

Statement of Purpose

Applicant's Name: **Abhinav Agarwal**

Proposed Program: **PhD in Electrical and Computer Engineering at UC Berkeley**

My name is Abhinav Agarwal and I am in my final year of the Bachelor of Technology (B. Tech) program in the Department of Electronics and Electrical Engineering at Indian Institute of Technology (IIT) Guwahati in India. I have always enjoyed the rigour involved in and the perseverance demanded by a scientific activity which pushes one to one's limit. The prospect of learning a new thing or idea is simply exhilarating. The intensity of work demanded at the highest level by a doctoral degree, the potential impact it can have on the expansion of a scientific field and, by extension, mankind and the satisfaction this can generate are awe –inspiring. Another reason for pursuing a doctoral degree is that I am interested in getting associated with academia somewhere in the future. During my undergraduate education, both my academic coursework and research experiences have contributed to both my passion and interest in scientific research. Right from my school days, I have had an excellent academic standing, securing many national level awards and scholarships. After coming to IIT, my learning curve shot up exponentially. I am presently ranked fourth in the Department of Electronics & Electrical Engineering with a GPA of 9.29 on a scale of 10.00.

My first exposure to research was during my sophomore summer, when I had an opportunity to work on a Mobile Wireless Surveillance System at Smart Sensor Architecture Lab (SSAL) in the Korean Advanced Institute of Science & Technology (KAIST), South Korea. Under the supervision of IEEE Fellow, Prof Chong-Min-Kyung in the Dept. of Electrical Engineering, I proposed a design time method to calculate the active time of transmission mode with high energy savings while satisfying the system constraints. In order to achieve that, I formulated an analytical relationship to predict the energy-optimal encoding bit-rate and modulation level of transmission while satisfying the constraints for encoding distortion and transmission time. My research was fruitful as we managed to submit a paper in *IEEE International Conference on Image Processing 2013* (currently under review). The project was mainly responsible for inculcating in me the virtues of team work as it was a large scale project involving many graduate students and interdependent subsystems. It also encouraged generation of new ideas, creating and sticking to deadlines – all essential to research. I passed through a gamut of emotions – excitement, joy, disappointment – marking a particularly excellent entry to research.

In my third year of coursework I took a lot of courses in Signal Processing, VLSI & Communication Engineering. It was because of my inherent love for mathematics, that I got really interested in Signal Processing. However, I quickly realised that most of the course textbooks focus very briefly on the latest technological developments. Thus apart from doing well in the regular coursework, securing top grades in courses, I paid particular attention to read the latest research papers in the related fields so as to remain updated with the state of the art developments. Soon I became an avid follower of the *IEEE Spectrum* (a leading scientific magazine) and started participating in the interesting weekly research discussions of the IEEE Student Chapter at my institute.

As a part of a Hardware Design project in the third year of my program, I worked on an *Field programmable gate array (FPGA) implementation of Cross-Product Based Low Complexity Fast Independent Component Analysis Algorithm (FICA)* with Prof. Amit Acharyya in Dept. of Electronics and Electrical Engineering at IIT Guwahati. This project provided with me a unique opportunity to show-case my creativity as I had the freedom to define my own research path. It was exciting to demonstrate that a simple concept of vector cross product, previously underappreciated by the signal processing community, could be applied to reduce the computational complexity & improve the latency of FICA. After some rigorous theoretical analysis followed by hardware demonstration of real time signal separation on FPGA as a proof of concept, my advisor strongly motivated me to publish and we ended up submitting results in *IEEE Transactions in Biomedical Engineering* (currently under review). The project highlighted the importance of a good grasp on the theoretical concepts and reinforced my belief in the need to excel at coursework.

For my junior research internship (summer after my 3rd year), I was awarded the prestigious *Mitacs-Globalink fellowship* to pursue research at the *University of British Columbia* in Vancouver, Canada under the supervision of *Prof. Rabab K Ward* in the Dept. of Electrical and Computer Engineering. As an extension of my hardware design project on Cross Product based FICA, I worked on developing low complexity algorithm and VLSI architecture for EEG signal compression using FICA as a pre-processing technique in compressed sensing framework. Later on, one of the graduate students in the lab demonstrated that my work could potentially be applied to improve the classification efficiency in Brain Computer Interface applications. The work has been submitted for review at *IEEE International Conference on Acoustic, Speech and Signal Processing (ICASSP) 2013*. In addition to the research experience, the internship provided me with an opportunity to interact with top researchers and graduate students in Canada. Discussions with fellow interns about their work, projects and graduate student life helped me strengthen my conviction that graduate school is definitely where I want to be post-graduation.

