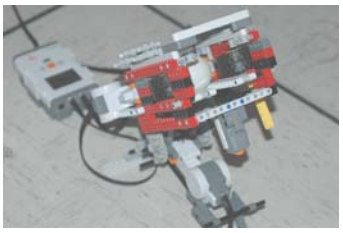
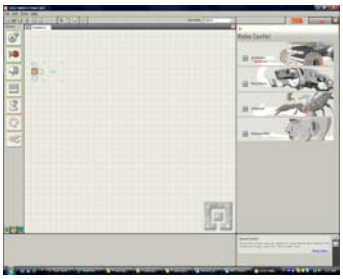
NXT Robot Challenge

Introduction

NXT Mindstorms robot kits are self contained building tools that allows students to explore various aspects of engineering relatively quickly, easily and without any supplemental equipment other than a computer for programming. In this project students will involve working in teams to design and construct a Wii remote control pathfinder integrate a wireless camera and a Nintendo Wii remote with the LEGO robotics system.





Educational Goals

- Provide students with hands on experience building a simple programmable robot.
- To demonstrate that design processes typically involve a multitude of skills and knowledge from many subject areas.
- Allow students to learn that in the real world there are not correct or incorrect solutions but ones that work well, others that don't work well, and many that don't work at all. Students will be able to see that several different solutions may work equally well.
- To familiarize students with the design process- from brainstorming, initial design, prototyping, testing, revising, to final production and competition.
- To allow students to experience the perilous designer/builder interface.
- To spark student's interest in Science and Technology.
- To win some Money ($100 winners take all)

References

1. Instruction Manual (comes with the kits)
2. Use those default programs and robot on the right in NXT program. It shows how to put robot together.
3. Basic Gear mechanics
4. http://www.philohome.com/nxt.htm (examples of NXT robots)
5. http://mynxt.matthiaspaulscholz.eu/ (examples of NXT robots)
6. http://www.techbricks.nl/My-NXT-projects/ (examples of NXT robots)

7. http://www.teamhassenplug.org/NXT/ (tips on sensors and programming)

Competition Guidelines

The objective is to build a Wii remote controlled wireless remote camera assisted unmanned rover that can move across an obstacle course in the shortest time and able to pick up targets along the way with an onboard projectile. Students will control the rover from a remote location with a Wii remote while the robot roams around the obstacle course, relaying sorely on what it sees from the video camera. With the new version NXTcamera, rover will control itself and become completely autonomous. The pathfinder must be designed with proper gear ratio and traction so that it is able to climb ramp, cross climb stairs, turn corner and free itself from a sandpit. In addition, the pathfinder needs to be able find targets to shoot to score points and able to open gates and move around autonomously without getting stuck. For a specific floor plan, please refer to the Playing Field section. The contest is also subject to a few ground rules. Please follow them carefully before begin your design.

Teams

The team will consist of three or four members. Each member is responsible for a part of the design and construction. Great emphasis will be placed on teamwork. Evaluation of contribution from each team member will play a big part in the team's final grade.

Robot Size and Weight

The maximum size of the Robot shall be 12" by 12" by 12 ". The Robot can not look over the walls of the structure and must never extend itself beyond 12 inches in any dimension. All Robots will be carefully measured. Don't let your Robot be disqualified because it is slightly over the limit.

There are no restrictions on the weight of the Robot.

The robot must have the comfort and look of a regular wheelchair. The robot also need to be able to support and hold a monchichi (will be provided) without losing it during the crossing. The robot must be able to turn on the crossing light (the lamp) at the crosswalk to cross safely without getting hit by traffic.

The robot must have three programs installed on the NXT. One must enable the robot to safely cross the obstacle course without losing its passenger. The second program is that the robot must move like a car on the street. It needs to able to move back and forth across a narrow (4 ft across) passage. It also needs to be able to stop for a crossing pedestrian. Cars need to be programmed to see the crossing lane and back away from it when the crossing light is on. The third program requires that the robot does anything you want to stop other competing robots. This robot should have a smart magnetism or a weapon to stop the other robot from going forward.

