Unit 3 Programming and Interfacing

Overview

Purpose

The purpose of this unit is to provide students with an opportunity to build knowledge and skills in programming and interfacing. Students will use the theory of programming and interfacing to manipulate a variety of sensors and actuators. They will learn how to select appropriate sensors and actuators based on their specific characteristics. Once they become familiar with the hardware, They will learn how to program these components in an object oriented event driven programming language. The skills learned in this unit will be used extensively when students begin the major design project in Unit 6. This unit is divided into five topics:

Topic 1: Introduction to Interfaces

Topic 2: Introduction to Programming

Topic 3: Input Devices

Topic 4: Output Devices

Topic 5: Remote Sensing and Control

Profile

In this unit students will be involved in:

- exploring common interfaces and their applications.
- learning about analog and digital input and output.
- investigating a variety of sensors and actuators.
- designing object oriented interfaces to manipulate sensors and actuators.

- investigating several options for non tethered robotics control.

Implementation

This unit should be completed in no more than 20 hours of class time. The programming section of the unit is intended to be taught side by side with the interfacing section. Students will only need a level of programming that is required to manipulate the various sensors and actuators used in the course. The programming and interfacing unit is a core unit for the course. Students will build essential skills that they will use extensively in the design activity in Unit 5.

Evaluation

Evaluation

Unit 3 is intended to introduce students to the tools and skills associated with programming and interfacing. this unit should account for 20 percent of the evaluation of Robotics Systems Technology 3205.

Outcomes and Strategies

Topic 1 - Introduction to Interfaces

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.1.1 define interface and provide examples of common interfaces

Delineation:

person to machine

machine to machine

machine to person

operating systems

application software

Suggested Teaching and Learning Strategies

For the Teacher

The purpose of this outcome is to have students understand what an interface is and identify common examples.

Points to Emphasize

Interfaces connect dissimilar materials, devices, systems, or processes that under ordinary circumstances would not interact: the interface makes interaction possible.

All interfaces have a physical component, some have a virtual component (programming existing in memory or on a chip) and those used by humans have a visual/audio component.

Commonly used interfaces include:

- Cell phone keypad
- Automated Teller Machine (ATM)

Person-machine interfaces allow humans to communicate with machines, and vice-versa.

Machine-machine interfaces allow machines to communicate with one another.

Machine-person interfaces allow machines to communicate with people in a language that people understand.

The most common interface is the graphical user interface (GUI) but it can also assume the form of a command line processing interface.

The operating system in a personal computer serves as an interface between:

- the BIOS and devices.
- the user and the computer.
- the various hardware components of the computer system.

For the Student

Students could analyze an interface and identify the physical, virtual and/or visual components.

Topic 1 - Introduction to Interfaces

Suggested Assessment and Evaluation Strategies

Performance

Students could Examine software interfaces and discuss their physical, virtual and/or visual components. Develop a **presentation** to outlining the components

Pencil and Paper

Students could create a board game that helps them remember the various types of interfaces.

Presentation

Explain how a touch screen works on a smart phone.

Journal

Have students identify examples interfaces encountered in everyday life.

Resources

Authorized Resource:

Robot Builders Bonanza, Ch. 12 – 13

CDLI Integrated Systems 1205 online resource:

http://www.cdli.ca/courses/isys1205/phidgets/unit_01.html, Unit 1, Section 02, ILO 1, 2, 3, 4

Topic 1 - Introduction to Interfaces

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.1.2 differentiate between the functions of computer hardware interfaces for sensing, switching and regulating.

Suggested Teaching and Learning Strategies

For the Teacher

Inputs are not directly connected to outputs. The computer senses the input and based on programming controls the output.

Points to emphasize

- The physical interface provides the hardware connections between the computer and external devices (sensors, actuators, signal devices).
- Inputs from hardware interface convey the state of external sensors.
- Computer hardware and software is used to control input and output from the interface and perform the required actions.
- Outputs are used to control actuators and signal devices.
- Custom built sensors and custom built controlled devices extend the capabilities of the hardware interface.

For the Student

Students could engage in a role play activity in small groups. The teacher could give the group a sensing and control problem. Each team could delegate the sensor, process and control roles to members of the team. Each team can then develop a role play to illustrate their solution to their teams sensing and control problem.

Topic 1 - Introduction to Interfaces

Suggested Assessment and Evaluation Strategies

Performance

Students could engage in a role play activity in small groups. The teacher could give the group a sensing and control problem. Each team could delegate the sensor, process and control roles to members of the team. Each team can then develop a role play to illustrate their solution to their teams' sensing and control problem.

Journal

Have students identify the role of several computer interfaces in their home or school.

Presentation

- Students could select various input and output devices and explain their function to the class.
- Students could research an interface for sensing, switching and regulating and explain to the class how the physical interface provides the hardware connections between the computer and external devices (sensors, actuators, signal devices).

Resources

Topic 1 - Introduction to Interfaces

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.1.3 distinguish between digital and analog input and output.

Suggested Teaching and Learning Strategies

For the Teacher

The purpose of this outcome is to emphasize the nature of digital and analog signals as being discrete (on or off) and continuous respectively.

