Unit 1: Python Fundamentals

Content Area: **Applied Tech**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Standards

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.2	Create generalized computational solutions using collections instead of repeatedly using simple variables.
CS.9-12.8.1.12.AP.3	Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice.
CS.9-12.8.1.12.AP.7	Collaboratively design and develop programs and artifacts for broad audiences by incorporating feedback from users.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.DA.1	Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
CS.9-12.8.1.12.DA.2	Describe the trade-offs in how and where data is organized and stored.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
CS.9-12.8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.1	Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made.
CS.9-12.8.2.12.ITH.2	Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.

Transfer Goals

In the era of the Internet of Things (IoT), it is necessary to rapidly develop and test prototypes with hardware and software. This course uses the Arduino hardware platform for the IOT section of the course and the Raspberry Pi Platform for the Artificail Intelligence portion of the course. Both platforms are open sourced. On the software side, the Python programming language has been prominent in the open software community for some time. Python is supported by software libraries that interface with Arduino hardware. These librariries offer support for user interfaces, plots, messaging, and cloud applications. Just like in industry, students use an Application Programmers Interface(API) to build their applications. Topics including: Python Data Types and Variables, Input and String Manipulation, Module Imports, Looping, Conditional Decision Making, Custom Functions, Exception Processing, Statistics Generation and Plotting.

Life Literacies and Key Skills.

HE.9-12.2.1.12.SSH.4	Demonstrate strategies to prevent, manage, or resolve interpersonal conflicts without harming self or others (defining and understanding the laws of consent and dating violence).
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.8	Evaluate media sources for point of view, bias, and motivations (e.g., NJSLSA.R6, 7.1.AL.IPRET.6).

Concepts

Essential Questions

- What is a variable?
- How to assign a value to a variable?
- What are the rules for designing variable names?
- What are the python Data Types?
- How can a float be casted to an integer value?
- How to use print() to display output?

- What are lists, tuples, or dicionaries useful?
- How can lists be manipulated by functions?
- How can two strings be concatenated?
- What is useful about importing modules like time, math, and random?
- Can Lists be composed of different data types?
- What are the python built-in functions?
- What are the ways for iterating through a list?
- How can for loops be used to iterate through a list?
- What's the difference between a For Loop and a While Loop?p
- What's the difference between conditional decision making and logical conditions?
- When is it useful to use breaks, continues, and conditionals in loops?
- How is the LocoIOT API Documentation used to build an application?
- Why is the LocoIoT Template Python File useful?

Understandings

Students will develop a basic knowledge of python as described in the Transfer Goals section to build IoT and AI Applications.

Critical Knowledge and Skills

Knowledge

Students will know:

- Data Structures(Lists, Tuples, Dictionaries)
- Math Library Functions
- Console Input, String Methods, Parsing, and Concatenation
- Time, Math, and Random Libraries
- While Loops, Logical Conditions/Expressions, and Booleans
- Commonly Used Built-in Python Functions
- Sequences, Iterations, While & For Loops, range()
- If, elif, else statements with Logical Conditions
- Conditionals in Loops, Break, and Continue Keywords
- Time-based while Loops, Multiple Outputs
- Function definitions, Function Inputs, Function Outputs

- How to use python mapping function.
- Scopes of Variables in Python Programs, global Keyword
- Try, except, else, raise, finally Keywords and Blocks
- Exception Handling
- Variables, Integers, Floating Points, Strings, Console Output, Comments

Skills

Students will be able to:

- Use appropriate variables and understand the different types: int, float, and bool
- Create local and global variables and assign values
- Predict the data type of a value returned from a mathematical equation.
- Use string indexes to make another string.
- Define and manipulate a list.
- Build a dictionary.
- Be able to use Python built-in functions like float, dict, map, min, max, len, int,import, and print.
- What variables to assign globally?
- Create a function with parameters and returns.
- Save user input in a dictionary.
- Display sensor data with appropriate units.
- Build and use a class structure.
- Use Logical and conditional expressions.
- Debug a program.
- Use comments for documentation.
- Use a pseudo language to build an algorithm.
- Know where to place variables so they have the appropriate scoping.
- Use For and While Loops when appropraite.
- Use conditional expressions to control program execution.
- Use exception keyword to recover from execution errors or interrupts.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for Discussion.

- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks.
- Groups whiteboard algorithms and sollicit feedback from the class.
- Students pose questions on Google Classroom.
- Students directly request teacher's assistance if other students can't answer their questions.

School Summative Assessment Plan

Since the student has satisfied the prequisites for this course, there is no formal review of their Python skills. They are utilized throughout this course and refreshed when needed.

Primary Resources

LocoRobo Innovations Development Environment and Courseware.

Supplementary Resources

Introduction to Computation and Programing Using Python by John V. Guttag Second Edition 2016 ISBN: 9780262529624

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
    - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

● **One to One Student's laptop**

- All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

● **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student's native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, special education students are given choice of topic and resources so that their

materials are within their ability level and high-interest.

❑ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - A program can be represented by a flow chart so that the control flow and number of iterations can be checked on paper befor commiting to code.

SCIENCE - An algorithm is best designed on paper before being coded.

SOCIAL STUDIES - The history of these programming constructs in computer science can be examined, namely what were the circumstances for their creation?

WORLD LANGUAGES - Use correct syntax and tab formatting in Python propgrams. Learn to refer to the dictionary of Python online at the standard Python3 designation.

VISUAL/PERFORMING ARTS - Students can act out an iterative construct.

BUSINESS EDUCATION - Students will realize that debugging a poorly designed program is often not productive from a business sense, it might be cheaper to simply redesign it.

