Blind graduate student 'reads' maps using CU software that converts color into sound

By Thomas Oberst

A melody of staccato piano notes sings out from the speakers of Victor K. Wong's desktop computer. But it is not a melody made by Bach or Liberace or even Alicia Keys. It is the melody of *color.*

Wong, a Cornell graduate student from Hong Kong who lost his sight in a road accident at age 7, is helping to develop innovative software that translates color into sound. "Color is something that does not exist in the world of a blind person," explains Wong. "I could see before, so I know what it is. But there is no way that I can think of to give an exact idea of color to someone who has never seen before."

He helped develop the software in Cornell's Department of Electrical and Computer Engineering (ECE) with undergraduate engineering student Ankur Moitra and research associate James Ferwerda from the Program of Computer Graphics.

The inspiration for using image-to-sound software came in early 2004 when Wong realized his problems in reading color-scaled weather maps of the Earth's upper atmosphere – a task that is a necessary part of his doctoral work in Professor Mike Kelley's ECE research group.

It is a field dubbed "space weather," which attempts to predict weather patterns high over the equator for use by Global Positioning System and other satellite communications. A space weather map might show altitude in the vertical direction (along the y-axis), time in the horizontal direction (along the x-axis) and represent density with different colors.

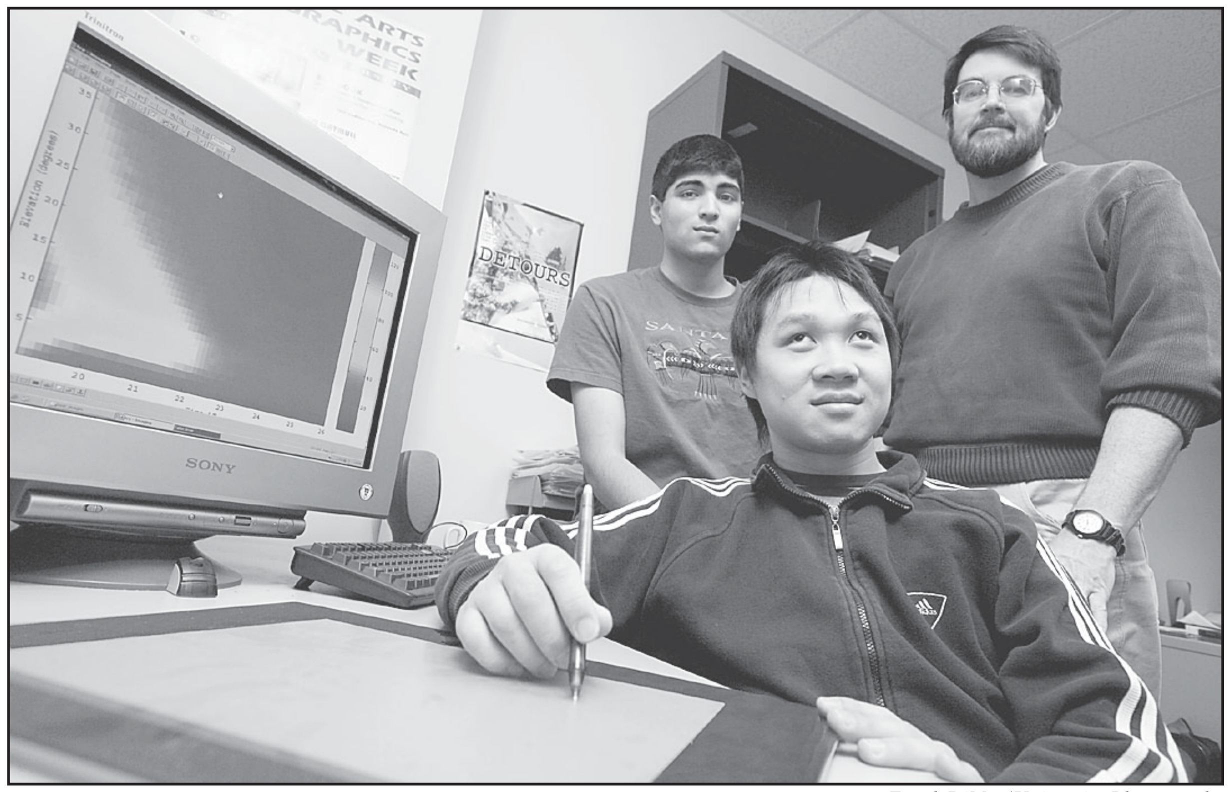
As a scientist, Wong needs to know more than just the general shape of an image. He needs to explore minute fluctuations and discern the numerical values of the pixels so that he can create mathematical models that match the image. "Color is an extra dimension," explains Wong.

At first, the team tried everything from having Kelley verbally describe the maps to Wong to attempting to print the maps in Braille. When none of those methods provided the detail and resolution Wong needed, he and Ferwerda began investigating software. Moitra later became their project programmer.

"We started with the basic research question of how to represent a detailed color-scaled image to someone who is blind," recalls Ferwerda. "The most natural approach was to try sound, since color and pitch can be directly related and [the human ear's] sensitivity to changes in pitch is quite good."

Over the summer of 2004, Moitra wrote a Java computer code that could translate images into sound, and in August he unveiled a rudimentary software program capable of converting pixels of various colors into piano notes of various tones.

Wong test-drove the software by exploring a color photograph of a parrot. He used a rectangular Wacom tablet and stylus – a computer input device used as an alternative to the mouse – which gives an absolute reference to the computer screen, with the bottom left-hand corner of the tablet always corresponding to the bottom left-hand corner of the screen.



