Patrick Carpenter
Shelby Ctr. for Engr. Tech.
Suite 3101
Auburn University, AL 36849
(334) 328-9722
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June 23, 2011
Re: NDIA Fellowship

NDIA Space and Missile Defense Working Group
1206 Kingsway Road SE
Huntsville, AL 35802

Attention: Joe Fitzgerald

Dear Mr. Fitzgerald / NDIA Space and Missile Defense Working Group:

This letter is in response to the call for applications to the National Defense Industrial Association Tennessee Valley Chapter 2011 Space & Missile Defense Working Group Graduate Fellowship Program. Please find enclosed in this application packet the following materials:

- One-page biographical sketch;
- One-page description of area of study;
- Letter of Endorsement by Dr. Weikuan Yu;
- Unofficial transcript;
- US birth certificate (original copy available upon request).

Please feel free to contact me with any questions or concerns you have regarding my application. Thank you for your consideration; I look forward to hearing from you regarding your decision.

Respectfully yours,

Patrick T. Carpenter

Enclosures (5)

Unofficial Academic Transcript

902069290 Patrick T. Carpenter
Jun 23, 2011 10:00 am

Auburn University

Transcript Data

STUDENT INFORMATION

Name: Patrick T. Carpenter

Birth Date: 12-OCT-87

Curriculum Information

Current Program

Master of Science

Program: MS Comp Sci & Softw Eng Thesis

College: College of Engineering

*** Transcript type: Unofficial Transcript is NOT Official ***

AWARDED:

Awarded: Bachelor of Science **Degree Date:** May 14, 2010

Institutional Honors: Summa Cum Laude

Departmental Honors: University Honors Scholar

Curriculum Information

Program: BS Computer Science

College: College of Engineering

Campus: Auburn Main Campus

Major: Computer Science

Major: Physics

UNDERGRADUATE TRANSCRIPT

Term : Fall 2006

College: College of Engineering

Major: Pre-Engineering

Academic Standing: Good Standing

Additional Standing: Dean's List

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
ENGL	1107	UG	Honors Writing Seminar I	A	3.000	12.00	
ENGR	1100	UG	Engineering Orientation	S	0.000	0.00	
ENGR	1110	UG	Intro to Software Engineering	A	2.000	8.00	
MATH	1617	UG	Honors Calculus I	A	4.000	16.00	
MUSI	2737	UG	Honors Appreciation of Music	B	3.000	9.00	
PHYS	1607	UG	Honors Physics I	A	4.000	16.00	

Term Totals (Undergraduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	16.00	16.00	16.00	16.00	61	3.81
Cumulative:	16.00	16.00	16.00	16.00	61	3.81

Term : Spring 2007

College: College of Engineering

Major: Pre-Computer Science

Academic Standing: Good Standing

Additional Standing: Dean's List

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
COMP	1210	UG	Fundamentals of Computing I	A	3.000	12.00	
ENGL	1127	UG	Honors Writing Seminar II	A	3.000	12.00	
MATH	1620	UG	Calculus II	A	4.000	16.00	
PHYS	1617	UG	Honors Physics II	A	4.000	16.00	
PSYC	2010	UG	Intro to Psychology	A	3.000	12.00	

Term Totals (Undergraduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	17.000	17.000	17.000	17.000	68.00	4.00
Cumulative:	33.000	33.000	33.000	33.000	129.00	3.91

Term : Fall 2007

College: College of Engineering

Major: Computer Science

Academic Standing: Good Standing

Additional Standing: Dean's List

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
COMP	2210	UG	Fund of Computer Science II	A	4.000	16.00	
ECON	2027	UG	Honors Prin of Microeconomics	A	3.000	12.00	
HIST	1210	UG	Technology and Civilization I	A	3.000	12.00	
MATH	2630	UG	Calculus III	A	4.000	16.00	
PHYS	2200	UG	Intro Quantum Phys. Relativity	A	3.000	12.00	

Term Totals (Undergraduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	17.000	17.000	17.000	17.000	68.00	4.00
Cumulative:	50.000	50.000	50.000	50.000	197.00	3.94