Ground Rules

The following set of constraints must be adhered to in the implementation of your respective designs. If you need further clarification, ***ask before you implement***!!!

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1. Robots must start from rest and not to be lifted off the track during starting.

2. No human intervention is allowed during the match (except with Wii remote).

3. Your machine must be self-contained and self-sufficient. In other words, it must provide its own energy. No "plug-ins" allowed.

4. Robots must be powered by an electric motor. No fuel engine or rocket propulsion is allowed.

5. Robots can be constructed with Lego bricks, or with any type of materials. The structure of the robot, including wheels and legs, can be strengthened or enhanced by any means. Unless otherwise stated, there are no restrictions on the types of motors to be used.

6. You may alter any Lego parts; however, all alterations and manufacturing must be approved by instructor.

7. Using homemade sensors or gadgets (without destroying the existing Lego parts) are encouraged. There are numbers of Lego Mindstorms related web sites deal with homemade sensors. Some are listed in the procedure.

8. The ambient light level in the contest area is impossible to determine until the actual day of the contest. Contestants will be given time on the contest day to make ambient light level readings if necessary to calibrate their Robot. The room will be lit by overhead florescent lamps.

9. No competitor shall employ devices that compromise the safety of competition spectators or machines. Machines deemed unsafe will be banned from the competition. Unsafe machines will be permitted to re-enter after the unsafe feature is removed.

10. Weapon designed to temporally disable or to throw the other team off balance is allowed. However, device must be operated under the strict safety code of rule # 8. Devices using projectiles (tethered or otherwise), rockets, explosives, open flame, caustic chemicals, fluid or cut-off discs are strictly forbidden. BTW, Flying Robots

are not permitted. The cost of the device * must be included in the calculation.

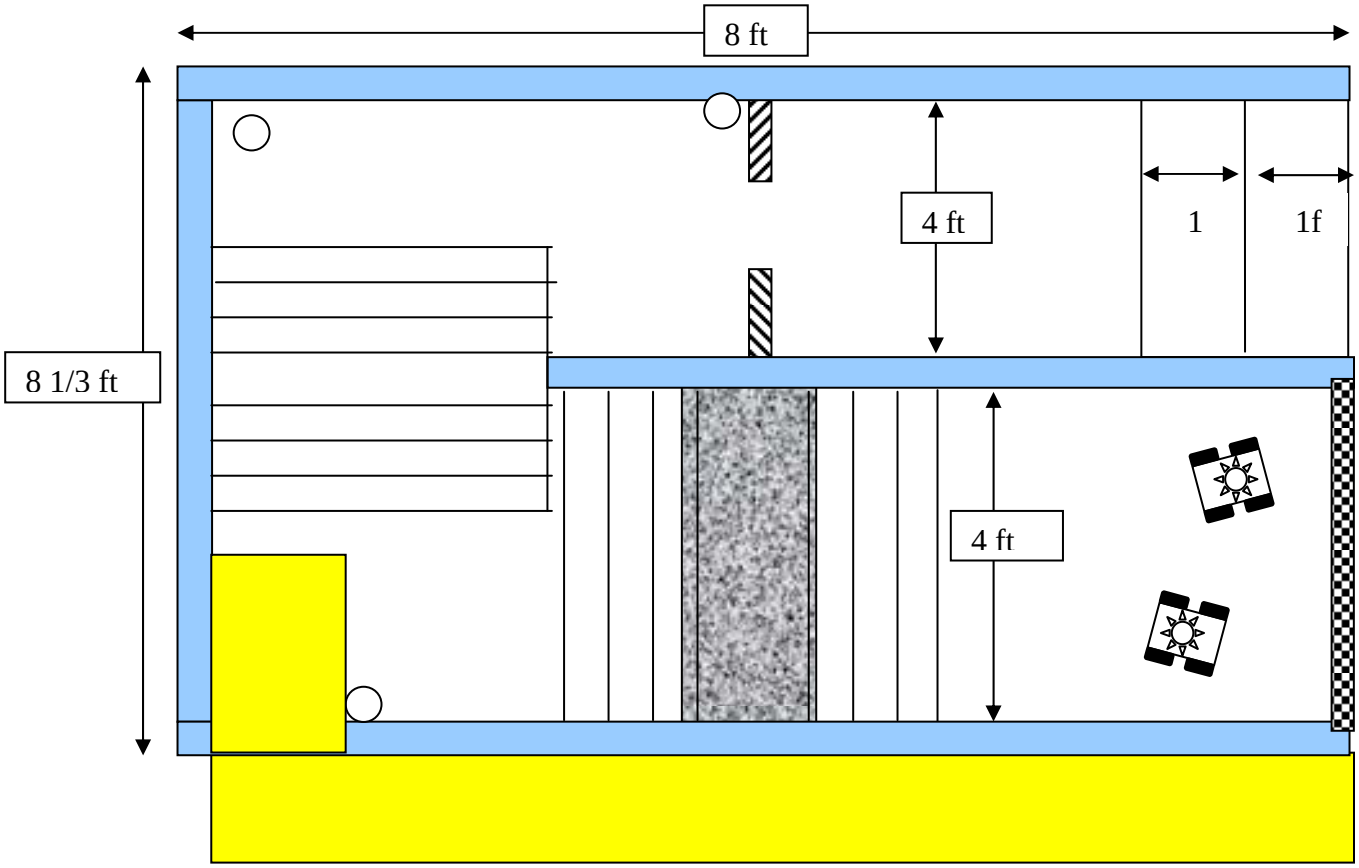
11. Final score will be awarded based on the total points. It is intended to make the contest as realistic and as fair as possible

