RUSSELL MANNING

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EDUCATION

1. **University of Wisconsin, Madison.** September, 1995, to August, 2003. M.S. in Computer Science, 1997. Ph.D. in Computer Vision and Graphics, 2003. Thesis: *Screw-Transform Manifolds for Camera Self Calibration*.

2. **Massachusetts Institute of Technology.** September, 1991, to May, 1992. In Ph.D. program for Computer Science.

3. **California Institute of Technology.** October, 1987, to June, 1991. B.S. in Engineering and Applied Science.

EMPLOYMENT

1. **University of Wisconsin, Madison, WI.** Research Assistant. June, 1997 to Present. *Research on camera self calibration, scene reconstruction, image-based rendering, and medical image analysis.*

2. **University of Wisconsin, Madison, WI.** Teaching Assistant. September, 1995 to May, 1997. *Taught introductory programming, graded for data structures class, and taught class introducing students to computers.*

3. **Star Media Systems, Naperville, IL.** Software Engineer. January, 1994 to August, 1995. *Created image-processing filters for computer video-editing system.*

4. **Massachusetts Institute of Technology, Cambridge, MA.** Research Assistant. September, 1991 to June, 1992. *Assisted research in medical expert systems.*

5. **California Institute of Technology, Pasadena, CA.** Summer Undergraduate Research Fellowship. Summer, 1990. *Independent research in combinatorics; generalized the Catalan numbers.*

6. **Argonne National Laboratory, Argonne, IL.** Summer Student Research Assistant. Summer, 1989. *Assisted research on automatic program transformation.*

7. **CYTAG Program, Iowa State University, Ames, IA.** Resident Assistant. Summer, 1988. *Supervised students at summer program for gifted youth.*

HONORS/ACHIEVEMENTS

1. "Outstanding Graduate Student Research Award," 2003; award given by Wisconsin Computer Science Department for the best thesis research. *Only one award is given per year and past recipients are professors at a variety of distinguished schools: Michael Franklin (Berkeley), Joe Hellerstein (Berkeley), Alvin Lebeck (Duke), Steven Reinhardt (U. Michigan), Steven Seitz (CMU/Washington), Johannes Gehrke (Cornell), Todd Munson (initially at Microsoft Research), Amir Roth (U. Pennsylvania), Daniel Sorin (Duke), and Craig Zilles (U. Illinois).*
2. Vilas Travel Award to present research at CVPR, 2001.
3. Programming contest of the International Conference on Functional Programming; top 10 finish, 2000. *Entered as a 1-person team; winning team had 4 people.*
4. Accepted to Harvard Law School, 1997 (upper 99.3 percentile on LSAT).
5. W. L. Putnam Mathematical Competition, 32nd out of 2500 (Honorable Mention), 1990; chosen for three-person Caltech Putnam team.
6. ACM International Programming Competition; Caltech team, placed 10th overall, 1989-1990.
7. Morgan Ward Prize from Caltech for undergraduate mathematics research, 1989.
8. The Caltech Prize (a large scholarship), 1990-91.
9. Summer Undergraduate Research Fellowship (SURF) from Caltech, 1989-90.
10. Carnation Merit Scholarship from Caltech, 1988-89, 1989-90.
11. Los Angeles Philanthropic Foundation Scholarship, 1988-89, 1989-90.
12. W. C. Byrd Scholarship, 1987-88.
13. Highest overall score out of 205 students in freshman physics at Caltech, 1988. *I am good at physics.*
14. Member of Chicago Area Math Team, in 1986 and 1987. *Team had 15 members chosen by direct competition in Chicago and suburbs; it included Matt Cook (winner of U.S. Math Olympiad) and Eric Winfree (now Caltech professor and winner of a McArthur Genius Fellowship).*
15. Numerous honors in high school math competitions, including 2nd place in Illinois for both "two person team" and "written competition."

PROFESSIONAL ACTIVITIES

1. Significant contributions to successful NSF grant proposal "View Synthesis for Dynamic Scenes, With and Without Reconstruction."
2. Gave Principal Investigator talk at DARPA-funded project meeting, Video Surveillance and Monitoring (VSAM), 1998; helped prepare PI talks for VSAM98 and VSAM99.
3. Speaker at Conf. on Computer Vision and Pattern Recognition (CVPR), 2001 and 1999.
4. 4.9/5.0 overall rating by students for "Would you recommend this teacher" from both sections of Spring 1997 introductory programming class.
5. Student member, Univ. of Wisconsin Computer Sciences Department Publications Committee.