My extensive literature survey during my internship exposed me to areas of diverse applications for FICA in low power Biomedical Electronics. Hence, I decided to explore one potential area of application which is *Mobile Ambulatory Health Care* for my Bachelor's thesis in the fourth year of my undergraduate program. I am currently working towards developing *VLSI Architecture for Under-Determined Blind Source Separation* employing FICA algorithm exploiting the potential benefit it offers in Biomedical Engineering applications. The area is extremely challenging as none to the best of our knowledge has explored VLSI architectures for Under-determined Blind Source Separation in the past. The limited literature available makes it indeed challenging to test our proposed algorithm due to lack of benchmark models. However, I believe that these kind of challenges make you mature as a budding researcher, who should be ready to face the rigors of graduate school.

After working in the above projects, I have not only gained academic knowledge but my soft and other skills have also improved. I am now comfortable with professional softwares like MATLAB, SIMULINK, MODELSIM, MULTISIM and programming languages like C++, VHDL, Verilog etc. The projects have built up my team skills. They have taught me patience. The project reports and presentations have developed my communication skills.

I have been very fortunate to receive several awards for my past research contributions. I was awarded the *Best Student Paper Award* in the *IEEE India MV Chauhan All India Student Paper Contest, 2012* organized by the IEEE Council (details in the CV). I was honoured to receive the award from the current IEEE President elected Dr. Peter Staecker at *IEEE Indicon 2012*. Very recently, my team of 4 students won the *Best Research Project Award* in the prestigious *GE Edison Challenge 2012* organized by General Electric R&D division in India. As an encouragement we have been

awarded 1 million Indian rupees (~ \$20,000 USD) to further develop this idea into a sophisticated product in the market. Most recently, I was selected as the only undergraduate all over India for the upcoming *Young Researchers Conclave 2012* at IIT Gandhinagar. I was also honored to serve as the Chairman of the *IEEE Student Chapter* at my institute IIT Guwahati (2011-12). These awards and acclaims motivate me to strive for excellence while maintaining high standards of academic integrity.

Consistent with my past education and research experiences, I am keen to pursue a career in Low Power Biomedical Electronics, a field that bridges the divide between Electrical and Biomedical engineering. For this reason, I am particularly interested in joining the PhD program in Electrical and Computer Engineering at the *University of California Berkeley*. As a graduate student, I want to be part of a team at the forefront of the design/application of new tools of biomedical utility. I am most interested in the work of **Prof. Jan Rabaey**, a well-known name in this field contributing immensely by books and papers which are followed by undergraduate students, the world over. A lot of his graduate students are doing interesting work at the intersection of low power IC design, signal processing and brain machine interface which is something I am really interested in pursuing at graduate school. A recent work from his lab featuring in the *San Francisco magazine* regarding the dramatic impact of his cutting-edge brain research to improve the lives of the disabled really inspires me as . I feel honoured to share the same vision. Recently, I was awarded the *Best Project Award* by General Electric in India for my project *on Developing a Pervasive EEG machine For Remote Monitoring of Autistic Children in India*. I am also interested in the work of **Prof. Jose M Carmena** on the Brain Computer Interface which seems quite similar to my Brain Computer Interface project during my internship at UBC. Having already gained some research experience in this field, I am confident of making a significant contribution to the on-going research at his lab.

The graduate program at UC Berkeley would give me a chance to interact and collaborate with some of the best researchers from all over the world, which would support me in my aim of doing pioneering research work. At this juncture in my life, I perceive graduate school as the perfect destination for myself as not only would it enable me to pursue knowledge in its purest form, but also provide me with the technical skill set and experience required to succeed at my long term goal: developing novel technologies that improve human lives.

I bring to UC Berkeley, my energy and enthusiasm for strengthening my community, pursuing extra-curricular activities and pursuing excellence in research.