GLOBAL AWARENESS - Students will realize the names of functions may have a cultural bent depending upon the frame of reference of the programmers from their native country.

Learning Plan / Pacing Guide

Week 1: Python Data Types and Variables, Scoping

Week 2: Python Input, String Manipulation, and Conditional Expressions

Week 3: Module Imports, Math Operations, and Function Creation & Use(Built-Ins)

Week 4: Lists, Tuples, and Dictionaries Construction and Manipulations

Week 5: Variable Scope, Exception Handling, Custom Functions

Unit 2: Digital Devices

Content Area: **Applied Tech**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Standards

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

Transfer Goals

What makes the Arduino microcontroller platform so useful is that the system is equipped with both inputs and outputs. These series of lessons will provide the student opprtunities for building applications which both sense the world and respond according to the designer. The student will use the following devices: LED's(Digital Input), Buttons(Digital Inputs), Active & Passive buzzers, 7 segment display and driver,

Ultrasonic sensor, Membrane Switch, LED Dot Marix, and a Real-Time Clock

Life Literacies and Key Skills.

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- How is hardware and microcontroller pins mapped to hardware codes in the Python Pin Reference Table?
- How can a resistor value be identified visually?
- What happens if no resistors are used in the LED Circuit?

- How are the 4 pins on a button related?
- Can a button be in a state different than an open or closed state?
- How can PWM signals be used to vary the brightness of an LED?
- Does it matter how fast the PWM signal is changing?
- How is an active buzzer differentiated from a passive buzzer?
- When i sit best to use an active buzzer?
- Can the 7 segment display be controlled without the integrtaed circuit driver component?
- Does it matter which of the tilt ball switch leads is connected for each connection point in the circuit?
- What steps can be taken if a program is getting unresponsive or unexpected behavior from the arduino microcontroller?
- How can the distance from an object to the ultrasonic sensor be calculated based on time?
- How can the range of the ultrasonic sensor be detected?
- Can a python program open and write to multiple files?
- Can LED Dot matrices be configured for multiple colors?
- Why is the real time clock(RTC) needed if the arduino provides a library of time control modules?
- How does one troubleshot a LCD showing a blank display?

Understandings

Gain experinece interfacing and troubleshooting digital input and output devices in the form of a hardware and software application.

Critical Knowledge and Skills

Knowledge

Students will know:

- How a Breadboard is wired up.
- Determine the maximum current an LED circuit can handle.
- High and Low voltage thresholds for an Arduino or other digital device.
- Understand the mapping in the LocoIoT API documentation.
- RGB stands for Red-Gren-Blue and refers to the individual colored LEDs inside the case.
- A Pulse Width Modulated(PWM) signal is used to vary the brightness of each color.
- A PWM signal oscillates between 0 & 5 Volts.

- A "Duty Cycle" refers to the ratio of high-time to the total time during a single period of a PWM signal.
- The LocoIoT class setData() function's first input is the class hardware setup code.
- setData() second argument is a list of three integer values between 0 and 255 specifying color and brightness.
- The passive buzzer contains a piezo disc and requires an oscillating signal to generate an acoustical
- The python program send the buzzer an oscillating signal for a specified duration at a specified frequency.
- Understand how the ultrasonic sensor takes data so an algorithm can be constructed.
- How to plot sensor data using LocoIoT functions.
- Understand how to use a membrane switch.
- Understand how to use an LED Dot Matrix to draw shapes.
- Understand how to use a Real Time Clock(RTC) integrated circuit.
- Understand how the NTC Thermistor takes accurate temperature readings.

Skills

Students will be able to:

- Wire up components on breadboards.
- Learn how to read the resistor code system.
- Connect and control a single LED with a Python program.
- Use a loop to sample and display a button's state continuously.
- Using loops and conditionals, create a repeating acoutiscal output.
- Complete the 1-digit 7-segment display circuit with the IC driver chip.
- Use the tilt ball switch as a vibration/motion detector.
- Visualize Ultrasonic sensor data and experiment with its range.
- Perform linear mapping of distance to RGB color or Passive buzzer frequency.
- Visualize Ultrasonic sensor data and experiment with its range.
- Perform linear mapping of distance to RGB LED color or Passive buzzer frequency.
- Use the Membrane Switch Module to control program behavior and load a password from a file.
- Use a python program to determine which if any keys have been pressed on the Membrane Switch.
- Create a user interface, a basic GUI, for setting the full state of the LED Dot Matrix.
- Use nested looping for widget creation and processing.
- Perform timing comparisons between the Python time module library and RTC time.
- Create a time-based alarm with the buzzer and an LED.
- Develop an RTC time-based motor-control system.
- Use the LCD to display RTC time data along with temperature readings.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for Discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks.
- Groups whiteboard algorithms and sollicit feedback from the class.
- Students pose questions on Google Classroom.
- Students directly request teacher's assistance if other students can't answer their questions.

School Summative Assessment Plan

The teacher will design mini-projects for the student to complete using LocoIoT hardware and software.

Primary Resources

LocoRobo Innovations Development and Execution Environment using WebAcademy courseware.

Supplementary Resources

Introduction to Computation and Programing Using Python by John V. Guttag Second Edition 2016 ISBN: 9780262529624

Exploring Arduino by Jeremy Blum Second Edition 2020 ISBN: 978-1-119-40537-5

Arduino Cookbook y Michael Margolis, Brian Jepson, and Nicholas Robert Weldin Third Edition 2020 ISBN: 9781491903520

Technology Integration and Differentiated Instruction

Technology Integration

● **Google Products**

- Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
- GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

● **One to One Student's laptop**

- All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

● **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student's native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials

are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❑ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - A program can be represented by a flow chart so that the control flow and number of iterations can be checked on paper befor commiting to code.