PUBLICATIONS

Ph.D. Thesis

1. Russell A. Manning, Screw-transform manifolds for camera self calibration, University of Wisconsin, defended July 3, 2003.

Refereed Conference Papers

2. Russell A. Manning and Charles R. Dyer, Stratified self calibration from screw-transform manifolds, *European Conf. on Computer Vision*, Copenhagen, Denmark, May 2002, pages IV:131-145 (32% accepted).

3. Russell A. Manning and Charles R. Dyer, Metric self calibration from screw-transform manifolds, *Proc. Computer Vision and Pattern Recognition*, Kauai, Hawaii, December 2001, pages I:590-597 (8% accepted for presentation).

4. Russell A. Manning and Charles R. Dyer, Affine calibration from moving objects, *International Conference on Computer Vision*, Vancouver, British Columbia, June 2001, pages I:494-500 (31% accepted).

5. Russell A. Manning and Charles R. Dyer, Interpolating view and scene motion by dynamic view morphing, *Proc. Computer Vision and Pattern Recognition*, Fort Collins, Colorado, June 1999, pages I:388–394 (15% accepted for presentation).

Refereed Conference Papers, Under Review

6. Russell A. Manning and Charles R. Dyer, Self calibration without minimization, submitted to 2004 *Conf. on Computer Vision and Pattern Recognition.*

7. Russell A. Manning, The classification of monocular camera displacements, submitted to 2004 *Conf. on Computer Vision and Pattern Recognition.*

Book Chapters

8. Russell A. Manning and Charles R. Dyer, Dynamic view interpolation without affine reconstruction, in *Confluence of Computer Vision and Computer Graphics*, A. Leonardis et al., eds., Kluwer, Boston, 2000, pages 123-142.

Unrefereed Conference Papers

9. Russell A. Manning and Charles R. Dyer, Interpolating view and scene motion by dynamic view morphing, *Proc. Image Understanding Workshop*, 1998, pages 323–330.

Technical Reports

10. Russell A. Manning and Charles R. Dyer, Research on self calibration without minimization, Computer Sciences Department Technical Report 1490, University of Wisconsin, February 2003.

11. Russell A. Manning and Charles R. Dyer, On screw-transform manifolds, Computer Sciences Department Technical Report 1482, University of Wisconsin, April 2003.

12. Russell A. Manning and Charles R. Dyer, Environment map morphing, Computer Sciences Department Technical Report 1423, University of Wisconsin, December 2000.

13. Russell A. Manning and Charles R. Dyer, Affine calibration from dynamic scenes, Computer Sciences Department Technical Report 1417, University of Wisconsin, March 2000.

14. Russell A. Manning and Charles R. Dyer, Dynamic view morphing, Computer Sciences Department Technical Report 1387, University of Wisconsin, September 1998.

In Preparation

15. Russell A. Manning and Charles R. Dyer, Screw-transform manifolds, in preparation for *Int. J. Computer Vision.*

16. Russell A. Manning, Moo K. Chung, and Charles R. Dyer, Automatic registration of maturing gray matter, in preparation for *NeuroImage.*

17. Russell A. Manning, A simple method for detecting shape primitives, to be submitted to 2004 *Int. Conf. on Pattern Recognition.*

18. Russell A. Manning, Robust, direct scene reconstruction using silhouettes and structured light, in preparation for *SIGGRAPH.*

19. Russell A. Manning, A new generalization of the Catalan numbers, in preparation for *European Journal of Combinatorics.*

REFERENCES

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TEACHING STATEMENT

I served two years as a Teaching Assistant before starting my thesis research. During the first year, I taught two lab sections for an introductory computer class and later served as grader for a data structures class (65 students). In the second year, I taught an introductory programming class for both semesters. This programming class had four sections per semester (two per half semester). At about 30 students per section, I had 240 students for the year! I had complete control over this class, creating and giving all lectures and creating and grading all homeworks and tests. I received excellent student evaluations from the classes I taught, with my highest mark being a 4.9/5.0 overall score for the question "Would you recommend this teacher" from both sections in the Spring semester of 1997.

