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**If you like U2, you'll love . . . Metallica?**

**Software that 'listens' to songs could help you find new favorites**

By Tom Avril  
Inquirer Staff Writer

Sure, you've heard U2. Hard to avoid the Irish rockers, a musical force since the 1980s.

But how do you find - let alone decide if you like - some garage band that's cut the killer new track that no one's ever heard of?

In his gleaming white lab at Drexel University, Youngmoo Kim has an answer: raw computing power.

He's an electro-DJ of sorts, part of a new wave that seeks to help consumers sift through the countless downloadable tunes on the Internet. It's a crowded field, with plenty of Web sites already promising consumers "if you like this, then you'll like that."

But most of those sites base their picks largely on what other consumers have purchased - perhaps reinforcing mass-market tastes at the expense of undiscovered gems. Kim and other researchers have embraced a more fundamental approach: using computers to "listen" to the music itself.

The technology is in its infancy, having emerged only in the last few years. And Kim, both an engineer and a trained choral singer, doubts it will fully replace the human ear or the sophisticated instrument attached to it - the brain.

But software can run through thousands of songs at a speed no consumer - or record-company executive - can match.

"It could really help democratize the music business," Kim predicted.

The concept is a new frontier for the Internet, said Eric Garland, chief executive officer of BigChampagne, a California company that analyzes sales of music downloads.

It's one thing to type in a song (or book, or movie) on a search engine such as Google, he said. But if you're looking for a recommendation, you can't very well type in a name you don't know.

"Search is great," Garland said. "Discovery is a more fundamental problem. What should I be looking for?"

**Mimicking the ear**

As engineering labs go, this one knows how to rock.

Someone has brought in the toy guitar from the Guitar Hero video game, which grad students are trying to tweak for use as a music-teaching aid.

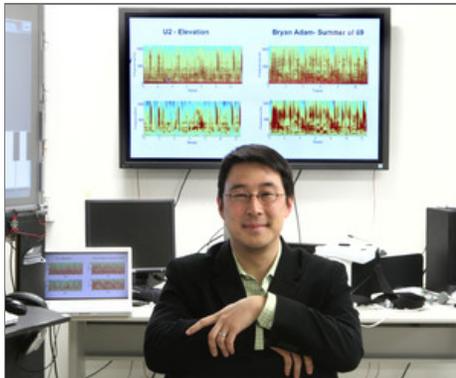
A giant touch-screen stands to one side, which the engineers use to play virtual instruments that they've invented - including a "polytheremin," a souped-up version of the thing used to make those spacey "wooo-ahhh" sounds in 1950s movies.

Kim, a Drexel assistant professor of electrical and computer engineering, once sang the classics as a member of the Boston Symphony Chorus. But he knows pop.

With a few taps on his keyboard, the speakers are blaring the opening bars of "Pride (In the Name of Love)," the live version from U2's *Rattle and Hum*.

A human being hears the driving guitar chords. The relentless drumbeat. Bono crying out, "One man come in the name of love . . ."

But to the computer, the first fraction of a second "sounds" like this:



DAVID M WARREN / Inquirer Staff Photographer

Drexel University researcher Youngmoo Kim in his lab with spectrograms of music by U2 and Bryan Adams. The computer scientist is working on software to find similarities between songs.

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How to analyze those data in a way that's relevant to the human experience of listening?

It's a tough problem, one that drew hundreds of scientists to a conference in Vienna, Austria, in September.

In some ways, the ear is far superior to a computer. A person can quickly tell the difference between Aretha Franklin and your sister goofing with a karaoke machine. Computers aren't there yet.

In other ways, the machine has the edge, and not just because of its sheer speed and memory.

People are good at telling apart sounds of different frequencies in the low to middle part of the spectrum - a range that includes most of the sounds in human speech - but not so good at the high end, said David Poeppel, a University of Maryland professor of biology and linguistics.

Some of the acoustic components of the letter S, for example, sound to us "like high-frequency noise," Poeppel said.

Yet a computer handles all frequencies equally well.

So the software developed by Kim's lab makes adjustments to mimic the way people hear - scrunching up the data from the high end of the spectrum, and spreading out the low end. A similar technique is used in speech-recognition software.

