Psy 627: Advanced Topics in Visual Perception

Fall 2015

Last update: October 10, 2015.

Tu, Th: 3:00 - 4:15 PM, Hampton Hall of Civil Engineering (HAMP), Room: 1266.

Read the assigned readings for the first week. Download the first paper from:

http://www1.psych.purdue.edu/~zpizlo/vision/week1/

Prerequisites: Basic math (matrix algebra, calculus, probability, elementary geometry).

Instructor: **Dr. Zygmunt Pizlo (zpizlo@purdue.edu)**

The course will focus on 3D visual perception with emphasis on mathematical and computational models of vision. Symmetry will loom large. PDFs of reading materials will be provided (except for the text – see the reference below).

There will be two exams. Each exam counts 50% towards the final grade. Midterm exam will be in class on October 22. Final exam is not cumulative. You can use your notes, papers and books during the exams.

Text: *Making a Machine that Sees Like Us, by Pizlo, Li, Sawada & Steinman. Oxford University press 2014.*

Available as e-book.

Week 1: Introduction: Perception viewed as an inverse problem.

Text*: Sections 1.8-1.9.*

Poggio T., Torre V. & Koch C. (1985) Computational vision and regularization theory. Nature 317, 314-319.

Week 2: Psychophysical methods.

Macmillan, N.A. & Creelman, C.D. (2005) Detection theory: a user's guide. Erlbaum – chapters 1, 2.

***Text**: Section 1.10.*

Week 3: Human eye and the visual cortex.

Week 4: Nativism vs. empiricism.

Hess E.H. (1956) Space perception in the chick. Scientific American 195, 71-80.

Hubel D.H. & Wiesel T.N. (1963) Receptive fields of cells in striate cortex of very young, visually inexperienced kittens. Journal of Neurophysiology 26, 994-1002.

Rock I. & Harris C.S. (1967) Vision and touch. Scientific American 216, 96-104.

Hochberg J. & Brooks V. (1962) Pictorial recognition as an unlearned ability: a study of one child's performance. American Journal of Psychology 75, 624-628.

Slater A. & Morison V. (1985) Shape constancy and slant perception at birth. Perception 14, 337-344.

Linden D.E.J., Kallenbach K., Heinecke A., Singer W. & Goebel R. (1999) The myth of upright vision. A psychophysical and functional imaging study of adaptation to inverting spectacles. Perception, 1999, 28, 469-481.

Weeks 5: Euclidean, similarity, affine, and projective groups. Invariants.

Mundy, J.L. & Zisserman, A. (1992) Geometric invariance in computer vision. MIT Press: Cambridge, MA (Chapter 1: Introduction – towards a new framework for vision).

Mundy, J.L. & Zisserman, A. (1992) Geometric invariance in computer vision. MIT Press: Cambridge, MA (Chapter 23: Projective geometry for machine vision).

Burns J.B., Weiss, R.S. & Riseman E.M. (1992) The non-existence of general-case view-invariants. In: Mundy, J.L. & Zisserman, A. (Eds.) Geometric invariance in computer vision. MIT Press: Cambridge, MA (pp. 120-131).

Week 6: Geometrical optics. Perspective and orthographic projection. Calibrated camera.

Pirenne M.H. (1975) Vision and art. In: Carterette E.C. & Friedman M.P. (Eds.) Handbook of Perception, vo. V: Seeing. NY: Academic Press (pp. 433-490).

Weeks 7-8: Definition of shape as geometrical self-similarity (symmetry). Shape constancy experiments.

***Text**: Sections 1.3-1.5.*

***Text**: Sections 2.1.*

Mishkin, M., Ungerleider, L.G. & Macko, K.A. (1983) Object vision and spatial vision: two cortical pathways. Trends in Neurosciences 6, 414-417.

Rock I. & DiVita J. (1987) A case of viewer-centered object perception. Cognitive Psychology 19, 280-293.

Edelman S. & Bulethoff H.H. (1992) Orientation dependence in the recognition of familiar and novel views of three-dimensional objects. Vision research 22, 2385-2400.

Biederman I. & Gerhardstein P.C. (1993) Recognizing depth rotated objects: evidence and conditions for three-dimensional view-point invariance. Journal of Experimental Psychology: Human perception & Performance 19, 1162-1182.