Points to emphasize

- Digital input involves the sensing of an electrical signal which can be in an on/off state (0V - 0.8V being off and 2.3V – 5.0V as on).
- Digital output is a signal from an interface board that can be in the on/off state.
- Analog input involves measuring a continuously changing electrical signal from a sensor as a result of some changing physical phenomenon. (ex: pressure, temperature, light, etc).
- Analog output is the ability of an interface card to provide a variation in voltage. (ex. MP3 player output, analog monitor, etc.)
- Because digital outputs generally have low currents, other devices such as power transistors, relays, etc. have to be used in conjunction with the output to control higher current devices.

For the Student

Using an oscilloscope or a logic probe, examine the characteristics of a set of signals and determine whether they are analog or digital.

Have students provide examples of digital input/output and analog input/output from common consumer products.

Topic 1 - Introduction to Interfaces

Suggested Assessment and Evaluation Strategies

Performance

Using the USB Oscilloscope determine whether a signal is analog or digital. For example the output of a motor controller, output of an audio amplifier, simple DC circuit (on-off), the output of a silicone solar cell pointed at a light. Each team could present their findings to the class.

Journal

Students could create a list of examples of digital input/output and analog input/output from common consumer products.

Pencil and Paper

Sketch the wave form of a digital signal and the wave form of an analog signal.

Presentation

Students could provide examples of digital input/output and analog input/output devices from common consumer products.

Resources

CDLI Integrated Systems 1205 online resource:

http://www.cdli.ca/courses/isys1205/phidgets/unit_02.htm
Unit 2, Section 4, ILO 1-4

External Link:

http://www.wisc-online.com/Objects/ViewObject.aspx?ID=CIS5908

Topic 1 - Introduction to Interfaces

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.1.4 describe the characteristics and function of an analog to digital converter

Delineation:

- Resolution
- Sampling rate
- Input voltage range
- Input type

Suggested Teaching and Learning Strategies

For the Teacher

The purpose of this outcome is to have students develop knowledge about the characteristics and function of an analog to digital converter (ADC).

Points to Emphasize

Analog to digital converters (ADC) change an analog signal (varying) to a digital signal. ie. signal from a microphone to a file for a computer.

Resolution refers to the smallest voltage increment that an ADC can divide voltage into.

The resolution of an ADC is measured in bits. For example, a 12 bit ADC has a resolution of 212 which equals 4096 divisions.

Sampling rate is the speed at which an ADC can take samples of the input signal and is measured in samples per second and/or Hertz (Hz).

Depending on the input voltage range of the ADC (typically 0 to 5 volts) and the transducer or sensor signal values the input may have to be amplified to be useful. Uni-polar voltage refers to a single sided voltage range such as 0V to +5V, where bi-polar refers to a dual sided voltage range that goes from -5V to 0V to +5V.

Operational amplifiers (OP AMPS) are used to amplify signals. The amplification of the OP AMP is typically controlled from the software used to control the ADC. If the sensor output is above the ADC specification the OP AMP can be used to de-amplify the output to a useable level.

For the Student

Students could research ADCs to determine the characteristics and functions of various ADCs.

Topic 1 - Introduction to Interfaces

Suggested Assessment and Evaluation Strategies

Performance

- Create an advertisement in the form of a video or poster to sell an ADC/DAC of their choice based on the characteristics of the device.
- Using a meter stick look at the various scales, mm, cm, dm, m and measure the thickness of a table top with each scale. Decide which scale would be best, and explain why. Relate this to ADC resolution.
- Think about physical parameters that can be sensed such as temperature, Barometric pressure, sound, light level, force. Indicate what type of sampling rate would be needed, fast, medium, slow.

Pencil and Paper

Students could look at commercially available ADCs and in a grid list its characteristics or specification.

Journal

Research several ADC's/DAC's and enter their characteristics in into a **journal** entry.

Resources

Authorized Resource:

Robot Builders Bonanza, 204-207

External Link:

http://www.technologystudent.com/elec1/anadig1.htm

Topic 1 - Introduction to Interfaces

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.1.5 describe the characteristics of a digital to analog converter

Delineation:

Resolution

Conversion rate

Output voltage range

Output type

Suggested Teaching and Learning Strategies

For the Teacher

The purpose of this outcome is to have students develop knowledge about the characteristics of a digital to analog converter (DAC).

Points to Emphasize

- Digital to analog converters (DAC) change a digital signal to an analog signal. EX. Digital music on Compact Disc converted to sound.
- DAC involves the conversion of computer stored or generated data into a continuously changing output voltage through some appropriate interface device.
- The most important characteristics of the DAC are resolution, conversion rate and output voltage range.
- The resolution of the DAC is measured in bits.
- Conversion speed is how fast the DAC chip can accept a number (binary word) from the computer and output a corresponding voltage.
- Output voltage range is the range of voltages that can be generated by the DAC. Typically ranges include 0V to 5V (unipolar type) and -5V to +5V volts (bipolar type). The larger the voltage range, the coarser the resolution for a given DAC chip.

For the Student

Students could research DACs to determine the characteristics of various DACs.

Topic 1 - Introduction to Interfaces

Suggested Assessment and Evaluation Strategies

Performance

Create an advertisement in the form of a video or poster to sell an ADC/DAC of their choice based on the characteristics of the device.