I also have lecture experience from several conferences. I have presented papers at two meetings of the Conference on Computer Vision and Pattern Recognition (CVPR), in 1999 and 2001. I gave the Principal Investigator talk for our research group at the DARPA-funded Visual Surveillance and Monitoring Workshop (VSAM), 1997, and helped prepare the PI talks for VSAM97 and VSAM98. In addition, I presented demonstrations of my research at VSAM97 and VSAM98.

I believe that the biggest mistake teachers and lecturers make is to assume that their audience readily understands everything being presented. To counteract this, I like to present material in a slow and careful manner. I place particular emphasis on identifying core concepts and making sure that the students become proficient in the core concepts by showing many concrete examples, which the students assist in working through. I also believe that it is important to keep students constantly aware of how the subject being taught fits into a larger context, motivating them by showing how the material could assist them in their future careers.

RESEARCH OVERVIEW

Most of my research has concerned *image-based rendering* (IBR), a subject with elements of both computer graphics and machine vision. In IBR, new computer graphic imagery is created from existing images, usually photographs of a real scene, which are called *reference views* in the discussion below. Most of what follows, except for the recent medical registration work, is incorporated into my thesis. The work is listed chronologically; my most significant work is the fast, robust self-calibration method discussed in the middle section.

Image-based rendering and dynamic scenes. Scenes that contain motion are called *dynamic scenes* and represent new challenges for machine vision and IBR. My research work at Wisconsin started with extending the image-based rendering technique of *view morphing* (Seitz and Dyer, *SIGGRAPH96*) to dynamic scenes containing straight-line motion. This investigation was funded as part of the DARPA/ NSF VSAM project. Later work extended view morphing to full and partial environment maps and to dynamic scenes containing rotational motion. The "calibration from scene motion" work discussed below was initially pursued as part of my image-based rendering research.

> *Papers:* Interpolating view and scene motion by dynamic view morphing, *CVPR99*, (15% accepted for speaker presentation); see also *Proc. Image Understanding Workshop*, 1998; Dynamic view morphing, *Technical Report 1387*, 1998; Environment map morphing, *Technical Report 1423*, 2000; Dynamic view interpolation without affine reconstruction, *Confluence of Computer Vision and Computer Graphics*, 2000; major contributions to successful NSF Grant Proposal for utilizing scene motion in computer vision, 1999.

Camera self calibration. More versatile image-based rendering techniques are possible if the calibration of the source cameras can be determined. For example, knowledge of camera calibration makes it possible to build a three-dimensional model of the original scene, which can then be viewed from arbitrary angles or used in a standard computer-graphics pipeline. My extensions to view morphing did not require scene reconstruction but consequently produced output with a restricted viewing position. To make further progress I began investigating *self calibration*, the possibility of determining camera calibration directly from the reference views without further information.

My first result in this area was an algorithm for determining *affine calibration* from two views of a dynamic scene containing straight-line motion. Methods for finding affine calibration are widely applicable in machine vision and, in particular, this work ensured that linear interpolation sequences could always be obtained from my earlier dynamic view morphing techniques. Furthermore, this research (originally presented in a tech report in 1998) is arguably the first use of simultaneous multiple moving objects in self calibration.

In later work, the **main result of my thesis**, I created a new algorithm for metric self calibration that is fundamentally different from all previous methods. My technique is arguably the fastest and most robust self-calibration algorithm in existence. My method also provides an underlying theoretical link between stratified and direct approaches to self calibration, and can be used reliably with the theoretical minimum of three camera views. My approach made it possible to demonstrate that camera self calibration is well-defined in the three-view case. Because my work tackles the larger, abstract problem of determining the mutual intersection point of several manifolds, which is a general problem in nonlinear optimization, my technique and improvements to it could lead to powerful tools for solving general scientific problems.

> *Papers:* Screw-transform manifolds for camera self calibration, Ph.D. Thesis, defended July 3, 2003; Metric self calibration from screw-transform manifolds, *CVPR01* (8% accepted for speaker presentation); Stratified self calibration from screw-transform manifolds, *ECCV02* (32% acceptance rate); Affine calibration from moving objects, *ICCV01* (34% acceptance rate); Research on self calibration without minimization, *Technical Report 1490*, 2003; On screw-transform manifolds, *Technical Report 1482*, 2003; Affine calibration from dynamic scenes, *Technical Report 1417*, 2000; Fast, robust self calibration using manifold intersection, submitted to *CVPR04*; The classification of monocular camera displacements, submitted to *CVPR04*; Screw-transform manifolds, in preparation for *Int. J. Computer Vision*.