SCIENCE - An algorithm is best designed on paper before being coded.

SOCIAL STUDIES - The history of these programming constructs in computer science can be examined, namely what were the circumstances for their creation?

WORLD LANGUAGES - Use correct syntax and tab formatting in Python propgrams. Learn to refer to the dictionary of Python online at the standard Python3 designation.

VISUAL/PERFORMING ARTS - Students can act out an iterative construct.

BUSINESS EDUCATION - Students will realize that debugging a poorly designed program is often not productive from a business sense, it might be cheaper to simply redesign it.

GLOBAL AWARENESS - Students will realize the names of functions may have a cultural bent depending upon the frame of reference of the programmers from their native country.

Learning Plan / Pacing Guide

Week 1: What is the Internet of Things(IoT)? How is IoT used in Everyday Life? How to use a breadboard and the IoT kit with two microcontrollers?

Week 2: Core Lessons using LED's, Buttons, RGB LED's, Active and Passive Buzzer

Week 3: Core Lessons using 7 Segment Display and Driver, Tilt Ball Switch, and Ultrasoniic Sensor

Week 4: Core Lessons using Membrane Switch, LED Dot Matrix, and Real Time Clock

Week 5: Mini-Project 1: Leds + Digital Inputs, Mini-Project 2: RGB LEDs + Buzzer

Week 6: Mini-Project 3&4: LCD with RGB LED and Thermometer

Week 7: Mini-Project 5: Temperature & Humidity Sensor with LCD

Week 8: Mini-Project 6: Membrane Switch with LED Dot Matrix, Mini-Project 7: RTC with LCD

Weeks 9 - 11: Photocell, Servo, DC Motor - Use to build Light Tracker made of Photocells mounted on a Servo

Week 12: Use a PIR Proximity Sensor to turn a light on or off.

-

Unit 3: Interface with the Environment

Content Area: **Applied Tech**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Standards

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.2	Describe the trade-offs in how and where data is organized and stored.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

Transfer Goals

Using assorted types of motors and actuators, and with the help of transistors, the arduino can be used to generate physical action in the real world. By pairing motors with an Arduino, an engineer can drive robots,

build mechanical arms, add an additional degree of freedom to distance sensors, and much more. To make these decisions, the engineer can provider information to the user using a LCD display.

Life Literacies and Key Skills.

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- What i sthe largest LCD screen that an Arduino can support?
- Why do LCDs of this type require so many connections?
- Do all Servos only rotate between 0 and 180 degrees?
- Why doesn't a servo move a full 180 degrees?
- Can the Arduino power two or more motors?

- What is the advantage of using a shift register over a LCD or dot matrix display?
- Why are LocoIoT objects declared in the Class?
- How are "method" names selected?
- Is there a way to control the display with fewer pins and without 4 shift registers?
- Can the arduino ever work properly without a ground signal connected?
- What is the workaround if the time data from the RTC is incorrect?
- Why can't more advanced displays be used?
- What needs to be understood about the stepper motor driver to get it working?
- How can an IR module be used to control a stepper motor?
- Why is there a D-shaft on the Rotary Encoder?
- What other types of encoders are there?

Understandings

With respect to LCD Displays, students will have an understanding of resolution, pixels, ascii reprsentation, keyboard input, and string iteration.

With respect to motion, students will develop an understanding of Servo Motors, Stepper motors, a control circuit, motor drivers, and Pulse Width Modulation(PWM) signals.

Regarding the LCD display, students will develop an understanding of classes, methods, lists, dictionaries, file opening/closing/reading and string manipulation.

Critical Knowledge and Skills

Knowledge

Students will know:

- The LCD ontains 2 rows and 16 columns of pixel grids.
- Each pixel grid can have individual pixels turned on or off to create a shape, such as numbers and characters.
- A Python program sends the microcontroller individual characters with row and column positions, which the arduino transmits to the LCD screen.
- The servo motor can vary its geared rotor between 0 and 180 degrees.
- The arduino uses the command angle to generate the required oscillating signal sent to the Servo motor.
- A DC motor converts electrical to mechanical energy when it is supplied direct current.

- An adjustable oscillating signal sent to the motor allows for power control.
- A python program can send the arduino the high time for the oscillating signal and the direction of rotation.
- Learn how to create a python class with member attributes.
- Understand how to use Python methods.
- How to create logic for timed LED animations.
- Understand the LocoIoT setup process in order to develop its logic in a class.
- Understand how to control a Stepper motor.
- Understand the IR Receiver module.
- Understand the LocoIoTWrapper class and how to use it.
- Learn how to use a shift register.

Skills

Students will be able to:

- Configure the circuit for the LCD and adjust display brightness.
- Create messages at different index locations on the LCD display.
- Use timing and looped logic to create a scrolling LCD message.
- Use push buttons to create scrollable LCD messages
- Set the Servo Angle using user keyboard input.
- Using a Servo motor, smaple light at different angles with a photocell.
- Control the speed and direction of a DC Motor.
- Create a custom Class definition with member attributes.
- Create methods for file creation and loading.
- Develop logic for timed animations with the LEDs.
- Modify a shift controller Class with additional methods.
- Combine sensor data and linear mapping for LED control.
- Integrate pyaudio into the class through music through methods and variables in order to play misic.
- Combine song-playing characteristics with the four-digit seven-segment display.
- Control a 4-digit display with logic based on RTC data.
- Use the stepper motor and driver for time and position-based control.
- Create a Steeper Motor Class and methods for calculating rotational to translational movement based on inputs and physical constraints.
- Setup the Stepper Motor and IR Receiver module to poll IR receiver state data and update the behavior of the stepper motor based on that data.
- Implement basic Stepper Motor Control based on processed Rotary Encoder data.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for Discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks.
- Groups whiteboard algorithms and sollicit feedback from the class.
- Students pose questions on Google Classroom.
- Students directly request teacher's assistance if other students can't answer their questions.

