Programmable Drone – Coding Exercise

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BACKGROUND:

Wittman-Battenfeld is a company that manufactures plastic injection molding machines and robots that work with the molding machines to handle parts into and out of the molds. The company has also developed a robot programming system that is user-friendly and can be used by technicians in industry (who may not be proficient with computer coding) to program the robots. Companies who use Wittman's robots are able to teach mold operators to program the robots for precise functions that speed up the production process. During the course of our externship, we were able to program a Wittman robot to perform a series of movements that simulated handling of parts into or out of a molding machine.

Companies such as Amazon and Uber are exploring the use of autonomous drones to deliver packages to customers. Watch the following videos for background on recent tests and developments in drone delivery services:

Amazon Prime Air: https://www.youtube.com/watch?v=gFj5SCdSYQg
Uber Air: https://www.youtube.com/watch?v=0yMv16p8FO8
Flirtey: https://www.youtube.com/watch?v=TedKIlo0c04

As mentioned in the videos, the goal of these companies is to use pre-programmed, autonomous drones to deliver packages to customers. Using a pre-programmed drone avoids potential problems with hackers intercepting or diverting the drones, which would be possible if they relied on ground controllers directing their flight path.

1. LESSON OBJECTIVES: At the end of this lesson, students will be able to write simple programs for an Arduino controller and guide a CoDrone Pro programmable drone through basic maneuvers and a simple obstacle course to a pre-defined landing point. This exercise will simulate use of an autonomous drone to perform functions for a company such as Amazon package delivery.

2. LESSON STRUCTURE

Total Time: Six class days including at least one block period

Teaching Approach: Independent review of drone uses and tutorials, small group collaboration for measuring obstacle course and constructing/writing programs, hands-on activity of flying the drone to achieve specified maneuvers.

Overall Outline (times are estimates):

1. Activity introduction – 45 minutes, 1 class period
2. Review of online tutorials (outside of class) – 40 minutes
3. Coding for basic maneuvers, uploading programs, and test flights of basic maneuvers – 90 minutes, 2 class periods or 1 block period.
4. Measurement & diagramming of obstacle course parameters by students – 45 minutes, 1 class period.
5. Coding for Obstacle Course – 90 minutes, 2 class periods or 1 block period
6. Uploading programs & obstacle course flight – 45 minutes, 1 class period

3. RESOURCES

- CoDrone Pro programmable drone, one for each group
- Classroom set of laptops with Arduino software installed
- Internet access for accessing tutorials outside of class
- Obstacle course materials: hoops, pads, cones, posts, etc.
- Measuring devices: meter sticks, metric tape measures, architectural scale/ruler
- Graph paper

4. SAFETY CONSIDERATIONS/MATERIALS

- Review of drone safety precautions

Lesson Plan

1. Activity Introduction: Drone technology, advancements, anticipated future uses of drone technology.

   Student Activity: conduct a YouTube search of "future of drone technology", "future uses of drones", or similar topic. Take notes on at least 4 current or future/anticipated uses of autonomous drones, and bring your topics to class for discussion.

   Discussion: Bonus points for unique applications that no one else finds!

2. Review of Tutorial Videos (outside of class):

   Go to "Learn CoDrone Pro" web page https://www.robolink.com/learn-codrone-pro/ , click on Start Learning at Basecamp, and view/read the following tutorials:
   1A, 1C, 1F, 1H, 2A, 2B, 2D, 2E, and 2F. Note: some of the tutorials are meant to do hands-on with the CoDrone remote; just read through these for familiarization and be prepared to use them when you have the computer, drone and remote in class.

3. Coding for Basic Maneuvers, uploading programs, and test flights of basic maneuvers:

   Using Tutorials 2A, 2B and 2D, program your drone to perform the basic flight events described in 2D.

4. Measurement & diagramming of obstacle course parameters:

   The obstacle course will be set up in a large room with a square grid on the floor (aka floor tiles). Using the provided measuring devices and a sheet of graph paper, produce a dimensioned, scale diagram of the obstacle course. Your diagram should include all relevant measurements for your drone to follow the course, including the takeoff and landing areas, and the positions, distances, heights, widths, etc. of all obstacles.

5. Coding for Obstacle Course:

   Within your group, write code for the drone to take off, navigate the obstacle course, and land within the target area. Use the previously-viewed tutorials through 2E, and any others on the web site, as needed to help your group construct a workable program. The program must include: vertical ascent and descent, flying forward/backwards (pitch), and sideways (roll), and rotation (yaw) by at least 90° left or right.

6. Uploading Program and Obstacle Course Flight:

   Once you have it completed, upload your program and test-fly the drone through the obstacle course. Evaluate its performance and, as needed, modify / troubleshoot your program to correct any problems with successfully navigating the obstacle course.