Journal

Research several ADC's/DAC's and enter their characteristics in into their journal.

Pencil and Paper

Students could work on answering the following questions:

- What is the sampling rate of a CD?
- Why can you fit only 10 – 12 songs on a regular music CD and hundreds of MP3 songs on the same sized CD?

Presentation

Using windows media player, rip regular music CD songs at various sampling rates to demonstrate playback quality.

Resources

Authorized Resource:

Robot Builders Bonanza, p. 207

External Links:

http://www.wisc-online.com/Objects/ViewObject.aspx?ID=CIS5908

http://www.technologystudent.com/elec1/anadig1.htm

Topic 1 - Introduction to Interfaces

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.1.6 employ digital input and output and analog input and output.

Suggested Teaching and Learning Strategies

For the Teacher

Employ common devices to illustrate digital and analog input and output. Programming and interfacing should not be used to examine input and output at this stage.

Points to Emphasize

- Input devices could be keyboards, mice, joysticks, graphics tablet, smartboard, touch screens, microphones, motion sensor, car keys, and security tags
- Output devices are LCD display, printers, speakers, automatic doors, card reader, and the buzzer on fire alarm.
- Movement of the joystick arm itself is an example of analog input while the buttons on the joystick are examples of digital input.

For the Student

Students, arranged in groups, should use interface equipment and software to manipulate digital input and output and analog input and output.

Topic 1 - Introduction to Interfaces

Suggested Assessment and Evaluation Strategies

Performance

- Demonstrate the differences between analog and digital input using a joystick (eg: the game controller program in Windows). Plug in a joystick and go to the control panel, under game controllers and properties. Observe the changes when the joystick and buttons are engaged. Determine which are digital and analog.
- Demonstrate analog input using a microphone, and analog output by playing music from a stereo.

Resources

Authorized Resource:

Pridget Interface Kit

Topic 1 - Introduction to Interfaces

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.1.7 distinguish between sensors and actuators

Suggested Teaching and Learning Strategies

For the Teacher

The purpose of this outcome is for students to understand the differences and similarities between actuators and sensors (transducers).

Points to Emphasize

- Sensors are input devices while actuators are output devices. Both input and output devices can be either digital or analog.
- Sensors (transducers) convert some physical measurement of a phenomenon such as heat, light, humidity, magnetism, etc. into electrical signals.
- Actuators convert electrical signals into physical phenomenon such as motion, light, sound, and heat.

For the Student

Students should identify the characteristics of a select set of sensors and actuators, and group them accordingly.

Topic 1 - Introduction to Interfaces

Suggested Assessment and Evaluation Strategies

Performance

Break students into teams have them develop a rap song that introduces the rest of the class to the characteristics of a certain type of actuator.

Presentation

Have the class brainstorm a list of sensors and actuators. Discuss the validity of the list. The list could be divided amongst the students who would research and present the characteristics of their sensors and actuators to the class.

Pencil and Paper

Create a grid listing sensors and actuators, and explain the differences and similarities.

Journal

Student could select a sensor and actuator and identify the characteristics of each and explain why they are sensors or actuators.

Resources

Authorized Resource:

Robot Builders Bonanza, p191 – 193, 195

Topic 2: Introduction to Programming

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.2.1 define object oriented/event driven programming.

Suggested Teaching and Learning Strategies

For the Teacher

A high level language that utilizes object programming and requires events to occur in order to execute the procedure.

Points to Emphasize

- An event occurs when a user selects or "clicks" a choice on the interface.
- An object is a graphical item that a user can select. ie. command button such as "login", scroll bar, input box.

For the Student

- Students could provide examples of objects and describe the events occurring with that object.
- Students could analyze object\event driven elements in common consumer electronics such as the Ipod.

Topic 2: Introduction to Programming

Suggested Assessment and Evaluation Strategies

Performance

Using a computer interface, identify the controls and events associated with these controls.

Pencil and Paper

Students could produce a list of objects and describe the events occurring with that object.

Resources

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 3, ILO 1-5

Topic 2: Introduction to Programming

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.2.2 identify the main components of an object oriented programming interface.

Suggested Teaching and Learning Strategies

For the Teacher

This outcome is meant to familiarize the student with the main components of the VB programming interface

Points to Emphasize

- Emphasize the main windows: properties, form, project explorer, toolbox, and menu bars.
- The toolbox shows the basic set of controls available to be used but these can be added to using the built in Windows modules or third party tool kits.
- The project window is useful for switching between form and code view.
- The form window allows the user to place objects on it to create the interface.
- The Properties window allows the user to change the properties of an object.
- Forms can be resized on screen.

For the Student

Students could be broken into teams and each team would be responsible for researching a component of an object oriented programming language. Each team would report their findings back to the class.

Topic 2: Introduction to Programming

Suggested Assessment and Evaluation Strategies

Performance

Identify and give the function of each of the windows of the VB programming interface.

Pencil and Paper

Given a screen shot of the VB programming interface, identify the main components.

Resources

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 2, ILO 1- 5

Topic 2 - Introduction to Programming

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.2.3 discuss how the graphical user interface (GUI) is developed on the form.