School Summative Assessment Plan

The teacher will design mini-projects for the student to complete using LocoIoT hardware and software.

Primary Resources

LocoRobo Innovations Development and Execution Environment using WebAcademy courseware.

Supplementary Resources

Introduction to Computation and Programing Using Python by John V. Guttag Second Edition 2016 ISBN: 9780262529624

Exploring Arduino by Jeremy Blum Second Edition 2020 ISBN: 978-1-119-40537-5

Arduino Cookbook y Michael Margolis, Brian Jepson, and Nicholas Robert Weldin Third Edition 2020 ISBN: 9781491903520

Technology Integration and Differentiated Instruction

Technology Integration

● **Google Products**

- Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
- GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

● **One to One Student's laptop**

- All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

● **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student's native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials

are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❑ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - A program can be represented by a flow chart so that the control flow and number of iterations can be checked on paper befor commiting to code.

SCIENCE - An algorithm is best designed on paper before being coded.

SOCIAL STUDIES - The history of these programming constructs in computer science can be examined, namely what were the circumstances for their creation?

WORLD LANGUAGES - Use correct syntax and tab formatting in Python propgrams. Learn to refer to the dictionary of Python online at the standard Python3 designation.

VISUAL/PERFORMING ARTS - Students can act out an iterative construct.

BUSINESS EDUCATION - Students will realize that debugging a poorly designed program is often not productive from a business sense, it might be cheaper to simply redesign it.

GLOBAL AWARENESS - Students will realize the names of functions may have a cultural bent depending upon the frame of reference of the programmers from their native country.

Learning Plan / Pacing Guide

Week 1: Learn the fundamentals of the LCD Display, and the Servo Motor.

Week 2: Learn the fundamentals of DC Motors, the Eight LED with Shift Register, and the 4-Digit 7-Segment Display.

Week 3: Learn the fundamentals of the Stepper Motor. Project: Eight LED with Photocell.

Week 4: Project: 4 Digit 7-Segment Display with RTC. Project: Stepper Motor with IR Receiver.

Week 5: Project: Stepper Motor with Rotary Encoder.

Unit 4: Analog Sensors

Content Area: **Applied Tech**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Standards

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

Transfer Goals

The world around us is analog not digital. The world can assume an infinite number of potential states, like the amount of sunlight or the temperature of the ocean or the amount of contaminants in the air after a refrinery fire. This section involves learning about the difference between analog and digital signals as well as interfacing some analog sensors to the Arduino. Digital information has only two possible states: on or off,

high or low, or a 1 or 0. Analog signals cannot be discretely classified; they vary within a range, theoretically taking on an ifinite number of possible values within that range. Analog-to-digital converters(ADC) convert analog values into digital representations with a finite amount of precision and speed. Suppose an engineer want sto measure the brightness of the classroom. When it is pitch black, a light sensor outputs 0V, and when it is completely saturated by light, it outputs 5V, with values in between corresonding to the varying amount of light, The accuracy of an ADC is determined by its resolution. The Ardduino Uno has a 10-bit ADC for doing analog conversions with $2^{10} = 1024$ values. This unit will provide the student opportunities for creating applications with analog sensors.

Life Literacies and Key Skills.

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- Why does a LocoIoT thermistor return a value in Celsius?
- Why is the push-button area so small?
- How does a Voltage divider circuit work?
- What is the advantage of linear mapping?
- How does the resistance of a photocell depend on light?
- How to troubleshoot unresponsive or unexpected behavior from the Arduino?
- Why can't the DHT11 sensor be sampled more than once per second?
- Does Python provide built-in functions for average, maximum, and minimum?
- How can temperature and humidity data be saved in python lists?
- What functions does LocoIoT provide for real-time data visualization?
- How many bits of resolution are the joystick analog data readings?
- What needs to be understood in order to write software and configure the circuit for an IR transmitter and receiver?
- What does the LED on the IR receiver board do?
- How can the pyaudio Python module be configured to play audio files?
- How does the MPU6050 Accelerometer and Gyroscope sense?
- How is accelerometer data converted to roll and pitch orientation angles?
- Can orientation angles be determined by gyroscope data?
- What is the physics behind a PIR (Passive Infrared) sensor?
- What are the configuration settings of the PIR sensor?
- What steps can be taken to troubleshoot a PIR sensor whose data is stuck at zero?
- How much of the LocoIot water sensor can get wet?
- How does an accelerometer and a gyroscope work? work?

Understandings

Students will explore integrating analog sensors into LocIoT applications. The following components will be used in this unit: a temperature and humidity sensor, joystick, potentiometer, a Passive Infrared(PIR) motion sensor, a combined accelerometer and gyroscope, a photocell, and a water level sensor.

