Research Statement:

I have finished the Bachelor of Engineering degree majoring in Electronics & Communication from Sri Jayachamarajendra College of Engineering, Mysore, India (Affiliated to Visveswaraiah Tech Univ, India) in 2006. My college ECE department is ranked No 2 at the state level. On a national level it is ranked in the top 12 after IISc, 7 IIT's.
My areas of research interest are listed below

MAI & ISI cancellation in Multiple Access Systems
Information Theory and Channel Coding
Space Time Communication
Multi Carrier Modulation

Under these areas, I am *familiar with* or *aware of* the following topics

MAI & ISI cancellation in Multiple Access Systems:

Iterative multi user detection algorithms in CDMA using Turbo codes, LDPC codes or TTCM offering near optimum performance at a reduced complexity.
Genetic Algorithm (GA) based multiuser detection algorithms in CDMA.
Non linear equalization of ISI channels using HMM's.
Joint MAI & ISI suppression based on subspace approach in CDMA.
Iterative joint MAI & ISI suppression in CDMA.

Information Theory and Channel Coding:

Turbo codes
LDPC codes
Trellis Coded Modulation

Space Time Communication*:*

STBC, STTC under Space time coding.
Beamforming and Linear precoding under Closed Loop MIMO.

Multi Carrier Modulation*:*

Pilot assisted & Decision directed channel estimation for OFDM.
Peak to Average Power Ratio reduction techniques.

During my undergraduate program, two projects from the list mentioned in my projects summary document provided me with really valuable hands-on research experience. Below I'll give a brief account of the experience I had during these two projects mentioning what I observed, what methods I tried.

Turbo Multiuser Detection in Coded Uplink CDMA Systems*:*

In the starting period, the ambitious goal was to study joint iterative equalization and multiuser detection in dispersive DS-CDMA channels using a modified BCJR algorithm with reduced states. The algorithm in the first place applies state-reduction techniques for the single user trellises and then partitions the soft feedback from channel decoders into unreliable and reliable sets using a reliability metric. The states of the single user trellises are constructed with the unreliable set and the interference from the reliable set is cancelled. Due to the lack of sufficient literature and subsequent superficial knowledge regarding the theory of reliable and unreliable sets of feedback from channel decoders, it was decided that iterative MUD for uplink coded CDMA in multipath channels will be studied. Strong-weak user environment under both symmetric and asymmetric conditions was used to test the system, in both cases it was observed that the weak user(s) had better than or equal BER than strong user. But this phenomenon could not be explained /studied analytically and remains a simulation observation.
The number of outer and inner iterations were varied to test the robustness of the system. For some 5 outer and inner iterations each, the BER values reached a saturation level. Increasing the number of iterations above 5 was not useful in improving BER. Stopping rules concept explains this simulation observation NOT predicted by the iterative exchange of extrinsic information theory. Similarly the processing gain PG had no effect on the system BER curve. The processing gain PG of the system was increased in fixed steps hoping for a better BER performance but for different values of PG, the system

had the same BER. The iterative multiuser detector studied in theory supports any number of CDMA users on the multipath channel. But in simulation the maximum number of users for acceptable BER was only 5. For number of users beyond 5, the BER performance degraded. For users beyond 5, errors in the soft estimates of the user's code bits used by the SIC stage to cancel interference got increased and as a result BER worsened due to improper interference cancellation.

