UNIVERSITY OF WASHINGTON

COMPUTER SCIENCE & ENGINEERING
RAJESH RAO, ASSOCIATE PROFESSOR

April 27, 2012

Dear Members of the Faculty Recruiting Committee:

Pradeep Shenoy is an exceptional candidate for a tenure-track faculty position in your department and I give him my highest recommendation. Pradeep is the strongest PhD student in computational neuroscience that I have supervised. His doctoral thesis on ECoG and EEG-based brain-computer interfacing made a number of important contributions to the field as detailed below. He joined Angela Yu's lab as a postdoctoral researcher and has since been gaining a reputation for himself as a rising star in computational neuroscience (his work was recognized by an oral presentation at the highly competitive *NIPS* conference). His strong technical skills and creativity, coupled with his great communication and teaching skills, make him a fantastic faculty candidate – you should not miss the opportunity to interview him.

Before joining my lab, Pradeep was a researcher in the field of databases and had already published several papers in top database conferences. He expressed an interest in switching to brain-computer interface (BCI) research for his doctoral research. He became the first graduate student in my group to start doing experiments in non-invasive brain-computer interfaces using electroencephalography (EEG) and electromyography (EMG). For his qualifying project, Pradeep designed a brain-computer interface system that used a dynamic Bayesian network to track brain and muscle state from EEG and EMG recordings during a motor task. This was one of the first applications of Bayesian Networks to brain-computer interfacing. This work was presented at the *Neural Information Processing Systems (NIPS)* conference in 2004 and published in the proceedings volume.

Pradeep made a number of important contributions to the field of brain-computer interfaces as part of his doctoral thesis research. First, he explored the application of machine learning techniques to the problem of classifying real and imagined motor actions based on electrocorticographic (ECoG) signals recorded from the surface of the brain (in patients prior to surgery). He showed that real motor actions can be classified with high accuracies (in the 95% range) while motor imagery can be classified with about 80% accuracy. These results are directly applicable to developing imagery-based communication and cursor control systems for the paralyzed. In a follow-up study, he demonstrated that individual finger movements can be discerned directly from ECoG activity, with accuracies near 80% for discriminating between the 5 classes, each denoting a finger movement. These results are very promising in that they constitute a first step towards developing brain-controlled prosthetic hands for amputees and other

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disabled individuals. Pradeep's work on ECoG-based BCI has been published in the *IEEE Trans Biomed Engineering* journal and the *Proceedings of the IEEE EMBS Conf. on Neural Engineering*.

A second set of experiments in Pradeep's thesis focuses on the problem of using the classified brain (or muscle) signals to control actual physical devices in the real world. With students Beau Crawford and Kai Miller, he showed that it is possible to control a 4-degree-of-freedom robotic arm in real-time to solve complex motor tasks using EMG muscle signals from the skin surface of the arm. This work was presented at the *AAAI annual conference* in 2005 and an extended report has been published in the *IEEE Trans Biomed Engineering* journal.

Pradeep also developed a non-invasive brain-computer interface that can be used to command a complex 25-degrees-of-freedom humanoid robot to pick up a desired object from among the ones in its field of view and bring it to a desired location, all based directly on non-invasive EEG signals. This work received substantial attention from a number of national and international media outlets, including CBS, ABC News, NPR, Discover magazine, The Telegraph, etc., and was published in the *Journal of Neural Engineering*, where it was selected as one of seven *Highlights of 2008*.

Pradeep has additionally made contributions to the area of "human-aided" (or "brain-aided") computing. In collaboration with Desney Tan's group at Microsoft Research (MSR), Pradeep developed methods for employing brain activity to directly solve hard computational problems, e.g., labeling image content. EEG signals from the scalp of human subjects were used to automatically classify images containing faces versus inanimate objects with accuracies as high as 91% for ten repetitions of a stimulus. Higher accuracies were also achieved by pooling across multiple users or by additionally employing computer vision techniques. This work was accepted for presentation at the top human-computer interaction and computer vision conferences (*CHI* and *CVPR*) in 2008.

For his postdoctoral research, Pradeep has worked with Angela Yu at UCSD on developing probabilistic and neural models of decision making. This is an important area in computational neuroscience that requires knowledge of Bayesian techniques, decision theory, optimization methods, and familiarity with data from neuroscience, psychology, and cognitive science. Pradeep's research in this interdisciplinary area has gained attention from both neuroscientists and the computational community, as was evident from the interest generated by his talk at the *Society for Neuroscience* meeting and his paper at *NIPS* last year.

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There are several reasons that make Pradeep one of the top candidates to interview this year. First, he is a rising star in computational neuroscience – there are few junior-level candidates with the kind of interdisciplinary background and technical skills that Pradeep brings to problems in this area. Second, having worked in diverse research areas such as cognitive science, neuroscience, databases, computer vision, machine learning, and brain-computer interfacing, Pradeep approaches research problems with an unusually broad perspective, and is capable of teaching and collaborating in a variety of areas. Third, he has demonstrated time and again that he has the ability to successfully lead research projects (e.g., in computational neuroscience, brain-computer interfaces, brain-aided computing) – he is thus well-poised to establish his own laboratory and embark on an ambitious research program. Fourth, Pradeep has successfully mentored numerous undergraduate and graduate students over the course of his graduate and postdoctoral career. It is clear that he is extremely good at guiding students through the various stages of a research problem, and has what it takes to become an excellent research advisor.

I could write more about Pradeep's abilities but rather than doing so, I encourage you to interview him and appreciate for yourself his amazing breadth, technical skills, and vision for the future – you will not be disappointed.

Sincerely,

Rajesh P. N. Rao

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