Note to the Teacher

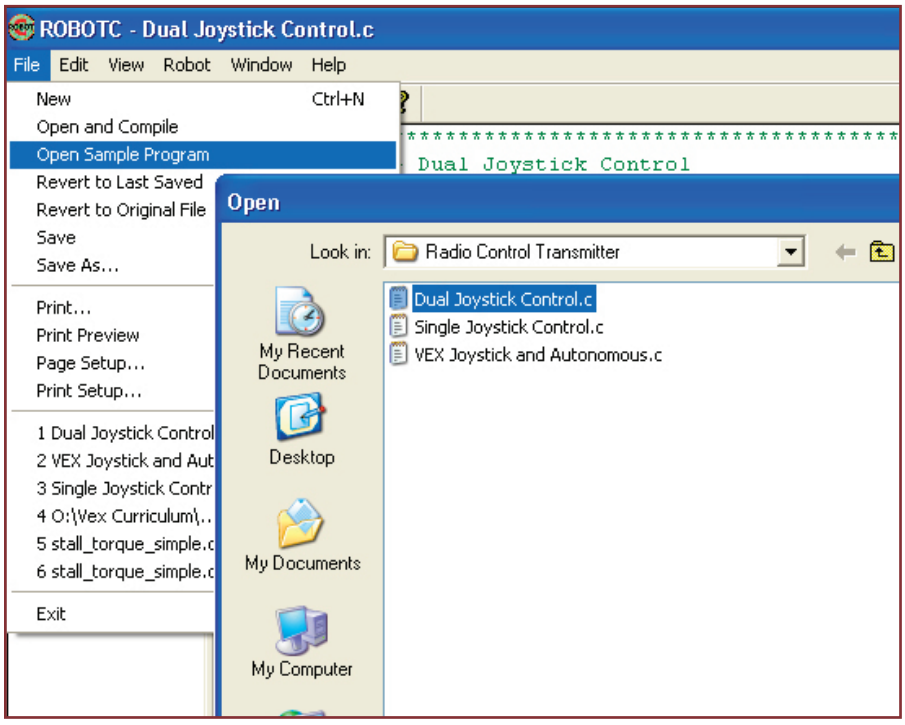
Overview

In this investigation, students will learn the relationships between radio control transmitters and receivers in a technological system. Students will use the Vex Robotics System in a laboratory setting and conduct scientific inquiry-based experiments to determine the effect of radio control transmitter antenna length and position on signal strength relative to the receiver. Students will construct a basic model of a working system that includes a radio control transmitter, a receiver, a microcontroller and motor driven output.

Students will gain an understanding of math and science concepts related to frequency and the time period of a sinusoid (sine wave). Students will apply engineering notation to frequency and time period calculation and demonstrate the ability to use a calculator programmed for engineering notation to determine the appropriate unit.

Please note

If you have ever downloaded ROBOTC firmware (or programs), you will now have to download a ROBOTC sample program, "Dual Joystick Control." Alternately, you can re-download the Vex Default Firmware.



- Select File/Open Sample Program
- Browse to Radio Control Transmitter/Dual Joystick Control and download it.
- Turn the robot on and off. The robot should now work with the remote control as it did out of the box.

Note that if you have never downloaded anything onto your VEX microcontroller, you can skip this step.

Activities

This investigation consists of 4 activities and has many multimedia supplements.

- This investigation should take approximately 3 - 4 forty minute periods
- Students will work in cooperative teams of 2 or 3

Note to the Teacher *continued*

- Managing a classroom when multiple investigations are being done using multiple Vex systems but only one crystal frequency is not recommended
- It is recommended that teachers purchase additional crystal kits for a Vex classroom (see Unit 6 page 22 in the Inventor's Guide)

VEX Kits and Accessories Needed

1. VEX Protobot Kit
2. Hardware and Metal Kit
3. Transmitter & Receiver Kit
4. VEX Microcontroller

Students will be able to:

1. Apply scientific process
2. While pointing the radio control transmitter at the receiver, identify and measure the maximum distance from the radio control transmitter antenna to receiver at various antenna heights
3. Use a fixed transmitter antenna height and fixed transmitter distance from the receiver to discover the optimal angle of the transmitter antenna
4. Determine the effect of an obstructed receiver on the signal strength of the radio control transmitter
5. Use a calculator with engineering exponential notation (such as CASIO fx-300sa or the TI 83, 86, 89) to determine the frequency and time period of a sinusoidal wave form
6. Collect data from their investigation
7. Apply and describe the various points of experimental procedure:
   a. Experimental hypothesis
   b. Measurement technique
   c. Multiple trials
   d. Systematic error
   e. Random error
8. Write a summary describing what they learned in the investigation