***Spoken Language Recognition**:*
A spoken language recognizer in which each language to be recognized is statistically modeled by a Hidden Markov Model was studied & implemented. At the onset a 5 state HMM for each language was considered but after sufficient training of the HMM's it was learned that only 1 state is sufficient for language modeling. Segmental K-Means algorithm was used for training HMM's. I tried Baum Welch algorithm to train the HMM's so that they become more robust. The algorithm turned out to be slow and computationally expensive. Although techniques to lessen the computational time were tried in an adhoc manner they were not useful and Baum Welch training was given up. Due to lack of time what was happening with the Baum Welch algorithm could not be figured out. For language recognition, Forward likelihood and Backward likelihood were used as decision metrics. But these two did not perform well to an acceptable level when fed by a Viterbi state sequence. But Viterbi likelihood did a good job when fed by a Viterbi state sequence of a HMM pattern. So for language recognition, Viterbi likelihood was used as a decision metric.
This work is very much relevant to the research interests listed in Ist paragraph since HMM's are recently used in Narrowband Interference suppression in CDMA, Joint user signal detection and Nonlinear equalization of ISI channels.
The two projects mentioned above resulted in two publications,
1. *Iterative joint receiver with parallel RAKE structure for multipath coded CDMA &*
2. *Language identification using ergodic Markov patterns*
details of which can be obtained from the resume and/or website.

The other projects mentioned in the projects summary document like *Subspace Based Blind Linear Multiuser Detector*, *Multi Tone Code Division Multiple Access*, *Residual Excited Vocoder* etc provided me with the opportunity to study very important theory in Communications and Signal processing like
Signal subspace based joint detection of user's signals.
Multi carrier modulation theory.
Linear prediction based analysis and synthesis of data.
Fundamental frequency extraction using inverse filter tracking.
MAP based channel decoding algorithms.
(*Please refer to my website for a detailed description of each project work*).
In my current work assignment in the company, I had the opportunity to study Space Time Communication theory ranging from space time block coding(STBC) to closed loop MIMO techniques like Linear Precoding & Beamforming. In the company, I am part of a team developing PHY layer IP for the yet to be standardized IEEE 802.11n MIMO OFDM based Wireless LANs.
It was primarily through the UG projects experience (most NOT part of the credits requirement except the UG thesis) and work assignment, the topics of research interest outlined were developed.
According to me, the following UG program plan prepares a student in a robust manner to take up graduate study and research.
1. Concentrate and work to score *good* grades in relevant courses.
2. Obtain research experience in the area of interest.
This plan helps a student to be prepared mentally to face the rigor of graduate study and research, which is by and large unstructured and requires the students to be flexible, adaptable and possess the skills to handle uncertain situations associated with research. Concentrating only on *excellent* grades in courses and having *NO* research experience is an incorrect preparation. Research experience in my view provides two opportunities
1. To study theory in the area of interest and associated prerequisites.
2. To get to know the procedures involved in research.
During the undergraduate projects and now work experience, I observed two facts associated with a research project/work.

1. In the beginning period of a project, I used to be overwhelmed with the mammoth amount of theory that had to be studied to kick start the work in a full fledge manner. In general for any research project, the greatest challenge a researcher faces at the onset is the huge chunk of (or still better, unknown) theory that needs to be known to address the problems.
2. Till the student has thought about the problem in depth, the advisor shows the way from his/her experience and breadth. Once the student has examined the problem /subproblems deeply, they become more or less like peers and generally the student takes the lead.
Please refer to the URL given to access the Resume, Publications, Research Statement, Research Summary document etc. The detailed description about each undergraduate project, publications, work experience is in the form of a Research Summary doc accessible from
www.geocities.com/amoevol/Homepage.html