Critical Knowledge and Skills

Knowledge

Students will know:

- Learn how a thermistor changes its resistance.
- Investigate how a photocell works so a night-light can be constructed.
- Understand where to place the photocell in a voltage divider.
- Know how to convert degrees Celsius to degrees Fahreheit.
- Understand how the use Python built-in functions: ord(), round(), str() , and range().
- Relative humidity is expressed by the DHT11 and is expressed as a percentage.
- An Analog Joystick reports its position using "X" and "Y" values.
- Filter and scale Joystick data.
- Create a circuit with a joystick control and a DC motor.
- The IR Receiver module consists of an IR remote and receiver board.
- When prompted by the Python program, the arduino initiates a read of the IR receiver board detected remote button state.
- The IR receiver contains a small photocell that is able to detect infrared(IR) light.
- The IR remote control emits pulses of IR light in the form of a pulse with modulated signal at 38 kHz, which is invisible to the naked eye.
- Using the MPU6050 accelerometer/gyroscope understand how to obtain its' orientation and rotation direction.
- Understand the equations for calculating the roll & pitch angle from accelerometer radian data.
- How does a Passive Infrared(PIR) motion sensor work?
- Understand the water level detection sensor.

Skills

Students will be able to:

- Manipulate an RGB LED based on the DHT11 temperature and/or humidity reading.
- Configure a circuit for a photocell and LED and experiment with sensor reading threshold values.
- Create a circuit with a DHT11, LCD, and buttons so that a button press will toggle between displaying the temperature in Celsius or Fahrenheit.
- Be able to adjust LCD display brightness.
- Samle and save temperature and humidity in lists.
- Create statistical functions.
- Use LocoIoT functions to read the joystick button states and x and y axes position data.
- Map joystick data to direction and position control of a DC Motor.
- Map single-direction joystick datat for motor speed with button presses to toggle direction.
- Use particular buttons on the IR remote to control the flow of an audio-file-playing Python
- Visualize acceleration data to map which axis has the largest detected acceleration while stationary.
- Convert acceleration data to roll and pitch orientation angles.

- Build and configure a circuit for the LCD and MPU6050.
- Display MPU6050 acceleration and angular velocity threshold crossings on the LCD
- Configure the PIR sensor for use as an alarm with LED and buzzer output
- Build a water level circuit to generate a visual and audible alarm when a water level threshold is exceeded.
- Implement conditional logic(IR states) for starting, pausing, continuing, and stopping the playing of an audio file.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for Discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks.
- Groups whiteboard algorithms and sollicit feedback from the class.
- Students pose questions on Google Classroom.
- Students directly request teacher's assistance if other students can't answer their questions.

School Summative Assessment Plan

The teacher will design mini-projects for the student to complete using LocoIoT hardware and software.

Primary Resources

LocoRobo Innovations Development and Execution Environment using WebAcademy courseware.

Supplementary Resources

Introduction to Computation and Programing Using Python by John V. Guttag Second Edition 2016 ISBN: 9780262529624

Exploring Arduino by Jeremy Blum Second Edition 2020 ISBN: 978-1-119-40537-5

Arduino Cookbook y Michael Margolis, Brian Jepson, and Nicholas Robert Weldin Third Edition 2020 ISBN: 9781491903520

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
    - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

- **One to One Student's laptop**
    - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

- **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student's native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❑ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - A program can be represented by a flow chart so that the control flow and number of iterations can be checked on paper befor commiting to code.

SCIENCE - An algorithm is best designed on paper before being coded.

SOCIAL STUDIES - The history of these programming constructs in computer science can be examined, namely what were the circumstances for their creation?

WORLD LANGUAGES - Use correct syntax and tab formatting in Python propgrams. Learn to refer to the dictionary of Python online at the standard Python3 designation.

VISUAL/PERFORMING ARTS - Students can act out an iterative construct.

BUSINESS EDUCATION - Students will realize that debugging a poorly designed program is often not productive from a business sense, it might be cheaper to simply redesign it.

GLOBAL AWARENESS - Students will realize the names of functions may have a cultural bent

depending upon the frame of reference of the programmers from their native country.

Learning Plan / Pacing Guide

Week 1: Learn the fundamentals of the *temperature and humidity sensor, joystick, and potentiometer.*

Week 2: Learn the fundamentals of a *PIR motion sensor,and a combined accelerometer and gyroscope.*

Week 3: Learn the fundamentals of *a photocell, and a water level sensor.*

Week 4: Project: LCD with Thermometer. Project: LCD with RGB LED.

Week 5: Project: Temperature and Humidity Sensor,, Project: Analog Joystick with LCD, Project: Analog Joystick with DC Motor.

Week 6: Project: Accelerometer/Gyroscope with LCD, Project: Water Level Detection.

Unit 5: Wireless Communication

Content Area: **Applied Tech**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Standards

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

Transfer Goals

A common requirement in many IoT projects is wireless connectivity. We will build IoT applications with RF(Radiio Frequency) , Bluetooth(BLE), and Wi-Fi via Python Websockets.

Life Literacies and Key Skills.

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- How does RF work?
- When should RF be used as a communications scheme?
- How do RFID scanners and cards work together?
- What is a UID value for a scanned RFID card?
- Why can't certain blocks in the RFID tag have data written to them?
- How are data values stored which exceed 255?
- What happens if multiple instances of the HTML WebSocket client page are opened?
- How is threading done with multiple cores?

- How is a localhost used?
- Can the Python "json" module parse JSON messages?
- Why is a global keyword necessary in certain cases?
- What is list comprehension?
- Waht would hapen if a block number was specified that contains access and security information for that sector?
- Why must all 16 bytes be sent for a block?
- What would happen if multiple instances of the HTML WebSocket client page were opened?
- How can threading be accomplished with multiple cores?
- How is communication established with a BLE device?
- What is the message string and how is it used?
- What are JSON messages and how can they be used with a Python client program?
- What is a polling function?

