Curriculum Development Grant Proposal
C490/B657 Computer Vision

Michael R. Scheessele
Department of Computer and Information Sciences, IUSB

Overview

The purpose of this project is to develop student exercises/projects for a new (to IUSB) course in Computer Vision. This proposed new course will target both advanced undergraduates (as CSCI C490) and graduate students in the recently started Masters in Applied Mathematics and Computer Science program (as CSCI B657). This project will focus on identifying and developing suitable 'hands on' exercises/projects that illustrate the major concepts of computer vision. This is crucial in a field such as computer vision, where lectures and book learning are not enough – students need to 'get their hands dirty', in order to fully appreciate the major ideas and issues in the field. Part of the reason for this is that computer vision has high mathematical and computational content and is therefore quite abstract. Without suitable exercises/projects, it is easy to lose sight of the fact that one is trying to get a machine to have sight. As an example, in my first semester of graduate school as a research assistant, I was trying to write a program that could recognize triangles and rectangles. In the general case this is a non-trivial problem, if one considers that a rectangle rotated in depth appears as a trapezoid on the human retina. With appropriate depth cues however, humans are readily able to judge that the shape is a rectangle and not a trapezoid. (For triangles the issue is stickier, because a triangle rotated in depth is just a different triangle.) How to capture this in a computer program though? Struggling with writing and debugging my program, I wondered whether the PI (my professor) knew what he was doing. Then, one afternoon the program finally was able to 'see'. For me, its recognition of these simple images was like having the fog lift precisely upon entrance to the Golden Gate Bridge.

Given that a good mix of exercises/projects is critical for an introductory course in computer vision, why offer such a course in the first place? The significance of this new course is threefold. First, developing this course will provide a new computer science elective for both undergraduate and graduate students. To ensure continued success of the recently established Masters in Applied Mathematics and Computer Science program, additional new elective graduate courses must be added over time. With respect to undergraduate electives, the retirement of one of our faculty members last spring resulted in the loss of an elective that he periodically taught. The proposed new course will help both in replacing that loss and in expanding the number of graduate computer science elective courses.

Second, half of the current Computer Science faculty has significant expertise in the area of Artificial Intelligence. To leverage this expertise, we have formed the 'Intelligent Systems Laboratory' and we hope to some day offer a Masters concentration in Artificial Intelligence. Computer Vision is typically a 'staple' course in programs that offer an AI concentration; therefore introducing this course at IUSB would be a step in the direction of eventually establishing a Masters concentration in AI.

Third, the application of computer vision techniques in everyday life is steadily growing. For example, at the 2001 Super Bowl, the idea of using face recognition systems outside the stadium, in order to identify criminals in the crowd, generated quite a

stir. Today, deployment of such technology has become commonly accepted at airports across the country. Increased use of computer vision techniques will also be required to keep up with the mountain of satellite image data generated each year. In health care, application of computer vision techniques to interpretation of radiographic images offers the promise of more effective and efficient diagnosis. In the areas of database and web-based search, typical searches are text-based. However, text-based searches do not work when searching unlabeled images on the basis of image content. As a result, image-based search has become an important area of research. Finally, it is anticipated that near-future robots will be endowed with more advanced visual systems and that such robots will have a dramatic impact on the economy and upon society (Brooks, 2004):

> "Robots with the vision capabilities of a two-year-old and the manipulation capabilities of a six-year-old will be more disruptive to our way of life than any robot portrayed by the governor of California."

In short, to be competitive, computer scientists will need a basic understanding of the computer vision techniques that serve as the foundation for these and other emerging technologies.

References

Brooks, R. (2004). The robots are here. *Technology Review, Feb. 2004*, p. 30.