Delineation:

Toolbox controls

Control properties

Control arrays

Suggested Teaching and Learning Strategies

For the Teacher

The Form window allows for placement of objects. The objects and the Form become the interface or GUI.

Points to emphasize

- Good visual design principles should be applied to form layout and design.
- The form is a work area where the functionality that will be called a window is designed, developed and coded.
- Tools from the toolbox are drawn on the form.
- Control arrays are instances (copies) of the same control which have exactly the same name but which are distinguished by an attached index. EX. command1(0), command1(1) etc.

For the Student

Students should familiarize themselves with examples of poorly and well designed forms, and should have some rudimentary practice in 'designing' a form.

Topic 2: Introduction to Programming

Suggested Assessment and Evaluation Strategies

Performance

Given some examples of forms, students could rate them as good or poor, based on the principles of good design

Presentation

Students could demonstrate examples of good and poor interfaces

Resources

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 2, ILO 3 & 4, Section 3, ILO 7

Topic 2 - Introduction to Programming

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.2.4 employ sketching techniques to design a user interface which can be developed in an object oriented programming language.

Suggested Teaching and Learning Strategies

For the Teacher

This outcome is aimed at having the student provide descriptive and graphic elements for a user interface that are drawn from the implementation details.

Points to Emphasize

- Sketching the interface is a great way to lay out the user interface.
- Sketching the interface is an excellent time to plan color use and combinations.
- Descriptive elements help the programmer to code the function of controls.
- Descriptive elements help the programmer make the function of the interface seamless and simplistic for the end user.
- If they design an interface in vb without planning they may have to start from scratch.

For the Student

The student should be able to use a set of implementation details to describe and sketch the design and function of a simple interface.

Topic 2: Introduction to Programming

Suggested Assessment and Evaluation Strategies

Performance

Each student could propose a need for a graphical user interface and using sketching techniques they could design an interface for that need.

Pencil and Paper

Sketch the design and function of a simple interface for a given need.

Presentation

Demonstrate a plan for an interface and give reasons for the chosen layout. Present this plan to the class.

Resources

CDLI Integrated Systems 1205 online resource:

Unit 1, Section 2, ILO 1-3

Unit 3, Section 1, ILO 3

Topic 2 - Introduction to Programming

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.2.5 demonstrate the use of operators.

Delineation:

Boolean

mathematical

relational

concatenation (+, &)

Suggested Teaching and Learning Strategies

For the Teacher

This outcome introduces the student to the Boolean operators used in logical processing in a microcomputer. This must include AND, OR, NOR, NAND, NOT, XOR; the mathematical operators including +, -, =, /, \, %, MOD; relational operators including =, <, >, <>, <=, >=; and concatenation operators including + and &.

Points to Emphasize

- Boolean operators are used in conditional statements.
- Each operator has a truth table associated with it that defines inputs and outputs.
- Mathematical operators are used in conditional statements and to perform calculations in programs.
- Relational operators are used in conditional statements in comparative and mathematical processing.
- Concatenation operators are used in conditional statements: input and output statements.
- Concatenation operators are used to join character strings.

For the Student

- Students could create a program using a set of numbers to demonstrate standard mathematical operators. Divide the class into groups. Have each group develop a skit or some other role play to demonstrate a variety of Boolean Logic gates.
- Students could create a program using a set of numbers to demonstrate standard mathematical operators.
- Students could create a program to demonstrate the use of relational operators.
- Students could create short programs that demonstrate the use of the standard concatenation operators.

Topic 2: Introduction to Programming

Suggested Assessment and Evaluation Strategies

Performance

- Students could create a basic calculator in Visual Basic to demonstrate the use of mathematical operators.
- Students could follow a set of tutorials to demonstrate the use of all the operators.

Pencil and Paper

Students could be give a sample program and identify the operators in the code.

Resources

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 3, ILO 4

Topic 2 - Introduction to Programming

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.2.6 demonstrate the use of variables.

Delineation:

Data types

Hungarian notation

Variable declaration (dim)

Variable arrays

Suggested Teaching and Learning Strategies

For the Teacher

This outcome introduces the standard set of variable types used in programming.

Points to Emphasize

- This should include Single, Double, Long, Integer, Boolean, Byte, Date, Currency, String, and Variant. The idea of a constant should also be introduced at this point.
- Know that reserved Visual Basic keywords cannot be used as variable names.
- Students should use Hungarian Notation as the standard using a letter prefix indicates the type of variable: int, lng, cur, dbl, bln, lng, etc.
- A descriptive name, with the first letter capitalized, is used.
- An underscore connects the prefix and name together.
- Variable names should be used that reflect the context of use of the variable.
- Declarations are done in the general declarations area or inside of the code block for a control.
- The scope of the variable is going to depend upon where it is declared: global versus local.
- Arrays are declared using the DIM statement.
- Arrays are groups of containers that can hold a variable per container.
- Arrays have a unique characteristic called an index.
- Indices are ‘addresses’ that identify the location of ‘containers’ in an array.
- Recognize that arrays can be multi-dimensional in nature.

For the Student

Students could be provided with a variety of scenarios and asked to specify which variable data type would be most appropriately applied to that scenario.

Topic 2: Introduction to Programming

Suggested Assessment and Evaluation Strategies

Performance

Students could perform a role play where each character takes on the role of a different type of variable. Students would have to act out the role of that variable.

