FOUNDATIONS

MINDS-i

STEM INTEGRATED ROBOTICS

S.T.E.M. Integrated Robotics Detailed Outline

Unit 1: An Introduction to MINDS-i

Time: 4 Days

Lesson 1.1 Introduction to MINDS-i

Time: 1 days

Concepts

1. A breif intro of how MINDS-i defines STEM education and STEM Integrated Robotics, includes a short description of each of the units included in the curriculum.

Performance Objectives

It is expected that students will:

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Lesson 1.2 Student Performance Development Process

Time: 1 days

Concepts

1. An explination of the Student Performance Development Process that is to be used to grade the student. Inspired by Tony Wagner, author of The Global Achievement Gap, focusing on the seven survival skills for the new world.

Performance Objectives

It is expected that students will:

- Understand the critera that they will be graded on for the class term.

Lesson 1.3 What is a Robot?

Time: 1 days

Concepts

2. A Robot is a mechanical or virtual artificial agent, usually an electronically operated mechanical machine that is guided by a computer program or electronic circuitry
3. Robots can be autonomous, semi-autonomous or remotely controlled by people
4. Autonomous Robots can perform tasks and interact within an unstructured environment without human guidance
5. Robotics are all around us and are often integrated into products and machinery that we normally would not think of as robotic

Performance Objectives

It is expected that students will:

- Identify examples of related real-world applications or careers

Unit 2: Continuous Learning & Improvement

Time: 10 Days

Lesson 2.1 Model for Inquiry

Time: 1 days

Concepts

1. Inquiry is the process by which a question is asked, an experiment is conducted, results are studied and acted upon
2. Continuos learning drives continuous improvement, and is key to maintaining real-world competitive advantage and survivability.
3. In the same way that biological organisms evolve, so must engineering and technology
4. Plan- Brainstorm engineering design changes to improve upon the task performance of a simple machine
5. Do- Select and implement engineering design changes, comparing the effectiveness of the original to the new design, and collect baseline data for both
6. Study- Apply math (average, range) to analyze the data and determine if the design change did in fact result in a performance improvement
7. Act- Document results on a scatter plot for original and new design, and decide whether to continue with another PDSA cycle

1. The use of simulations as both a learning tool and as a means to measure progress toward a goal.

Performance Objectives

It is expected that students will:

- Demonstrate understanding of the method for Inquiry
- Document a PDSA Cycle reflecting back to the lessons learned from the roller coaster simulation in Unit 1
- Understand the importance of simulations as tools for planning and learning

Lesson 2.2 The Importance of Data

Time: 3 days

Concepts

1. The importance of math and data within the process of experimentation
2. Effective data collection and analysis is needed to determine if a change was in fact an improvement
3. Reliance on intuition alone will often result in misinterpretation, and the sub-optimization of the system

Performance Objectives

It is expected that students will:

- Demonstrate understanding of the “Study” aspect of the PDSA cycle (Plan, Do, Study, Act) and how it

relates to hypothesis, predictions, data baseline, experimentation, pilot-test, and data-analysis

Lesson 2.3 Parts & Purposes

Time: 1 days

Concepts

1. Recognizing an object from a detailed description

Performance Objectives

It is expected that students will:

- Match the correct image of an item to the description

Lesson 2.4 Simple Machines

Time: 4 days

Concepts

1. Leveraging the strengths of the members in your group to accomplish a goal
2. Designing and building a simple machine

Performance Objectives

It is expected that students will:

- Design and construct a simple machine out of mechanical construction elements to perform a specified task objective
- Document the design process for the simple machine

Unit 3: Variables of Force & Motion

Time: 13 Days

Lesson 3.1 Force & Motion

Time: 1 days

Concepts

1. The relationships between the different laws of force and motion and their impact on objects, including key factors such as; acceleration, inertia, mass, momentum, friction, speed, balanced and unbalanced forces

Performance Objectives

It is expected that students will:

- Demonstrate understanding of the different laws of force and motion and their impact on objects.