How to Use the Lesson Materials

1. Review all the lesson materials thoroughly.
2. The following teaching materials and supplementary multimedia are included with this investigation:
   a. Overview / Video Preview: Serves as an introduction to the investigation; recommended for use before beginning the investigation
   b. Overview / Guides / Note to the Teacher: Highlights all of the investigation content, summarizes the lesson goals and procedures, and makes suggestions about how to teach this material
   c. Overview / Guides / Note to the Student: Highlights all of the investigation content and resources; summarizes the lesson goals and procedures; recommend distributing prior to investigation
   d. Overview / Quiz / Check for Understanding: Designed to be assigned at the end of the investigation; covers topics including resonance, frequency, periods, sine waves, scientific and engineering notation,

Note to the Teacher *continued*

lesson conclusions and experimental procedure

e. Overview / PowerPoint / Lesson Guide: Serves as a guide for lesson content and overviews resonance

f. Background / Slide Shows / Tacoma Bridge: Provides a real world example of resonance; recommend assigning prior to investigation

g. Background / Helper Links / Engineering and Scientific Notation: Covers these notations; assign for review if students are unfamiliar with these types of notations

h. Background / Resources / Lesson Datasheet: Provides a template for the datasheet for the four laboratory based lessons; note that you should choose whether to print and hand out the Excel document or whether you want students to use a computer to modify the Excel file; note that you will also need to modify this template for each of the lessons

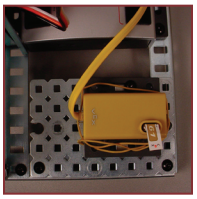


Figure 1

i. Background / Resources / Radio Control Transmitter Guide: A slide show with linked videos to use as a reference for advanced radio control transmitter use

j. Background / Resources / Signal Platform Construction Show: A step-by-step guide to building the robotic platform necessary for the lessons; must be constructed prior to completing the lessons

k. Lesson / Multimedia / Vex Controller and Resonance: Provides an animated explanation of how resonance works in sending signals

l. Lesson / Printable PDF / Horizontal Antenna Test Procedure, Vertical Antenna Test Procedure, Test Obstacle Procedure: These three PDFs are for the laboratory based lessons and provide step-by-step procedures; recommend printing and giving to each lab group as a procedure guide

m. Lesson / Printable PDF / Sinusoids, Frequency and Period: This PDF explains sinusoids, and the relationship between frequency and period

n. Lesson / Printable PDF / Scientific and Engineering Notation: Procedure: This PDF explains engineering and scientific notation procedure for students unfamiliar with them

3. Modify and add to these lessons in the way that will best serve your classroom.

4. It is recommended to have your students review all the material in "Background" before beginning the lessons. This will refresh their memory on many topics and provide good reference material for when they begin the lessons.

6. Teach the lesson, drawing on lesson materials where appropriate. You may wish to begin the lesson by having your students view the Video Preview, then hand out "Note to the Student". Then, you can review engineering and scientific notation. Use the included multimedia videos and PowerPoint slides to teach resonance and provide an overview for the lessons. Use the printable PDFs as a procedural guide for all four laboratory-based lessons.

7. Assign the "Checking for Understanding" quiz.

Description of the Lessons

To begin this investigation, students will work in teams of 2 or 3 and construct a simple test robot system that can be controlled by a radio control transmitter

Note to the Teacher

and has an observable output. The actual system can vary and students should be encouraged to make it simple. The system must include the following Vex components:

- Radio control transmitter with crystal and adequate battery power
- Receiver with matching crystal
- Antenna wire on the receiver should be wrapped around the receiver as shown in Figure 1; if the antenna wire is fully extended, the reception distance becomes too large to easily measure
- Vex microcontroller and charged battery
- One motor
- Visual demonstration of motor output (ex. wheel turning, fan blades spinning)

Once students have used “Background / Resources / Signal Platform Construction Show” to construct their robotic system, you can begin the lessons. For all lessons, adjust or have your students adjust the “Background / Resources / Lesson Datasheet” to fit each lesson.

HORIZONTAL ANTENNA TEST / Lesson 1

Goal of this Lesson: The team will explore the relationship between antenna height and signal strength. The hypothesis is that transmission strength of the radio control transmitter is directly related to antenna height.

VERTICAL ANTENNA TEST / Lesson 2

Goal of this Lesson: The team will explore the relationship between antenna height and signal strength. The hypothesis is that the transmission strength of the radio control transmitter is better when not directly pointing at the receiver. Thus, the results from Lesson 2 should show a higher distance to failure than the results from Lesson 1.

TEST WITH OBSTACLES / Lesson 3

Goal of this Lesson: The team will determine the effect of an obstructed receiver on the radio control transmitter signal strength. The hypothesis is that the steel will interfere with the radio control transmitter and receiver the most.

SINUSOIDS, FREQUENCY AND PERIOD / Lesson 4

Goal of this Lesson: The team will learn about sinusoids and the relationship between frequency and period.