Term : Spring 2008

College: College of Engineering

Major: Computer Sci & Software Engr

Academic Standing: Graduate Good Standing

Additional Standing: Dean's List

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
COMP	3240	UG	Discrete Structures	A	3.000	12.00	
ELEC	2200	UG	Digital Logic Circuits	A	3.000	12.00	
HIST	1220	UG	Technology and Civilization II	A	3.000	12.00	
MATH	2650	UG	Linear Differential Equations	A	3.000	12.00	
PHYS	2100	UG	Intermediate Mechanics	A	3.000	12.00	
PHYS	2300	UG	Physics Laboratory Skills	A	2.000	8.00	

Term Totals (Undergraduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	17.000	17.000	17.000	17.000	68.00	4.00
Cumulative:	67.000	67.000	67.000	67.000	265.00	3.96

Term : Fall 2008

College: College of Engineering

Major: Computer Science

Academic Standing: Good Standing

Additional Standing: Dean's List

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
COMP	2710	UG	Software Construction	A	3.000	12.00	
COMP	3350	UG	Comp Org And Asm Lang Prog	A	3.000	12.00	
ENGL	2200	UG	World Literature I	A	3.000	12.00	
PHYS	3100	UG	Intermed Electricity Magnetism	A	3.000	12.00	
PHYS	4100	UG	Fund of Quantum Mechanics	A	3.000	12.00	
STAT	3600	UG	Probability and Statistics I	A	3.000	12.00	

Term Totals (Undergraduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	18.000	18.000	18.000	18.000	72.00	4.00
Cumulative:	85.000	85.000	85.000	85.000	337.00	3.96

Term : Spring 2009

College: College of Engineering

Major: Computer Science

Academic Standing: Good Standing

Additional Standing: Dean's List

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
COMP	3220	UG	Prin of Programming Languages	A	3.000	12.00	
COMP	3270	UG	Introduction to Algorithms	A	3.000	12.00	
COMP	3500	UG	Intro to Operating Systems	A	3.000	12.00	
COMP	3700	UG	Software Modeling and Design	A	3.000	12.00	
MATH	2660	UG	Topics in Linear Algebra	A	3.000	12.00	
PHYS	3200	UG	Statistical Thermodynamics	A	3.000	12.00	

Term Totals (Undergraduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	18.000	18.000	18.000	18.000	72.00	4.00
Cumulative:	103.000	103.000	103.000	103.000	409.00	3.97

Term : Summer 2009

College: College of Engineering

Major: Computer Science

Academic Standing: Good Standing

Additional Standing: Dean's List

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
COMM	1000	UG	Public Speaking	A	3.000	12.00	
COMP	5720	UG	Real Time & Embedded Systems	A	3.000	12.00	
ENGL	2210	UG	World Literature II	A	3.000	12.00	
PHYS	1040	UG	Business Ethics	A	3.000	12.00	

Term Totals (Undergraduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	12.000	12.000	12.000	12.000	48.00	4.00
Cumulative:	115.000	115.000	115.000	115.000	457.00	3.97

Term : Fall 2009

College: College of Engineering

Major: Computer Science

Academic Standing: Good Standing

Additional Standing: Dean's List

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
COMP	4200	UG	Formal Languages	A	3.000	12.00	
COMP	4300	UG	Computer Architecture	A	3.000	12.00	
COMP	4320	UG	Intro to Computer Networks	A	3.000	12.00	
COMP	4997	UG	Honors Thesis	A	3.000	12.00	|
COMP	5700	UG	Software Process	A	3.000	12.00	
PHYS	3500	UG	CUBESAT – Software Devel.	A	3.000	12.00	|

Term Totals (Undergraduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	18.000	18.000	18.000	18.000	52.00	4.00
Cumulative:	133.000	133.000	133.000	133.000	581.00	3.98

Term : Spring 2010

College: College of Engineering

Major: Computer Science

Academic Standing: Good Standing

Additional Standing: Dean's List

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
COMP	4730	UG	Computer Ethics	A	3.000	12.00	
COMP	4997	UG	Honors Thesis	S	3.000	0.00	|
MATH	5140	UG	Data Compression	A	3.000	12.00	
MATH	5180	UG	Cryptography	A	3.000	12.00	
MATH	5280	UG	Systems of Diff Eq and Apps	A	3.000	12.00	
PHYS	3500	UG	CUBESAT: Software Devel.	A	3.000	12.00	|