Pencil and Paper

Students could create a list of variable types, and determine their scope.

Resources

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 3, ILO 3

Topic 2 - Introduction to Programming

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.2.7 demonstrate the syntax and use of the definite, indefinite, and conditional looping structures available in programming.

Suggested Teaching and Learning Strategies

For the Teacher

This outcome addresses function of the looping structures used to do set numbers of iterations in a block of code, and those conditional looping structures whose number of iterations are determined by the condition attached to the structure.

Points to Emphasize

Definite looping: FOR … NEXT

- Conditional looping: DO <statements> LOOP WHILE (condition), and DO <statements> LOOP UNTIL (condition), DO WHILE (condition) <statements> LOOP, DO UNTIL (condition) <statements> LOOP
- Indefinite loop: DO <statements> LOOP

For the Student

Students could construct statements, blocks of code, or programs that use definite, indefinite and conditional looping structures.

Topic 2: Introduction to Programming

Suggested Assessment and Evaluation Strategies

Performance

Students could follow a set of tutorials to demonstrate the use of the definite, indefinite, and conditional looping structures.

Pencil and Paper

- Given samples of types of loops, students could determine whether they are definite, indefinite, or conditional.
- Students could be given a scenario and asked to write a loop to solve the problem.

Resources

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 3, ILO 6

Topic 2 - Introduction to Programming

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.2.8 demonstrate the syntax and use of conditional processing structures available in programming.

Suggested Teaching and Learning Strategies

For the Teacher

This outcome addresses the investigation of the function of the structures used to do conditional processing.

Points to Emphasize

This must include: IF ... THEN, IF ... THEN … ELSEIF … ELSE … ENDIF, SELECT CASE.

For the Student

Students could construct statements, blocks of code, or programs that use conditional processing structures.

Topic 2: Introduction to Programming

Suggested Assessment and Evaluation Strategies

Performance

Students could follow a set of tutorials to demonstrate the use of the conditional processing structures.

Pencil and Paper

- Students could be given samples of conditional processing structures, and asked to determine their type.
- Students could be given a scenario, where they would be required to write a conditional processing structure to solve the problem.

Resources

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 3, ILO 5

Topic 2 - Introduction to Programming

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.2.9 identify the properties of and recognize the scope of a procedure and function.

Suggested Teaching and Learning Strategies

For the Teacher

This outcome encourages students to investigate the properties of a procedures (also called a subroutine or sub procedure) and functions.

Points to emphasize

- Students should utilize procedures to create reusable code.
- Procedures do not accept or return values
- Procedures can be private or public which determines the scope of the procedure
- Procedures can be called from other parts of the program code
- Functions are almost identical to procedures but return a value to the main program, whereas sub procedures do not. EX. A function to convert feet to meters. The main program would pass the number of feet to the function and would return the length in meters. Function converts feet to meters and returns the value to the program.

For the Student

Students could create and manipulate procedures and functions in a Visual Basic program.

Topic 2: Introduction to Programming

Suggested Assessment and Evaluation Strategies

Performance

Students could create and manipulate procedures and functions in a Visual Basic program.

Pencil and Paper

Students could be given a printout of programming code and be asked to explain the properties and scope and the functions.

Resources

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 3, ILO 1

Topic 3 - Input Devices

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.3.1 identify the purpose of common sensor types utilized in robotics.

Delineation:

Temperature

Voltage

Current

Distance

Position

Force

Pressure

Humidity

Light

PH

Contact

Sound

Infrared

Suggested Teaching and Learning Strategies

For the Teacher

There are many different types of sensors. Sensors react to some physical phenomena and produce an electrical signal which is related to the change in the phenomena.

Points to Emphasize

- Sensors can be analog or digital. An analog sensor produces a continuously varying signal. If the signal is to be processed by a computer it must be converted to a digital signal.
- A digital sensor, like a simple switch, can be read directly by a computer.
- Sensors can vary an applied voltage to create the electrical signal (photocell) or can produce their own electrical signal (piezo crystal or silicon photocell).

Characteristics of sensors include:

- sensitivity – minimum signal that can be detected
- range – the spacing between the minimum and maximum values that can be detected
- resolution – smallest change that can be detected
- accuracy – how close a response is to an accepted value
- precision – the repeatability of a sensor, the ability to get the same value for a given input every time
- linearity – the sensor response varies in direct proportion to its input along its range

For the Student

Students could investigate Micro-machines (MicroElectroMechanical Systems (MEMS)) which are increasingly important as a source of sensors. Accelerometers for instance can be grown on a single piece of silicon. This results in tiny (sub-millimeter) sensor with built-in circuitry.

Topic 3 - Input Devices

Suggested Assessment and Evaluation Strategies

Presentation

- Students could be given a selection of sensors. They could identify each sensor and explain its purpose. Each student could be asked to Present their own data sheet on each sensor.
- Categorize sensors as either analog or digital, and explain their use.

Pencil and Paper

- Research the use of Micro-machines (MicroElectroMechanical Systems (MEMS))
- Research common sensor types and explain which parameters trigger their response.