Extenuating circumstances:
If the admissions committee refers to the transcripts, it can be observed that in 3 courses
Digital Signal Processing (DSP)
Digital Communication (DC)
Information Theory & Coding (ITC)
the grades scored differs from that of other relevant courses like Analog Communication, Wireless Communication, Telecommunication & Switching, Image Processing, Signals & Systems etc. I consider it my fundamental right to mention the reasons behind the anomalies observed in these 3 course grades. There are two reasons for this
1. During my junior year (5^{th} & 6^{th} Sem) I was involved in faculty research projects (one at IISc) as part of the preparation for graduate study in the proposed areas of interest until May 2005 when an unfortunate event occurred and stopped most of my activities. *Prior to that event*, with respect to course grades I had concentrated to work for reasonably good grades and put more efforts in faculty projects. Accordingly I had decided to take the final exam of my DSP course in 6^{th} Sem instead of 5^{th} Sem and my college allows such an option.
2. But the more important (also unfortunate) event that became an obstacle in my preparation for graduate study and changed not only my 6^{th} Sem grades but also my entire life was a road accident involving my family in the middle of 6^{th} Sem in May 2005. I had been hospitalized for 3 months from May to July for a broken knee, badly damaged head of femur and spine. Since I had absolutely no time for preparation for final exams, accordingly the grades for the 6^{th} Sem & DSP courses are not comparable to that of other relevant courses.
I consider it my FUNDAMENTAL RIGHT to mention the effects of the unfortunate & untimely road accident on my educational career. Due to the horrendous experience I had to go through after this accident & its recovery, I was subjugated for 6 months or so that I was not involved in any kind of preparation in the proposed areas of interest for graduate study except for coursework (including REVISING the 3 above mentioned courses DSP,DC & ITC) during the subsequent semester. Then I made an assessment in Fall 2005 that I did NOT have sufficient preparation for graduate study in the proposed areas of interest and postponed graduate studies by 1 full year from Fall 2006 to Fall 2007. Now, 1 year later in Fall 2006 after having completed the UG thesis and having work experience in MIMO OFDM, I consider myself to have reasonably good preparation for graduate study in the proposed areas of interest and therefore applying for graduate study admissions in Fall 2007. (Refer to the resume).
The admissions committee should consider the line of reasoning adopted below for a more logical explanation of my case.

If the applicant has scored a FCD in the courses Image Processing, Signals & Systems (Refer to the transcripts: VII & III Sem), then with equal amount of preparation he should be able to score a FCD in the course Digital Signal Processing, since these three courses come under one category in electrical engineering.
If the applicant has scored a FCD in the courses Analog Communication, Wireless Communication, Telecommunication & Switching (Refer to the transcripts: V & VII Sem), then with equal amount of preparation he should be able to score a FCD in the courses Digital Communication, Information Theory & Coding, since these five courses come under one category in electrical engineering.

The transcripts themselves contain sufficient data to REASON that the applicant would have scored a FCD in the 3 courses mentioned above had he had the opportunity to have a preparation comparable to the previous (<6) & later (>6) semesters.

Why in need of a PhD: At this point of time in my career where I hold a Bachelors degree and currently working in a communication technology startup, my primary aim is to become a professor at a research university. So the graduate program work that I am trying to enroll is a part of the work plan that is required to achieve that primary aim. The propensity that I have now to become a research professor was developed primarily through the undergraduate research experience, although the current work experience in the company has provided me with new insights into the research/theory and implementation/practical systems cycle. *In one experience of mine, I had come across 2 different solutions to a particular problem by 2 different professors at different times (I will not name the 2 professors). One professor had provided a solution to the problem in 1999.The second professor came up with a solution 3 years later. But the latter solution was based on a fundamental remodeling /rethinking of the problem, which was prevalent from around 1995. As a result the second solution was far better than the first one in terms of computational complexity*. Although this process happens at everytime with everything in research, it is imprinted in my mind because it was my first such experience. In this manner, as a research professor my intention is to work with motivated graduate students and fellow researchers to address research problems that I can identify and try to solve them in a manner that is palatable and acceptable by the research community or at least identify new possible means/directions to solve the same. In my short industry experience, I came to the understanding that solutions which are affordable by the implementation community are to be explored /studied rather than concentrate on achieving a target list of archival journal publications. The primary motivation as of now is to do Research Research Research whether I'll be
in a research university as a professor or a research lab technical staff
is a secondary issue.

I have decided to apply to those graduate programs that have maximum correlation with my general research interests described in first paragraph. Possible areas which can be considered for choosing a thesis topic
1. Non linear interference cancellation (MAI & ISI) in wireless channels (Interest carried over from the HMM experience).
2. Joint MAI & ISI suppression in dispersive CDMA (since I had failed previously, I am more eager here)
3. Coded Modulation TCM, STTC
4. Space time coding for optimum space time diversity & spatial multiplexing.
5. Closed loop techniques Linear precoding & Beamforming based on covariance feedback, partial state feedback etc.