Term Totals (Undergraduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	16.000	16.000	16.000	13.00	52.00	4.00
Cumulative:	149.00	149.00	149.00	146.00	581.00	3.98

TRANSCRIPT TOTALS (UNDERGRADUATE)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Total Institution:	149.000	149.000	149.000	146.000	581.00	3.98
Total Transfer:	0.000	0.000	0.000	0.000	0.00	0.00

GRADUATE TRANSCRIPT

Term : Fall 2010

College: College of Engineering

Major: Computer Sci and Software Engr

Academic Standing: Graduate Good Standing

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
COMP	6710	GR	Software Quality Assurance	A	3.000	12.00	
COMP	7930	GR	Directed Study	A	3.000	12.00	
COMP	7997	GR	Systems Engineering I	A	3.000	12.00	

Term Totals (Graduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	9.000	9.000	9.000	9.000	36.00	4.00
Cumulative:	9.000	9.000	9.000	9.000	36.00	4.00

Term : Spring 2011

College: College of Engineering

Major: Computer Sci and Software Engr

Academic Standing: Graduate Good Standing

Last Standing: Graduate Good Standing

Subject	Course	Level	Title	Grade	Cred. Hrs.	Qual. Pts.	R
COMP	6320	GR	Des & Anlys of Comp Networks	A	3.000	12.00	
COMP	6340	GR	Network Qual Assurance & Sim	A	3.000	12.00	
COMP	6350	GR	Digital Forensics	A	3.000	12.00	
COMP	7990	GR	Research & Thesis	TD	1.000	0.00	

Term Totals (Graduate)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	10.000	10.000	10.000	9.000	36.00	4.00
Cumulative:	19.000	19.000	19.000	18.000	72.00	4.00

TRANSCRIPT TOTALS (GRADUATE)

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Total Institution:	19.000	19.000	19.000	18.000	72.00	4.00
Total Transfer:	0.000	0.000	0.000	0.000	0.00	0.00

COURSES IN PROGRESS

Term : Summer 2011

College: College of Engineering

Major: Computer Sci and Software Engr

Subject	Course	Level	Title	Cred. Hrs.
COMP	6120	GR	Database Systems I	3.000

Term : Fall 2011

College: College of Engineering

Major: Computer Sci and Software Engr

Subject	Course	Level	Title	Cred. Hrs.
COMP	6370	GR	Computer and Network Security	3.000
COMP	6620	GR	User Interface Design and Eval	3.000
COMP	7970	GR	Trends in Spatial Databases	3.000

Biographical Sketch

Name: Patrick Thomas Carpenter **Phone**: (334) 328-9722 **E-mail**: carpept@auburn.edu

A. PROFESSIONAL PREPARATION

College/University	Major	Degree & Year
Auburn University	Computer Science and Physics	Bachelor of Science, 2010
Auburn University	Computer Science & Software Engineering	Master of Science, 2012

B. ACADEMIC/PROFESSIONAL APPOINTMENTS

Auburn University, Parallel Architecture and System Laboratory
Graduate Research Assistant (*Advisor: Dr. W. Yu*) 01/11 – Present

Auburn University, Department of Computer Science and Software Engineering
Graduate Teaching Assistant (*Advisors: Drs. H. Carlisle, L. Yilmaz, A. Lim*) 08/10 – 05/11

Los Alamos National Laboratory, HPC-3
Graduate Student Intern BS+0 (*Advisor: Ms. C. Martin*) 05/10 – 08/10

Auburn University, Department of Physics
Undergraduate Research Assistant (*Advisor: Dr. F. Robicheaux*) 02/07 – 12/08

C. PUBLICATIONS

B. Wang, P. Carpenter, M. Liu, J. Gao, W. Yu, H. Tian. “Dynamic Task Scheduling and Aggregation for Scalable Ecosystem Modeling” The Journal of Computational Science (under review) (2012).

B. Gu, P. Carpenter, W. Yu. “Load Balancing on Clusters through Data Distribution based on the Number of Cores” EKRI Journal (under review) (2011).