Pizlo Z. & Stevenson A.K, (1999) Shape constancy from novel views. Perception & Psychophysics, 61, 1299-1301.

Chan, M.W., Stevenson, A.K., Li, Y. & Pizlo, Z. (2006) Binocular shape constancy from novel views: the role of a priori constraints. Perception & Psychophysics ,68, 1124-1139.

Week 9: Monocular shape recovery based on a minimum principle.

Hochberg J. & McAlister E. (1953) A quantitative approach to figural "goodness". Journal of Experimental Psychology 46, 361-364.

Attneave F. & Frost R. (1969) The determination of perceived tridimensional orientation by minimum criteria. Perception & Psychophysics 6, 391-396.

Perkins D.N. (1976) How good a bet is good form. Perception 5, 393-406.

Li, Y., Pizlo, Z. & Steinman, R.M. (2009) A computational model that recovers the 3D shape of an object from a single 2D retinal representation. Vision Research 49, 979-991.

***Text**: Sections 2.2-2.5.*

Weeks 10-11: Symmetry.

Wertheimer M. (1923/1958) Principles of perceptual organization. In Beardslee D.C. & Wertheimer M. (Eds.) Readings in Perception (pp. 115-135). Princeton NJ: van Nostrand.

Barlow, H. & Reeves, B.C. (1979) The versatility and absolute efficiency of detecting mirror symmetry in random dot displays. Vision Research, 19, 783-793.

Mascalzoni E., Osorio D., Regolin L. & Vallortigara G. (2012) Symmetry perception by poultry chicks and its implications for three-dimensional object recognition. Proc. R. Soc. B. 279, 841-846.

Feldman J. & Singh M. (2006) Bayesian estimation of the shape skeleton. PNAS 103, No. 47, 18014-18019.

Sawada, T. & Pizlo, Z. (2008) Detection of skewed symmetry. Journal of Vision 8(5), No. 14.

Sawada, T. (2010) Visual detection of symmetry of 3D shapes. Journal of Vision 10(6), 1-22.

***Text**: Chapter 3.*

Week 12: Symmetry and the correspondence problem.

*Sawada, T., Li, Y. & Pizlo, Z. (2011) Any pair of 2D curves is consistent with a 3D symmetric interpretation. Symmetry **3**, 365-388.*

Sawada T., Li Y. & Pizlo Z. (2014) Detecting 3-D mirror symmetry in a 2-D camera image for 3-D shape recovery. Proc. IEEE, 102, 1588-1606.

***Text**: Chapter 4.*

Week 13: Binocular vision.

Johnston E.B. (1991) Systematic distortions of shape from stereopsis. Vision Research 31, 1351-1360.

Pizlo Z., Li Y. & Francis G. (2005) A new look at binocular stereopsis. Vision Research 45, 2244-2255.

Li Y. & Pizlo Z. (2011) Depth cues versus the simplicity principle in 3D shape perception. Topics in Cognitive Science 3, 667-685.

*Li, Z., Sawada, T., Shi, Y., Kwon, T. & Pizlo, Z. (2011) A Bayesian model of binocular perception of 3D mirror symmetric polyhedra. Journal of Vision, **11(4)**:11, 1-20.*

Text: Chapter 5.

Week 14: 3D scene recovery – figure-ground organization - veridicality.

Pizlo Z., Sawada T., Li Y., Kropatsch W.G. & Steinman R.M. (2010) New approach to the perception of 3D shape based on veridicality, complexity, symmetry and volume. Vision Research 50, 1-11.

Li, Y., Sawada, T., Latecki, L.J., Steinman, R.M. & Pizlo, Z. (2012). A tutorial explaining a machine vision model that emulates human performance when it recovers natural 3D scenes from 2D images. Journal of Mathematical Psychology 56, 217-231.

Pizlo Z. (2015) Philosophizing cannot substitute for experimentation: comment on Hoffman, Singh & Prakash. Psychonomic Bulletin & Review (in press).

Text: *Sections 1.6-1.7.*

Text*: Chapter 6.*

Weeks 15: Visual prediction.

Text*: Chapter 7.*