AINT308: Computer Vision and Behavioural Computing
Phil Culverhouse

Overview

Students will learn how to (a) actuate servos to control the OWL robot using the Raspberry Pi , (b) learn how animals use vision to interact with the world, (c) how to use OpenCV to implement visual routines to make the OWL robot behave like an animal and (d) review complex vision recognition in current commercial toy robots.

Assessment

There are two assignments, the first is worth 40% of the module mark, the second 60%. Both require that you control the servos to provide smooth control with image video evidence. The reports must be well written with good use of English. To gain first-class marks you will need to consider animal vision systems in your report, including useful references to books, academic papers and web resources. Your videos must be short and demonstrate the required item.

Assignment 1 – 40% of module mark

Deadlines end February – see DLE for details. Submit report to DLE.

Control servos to do the following:

i. Neck control to pan head in a sinusoidal manner (side to side) where the head moves fastest in the centre of the range.
ii. Eye control from host computer (key press selection of each)
    1. Show stereo control by adjusting PWM to each eye and scan horizontal axis at a plausible rate, mimicking human eye motion following a target.
    2. Show chameleon like eye motion for 10 seconds.
    3. Show two other behaviours that mimic human or animal emotive eye motion.

Assessment: Report detailing the achieved PWM sequences, code snippets and flow charts. Provide small video snippet OR link to YouTube video. Discuss in relation to animal equivalents (references required for good marks). Recordings of live video from each motion will support a higher score, if they demonstrate robust stable vision. Suggest having a fovea region overlaid on the video stream so we can see where the robot Owl's centre of attention is placed. Smooth robot actuation, no judder, is important. Video stream should show stable images after each motion phase (where appropriate). Top marks you should exceed my expectations.

Marking scheme:

1. Video/demonstration (submitted with your report) 25%
2. Report: background on animal systems, theory on code implementation, use of English, Figures and References 25%
3. Source Code: quality, extent and commentary 25%
4. Achievements, incl. maths, flow charts and code snippets 25%

Total: 100% == 40% module mark

Assignment 2 – 60% of module mark

You will need to use a Smeaton 302/303 laboratory computer and an OWL robot for the coursework. (indicative effort in brackets)

- Deadlines mid-April; see DLE for date. Submit report via DLE.
- Stereo vision software & eye control
  - (10%) Using simple Cross-correlation & Servo control
    - Verge onto a slow-moving target with both eyes,
    - Give estimate of distance to user, report distance against measured
    - Track target for 10 seconds over whole field of view of robot
  - (25%) Using Homography in OpenCV & servo control
    - Calibrate cameras in orthographic mode
    - Show live disparity images,
    - Calculate disparity of a target, produce depth map, demonstrate calibration against ruler, assess errors
  - (40%) Using Itti & Koch's bottom-up Saccadic model of stereo eye control, develop a processing model and apply it to process a scene. The model should Saccade to salient targets, acquire images, map distances to targets, on a live stereo video stream.
  - (20%) Report on all above, with references and comparisons between your results above and with animal stereo systems
  - (5%) Review available computer vision-based toys and compare to your OWL design.
- Note: expected effort and proportion of report is in percent.

Marking scheme (marks in brackets):

- Video/demonstration: (25%)
  - submitted as links within report
- Report: (25%)
  - background theory on robot/animal/human systems,
  - and theory on OpenCV code used,
  - Use of English, quality of Figures and References
- Source Code: (25%)
  - quality,
  - extent and commentary
- Results, Maths, Functions & Error exploration: (25%)
  - incl. descriptions of the maths used,
  - flow charts giving overview of code function
  - discuss results & robustness of operation (assessment of errors/failure to operate as expected)

Total: 100% == 60% module mark

NOTE: Please use the ShortReportFormat_r1.pdf as a guide to good reporting practice

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Referred assessment – 100% of module mark

This is essentially a repeat of the second coursework assessment of the module. You will need to use a Smeaton 302/303 laboratory computer and an OWL robot for the coursework. Note that MACs may not be a viable platform due to the lack of MJPEG streaming.

Please make arrangements, as early as you are able, to use these resources.

- Deadlines mid-August; see DLE for date. Submit report via DLE.
- Stereo vision software & eye control (expected effort in brackets)
    - (10%) Using simple Cross-correlation & Servo control
        - Verge onto a target ensuring eye symmetry, give estimate of distance
        - Track target for 10 seconds
    - (25%) Using Homography in OpenCV & servo control
        - Calibrate cameras in orthographic mode
        - Take static images, calculate disparity of a target
        - Produce depth map, demonstrate calibration against ruler
    - (40%) Using bottom-up Saccadic stereo eye control develop a processing model and apply it to process a scene. The model should Saccade to salient targets, acquire images, map distances to targets
    - (20%) Report on all above, with references and comparisons between machine and animal stereo systems
    - (5%) Review available computer vision-based toys and compare to your OWL design.
    -

Marking scheme (marks in brackets):

- Video/demonstration: (25%)
    - submitted as links within report
- Report: (25%)
    - background theory on robot/animal/human systems,
    - and theory on OpenCV code used,
    - Use of English, quality of Figures and References
- Source Code: (25%)
    - quality,
    - extent and commentary
- Maths, Functions & Error exploration: (25%)
    - incl. descriptions of the maths used,
    - flow charts giving overview of code function
    - discuss robustness of operation (assessment of errors/failure to operate as expected)

Total: 100% == 100% module mark

NOTE: Please use the ShortReportFormat_r1.pdf as a guide to good reporting practice

Assessed Learning Outcomes

- Demonstrate understanding of the underpinning vision theories
- Demonstrate understanding of the current theory and practice in object recognition
- Design and implement a practical vision application