G.B. Andresen, M.D. Ashkezari, M. Baquero-Ruiz, W. Bertsche, P.D. Bowe, E. Butler, P.T. Carpenter et al. "Autoresonant excitation of antiproton plasmas" Phys. Rev. Lett. 106, 025002 (2011).

P. T. Carpenter (2010). *Performance in scientific computing with a performance characterization of the Parallel Ocean Program on Ranger*. B.S. Thesis (Honors). Auburn University, Auburn University, AL (USA).

J.L. Hurt, P.T. Carpenter, C.L. Taylor, and F. Robicheaux, “Positron and electron collisions with anti-protons in strong magnetic fields” J. Phys. B 41, 165206 (2008).

D. HONORS & AWARDS

University Honors Scholar	5/10
Auburn Undergraduate Research Fellowship Program (*of twenty at Auburn*)	05/09 – 05/10
Outstanding Student in Computer Science (*one student per major*)	04/10
NCUR 2010 Conference Presentation (*of ten at Auburn*)	04/10
Supercomputing 2010 Conference Student Volunteer (*from a national pool*)	11/09
Sigma Pi Sigma Honor Society (*of nine at Auburn*)	05/09

E. FUTURE PLANS

- Employment involving high-performance computing at a strong corporation/national laboratory
- R&D in scientific computing applications and high-performance computer architecture
- Possible doctoral studies relatively early in professional career
- Renewed academic or industry employment

Area of Study and Relation to Space and Missile Defense

Patrick Carpenter, Parallel Architecture and System Laboratory

Since the development of the modern electronic computer around the middle of the twentieth century, computational science and scientific computing (CS&SC) have drastically and fundamentally changed the way scientists and engineers approach their respective professions. High-performance computing (HPC) studies powerful computing systems which enable massive-scale scientific computation, and understanding HPC is needed to achieve significant speedup for complex CS&SC applications. Recently, the use of graphics processing units (GPUs) to accelerate CS&SC applications has become attractive due to GPUs' low cost and high performance. The GPU holds great potential for many CS&SC applications, many of which are of direct relevance to Space and Missile Defense (SMD).

During my graduate and undergraduate studies, I have gained exposure substantial exposure to research in CS&SC and HPC. As an undergraduate research assistant in Auburn University's physics department, I contributed to several research projects involving the simulation and modeling of antiproton plasmas Later, I gained much deeper exposure to HPC as an undergraduate research fellow studying the Parallel Ocean Program (POP), a complex ocean modeling application, a performance characterization of which formed the basis for my senior thesis. As a member of the Parallel Architecture and System Laboratory (PASL) [1] at Auburn University, my area of study is in parallel and distributed architecture, systems and applications. Currently, I am focusing on using GPUs and NVIDIA's Compute Unified Device Architecture (CUDA) to accelerate general-purpose scientific applications in hybrid HPC systems. General-purpose programming on GPUs (GPGPU) is a promising technique which can make efficient use of (relatively) cheap, off-the-shelf components to dramatically accelerate important applications in CS&SC. Currently, I am working with Bin Wang and Dr. Weikuan Yu on efficiently accelerating an ecosystem modeling application – the Dynamic Land Ecosystem Model (DLEM) – using a hybrid MPI/CUDA (and possibly OpenMP) implementation. Dr. Yu and I are constantly looking for new and exciting directions in which to expand the scope of our HPC and GPGPU research.

GPGPU is being used to enhance a wide range of CS&SC applications of importance to SMD, including remote sensing image data fusion by accelerating IHS and inverse IHS transforms [2], real-time detection of infrared targets [3], high-throughput embedded signal processing [4], real-time tracking via on-line learning and complementary tracking [5], efficient mid-course missile tracking [6, 7, 8], etc. GPGPU is an attractive technique for such problems because solutions to many common problems involve large-scale matrix-algebraic computations (e.g., discrete Fourier transform, matrix multiplication, matrix inversion, simulated annealing, gradient descent, deconvolution, interpolation, etc.). Such computations are ideally suited to the GPU, which excels at what are referred to as *data-parallel* computations (those involving similar operations being carried out on all the elements of a large data set). Other applications of interest to SMD for which GPGPU shows great promise include those which perform modeling and simulation (M&S). Relevant examples of this kind of application include simulations of the dynamics of a large system of rigid bodies [9], a hypersonic vehicle configuration [10], computational fluid dynamics (CFD) [11], unstructured grid solver for missile simulations [12], etc. Attempts to add GPU capability to such arithmetically-intensive, grid-based applications are typically quite successful in terms of the achieved speedup. Finally, the relevance to SMD of applications which PASL and I have studied – the POP [13, 14] and the DLEM [15, 16] – should not be understated.