#### The data crunch

The software then breaks a song down into 20 component wave-forms - ranging from ultra-low to very high frequency - and computes how much of each one is present in the music.

It's a broad characterization of the song's musical timbre, or audio texture - whether it's smooth or spiky, soft or loud. (Other computer scientists have opted to analyze features such as tempo and rhythm.)

The program then calculates how much each of the 20 values varies when compared with the others - a process that yields a distribution of 230 numbers for each song.

The statistical "distance" between one song's distribution and another is called the Kullback-Leibler divergence.

If you like one song, in theory, you'll also like the ones that are statistically close to it.

The analysis can yield surprises.

When Kim ran the numbers for U2's "Pride," the closest song was "Low Man's Lyric," by the heavy-metal group Metallica - a song Kim had never heard of.

"I'm sort of afraid of what this is," he said, as he cued up the Metallica track on his speakers.

"Very different tempo," Kim said after listening for a few moments. "And yet the harmonies are actually quite similar."

The database contained just 1,000 songs when the computer made that pick. A later run against more than 7,000 songs returned some closer matches, the best of which was "You're So Static," by Elton John. Ultimately, Kim said, the best solution may be a mix of analyzing the music and other data, like sales patterns. But there's no question that when a machine listens, it offers a different brand of insight.

"The computer has no biases built in," Kim said. "It doesn't say 'Oh, U2 and Metallica would never sound the same.'"

#### A pro's take

Philadelphia DJ Robert Drake owns so many compact discs he's lost track - 6,000? - not to mention an additional 30 gigabytes of music in electronic storage.

A radio producer at WXPX-FM (88.5), he prides himself on knowing the obscure and the up-and-coming (current fave: The Clicks, a punk-rock group from Brooklyn).

But when asked about the computer scientists invading his turf as a tastemaker, Drake said he was all for it. He's already excited by how people spread word of new bands on MySpace.com and other sites. Another site, Pandora.com, generates personalized radio stations from a library of songs that human experts have evaluated for their tempo, types of instruments, and other elements in their musical "genes."

"That might become the industry," Drake said of the various computer-aided approaches. "Not labels pushing things out, but a lot of viral things. The consumer is going to become more aware."

Can software alone get the job done? Computers have muscled into other fields once dominated by subjective judgment, among them baseball scouting and fine wines.

Music-industry people scoff at the notion that their ability to predict hits could ever be matched by a computer program, said BigChampagne's Garland.

But at the very least, he predicts, software such as Kim's will be valuable to consumers, enabling them to rediscover forgotten tunes among thousands on their iPods.

"Wouldn't it be wonderful," Garland said, "if someone or something could come into your own music collection and make it new?"

The challenge excites the youngish crowd of engineers who have taken it up, said Dan Ellis, an associate professor of electrical engineering at Columbia University.

"There are no real adults," he quipped.

But Ellis said the task also made him and other researchers uneasy.

They can readily test whether their design of a bridge or computer circuit is successful. It's not so simple when they bring technology to the subjective realm of the arts.

"The problem with this is: The actual right answer is not completely clear," Ellis said.

If anyone has the expertise to figure it out, it's Kim. Unsure whether to pursue a career in music or engineering, he majored in both at Swarthmore College.

Now back in Philadelphia after stints at Stanford and the Massachusetts Institute of Technology, he continues to combine both his interests.

"The purpose of using the technology isn't to replace the human. It's to enable us to do more," Kim said. "I think I

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### One Song's Best Matches

Software from a Drexel University lab computes the statistical "distance" between songs. A perfect match - that is, comparing a song to itself - would be zero.

Here are the values for the five best matches to U2's "Stuck in a Moment You Can't Get Out Of," from a database of 7,135 pop songs:

**7.9157:** "Face and Ghost," by Live

**8.5183:** "Confidential," by Tina Turner

**8.5967:** "I Do But I Don't," by Tim McGraw

**8.6928:** "Never You Mind," by Semisonic

**8.8624:** "Brother My Brother," by Blessid Union of Souls

Audio clips comparing two songs, plus charts and more details: <http://go.philly.com/science>

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U2 and Metallica: Perfect together? Drexel's software thinks so. Check it out at <http://go.philly.com/science>

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