Ranking:

1. **The team with the best score will win the competition and to be awarded the top prize of $100 in cash (split amongst the group)!!!!!!!!!!.**
2. The WINNER's score will also get the maximum 20% of the grade.
3. The scores of all other teams will be calculated on the basis of the winner's score.

Playing Field

The floor plan contest layout is shown in Figure 1. The playing field is on a hard concrete floor (somewhere in the Learning Factory). A wall made of cinder blocks surrounds the playing field. A 4” tall ramp is placed immediately after the starting block. It is followed by a gate. There is a corner turn located before the robot will confront a couple unfriendly wheelchair robots. Then the course changes to an up and down stair case with 4” steps and finally finishes off with a sand pit at the end.



Non-Painted wooden walls -stack two 2x4x8

Gate require bumper to touch to open

Sky bridge

Up and down stair – 8 steps, Step- 0.25” height 3” wide Highest step is 6” wide

Ramp

Target to shoot

1/4” deep Sand pit

 Finishing line

 Unfriendly robots

Scoring Equations

Scoring for this project is based on the time and the numbers of obstacles the pathfinder successfully completed and extra point pick up during the shooting of the targets:
10 pts if successfully going over the ramp
10 pts if successfully trigger the touch sensor to open the gate
10pts if successfully going up and down a stair
10 pts successfully going across the sandpit
50 pts successfully going around the unfriendly robots
30pts successfully going on the skybridge

Bonus points:
20 pts bonus for each target that's hit
10 pts for cannon with longest range
10pts x (300 seconds-actual time)/20seconds

Robot project Schedule

Week 1:

NXT programming Tutorials

The tutorials progressively build on the student's understanding of the programming software, and gradually increase in difficulty.

1. In the first video tutorial, student will be introduced to all the basic commands and functions in the NXT-G graphical language of the LEGO® Mindstorms® NXT system.

NXT Tutorial 1

2. In the second tutorial, the exercise is divided into five different labs. Each lab introduces a different technology and application that will be useful in programming your final competition robot.

NXT Tutorial 2

The lab topics include:

1. Motion basics and the use of rotational encoders
2. Object avoidance using ultrasonic and touch sensors
3. Controlling a robot using only a sound sensor
4. Mimicking movement between robots using Bluetooth wireless technology
5. Line follower application using a closed loop feedback motion control algorithm

NOTE: A LEGO MINDSTORMS NXT retail kit is required for all of the labs with the exception of Lab 4 which will need at least two kits to demonstrate the exercise. The Tribot hardware design is recommended for all of the labs.