In conclusion, my area of study – which can be broadly categorized as parallel and distributed architecture and systems and more narrowly categorized as HPC architecture and GPGPU – deals with the technologies required to enable ground-breaking research in CS&SC applications relevant to SMD. I believe that my multidisciplinary background and passion for HPC and CS&SC will help me make meaningful contributions to both computing and computational science, and I am excited to see what the future holds for these fields. Likewise, I believe that HPC and CS&SC will continue to be of great importance to SMD and national security and that they are indispensable tools for the betterment of society.

References

[1] Parallel Architecture and System Laboratory – Home. http://pasl.eng.auburn.edu/

[2] L. Jun, Z. Baoming, "An Accelerated IHS Transform Fusion of Remote Sensing Image Data Based on GPU," ESIAT 2009, pp 492.

[3] He-Xijun, Chen, Hua-chu, "Accelerated realization method of infrared targets detection based on GPU," ICEICE 2011, pp 3914.

[4] S. Mu, C. Wang, M. Liu, D. Li, M. Zhu, X. Chen, X. Xie, Y. Deng, "Evaluating the potential of graphics processors for high performance embedded computing," DATE 2011, pp 1.

[5] J. Santner, C. Leistner, A. Saffari, T. Pock, H. Bischof, "PROST: Parallel robust online simple tracking," CVPR 2010, pp 723.

[6] J. L. Tomkins, J. P. VanDyke, "Massively parallel computing and the mid-course tracking problem," SC 1991, pp 796.

[7] T. Shao-xun, Y. Xian-qing, L. Xue-shan, "Research on Early-Warning Detecting Tasks Re-scheduling and Sensor Resources Allocation Strategy of Midcourse Maneuverable Ballistic Targets," SENSORCOMM 2010, pp 357.

[8] W. Bo, A. Wei, Z. Yi-Yu, "Research on Sensor Management Algorithm of Midcourse Object Tracking," ISA 2009, pp 1.

[9] A. Tasora, D. Negrut, M. Anitescu. GPU-based Parallel Computing for the Simulation of Complex Multibody Systems with Unilateral and Bilateral Constraints: An Overview. Computational Methods in Applied Sciences, Volume 23, 2011, 283-307. Springer Verlag, Berlin.

[10] E. Elsen, P. LeGresley, E. Darve. "Large calculation of the flow over a hypersonic vehicle using a GPU," Journal of Computational Physics (2008), pp 10148-10161.

[11] D. A. Jacobsen, J. C. Thibault, and I. Senocak, "An MPI-CUDA Implementation for Massively Parallel Incompressible Flow Computations on Multi-GPU Clusters," In Proceedings of the 48th AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition, January 2010.

[12] A. Corrigan, F. F. Camelli, R. Loehner, J. Wallin, "Running unstructured grid-based CFD solvers on modern graphics hardware," International Journal for Numerical Methods in Fluids (2010).

[13] Los Alamos Climate Ocean and Sea Ice Modeling: Models: POP http://climate.lanl.gov/Models/POP/

[14] P. T. Carpenter (2010). Performance in scientific computing with a performance characterization of the Parallel Ocean Program on Ranger. B.S. Thesis (Honors). Auburn University, Auburn University, AL (USA).

[15] G. Chen, H. Tian, M. Liu, W. Ren, C. Zhang, S. Pan, "Climate Impacts on China's Terrestrial Carbon Cycle: An Assessment with the Dynamic Land Ecosystem Model," In Proceedings of Environmental Modeling and Simulation (2006).

[16] B. Wang, P. Carpenter, M. Liu, J. Gao, W. Yu, H. Tian. "Dynamic Task Scheduling and Aggregation for Scalable Ecosystem Modeling" The Journal of Computational Science (under review) (2012).