Medical image registration. Recently I have been working on the problem of registering (i.e., finding correspondences between) two three-dimensional reconstructions of a maturing human brain. The brain scans come from the same teenager but are separated by roughly a three-year interval so that the sulci (i.e., folds) on the brain surface have changed significantly. Typically, the sulci drift into new positions, expand, contract, split, or merge with neighboring sulci over time. The challenge is to automatically determine what changes have occurred. My solution uses a highly-efficient, global, brute-force search technique. Because there are many problems in medicine that mirror the brain-registration problem, I believe this area will be a rich source of new research problems in the future.

FUTURE RESEARCH DIRECTIONS

My background in relation to my future research

In the broadest terms, my research interests are in artificial intelligence and computer graphics. These interests did not just arise in graduate school or even as an undergraduate. I began thinking about and experimenting with artificial intelligence in fourth grade and I went to graduate school at MIT specifically to pursue a Ph.D. in artificial intelligence, as I had planned since high school. I also did my Ph.D minor in psychology out of a general interest in how the mind works. I have a life-long interest in art, animation, and computer graphics stemming from the fact that my parents are artists and my father was a professor at the Art Institute of Chicago and with the New Bauhaus at the Illinois Institute of Technology. I wrote my first 3D graphics renderer in eighth grade after attending a SIGGRAPH workshop and I later studied computer graphics under Al Barr at Caltech. After leaving MIT, I worked with a start-up company producing a desk-top video editing system, where I cloned all the image-processing capabilities of Adobe Premiere (the leading video editing system of the time) and Faux Matisse (a sophisticated computer painting program).

My Ph.D thesis research has been in machine vision because this area gives me a chance to do research in both artificial intelligence and computer graphics. There are some additional fields of personal interest to me, namely art, history, pure mathematics, paleontology, astronomy, and movie making, that will certainly influence the direction of my future research.

I have always been able to pursue research in a highly independent manner, both at Wisconsin and in earlier research at MIT, Argonne National Laboratory, Star Media Systems, and during a summer internship at Caltech. I also have significant experience in creating and writing grant proposals, having worked closely with my advisor on two NSF grant proposals.

A few specific research plans

Synthetic environments. I am interested in problems related to "virtual reality" – creating synthetic, immersive environments for education, long-distance communication and vehicle control, and entertainment. My thesis research involved automatically converting photographs of real scenes into 3D computer models, and I am now investigating the problem of recovering detailed 3D models of individual objects under controlled conditions. I am also interested in problems related to populating synthetic environments with artificial life, such as synthetic actors for a city simulation.

"Blob" matching, specifically for measuring brain growth. The challenge is to create an algorithm that can find a logical correspondence (e.g., similar to what a person might produce) between two somewhat different deformable, organic shapes. I have already designed and implemented a method for finding correspondences between two 3D models of a maturing brain, and the results are very promising. This is a rich area of research with many important problems to be solved, both in medical imaging and more general machine vision areas.

Curve and silhouette classification and identification. I have recently been investigating the problem of categorizing objects based on their outer silhouettes. This can be useful as a first step in scene recognition (e.g., identifying that some region of a photograph contains a "car" shape can lead to further processing for car-like features) and for parsing human-made 2D icons and graphics (e.g., a "heart" shape or a corporate logo such as the symbol for Atari). Can a reliable, general-purpose, and preferably simple algorithm be created that is able to identify different leaf shapes (e.g., distinguish a ginkgo leaf from a white oak leaf)?

Brute-force problem solving. This refers to computationally-intensive search methods such as genetic algorithms or Monte Carlo Markov Chain estimation. The centerpiece of my Ph.D. thesis was a brute-force technique for camera self calibration that worked quickly (1 or 2 seconds) and located all global solutions to the problem without getting caught in the local minima of an objective function (a common pitfall of nonlinear optimization). I am interested in further exploring the properties and potential of such methods.