By Sara Tehranian

After completing high school in India, Raj Rangayyan faced a tough choice between two careers: engineering or medicine? At that point, Rangayyan chose engineering, primarily because of his father's success as an industrialist and entrepreneur. But in later years, he went on to combine them when he joined the University of Manitoba in 1981 in a post-doctoral research position in the Faculty of Medicine and then secured a faculty position in biomedical engineering at the University of Calgary in 1984. Today, Rangayyan is making significant contributions in the field of biomedical engineering through his research in digital image processing techniques to diagnose a leading cause of childhood blindness and designing diagnosis methods for the early detection of breast cancer.

Photo by Kshitij Vasudevan

Raj Rangayyan playing the bamboo flute *bansuri.*

Raj Rangayyan

Master of Many Crafts

RAJ RANGAYYAN HAS been chosen by the Institute of Electrical and Electronics Engineers (IEEE) Canada for the Outstanding Engineer Award for 2013. Established in 1994, this award recognizes outstanding Canadian engineers for significant contributions to electrical and electronics engineering. The award was presented in May at the Canadian Conference on Electrical and Computer Engineering (CCECE) in Regina.

Rangayyan is an accomplished biomedical researcher whose work has the potential to improve the lives of countless people who suffer from a range of diseases and disorders. He is a professor in the Department of Electrical and Computer Engineering and an adjunct professor in the Faculty of Medicine's Department of Surgery and Radiology at the University of Calgary.

In addition to his scientific papers, Rangayyan has written several books on the subjects of image processing and signal analysis and has received many accolades for his work. Among the most recent was a Publication Prize from the Institute of Cancer Research for a paper describing the development of a computer-aided diagnosis method to detect subtle signs of breast cancer over a year before the current clinical diagnosis methods.

The path to biomedical engineering

While growing up in India, Rangayyan developed an interest in math and science. While he gravitated towards engineering, he also had a keen interest in medicine.

"In India, for various cultural and economical reasons, there is a lot of pressure on students to get into a few select areas, the top two being medicine and engineering. Almost every high school student faces this decision. My father was an industrialist and entrepreneur. So that pulled me more towards engineering."

Rangayyan received his Bachelor of Engineering in Electronics and

Communication in 1976 from the University of Mysore at the People's Education Society College of Engineering in Mandya, Karnataka, India. During his undergraduate studies, he became interested in the biomedical applications of engineering.

"I came across articles about biomedical engineering and I heard some lectures. I considered that to be an appealing way to apply engineering: to solve real-life health issues that affect ordinary people."

He received his PhD in electrical engineering from the Indian Institute of Science in Bangalore, Karnataka, India in 1980 and joined the University of Manitoba in 1981 in a post-doctoral research position in the Faculty of Medicine.

By 1984, he was interested in a faculty position in biomedical engineering and joined the University of Calgary. He became a full professor in 1989 and has built up an impressive research program in the years since. Rangayyan is currently mentoring his students in the Biomedical Signal and Image Analysis Laboratory at the Schulich School of Engineering.

"In biomedical engineering research, the key point is effective collaboration in multidisciplinary teams," says Rangayyan as he explains various areas of his research. "My research is currently focused on two main areas: digital image processing techniques to diagnose a leading cause of childhood blindness and designing diagnostic methods for the early detection of breast cancer."

Rangayyan's team has also worked on knee-joint sound signal analysis for noninvasive diagnosis of articular cartilage pathology and has developed image analysis techniques to improve the monitoring and treatment of neuroblastoma, a form of cancer affecting children. It originates in the developing nervous system and can cause tumours anywhere in the body.

Cancer detection: earlier diagnosis may be possible with computer-aided system

Raj Rangayyan, along with researchers Shantanu Banik and Leo Desautels, developed a system that detects architectural distortion, which demonstrates specific patterns in the breast tissue that seem to be precursors to tumours and are often missed in routine screenings. In collaboration with the Alberta Breast Cancer Screening Program, they analyzed and detected these patterns in mammographic images taken from routine screenings of women who later developed breast cancer.