Resources

Authorized Resource:

Robot Builders Bonanza, Ch. 14, 29 – 35

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 4, ILO 1 – 4 and Section 5, ILO 1 - 3

Topic 3 - Input Devices

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.3.2 identify the role of digital sensors.

Delineation:

Contact

Non-contact

Suggested Teaching and Learning Strategies

For the Teacher

The purpose of this outcome is to identify digital sensors that exist in two states and for students to be able to identify and understand the characteristics of contact and non-contact digital sensors

Points to Emphasize

- Digital sensors provide binary output which has two discrete states (on or off).
- One of the most basic digital sensors is the switch which is normally open (NO) or normally closed (NC).
- Contact digital sensor – These are mechanical switches that make a connection to complete a circuit and allow an electrical current to flow.
- Non-contact digital sensor – These devices do not require physical touch to open or close a circuit.

For the Student

Students could design and fabricate simple circuits that contain digital sensors, and examine the states of the sensors in the context of their use in the circuit.

Students could be provided with digital sensors and research the characteristics and potential uses of each respective sensor.

Topic 3 - Input Devices

Suggested Assessment and Evaluation Strategies

Performance

Design and fabricate simple circuits that contain digital sensors, and examine their states.

Journal

Students could write a journal entry indicating where digital sensors are used in household appliances and electronics.

Presentation

Students could demonstrate the use of digital sensors in a presentation to the rest of the class.

Resources

Authorized Resource:

Robot Builders Bonanza, pp. 198 – 201

CDLI Integrated Systems 1205 online resource:

Unit 2 Section 5, ILO 1 – 3

Topic 3 - Input Devices

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.3.3 identify the role of analog sensors.

Delineation:

Generating voltage

Modifying voltage

Suggested Teaching and Learning Strategies

For the Teacher

The purpose of this outcome is for students to recognize that sensors return a signal voltage which is proportional to a change in a physical phenomenon.

Points to Emphasize

These sensors can be categorized as those that generate a voltage and those that modify an external, applied voltage by a resistance or capacitance (or inductance) change.

Examples of sensors that generate signal voltages: piezo effect (vibration), electromagnetic induction (dynamic microphone), silicon photocell (light level), thermocouple (high temperature).

Examples of sensors that modify an applied voltage:

- resistance change (potentiometer, cadmium sulphide photocell, strain gage, thermister, pressure sensor)
- capacitance change (condenser microphone, ice sensors on aircraft)

For the Student

Investigate examples of analog sensors in technology and identify how they output a signal voltage.

Topic 3 - Input Devices

Suggested Assessment and Evaluation Strategies

Performance

Students could investigate examples of analog sensors in technology and identify how they output a signal voltage.

Perform activities using analog sensors

Pencil and Paper

Create a table of different sensors and explain their parameters.

Resources

Authorized Resource:

Robot Builders Bonanza, pp. 201 – 204

Authorized Resource:

Getting Started in Electronics

Topic 3 - Input Devices

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.3.4 calibrate an analog sensor signal.

Delineation:

Linear

non-linear

types of equations

Suggested Teaching and Learning Strategies

For the Teacher

Sensor signal conditioning is used to modify the output of a sensor so that it complies with the input characteristics of the next stage of data acquisition which is usually the Analog to Digital converter (ADC). Sensors output a voltage proportional to some applied physical stimulus. That voltage must be converted to the unit of measurement associated with that stimulus.

Points to Emphasize

- Sensors must be calibrated so their output can be reported in the correct units of measurement.
- A calibration procedure determines the relationship between the voltage output and the physical stimulus.
- The relationship (most often an equation derived from a dataset) is applied in software to display/report/store an accurate measurement and the correct unit.
- Sensors that have a linear relationship are easiest to calibrate. Non linear relationships can be determined with the aid of appropriate software and compared to information from sensor datasheets.
- If calibrated data is included with a sensor datasheet, the actual calibration data obtained by an activity can be compared to the theoretical (predicted).

For the Student

- Students could investigate examples of sensors with linear and non-linear outputs and carry out an activity to determine the calibration equation.

Topic 3 - Input Devices

Suggested Assessment and Evaluation Strategies

Performance

Carry out an activity to determine the calibration equation of an analog sensor.

Presentation

Discuss why signal conditioning needs to be applied to sensor voltage output.

Resources

Potentiometer Activity:

http://gander.cdli.ca/es3205/analog/index.htm

Topic 4 - Output Devices

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.4.1 differentiate between motor types typically used in robotics.

Delineation:

DC

Servo

Stepper

Suggested Teaching and Learning Strategies

For the Teacher

The purpose of the outcome is to differentiate between motor types

Points to Emphasize

- A stepper motor is a brushless motor that uses coils and a toothed magnet to give precise speed and positioning. It is commonly controlled by some sort of circuit which energizes each coil sequentially. The resulting magnetic field causes the coils to rotate, and thus drives the motor.
- The basic DC drive motor is a brushed motor that uses coils and magnets in the reverse configuration to the stepper. Coils are energized in the center of the motor, which rotate due to the attraction and repulsion of the permanent magnets around the outside of the casing.
- A servo motor is a small motor that can rotate approximately 180 degrees to accurately place an attachment in that range. The device has a control-feedback unit built in, such that it will respond to change. A control wire communicates the desired angle by a pulse of a given duration.