Understandings

There are many ways to achieve wireless connectivity, but the most basic is simple RF(radio frequency) modules. RF communication devices are varied but have a similar mode of operation: when a single input changes on the transmitter, a matched output changes on the receiver module. Effectively, they operate just like a wire, with one bit of information going in and out at a time. The RF transmitter sends short bursts of data at a particular approved frequency. Realizing RF connectivity is rather limited, we will explore Bluetooth technology whose variants are used in headsets, keyboards, mice, computers, smartphones, location beacons, and more. The Bluetooth standard was developed and maintained by the Institute of Electrical & Electronics Engineers(IEEE). Bluetooth specifications have evolved through several versions, with each version adding new features and enhancements to the technology. This course studies Bluetooth Low Energy(BTLE or BLE) introduced in 2013. BLE is implemented To implement BLE, a designer needs hardware in the form of a third-party circuit board which has its own librariies which can interface to the Arduino. Lastly, the Aduino can be connected to the internet with Wi-Fi using python websockets. This will also require a 3rd party Arduino compatible board.

Critical Knowledge and Skills

Knowledge

Students will know:

- Understand a UID scanning function.
- Understand flow charting and conditional logic.

- understand the definition of a "valid" RFID card.
- Why can't certain blocks in the RFID tag have data written to them?
- Apply knowledge of RFID module and DC Motor and driver.
- Test the full logic of a program.
- Incorporate UID file creation and loading.
- Understand how to break a 16 bit data value into an upper and lower 8 bit portion.
- Read in data and then reassemble data values for motor and buzzer.
- Understand how to use HTML Websockets as a communications strategy.
- How to obtain user input from a HTML page.
- How WebSockets can be used to communicate between a HTML page and circuit hardware.
- Configure a thread for a delayed update.
- Create a thread to continuously call a function.
- How to configure a thread for a delayed update and to continuously call a function.
- How to use the "localhost".
- What is a global flag?
- UID is a unique string identifier.
- Understand a threaded repeating function.

Skills

Students will be able to:

- Create a UID scanning function.
- Use stored data from multiple blocks in an RFID tag to change the behavior of the RGB LED.
- Perform simple read and write operations on "valid" cards.
- Configure a circuit for the RFID module and RGB LED.
- Create a function for setting data in 3 specific blocks.
- Create a function for reading data from 3 specific blocks.
- Develop motor state UID-based activation and deactivation.
- Set up RFID with DC Motor circuit.
- Set up RFID with a passive buzzer circuit.
- Control LED behavior using user input from the HTML page.
- Use a push button to change the display colors in a HTML page.
- Process strings sent by the WebSockets to set an RGB LED to different colors.
- Create a global flag that updates on opening and closing of the Python client WebSocket.
- Implement a polling function for the DHT11 sensor that runs on a thread.
- Use UID reading to update the text displayed in the webpage through the websocket connection.
- Use RFID Read/Write with Websockets to analyze message data from a multi-input web page.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for Discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks.
- Groups whiteboard algorithms and sollicit feedback from the class.
- Students pose questions on Google Classroom.
- Students directly request teacher's assistance if other students can't answer their questions.

School Summative Assessment Plan

The teacher will design mini-projects for the student to complete using LocoIoT hardware and software.

Primary Resources

LocoRobo Innovations Development and Execution Environment using WebAcademy courseware.

Supplementary Resources

Introduction to Computation and Programing Using Python by John V. Guttag Second Edition 2016 ISBN: 9780262529624

Exploring Arduino by Jeremy Blum Second Edition 2020 ISBN: 978-1-119-40537-5

Arduino Cookbook y Michael Margolis, Brian Jepson, and Nicholas Robert Weldin Third Edition 2020 ISBN: 9781491903520

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
    - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

- **One to One Student's laptop**
    - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

- **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student's native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❑ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - A program can be represented by a flow chart so that the control flow and number of iterations can be checked on paper befor commiting to code.

SCIENCE - An algorithm is best designed on paper before being coded.

SOCIAL STUDIES - The history of these programming constructs in computer science can be examined, namely what were the circumstances for their creation?

WORLD LANGUAGES - Use correct syntax and tab formatting in Python propgrams. Learn to refer to the dictionary of Python online at the standard Python3 designation.

VISUAL/PERFORMING ARTS - Students can act out an iterative construct.

BUSINESS EDUCATION - Students will realize that debugging a poorly designed program is often not productive from a business sense, it might be cheaper to simply redesign it.

GLOBAL AWARENESS - Students will realize the names of functions may have a cultural bent depending upon the frame of reference of the programmers from their native country.

Learning Plan / Pacing Guide

Week 1: RFID Module. Mini-Project: RFID with RGB LED

Week 2: Mini Project: RFID with DC Motor. Mini Project: RFID with Passive Buzzer

Week 3: Introduction to WebSockets. Application: LED with WebSockets.

Week 4: Push Buttons with Websockets. Mini Project: RGB with WebSockets

Week 5: Sensor Data with WebSockets. RFID UID with WebSockets.

Week 6: RFID Read/Write with WebSockets.

Weeks 7 -8: Use an IR Remote to control the playing of music: pause, rewind, fast-forward, increase/decrease volume, select another song

Unit 6: Introduction to Artificial Intelligence

Content Area: **Applied Tech**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Standards

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

Transfer Goals

Students will understand enough about Artificial Intelligence(AI) to: create a description of a modern AI system, articulate its ethical challenges, and suggest AI techniques best suited to specific problems.

Life Literacies and Key Skills.

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- What is artificial intelligence?
- What academic disciplines are important to AI?
- What is the Turing test?
- Can computers recognize speech?
- Why is speech recognition very difficult?
- Can computers learn and adapt?
- Can computers see?

