B Project Summary.

More than ten million Americans have color-deficient vision. Although color-deficient vision is far from the most severe of human disabilities, its impact is felt by a large segment of the population, and its importance is growing, as our society increasingly depends upon the display of color images and color image sequences for information and education. The trend is not surprising, in that technology can now deliver color images at high speed and low cost, and the information bandwidth available to humans through image processing far exceeds that available through text processing alone. Nevertheless, designers of images for color displays rarely account for the potential loss of information that may be experienced by color-deficient observers. Consider the simple, if contrived, example shown in Figure 1. The image on the left conveys information in the form of colored blocks. The image on the right is the very same image, as seen by a (simulated) observer with deuteranopic deficiency, a most common form of color-deficient vision. Consistent with the

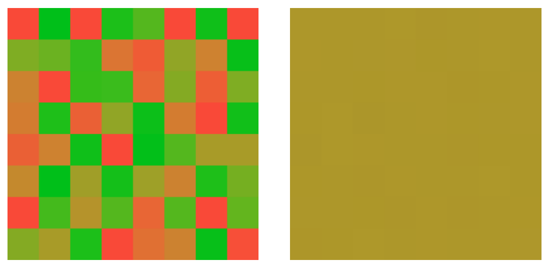

Figure 1: *Why re-coloring is necessary:* a color image with information provided by 36 colors (left), and the same image as seen by a (simulated) observer with deuteranopic deficiency (right).

NSF Program 06-572 directive, “Human-centered technology will enable all people to take advantage of the full benefits of computing, will empower people with disabilities,” this proposal focuses on the design and implementation of a software system for real-time color-correction on computer displays that will provide markedly enhanced image information to viewers with protanopic, deuteranopic, and tritanopic deficiencies.

Intellectual Merit. Design and implementation of this system will require significant advances in three areas. First, an objective function defined on the color spaces of both the normal viewer (dimension 3) and the color-deficient viewer (most often dimension 2) that effectively captures both contrast and gradient consistency must be identified. We have made significant progress in this direction, but much work remains. Second, the form of this objective function will almost certainly call for a constrained, non-linear optimization over a large domain. Real-time requirements will supersede global optimization, and fast approximations that provide only local error minima may be preferable to global solutions. Third, experience with this problem suggests that the mostly untapped SIMD computing power available in modern PC graphics cards (GPUs) may be effectively applied here to deliver the required real-time performance.

Broader Impact. Development of a freely-distributed system such as that described could quickly remove the growing barriers to receiving information that are encountered by as many as ten million Americans. As society becomes increasingly visually-oriented, with displays in homes, schools, automobiles, and sites for public information, it is important to provide the assistive technology that will allow all individuals to fully participate in the new modes of information exchange and education. Future migration of the technology to heads-up displays could ameliorate several important difficulties, e.g., suppose the colors of Figure 1 were encountered on a horizontally-mounted traffic signal by an automobile driver with deuteranopic deficiency.
Key Words: *color-deficient vision; enhancement filtering; color correction; scan-path analysis.*