For the Student

In groups students could prepare a presentation to introduce the rest of the class to the characteristics of different types of motors.

Topic 4 - Output Devices

Suggested Assessment and Evaluation Strategies

Performance

Given a selection of motors, students will identify and explain the use of the various motors in robotics

Journal

Research DC, Servo and Stepper and create an entry explaining the difference between them. Include a image of the Motor.

Resources

Potentiometer Activity:

http://gander.cdli.ca/es3205/analog/activity2/activity2.htm

Authorized Resources:

Robot Builders Bonanza, Ch. 19, 20 , 21 and 22

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 5, ILO 5 – 8

Topic 4 - Output Devices

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.4.2 differentiate between the two main types of electromechanical actuators.

Delineation:

Linear

Rotational

Suggested Teaching and Learning Strategies

For the teacher

The purpose of this outcome is to make students aware of two main types of electromechanical actuators.

Points to Emphasize

Actuators are things that cause movement. In robotics there are two main types of actuators; linear and rotational. As the names might suggest, the basic difference is that linear actuators (such as pneumatic cylinders) cause movement in a straight line and rotational actuators (such as a basic DC drive motor) cause movement in a circular path.

For the Student

Students could identify the most appropriate applications for each type of actuator. A list could be generated and comparisons made between groups.

Topic 4 - Output Devices

Suggested Assessment and Evaluation Strategies

Performance

Select one actuator of each type and explain how each actuator works and what kinds of tasks can be accomplished by each.

Journal

Research actuators and create a list of examples of actuators and their uses.

Resources

CDLI Integrated Systems 1205 online resource:

Unit 2, Section 5, ILO 5 – 8

Topic 4 - Output Devices

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.4.3 use pulse width modulation to demonstrate proportionate control for servo and DC Motors

Suggested Teaching and Learning Strategies

For the Teacher

Servo motors consist of a built-in control circuit and sensor (a potentiometer) connected to a geared motor. The device can rotate approximately 180 degrees to accurately place an attached device in that range. A control wire communicates the desired angle by a pulse of a given duration. This kind of control is called Pulse Width Modulation – a pulse of 1.5 milliseconds for instance might turn the motor to the 90 degree position.

Points to emphasize

- Since servos are active they will maintain their position against a torque.
- In robotics servos are mainly used for actuation of arms, grasping and walking.
- A servo motor is used with a servo controller, the two act together to give the control and motion necessary. An example of this is the Phidget servo controller.
- Electronic speed controllers are primarily used to control the speed and direction of drive motors used for robot mobility. These motors typically rotate continuously and draw much higher current than servo motors.
- Electronic speed controllers are typically driven by the same signal as a servo motor. The speed controller is inserted between the servo controller and the drive motor, and supplies a variable amount of current to the drive motor. Based on the signal from the servo controller, this gives proportional control of the rotational speed of the drive motor.

For the student

Students could connect a servo motor to a servo controller test the controller using the Phidgets monitor.

Topic 4 - Output Devices

Suggested Assessment and Evaluation Strategies

Performance

Connect a servo motor to an electronic speed controller and configure the program for proportional control of the motor.

Journal

Write an entry reflecting on how you see proportional motor control being used in common household appliances and consumer electronics.

Resources

CDLI Integrated Systems 1205 online resource:

http://www.cdli.ca/courses/isys1205/phidgets/unit03_org02_ilo07/a_getready.html

http://gander.cdli.ca/es3205/unit02/section05/lesson08/3-lesson-a.htm

Topic 4 - Output Devices

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.4.4 use sensors and actuators to demonstrate analog and digital sensing and control.

Suggested Teaching and Learning Strategies

For the Teacher

This outcome will require the students to do skill building activities to implement the theory from previous outcomes.

Points to emphasize

- Digital and analog sensing and control are done using appropriate sensors, actuators, and interface devices.
- Interface control is done using a computer and an appropriate programming language .
- Some sensors can be fabricated using discrete electronic components and prototyping boards.
- Calibration exercises are important to emphasize the point that sensors do not measure temperature, pressure, etc. directly.

For the Student

Students could engage in skill building activities to practice the theory of sensing and control.

Topic 4 - Output Devices

Suggested Assessment and Evaluation Strategies

Performance

Students could use a computer, programming code and sensors to sense various external phenomena. They could then have an actuator such as a motor move in response to what is being sensed.

Pencil and Paper

Students could sketch out the a system that does digital and analog sensing and control. This sketch could be in the form of a flow chart showing the various components of the system.

Resources

Integrated Systems 1205 online resource:

http://www.cdli.ca/courses/isys1205/phidgets/unit_02.html, Section 5, ILO 5 – 8

http://www.cdli.ca/courses/isys1205/phidgets/unit_03.html, Section 2, ILO 1 - 9http://gander.cdli.ca/es3205/analog/index.htm

Topic 4 - Output Devices

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.4.5 identify applications of pneumatics for robotics.

Suggested Teaching and Learning Strategies

For the Teacher

Pneumatic actuators are used mainly for grippers and movement of joints in robotic applications.