- Can computers plan and make decisions?
- What are examples of AI systems used in everyday life?
- Can AI systems predict the stock market?
- What are the most pressing ethical issues in AI?
- Could jobs be created because of AI?
- What is machine learning?
- What are neural networks?
- How is it decided what AI technique(reinforcement learning, machine learning, or neural networks) to use for an application?

Understandings

What is Artificial Intelligence(AI)? A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes. (Schalkoff, 1990) The study of how to make computers do things at which, at the moment, people are better. (Rich and Knight, 1991) It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable. Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals, and some machines. (John McCarthy, Stanford University) What's involved in intelligence? Ability to interact with the real world, reasoning and planning, and learning and adaption.

Job Loss and Wealth Inequality are a primary concern for people worried about the ramifications of AI systems. If AI systems lack empathy, instinct, and wisdome in decision making, should their integration into society be limited? According to Kambria, the most pressing issues in AI include: Job Loss and Wealth Inequality, AI is imperfect - What if it Makes a Mistake?, Should AI Systems be Allowed to Kill?, Can AI go Rogue?, IF AI's evolve to surpass human beings, will humans be controlled or become obsolete?, Should robots be granted human rights or citzenship?, How is Bias introduced in AI systems and waht can be done about it?

According to EDUCBA, the top 4 Techniques of Artificial Intelligence are: Machine Learning, Natural Language Processing(NLP), Automation and Robotics including neural networks, and Machine Vision including pattern recognition.

Critical Knowledge and Skills

Knowledge

Students will know:

- How do neural networks differ from machine learning?
- What is meant by training an AI system?
- What is reinforcement learning?

Skills

Students will be able to:

- Be proficient in creating a description of a modern AI system.
- Be able to articulate ethical challenges that may be posed by an AI system.
- Be able to suggest AI techniques best suited to specific problems.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for Discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks.
- Groups whiteboard algorithms and sollicit feedback from the class.
- Students pose questions on Google Classroom.
- Students directly request teacher's assistance if other students can't answer their questions.

School Summative Assessment Plan

The teacher will design mini-projects for the student to complete using LocoIoT hardware and software.

Primary Resources

LocoRobo Innovations Development and Execution Environment using WebAcademy courseware.

Supplementary Resources

Introduction to Computation and Programing Using Python by John V. Guttag Second Edition 2016 ISBN: 9780262529624

Exploring Arduino by Jeremy Blum Second Edition 2020 ISBN: 978-1-119-40537-5

Arduino Cookbook y Michael Margolis, Brian Jepson, and Nicholas Robert Weldin Third Edition 2020 ISBN: 9781491903520

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
    - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.
- **One to One Student's laptop**
    - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.
- **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student's native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❑ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - A program can be represented by a flow chart so that the control flow and number of iterations can be checked on paper befor commiting to code.

SCIENCE - An algorithm is best designed on paper before being coded.

SOCIAL STUDIES - The history of these programming constructs in computer science can be examined, namely what were the circumstances for their creation?

WORLD LANGUAGES - Use correct syntax and tab formatting in Python propgrams. Learn to refer to the dictionary of Python online at the standard Python3 designation.

VISUAL/PERFORMING ARTS - Students can act out an iterative construct.

BUSINESS EDUCATION - Students will realize that debugging a poorly designed program is often not productive from a business sense, it might be cheaper to simply redesign it.

GLOBAL AWARENESS - Students will realize the names of functions may have a cultural bent depending upon the frame of reference of the programmers from their native country.

Learning Plan / Pacing Guide

Week 1: Introduction to AI(vocabulary and components of systems.)

Week 2: Applications of AI-An Ethics Perspective. AI vs Natural Intelligence - A historical perspective.

-

Unit 7: Image Analysis

Content Area: **Applied Tech**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Standards

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

Transfer Goals

Students will take pictures with a Raspberry PI camera and save them as images. The images are corrected by using denoising and smoothing techniques. Once the images are corrected, edge, contour, and color detection techniques, are used to locate certain objects in the image.

Life Literacies and Key Skills.

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.

Concepts

Essential Questions

- What is image acquisition?
- What is a noisy image?
- How is noise removed from an image?
- What is the difference between object detection and object recognition?
- What objects can be detected in the processed image?
- Are objects detected through pattern recognition?
- What is pattern recognition?

- What is the Sliding Windows technique in computer vision?
- When is an object image processed enough so object detection can begin?

Understandings

Image acquisition is the process of capturing an image with a sensor and coverting it into a manageable entity. Image enhancement improves the quality of an input image and extracts hidden details from it. Image restoration removes noise from an image in order to get a cleaner version. This process is based on probabilistic and mathematical models. Color image processing includes both pseudocolor(grayscale) and RGB color processing. The Open Source Computer Vision Library(OpenCV) is a popular computer vision library which provides hundreds of computer and machine learning algorithms with C^{++}, Java and Python interfaces. This library is provided to our students through the Anaconda release and is used for image processing and object detection.

Critical Knowledge and Skills

Knowledge

Students will know:

- Understand Image Acquisition using IoT software.
- Understand the science and matematics behind denoising and smoothing correction techniques.
- Understand color detection techniques.
- Understand enough about image processing to detect a robot.

Skills

Students will be able to:

- Be able to saved images taken with a Raspberry Pi?
- Use IoT software to apply Denoising and smooting correction techniques to images.
- Apply color detection techniques locate specific colored objects in images.
- Apply edge and contour detection techniques.
- Use IoT software techniques to to identify objects in images.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for Discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks.
- Groups whiteboard algorithms and sollicit feedback from the class.
- Students pose questions on Google Classroom.
- Students directly request teacher's assistance if other students can't answer their questions.

