#### Roger Williams University

#### ENGR 430 Computer Vision

#### Quadcopter Project

#### 200 Points

The project objective is stable position control of a quadcopter using computer vision. As this is only possible when numerous component technologies are working together; the project is organized along the lines of these component technologies enumerated below.

1. Quadcopter – The quadcopter must be flightworthy. This requires controlled power delivered to four working motors driving four propellers in response to commands from a flight controller.
2. Command computer – The onboard command computer (Raspberry Pi) must execute software that commands the flight controller in response to operator commands and its estimate of the current state if the quadcopter.
3. Computer vision – Software that interprets a stream of live camera images and produces the best estimate of the quadcopter’s current location. This software is written by students in the Python programming language that extracts information from image data produces location estimates.

Each student is expected to achieve all three of these objectives during the semester. Progress is both assisted and assessed by the completion of milestones. A milestone is the demonstration of a component technology by a specified date.

Milestone 1 – October 11th 4PM Instructor Checkoff, October 16th 4PM Flight Worthiness

Quadcopter is flight-worthy as demonstrated by a flight test under radio remote control. Student has successfully followed instructions to assemble the quadcopter including soldering appropriate connections and careful physical construction without breaking components. Motor controllers and flight controller are successfully configured by following configuration instructions. Command computer is not necessary for this milestone and has been removed both to keep it safe and to lighten the quadcopter, easing flight. Although I anticipate each student will want to control their own quadcopter, students may ask **another student** to operate the remote control, but not the instructor.

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| Achievement | Points |
| Quadcopter flies stably for 20 seconds under student control. Flight need not be pretty but must not go unsafely far or high and must be completely airborne for duration. Three official trials. | 50 |
| Quadcopter demonstrated by due date but not on an official trial | 40 |
| Demonstration within 1 week past the due date | 35 |
| Demonstration within 2 weeks past the due date | 30 |
| Demonstration by the last day of classes | 25 |
| Instructor Checkoff after due date | -10 |

Milestone 2 – October 31st Flight under command computer control

Following online instructions, quadcopter flies in velocity mode with supervisory control by ground station in the test pen. Quadcopter may gently bounce off the walls of the test pen but may not violently slam into the side walls or contact the top netting. A violent crash is defined as leaving one wall and directly crashing into the opposite wall with no apparent football moves in-between. Three official trials.

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| Achievement | Points |
| Quadcopter flies for 20 seconds in test pen under velocity mode control via command computer keyboard. | 50 |
| Quadcopter demonstrated by due date but not on an official trial | 40 |
| Demonstration within 1 week past the due date | 35 |
| Demonstration within 2 weeks past the due date | 30 |
| Demonstration by the last day of classes | 25 |

Milestone 3 –November 26th Position determination via camera

When suspended above student map, quadcopter correctly reports its position and responds predictably to movements. Student has created a sufficiently feature rich map to allow position determination at all positions possible from inside the test pen. As there are unlimited opportunities for students to self-test **only one official trial**.

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| Achievement | Points |
| Instructor will suspend quadcopter at three random locations above the map, and the web interface must display corresponding location. At each location instructor will move the quadcopter left-right, forward-backward and the displayed position must change consistent with this motion. | 50 |
| Demonstrated by due date but not on official trial | 40 |
| Demonstration within 1 week past the due date | 35 |
| Demonstration within 2 weeks past the due date | 30 |
| Demonstration by the last day of classes | 25 |

Final Demonstration –December 5th or December 10th Position controlled flight

Students must demonstrate position controlled flight for 30 seconds in the test pen. Each student must demonstrate control within a 10-minute slot assigned by random lot on testing day. Student initiates takeoff and stabilizes the quadcopter in the center of the test pen using keyboard control. Student then switches the quadcopter to position mode and the timer starts. Contact with the test pen walls is permitted but the Quadcopter must not crash, exhibit uncontrolled flight or switch itself out of position control mode in the 30-second period. Students may reinitiate the process of establishing stable flight in velocity mode and starting positon control any number of times within the 10-minute slot without penalty.

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| Achievement | Points |
| 30 seconds of stable flight within the test pen demonstrated in original time slot. | 50 |
| 10 seconds of stable flight within the test pen demonstrated in designated time slot. | 40 |
| Student “passes” on first day but demonstrates on second day if time remains. | 40 |
| 30 seconds of stable flight demonstrated outside time slot | 30 |
| Any length of sustained flight in position control at any time. | 25 |

On December 5th students will be called at random (likely by playing card) and offered a 10-minute slot to demonstrate control. Students may choose to pass if their quadcopter is not ready at that time, and selection will continue until all class time is consumed. Passing students will be offered a slot on December 10th only if time remains after all students have had a first opportunity to demonstrate. Passing students will again be selected randomly with the last slot offered at 12:20PM December 10th. If all quadcopters are successfully demonstrated on December 5th, December 10th we will have a party.