Points to Emphasize

The advantages of pneumatic systems are they:

- allow easier control of high force applications
- can provide a better force to weight ratio than hydraulic systems or electric motors with similar power
- are less expensive

For the Student

- Students could research the applications of pneumatics (and hydraulics) in robotics. They could identify what these applications have in common while considering the advantages of pneumatics.
- Students could research the advantages of pneumatics and perform a simple experiment to compare the amount of force exerted by an electric motor with the amount of force exerted by a pneumatic actuator.

Topic 4 - Output Devices

Suggested Assessment and Evaluation Strategies

Presentation

Students could develop a short presentation outlining some of the areas in industry where pneumatic systems work with robotics.

Journal

Students could journal about what they consider to be the advantages and disadvantages of pneumatics for robotic systems.

Resources

CDLI Integrated Systems 1205 online resource:

http://www.cdli.ca/courses/isys1205/phidgets/unit02_org04_ilo03/a_getready.html

Topic 4 - Output Devices

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.4.6 identify the characteristics and function of indicators in electronic circuits.

Suggested Teaching and Learning Strategies

For the Teacher

The purpose of this outcome is for students to consider the variety of characteristics, as well as the function of indicators in electronic circuits.

Points to Emphasize

- Light emitting diodes (LED) - This is a direct current device that gives off light using small amounts of electrical current. Most LEDs require current limiting resistance.
- Infrared emitting diodes (IRED) - An LED which only emits light below red frequencies in the color spectrum. Infrared light is not visible to the human eye.
- Incandescent bulb – A source of artificial light where an electrical current passes through a filament that, because of its resistance to electron flow, heats up, producing light as a by-product of that heating. The enclosing glass bulb prevents the oxygen in air from reaching the hot filament.
- Piezo electric crystals – Materials which either change their shape in response to the application of electrical current or produce electrical current in response to a shape change.

For the Student

Students could identify and explain the function of circuit indicators in consumer electronics. i.e. IPods, cell phones, game controllers, DVD players, etc.

Topic 4 - Output Devices

Suggested Assessment and Evaluation Strategies

Presentation

Student teams could select a piece of consumer electronics and develop a presentation on how indicators are used in that piece of electronics.

Journal

Students could discuss some of the roles of indicators in consumer electronics.

Pencil and Paper

Students could be given a problem and asked to identify what indicator that would solve that problem in an electronic circuit.

Resources

CDLI Integrated Systems 1205 online resource:

http://www.cdli.ca/courses/isys1205/phidgets/unit02_org04_ilo03/a_getready.html

Topic 5 - Remote Sensing and Control

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.5.1 describe unique features of wireless control.

Delineation:

Traditional radio control

IP Control

Bluetooth

Suggested Teaching and Learning Strategies

For the Teacher

This outcome will require students to identify common features of robots and unique features of wireless robots. It does not matter which type of wireless connectivity chosen, configuration is similar in each case.

Points to Emphasize

Radio controlled robots will share many common features with other robots in general. Robots are usually radio controlled for one essential reason—to allow for vastly increased mobility due to the absence of any tethers or hard wiring.

All robots will have certain features in common. They are the:

- ability to accomplish repetitive tasks accurately
- ability to travel and operate in areas where humans cannot

Radio controlled robots will have the following features:

- Contain a radio receiver and transmitter (transmitter is not located onboard the robot).
- Contain onboard power supply or supplies.

For the Student

Students could identify the features of wireless and tethered robots.

Topic 5 - Remote Sensing and Control

Suggested Assessment and Evaluation Strategies

Presentation

Students could research the characteristics of wireless control and develop a Prezi presentation outlining some of its applications in industry.

Journal

Students could write an entry outlining what they already know about wireless communications and where it is used.

Pencil and Paper

Students could develop a chart outlining the advantages and disadvantages of wireless communications.

Resources

Authorized Resource:

Robot Builders Bonanza, pp.657 – 658

External Link:

http://www.societyofrobots.com/electronics_bluetooth_robot.shtml

Topic 5 - Remote Sensing and Control

Specific Curriculum Outcomes

Robotic Systems Technology 3205

Students will be expected to:

3.5.2 describe applications for wirelessly controlled robotics.

Suggested Teaching and Learning Strategies

For the Teacher

Wirelessly controlled robots are used in applications where increased mobility and freedom of movement are desirable. It should also be noted that wirelessly controlled robots can suffer from problems specific to wireless communication; radio interference and loss of signal.

Points to Emphasize

Typical applications include:

- "Spy-bots" that gather video or other information of a remote location.
- Travel over rough or otherwise difficult terrain where a tether may impede or prevent motion.
- Travel in areas deemed undesirable or dangerous to humans.
- Travel over very large distances, as in the case of space exploration.

For the Student

In small groups or the class as a whole, students could generate a list similar to the above using a brainstorming and discussion session.

Topic 5 - Remote Sensing and Control

Suggested Assessment and Evaluation Strategies

Performance

Students could write a design challenge presenting a robotic problem that could be solved using the unique features of wireless communications.

Journal

Describe some of the situations that you have seen wireless robotics being used.

Pencil and Paper

Sketch a flowchart or a map of a manufacturing floor that would use a wirelessly controlled robot.

Resources

Authorized Resource:

Robot Builders Bonanza, pp.657 – 658

External Link:

http://www.societyofrobots.com/electronics_bluetooth_robot.shtml