School Summative Assessment Plan

The teacher will design mini-projects for the student to complete using LocoIoT hardware and software.

Primary Resources

LocoRobo Innovations Development and Execution Environment using WebAcademy courseware.

Supplementary Resources

Introduction to Computation and Programing Using Python by John V. Guttag Second Edition 2016 ISBN: 9780262529624

Exploring Arduino by Jeremy Blum Second Edition 2020 ISBN: 978-1-119-40537-5

Arduino Cookbook y Michael Margolis, Brian Jepson, and Nicholas Robert Weldin Third Edition 2020 ISBN: 9781491903520

Technology Integration and Differentiated Instruction

Technology Integration

● **Google Products**

- Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
- GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

● **One to One Student's laptop**

- All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

● **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student's native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials

are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❑ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - A program can be represented by a flow chart so that the control flow and number of iterations can be checked on paper befor commiting to code.

SCIENCE - An algorithm is best designed on paper before being coded.

SOCIAL STUDIES - The history of these programming constructs in computer science can be examined, namely what were the circumstances for their creation?

WORLD LANGUAGES - Use correct syntax and tab formatting in Python propgrams. Learn to refer to the dictionary of Python online at the standard Python3 designation.

VISUAL/PERFORMING ARTS - Students can act out an iterative construct.

BUSINESS EDUCATION - Students will realize that debugging a poorly designed program is often not productive from a business sense, it might be cheaper to simply redesign it.

GLOBAL AWARENESS - Students will realize the names of functions may have a cultural bent depending upon the frame of reference of the programmers from their native country.

Learning Plan / Pacing Guide

<u>WEEK</u> 0: Assemble Raspberry Pi 4 with Case and Camera Module. Install Linux OS, python, and connect to WD network.

Week 1: Image and Video Acquisition, followed by a relevant Challenge

Week 2: Color Segmentation and Detection, followed by a relevant Challenge

Week 3: Blur and Denoise Techniques

Week 4: Edge Detection

Week 5: Line Following Robot

Week 6: QR Code Reading

Week 7: Triangle Similarity

Week 8: Stereo Vision

Week 9: Object Detection (Haar Cascades)

Week 10: Optical Character Recognition

Week 11: YOLOv5 Object Detection

Unit 8: Video Analysis

Content Area: **Applied Tech**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Standards

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.
	Successful troubleshooting of complex problems involves multiple approaches including research, analysis, reflection, interaction with peers, and drawing on past experiences.

Transfer Goals and Career Ready Practices

Transfer Goals

Students will use a combination of Python, software support modules, and a Raspberry Pi Camera to capture,

manipulate, and save video files. Then they will process the videos using color detection and tracking using Python code and the OpenCV library. Students will then take a defined colored object and use measurement and test cases to dynamically approximate its distance based on its relative size in an image.

Life Literacies and Key Skills.

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- What types of colored objects can be detected in an image with our algorithm?

Understandings

The real world poses challenges like having limited image data and having tiny hardware like a Raspberry Pi

to acquire images and process them using a windows laptop. In object detection, by drawing mulitple boxes in an image, it is segmented into different parts. This segmentation allows for the possibility of object detection.

Critical Knowledge and Skills

Knowledge

Students will know:

- Know how to operate a Raspberry Pi (Raspi).
- Use the Raspi Camera.
- How to save and process Raspi videos.
- Understand the algorithm for color detection and tracking.
- How to define a "colored" object in Python software.
- Understand algorithm for detecting a "colored" object in a video.
- How to calculate the relative size of a "colored" object in an image.
- Understand the 2D distance formula.

Skills

Students will be able to:

- Take videos with a Raspberry Pi Camera using Python Code.
- Process and save Raspi Camera videos.
- Use Python code and video files to detect colored object positions.
- Calculate the distance of an object in an image using Python code with scale and calibration based estimation.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for Discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks.
- Groups whiteboard algorithms and sollicit feedback from the class.
- Students pose questions on Google Classroom.
- Students directly request teacher's assistance if other students can't answer their questions.

School Summative Assessment Plan

The teacher will design mini-projects for the student to complete using LocoIoT hardware and software.

Primary Resources

LocoRobo Innovations Development and Execution Environment using WebAcademy courseware.

Supplementary Resources

Introduction to Computation and Programing Using Python by John V. Guttag Second Edition 2016 ISBN: 9780262529624

Exploring Arduino by Jeremy Blum Second Edition 2020 ISBN: 978-1-119-40537-5

Arduino Cookbook y Michael Margolis, Brian Jepson, and Nicholas Robert Weldin Third Edition 2020 ISBN: 9781491903520

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)

- GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

● **One to One Student's laptop**

- All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

● **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student's native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❑ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - A program can be represented by a flow chart so that the control flow and number of iterations can be checked on paper befor commiting to code.

SCIENCE - An algorithm is best designed on paper before being coded.

SOCIAL STUDIES - The history of these programming constructs in computer science can be examined, namely what were the circumstances for their creation?

WORLD LANGUAGES - Use correct syntax and tab formatting in Python propgrams. Learn to refer to the dictionary of Python online at the standard Python3 designation.

VISUAL/PERFORMING ARTS - Students can act out an iterative construct.

BUSINESS EDUCATION - Students will realize that debugging a poorly designed program is often not productive from a business sense, it might be cheaper to simply redesign it.

GLOBAL AWARENESS - Students will realize the names of functions may have a cultural bent depending upon the frame of reference of the programmers from their native country.

Learning Plan / Pacing Guide

Week 1: Video Acquisition, Randering, and Saving.

Week 2: Video Processing: Color Tracking

Week 3: Video Processing: Distance Estimation.

Week 4: TBD