This method may one day lead to earlier diagnosis of breast cancer and improve the survival rate. Before this technology can be used as a diagnostic method, more funding is needed for additional research.

Improving the lives of children: using digital image processing to prevent blindness

From computer programming and biomedical signal analysis courses for first- and fourth-year undergraduate students to graduate courses on image processing, Rangayyan has taught at all levels.

"But the most enjoyable part of my job is working with my graduate students in the lab. My PhD student, Faraz Oloumi, is currently working on digital image processing techniques to improve the diagnosis of retinopathy of prematurity (ROP), the leading cause of potentially preventable childhood blindness."

Raj Rangayyan examines images of mammograms in the Biomedical Signal and Image Analysis Laboratory at the Schulich School of Engineering.
Photo by Riley Brandt

In premature babies, normal retinal vessel development may be disrupted and abnormal vessels can grow. These fragile vessels can leak and cause bleeding in the eye. This can cause the retina to detach, leading to blindness. Premature infants are screened by taking an image of the retina to examine the retinal blood vessels. The ophthalmologist compares these images with gold standards. There is substantial variation among experts on the diagnosis of this condition because of the visual and qualitative nature of this method. In babies with ROP, retinal blood vessels are modified in terms of their width and shape. The major blood vessels coming out of the optic nerve head form a path that becomes narrower in ROP.

"Together with Dr. Anna Ells, pediatric ophthalmologist at the Alberta Children's Hospital, we are characterizing these patterns to develop novel models that can facilitate quantitative analysis of the images and overcome limitations associated with subjective manual analysis."

Not all work and no play

Rangayyan believes may things contribute to a fulfilling life. So it's no surprise that biomedical engineering isn't his only passion.

"Music enhances the quality of life, it soothes the soul. During high school and undergraduate studies, I played music, sang and had a music group with my friends," recalls Rangayyan. "I got into classical music of India later in graduate school and received training on the bamboo flute bansuri and the sitar. Here in Calgary, I play and collaborate with musicians at the Department of Music and also musicians playing Indian classical music."

He has even released a range of CDs, some of which have been licensed to museums and yoga and meditation schools to facilitate contemplation, reflection and relaxation.

Rangayyan is clearly a man who knows how to weave many aspects of his life together seamlessly: engineering and medicine, science and art, east and west. And he has taken this art to a new level. While many families struggle to find common ground when the children grow up, Rangayyan's is glued together with their common interests in the arts and engineering. Rangayyan's wife Mayura is an artist with a degree in home economics. She volunteers for many organizations including the Alberta Children's Hospital and the Canadian Cancer Society. Both their children are alumni of the Schulich School of Engineering. Vidya completed a joint degree in geomatics engineering and international relations. She was president of the student chapter of Engineers Without Borders and received the U of C President's Internationalization Award in 2004. Their son Adarsh has a degree in mechanical engineering and plays a range of instruments as a heavy-metal musician.

Like his family, Rangayyan believes the medicine, engineering and art contribute to the physical, emotional, intellectual, and spiritual well-being of individuals at different levels.

RESEARCH INTERESTS

- Digital signal processing
- Digital image processing
- Their applications in biomedical engineering

BOOKS

- *Color Image Processing with Biomedical Applications*
- *Biomedical Signal Analysis*
- *Biomedical Image Analysis*
- Several books published in the Morgan & Claypool Lecture Series

MUSIC

- Has performed extensively in India, Canada and Brazil
- Offers private music lessons
- Volunteer music instructor at the School of Indian Languages & Performing Arts in Calgary

CDS

- *Totally peaceful* (2009)
- *Listen, Honey ... A Melodious Love Story* (2003)
- *If You Have the Time* (2000), *In Tune with You* (1998)
- *Just in Time ... Just for You!* (1998).