Each lab consists of three main parts:

Part A: A sensor is introduced to a student. The student will explore its functionality, and gain an understanding of its purpose and limitations.

Part B: The student will follow a script to write an example application that employs the technology. This will build their programming skills, and reinforce the purpose of the technology. Once the program is finished, it can be tested with the robot to see the end result.

Part C: A challenge is offered to give the student a chance to use their imagination. Generally the challenge objectives are an extension to the application from

Part B. Guidelines and tips are provided to ensure that the student stays focused on the correct task, and completes it within a reasonable amount of time.

You must complete all the exercises and questions in the following two tutorials (except lab 4 in NI tutorial). Please make sure you include all the answers to the questions and codes you write in each exercise in the memo and turn it in to TA for credit.

Additional information on NXT robots and etc

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* Instruction Manual (comes with the kits)

* Use those default programs and robot on the right in NXT program. It shows how to put robot together.

- Basic Gear mechanics
- http://www.philohome.com/nxt.htm (examples of NXT robots)
- http://mynxt.matthiaspaulscholz.eu/ (examples of NXT robots)
- http://www.teamhassenplug.org/NXT/ (tips on sensors and programming)
- http://www.philohome.com/nxt.htm (more examples)
- http://mynxt.matthiaspaulscholz.eu/ (more examples)

Week 2

Sensors Performance Test

For this NXT Lego Challenge, students will build a series of robots. But before they can do this, they will need to test the sensors and motors that come with the NXT kits. Engineers need to know the performance of the components they use in order to build efficient and practical designs. The NXT kits come with four sensors:

1 Touch sensor
2 Light sensor
3 Sound sensor
4 Ultrasonic sensor

In addition, the students will test the three NXT motors by a static torque test and an angular velocity test. This is designed to apply basic physical principles about torque and its relation to forces and moment arms in order to find how well NXT motors perform and introduce students to the relationships between angular velocity of gears and their diameters.

Week 2 and 3

Program NXT Robots Using NI LabVIEW

LabVIEW users can also program their MINDSTORMS NXT robots in LabVIEW. The LabVIEW Toolkit for LEGO MINDSTORMS gives existing LabVIEW users the ability to create and download VIs to operate and control their LEGO robotics systems. The toolkit also makes it possible for third-party software and hardware developers to create native blocks for MINDSTORMS NXT software. However users will need to download and install the LabVIEW software and the LabVIEW Toolkit to be able to program the robot. In this case, both are installed in our lab's computers.

In this exercise, you will learn how to use the LabVIEW program to integrate a wireless camera and a Nintendo Wii remote with the LEGO robotics system. With the completion of the exercise, you will have enough background to complete one of the two competition robots.

Link to NI LabVIEW tutorial

Additional references for using LabVIEW program for LEGO MINDSTORMS system.
3 hours NI LabVIEW program tutorial
6 hours NI LabVIEW program tutorial

Week 4

Design Competition Robots

a) Remote control monkey hunter
b) Antonymous robotic wheelchair

Week 5

Testing and Competition

Deliverable and Grading Breakdown

· Due Monday, week 7 – Finish NXT tutorial (10%)

· Due Monday, Wekk 8 – Ni LabVIEW tutorial for NXT

· Due Monday, week 9 - Design Specification (10%)

· Due Friday, week 10 – A built, competition-ready machine for competition (30% of grade), Score will be determined by the ground rule equation which is available on the robotics project description.

· Due Friday, week 11- Final Design Project report (30% of grade) with proper layout of a professional document. The report should contain graphs, tables drawings and equations that will clarify the text. You also need to make sure to reference all ideas, equations, figures or quotes that have been taken from other sources.
· Due Friday, week 11- Each team will evaluate its team member's contribution (10% of your project grade). The evaluation should be included in your final report.