Frank DiMeo/University Photography

Engineering graduate student Victor Kai-Chu Wong uses software he helped develop with undergraduate Ankur Moitra, left, and research associate James Ferwerda, right, that translates colors into sounds. The image-to-sound software enables Wong to continue his research into space weather. He is shown working with a space weather map that represents atmospheric density in different colors.

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>
> – Graduate student Victor Wong

As Wong guided the stylus about the tablet, piano notes began to sing out. The full range of keys on a piano was employed, allowing color resolution in 88 gradations, ranging from blue for the lowest notes to red for the highest.

The software also has an image-to-speech feature that reads aloud the numerical values of the x- and y-coordinates as well as the value associated with a color at any given point on the image. "In principle I could turn off the music and just have the software read out the value of each point," Wong says. "I would know what the gradient is in a more absolute sense, but it would get annoying after some time. It keeps reading out '200.1,' '200.8,' '200.5' and so on."

One of the biggest challenges of the project is the so-called "land-and-sea" problem. "Sometimes I just want to know where is the land and where is the sea," says Wong – meaning that he would like to have an idea where the major boundaries in the image lie, such as the boundary between the parrot and the background. The problem hinges on shape-recognition, which for Wong can be difficult.

In the simplest situation, the right half of an image would be completely blue and the left half completely red. To find the boundary, Wong has to move the stylus continuously back and forth from one color to the next along the length of the tablet, which is both time-consuming and error-prone.

To solve the land-and-sea problem, Wong, Moitra and Ferwerda tried printing the major boundary lines of an image in Braille and then laying the printed sheet over the Wacom tablet, combining both audio and tactile detection. However, they are still working to develop software that can effectively pick out the important boundaries in an image so that they can be printed.

"It is also important that there is no time delay between notes," said Moitra. "That is something we need to improve. Otherwise, the image will become shifted and distorted in Victor's mind."

One of the major issues facing the project is funding. "The initial work was done on a shoestring as a side project to grants Kelley and I have received," says Ferwerda, who is preparing a proposal to the National Science Foundation to extend this work and explore other ideas for making images and other technical content accessible to blind scientists and engineers.

Says Wong, "Tackling complex color images is only one problem out of many that blind scientists are facing. But I think this is a pretty important idea."

Reported and written by Thomas Oberst, a science writer intern with Cornell News Service.

Cornell scientists discover critical step in flu virus infection pathway

By Susan S. Lang

Two Cornell researchers have found a pathway that is critical for the flu virus to enter and infect a cell. The discovery could lead to the development of antiviral medications and vaccines that would target all influenza viruses.

The newly discovered pathway occurs after the virus attaches to a cell. The next stage of infection, the Cornell researchers said, involves an unknown co-receptor that allows the virus to infect the cell.

"Now that we know there's a second step involved in influenza infection – that a co-receptor is crucial for the virus to enter a cell – we can go after it," said Gary R. Whittaker, assistant professor of virology at the College of Veterinary Medicine at Cornell.

"Once we identify the receptor, we expect that a whole new avenue of antiviral medications and vaccines could be developed that would target all influenza viruses, not just one strain at a time," he said.

Whittaker and Victor C. Chu, a graduate student in comparative biomedical sciences, have published their findings in the *Proceedings of the National Academy of Sciences* (Dec. 28, 2004; Vol. 101, 52, 10153-18158). It is an open-access article, freely available online at <http://www.pnas.org/cgi/reprint/101/52/18153>.

Scientists have known for about 50 years how the influenza virus attaches to cells before it infects them. Previous work focused on red blood cells, which are suitable experimental systems for examining virus attachment. However, red blood cells don't have nuclei and don't get infected by the virus. Until now, scientists had never found a mammalian cell with a nucleus that didn't get infected by the influenza virus. The Cornell researchers, however, have now identified a line of nucleated cells that are resistant to infection by the flu virus. The critical factor that protects these cells from infection is the lack a specific surface receptor comprising N-linked glycoprotein.

Thus, although the influenza virus can still attach to these cells, without the surface N-linked glycoprotein the virus cannot infect them.

Whittaker pointed out the latest influenza discovery is paralleling the research advances with the HIV-AIDS virus about nine years ago, when a second HIV co-receptor was discovered. This enabled researchers to develop new drugs that are now in clinical trials.

Influenza kills some 20,000 people every year in the United States and up to one-half million people worldwide. New strains keep cropping up for which vaccines must be developed. The development of vaccines for each strain is costly, time-consuming and not always effective; sometimes new and more virulent strains crop up by the time a new vaccine for a less virulent strain is available. Whittaker also noted the concern about a bird flu virus in Southeast Asia that could overwhelm our ability to control it. Potentially this avian virus threatens the lives of tens of millions of people worldwide.

Whittaker explained that it has been known for years that the influenza virus first binds to the host cell via a sialic acid receptor – a surface-cell carbohydrate that is near universal – and then fuses with it.

"These events generally have been well characterized from a biochemical and biophysical perspective, but many of the cell biological aspects of virus entry have been unclear," Whittaker said. Instead of red blood cells, which most influenza virus researchers use to study virus binding and fusion, Whittaker and Chu turned to a line of Chinese hamster ovary (CHO) cells, which have been used since the 1970s to study cell genetics. The normal line of CHO cells gets infected just as all nucleated cells do, but a mutant line of these cells – called Lec1 cells – are deficient in the surface N-linked glycoprotein and are resistant to the influenza virus.

Furthermore, the researchers showed that recovery of the N-linked glycoprotein using an enzyme from normal CHO cells could rescue an influenza virus infection.

"Our work shows that the influenza virus requires a protein to enter cells and that sialic acid, although an efficient attachment factor, is not sufficient for infection," said Whittaker. He noted that Lec1 cells may also provide a new model for influenza virus infection research.

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