Lesson 3.2 Parts & Purposes

Time: 1 days

Concepts

1. Recognizing an object from a detailed description

Performance Objectives

It is expected that students will:

- Match the correct image of an item to the description

Lesson 3.3 Gear Ratios; Speed & Torque

Time: 9 days)

Concepts

1. Calculating gear ratios in multiple gear systems.
2. Determining vehicle speed
3. Gain an understanding of how changing gear ratios effects force (torque) and motion (speed) and their interrelationships with one another

Performance Objectives

It is expected that students will:

- Calculate the ratio of one of gear set, and mathematically determine it's effects on force (torque) and motion (speed), and will validate calculations with tachometer and torque meter
- Calculate the ratio of a second gear set, and mathematically determine their effects on force (torque) and motion (speed), and compare the results to the first study above
- Calculate the robot speed using revolutions-per-minute (RPM), tire diameter and circumference

Lesson 3.4 Friction

Time: 1 days

Concepts

1. The relationships between friction and gravity and their impact on objects, including the relationship to the laws of force and motion

Performance Objectives

It is expected that students will:

- Demonstrate understanding of the principals of friction, including concepts such as no energy is destroyed due to friction but is instead dissipated as heat

Lesson 3.5 Inertia

Time: days

Concepts

1. Inertia is the property of an object to want to remain still or maintain their movement

Performance Objectives

It is expected that students will:

- Conduct electrical tests and mathematically estimate the amount of energy required to overcome the

robot's inertia

Unit 4: Software Programming, Sensors & Servos

Time: 15 Days

Lesson 4.1 Why Programming?

Time: 1 days

Concepts

1. Programming allows a user to create a device that is capable of both interacting with its environment and choosing a pre-determined response based on those interactions
2. The most basic of programmable robotics include, Inputs (Sensors), Control Structures (Code for decision making) and Outputs (Motors, Servos, Lights etc.)

Performance Objectives

It is expected that students will:

- Identify and describe the function of the core components associated with robotic control systems, such as sensors, transmitters, micro-controller, software, operating code, syntax, servos, motors, and their relationship to inputs, control structures, and outputs

Lesson 4.2 Parts & Purposes

Time: 1 days

Concepts

1. Recognizing an object from a detailed description

Performance Objectives

It is expected that students will:

- Match the correct image of an item to the description

Lesson 4.3 Testing the Micro-controller

Time: 1 days

Concepts

1. Familiarization with Micro-controller set-up and operation including menus, buttons, opening and saving new programs

Performance Objectives

It is expected that students will:

- Become familiar with the Micro-controller users interface and be able to demonstrate basic utilities such as opening a new programs, saving, checking and uploading programs

Lesson 4.4 Creating the Breadboard / Servo

Time: 2 days

Concepts

1. Create a test environment bread-board for applying and understanding various robotic inputs, control structures, and output operations
2. Test and experiment with basic micro-controller and servo actuation outputs using pre written programs on the bread-board

Performance Objectives

It is expected that students will:

- Gain understanding of the operation of outputs (Servos) based on Micro-controller commands

Lesson 4.5 Adding to the Breadboard / ESC

Time: 2 days

Concepts

1. Using a test environment bread-board for applying and understanding various robotic inputs, control structures, and output operations
2. Test and experiment with basic micro-controller and ESC / Motor actuation outputs using pre written programs on the bread-board

Performance Objectives

It is expected that students will:

- Gain understanding of the operation of outputs (ESC / Motor) based on Micro-controller commands

Lesson 4.6 Adding to the Breadboard / Radio Transmitter

Time: 2 days

Concepts

1. Using a test environment bread-board for applying and understanding various robotic inputs, control structures, and output operations
2. Test and experiment with basic micro-controller and Radio Transmitter inputs using pre written programs on the bread-board

Performance Objectives

It is expected that students will:

- Gain understanding of the operation of inputs (Radio Transmitter) based on Micro-controller commands

Lesson 4.7 Adding to the Breadboard / Ultrasound Sensor

Time: 2 days

Concepts

1. Using a test environment bread-board for applying and understanding various robotic inputs, control structures, and output operations

2. Test and experiment with basic micro-controller and Ultrasound sensor inputs using pre written programs on the bread-board

Performance Objectives

It is expected that students will:

- Gain understanding of the operation of inputs (Ultrasound sensor) based on Micro-controller commands

Lesson 4.8 Adding to the Breadboard / QTI Sensor

Time: 2 days

Concepts

1. Using a test environment bread-board for applying and understanding various robotic inputs, control structures, and output operations
2. Test and experiment with basic micro-controller and QTI sensor inputs using pre written programs on the bread-board

Performance Objectives

It is expected that students will:

- Gain understanding of the operation of inputs (QTI sensor) based on Micro-controller commands

Lesson 4.9 Core Syntax

Time: 2 days

Concepts

1. Familiarization with the parts that make up a program (Core Syntax) including setup, loops, comments, start and end brackets, etc.

