key element to this design solution.

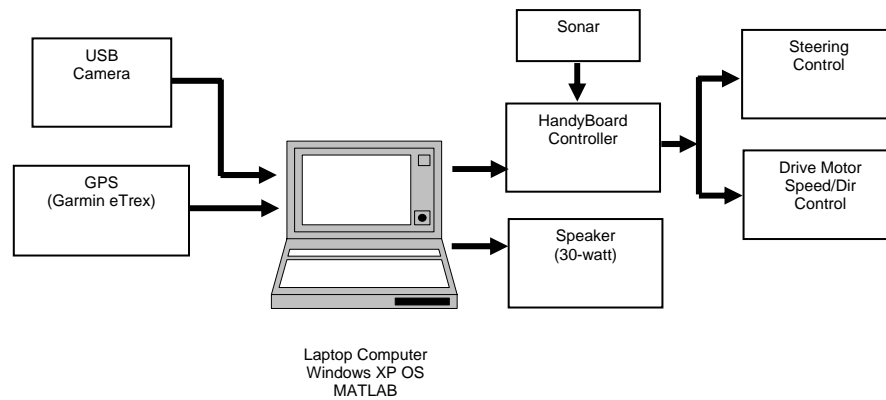


Figure 1: Block Diagram of Robot System

Figure 1 depicts the block diagram of the key components of the robot design, and figure 2 shows the Penn State Abington outdoor robot platform on a campus path.

Mini Grand Challenge Highlights

The Mini Grand Challenge event consists of two major phases. In phase 1, the robot must navigate along an 8-foot wide paved path throughout a campus environment. The path is unmarked and the path edge characteristics vary considerably throughout the course. At the location of path splits and forks, there will be orange cones that will block the undesired path or fork. Prior to the contest, the participants will be provided GPS coordinates for the starting position and 5 waypoints located along the path network. Points will be scored for reaching the waypoints and also for avoiding human obstacles, who might be present on the paths. Additionally, the robot should be capable of providing some entertaining or interactive behaviors for the spectators.

In phase 2, the robot will depart from the paved path and travel across an open field to reach the final waypoint destination. The robot will need to travel within a 20-foot wide corridor in this off-road segment. The robot should also avoid any natural obstacles, such as trees and boulders. The overall course length, combining phase 1 and 2, will be approximately 0.5 miles.

Each robot participating in the contest should be capable of transporting one gallon of water throughout the course. This payload emphasizes the basic utility of a real-world robot application. The robot should travel at an average speed between 2mph and 5mph. The upper limit for robot speed is to insure safety. Additionally, each robot must be equipped with an emergency off switch.

A detailed list of contest rules and specifications can be found at the Mini Grand Challenge website [2].

Summary and Conclusions

The Abington Mini Grand Challenge autonomous robot competition was developed to promote innovations in mobile robotics for educators and researchers. The first event was offered in April of 2005. The event is planned to continue as an annual competition. The contest has been designed to allow low-cost hardware solutions, and a prototype robot

platform has been constructed at a cost of a few hundred dollars. Additionally, the use of MATLAB (with the image processing toolbox) on a laptop computer with a low-cost camera has allowed lower-division engineering and computer science students to participate in this activity. The Mini Grand Challenge has a "suburban" theme, and requires robots to interact with spectators.

The expected applications and outcomes of the robot platform and Mini Grand Challenge include curriculum enhancement, increased interest in undergraduate research, recruitment and retention, and K-12 outreach. The Mini Grand Challenge experience can also serve as an effective and practical first step towards preparation for the DARPA Grand Challenge. More information on the Penn State Mini Grand Challenge can be found at the website [2].



Figure 2: Penn State Abington robot on campus path

References

- [1] DARPA Grand Challenge website: <http://www.darpa.mil/grandchallenge/>
- [2] Penn State Abington Mini Grand Challenge website: <http://www.ecsel.psu.edu/~avanzato/robots/contests/outdoor/contest05>