Performance Objectives

It is expected that students will:

- Identify and describe core software code syntax language components, such as; setup, loops, comments, start and end brackets, data types, arithmetic operators, comparisons, digital and analog input/output selection, and time

Unit 5: Autonomous Robotics

Time: 8 Days

Lesson 5.1 What Makes a Robot Autonomous?

Time: 3 days

Concepts

1. A fully autonomous robot has the ability to
- (Rule #1) Gain information about the environment

- (Rule #2) Work for an extended period without human intervention
- (Rule #3) Move either all or part of itself throughout its operating environment without human assistance
- (Rule #4) Avoid situations that are harmful to people, property, or itself unless those are part of its design specifications

Performance Objectives

It is expected that students will:

- Be able to correctly identify whether a machine is or is not autonomous

Lesson 5.2 Basic Control Structures

Time: 3 days

Concepts

1. Understanding of basic control structures using pre written programs, such as; IF; IF-ELSE, and WHILE

Performance Objectives

It is expected that students will:

- Be able to explain the reason and use of each of the basic control structures

Lesson 5.3 Autonomous Obstacle Avoidance

Time: 1 days

Concepts

1. Utilization of Ultrasound sensors to create a robot that is capable of detecting obstacles in its path as well as avoiding them

Performance Objectives

It is expected that students will:

- Test, experiment with, apply, and optimize advanced micro-controller and multi-ultrasound sensor input code using pre written programs for utilization with cumulative project

Lesson 5.4 Line Following

Time: 1 days

Concepts

1. Utilization of QTI sensors to create a robot that is capable of detecting contrasting lines then alter its path to follow the line

Performance Objectives

It is expected that students will:

- Test, experiment with, apply, and optimize advanced micro-controller and multi-QTI (line follower)

sensor input code using pre written programs for utilization with cumulative project

Unit 6: Mechanical & Structural Engineering

Time: __ Days

Lesson 6.1 Levers, Cams & Span

Time: __ days

Concepts

1. How the force of gravity affects levers, cams, span and torque

Performance Objectives

It is expected that students will:

- Gain understanding on how gravity affects the operation of their robot

Lesson 6.2 Structural Design

Time: __ days

Concepts

1. Application of structural design principles using vertical and diagonal mechanical construction elements (i.e. triangles, rectangles, parallelograms) and actuators for bracing, spanning and mechanical actuation

Performance Objectives

It is expected that students will:

- Gain understanding on how to properly design and build structures capable of their needs

Lesson 6.3 Robot Arm & End of Arm Tool

Time__ days

Concepts

1. How to work as a team to brainstorm, design, build and then test the design
2. Being able to produce a working product that both functions as intended and complies to all limiting factors in the time allotted

Performance Objectives

It is expected that students will:

- Design and build a robot arm and end-of-arm tooling utilizing the structural design principles from above.
- ***Analyze the design and predict how it will behave in response to the application of the force from above, including simple calculations of torque and mechanical leverage in comparison to the working load requirements***
- ***Test their robot by completing a small challenge***

Unit 7: Culminating Project

Time: __ Days

Lesson 7.1 Preparing for The Challenge

Time: __ days

Concepts

1. Development of a project plan to keep track of progress compared to goals
2. Effective use of interpersonal skills
3. Proper communication
4. Group productivity

Performance Objectives

It is expected that students will:

- Develop a project plan with specific goals and responsibilities and apply what has been learned to combine, develop and optimize a software program that is capable of
- Manually switching between manual and autonomous navigation through the micro-controller
- Autonomously switching between ultrasound sensors and QTI (line follower) sensors
- Use the time allotted to refine and adjust the robot design as well as programming to complete the presented challenge

Lesson 7.2 Cleanup/ Organizing

Time: __ days

Concepts

1. Organization / Housekeeping

Performance Objectives

It is expected that students will:

- Dissaseble the MINDS-i kit accounting for all of the parts then organize into bins/totes for storage or teh next class to use.