The Interplay of Student Projects and Student-Faculty Research

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Abstract: One of the novel approaches we use to support student dissertation and faculty research is to create research-supporting projects in several courses. We teach our dissertation students how to conduct research in a number of areas of computing, and our student project teams how to develop real-world computer information systems. In recent years, we have experimented with the interplay of dissertation research and projects created specifically to develop the supporting software infrastructure for that research. We describe 63 research-related projects supervised by the authors over the last six years and their related research with 132 publications.

Introduction

This is the third paper describing the way real-world student projects have been integrated into the capstone computing courses in the School of Computer Science and Information Systems at Pace University. The first emphasized the development of computer information systems for actual customers (Tappert 2002). The second emphasized projects relating to security (Tappert & Cha 2004). This third paper emphasizes the interplay of student projects and research done by students and/or faculty. One of the novel approaches we use to support student dissertation and faculty research is to create research-supporting projects in several of our courses. We teach our dissertation students how to conduct research in a number of areas of computing, and our student project teams how to develop real-world computer information systems. In recent years, we have experimented with the interplay of dissertation research and projects created specifically to develop the supporting software infrastructure for that research.

We use team projects modeled on real-world development practice to provide students with the educational experience of collaborative efforts, similar to what is done in industry, in order to design, build, and test computer information systems. Some of the project customers are faculty members or dissertation students who need supporting software infrastructures to conduct their research. Thus, there is interplay between the project and research activities.

The following sections describe the research-related student projects, the student-faculty research, the benefits of the research and project activity interplay, and conclusions.

Research-Related Student Projects

In this paper we present and discuss a total of 63 research-related projects that were supervised by the authors over the last six years, resulting in 132 publications, as summarized in Table 1, with project sources in Table 2, publication outlets in Table 3, and project details in Table 4. Full publication references are shown in Table 5 of the Appendix. All of the 63 projects were in masters-level courses except for 4 in undergraduate courses. All of the masters-level courses had the project as the centerpiece, with 52 of these 59 masters-level projects in the capstone courses, “Software Engineering” and “Capstone Project." The remaining 7 were in a “Pervasive Computing” elective. There were 132 resulting publication. 94 were directly project-related. 38 were similar in kind and designated “offshoot publications” in Table 1. Table 4 offers descriptive titles of the projects and keys to the publication citations in Table 5.

Because many of the projects were continued, often with a different emphasis, by different student teams in successive courses and because some of the student and faculty research was conducted without supporting projects, the project and research work, in seven broad categories, fall into the 44 titular groups shown in Table 4,. Each project was conducted by a student team. The 63 teams consisted of a total of 183 students, resulting in an average team size of roughly three students per team. One or two projects from each broad category will be described here to convey a sense of the content. It should be noted that while these topics and categories pertain to the interests and expertise of the authors, the projects and research interplay idea could be used with almost any collection of research-related topics.

The **Pace Weather Information and Web Database System** uploads local weather information collected from sensors in the Pace Environmental Center into a server database every 15 minutes for graphical viewing over

Table 1. Summary of projects and publications.
33 of the 63 projects spanned both semesters
of the "Software Engineering" course.

Project Category	Number Projects	Project Semesters	Project Related Pubs	Offshoot Pubs
Web Applications	8	12	8	
Pervasive Systems	14	24	18	
PC Applications	10	17	11	
Artificial Intelligence	6	8	8	
Pattern Recognition	8	11	27	19
Biometric Systems	12	15	17	19
Quality Assurance	5	9	5	
Totals	**63**	**96**	**94**	**38**

Table 2. Project sources.

Project Source	Number
Faculty Ideas or Research	32
Student Ideas or Research	13
External Community	10
Internal University Needs	8
Totals	**63**

Table 3. Publication types.

Publication Type	Number
External Conference Papers	48
Journal Articles	4
Book Chapters	1
Doctoral Dissertations	15
Masters Theses	3
Internal Conference Papers	57
Internal Technical Reports	4
Totals	**132**

Table 4. Project and research group details, with the research groups indicated by *.

Category	Project/Research Group	Number Projects	Project Semesters	References
Web App	Online Course Opinion Survey System	1	2	PET
Web App	Genealogy Web Application	3	5	BAR,FAN,REN
Web App	Automated Complaint Desk System	1	1	BOO
Web App	Rockefeller State Park Information Website	1	1	AVH
Web App	Pace Weather Information and Web Database System	2	3	PER,VIJ
Web App	Online Patient Medical Data Entry System	2	3	BRA1-2,CHU,WAL
Pervasive	Handheld Nurse Information System	3	4	LEF,PAL
Pervasive	VoiceXML Development Facility and Applications	3	6	DES,FU,GALL,LAW1-2
Pervasive	Multimodal Voice/InkXML System	2	3	TRA1-2
Pervasive	PC Maintenance/Tracking System	1	2	KAL1-2
Pervasive	Emergency Pre-Hospital Care Communication System	1	1	PAR
Pervasive	Medical Vital Sign Wearable Computer System	1	1	
Pervasive	Hospice Nurse Telemedicine System	3	6	ESH,HUBT1-2,LAP,PAZ,STL
PC App	Cluster and Grid Computing Systems	1	2	CLA
PC App	Test Item Reliability Analysis System	1	2	
PC App	Set of NLP Algorithms for Teaching and Research	1	1	
PC App	Pitch Training System for Western and Eastern Music	1	2	ORD
PC App	Automated XML Teaching System	1	2	KAR
PC App	Astronomy Image Database and Retrieval System	1	2	PAS
PC App	Reengineered Antique Business Filing System	1	2	BAKS,FRA
PC App	Depth-wise Hashing Structure	1	1	CAP
AI	Project Group Assignment System	2	3	DOY,YAL
AI	AI Optimizing Bridge Bidding Website System	1	1	GAL1-3
AI	Human Brain Systems: Neural Network and Hawkins	1	2	GUS,NI
AI	Mixed-Reality Pocket Billiards System	2	2	HAM
Pattern Reco	Interactive Visual System – Flower Identification App	1	2	EVA1-2
Pattern Reco	Interactive Visual System – Rare Coin Grading System	2	3	BAS1-3
Pattern Reco	Interactive Visual System – Flag Identification App	1	1	HAR1-3
Pattern Reco	Visual Classification Systems – Pottery, Painting, Melanoma	*	*	BIS1-4,LOM1-4,SIK
Pattern Reco	Shorthand Handwriting Recognition System	1	1	HUB1-3,TAP1-2
Pattern Reco	Spam Detection System	1	1	SEG,STU1-2
Pattern Reco	Automatic Language Detection of Text Files	1	1	AHM1-4, LAW3-4
Pattern Reco	Handwriting Forgery Quiz System	1	2	CHA6-7,CHE1-2
Pattern Reco	Visual Systems, Theoretical Studies, etc.	*	*	ABR1-5, CHA4-5,HER,LEE1-2,YOO6
Biometric	Multimodal User Verification System	1	1	BAK
Biometric	Eigenface Recognition System	1	2	
Biometric	Voice Authentication Biometric System	1	1	TRI1-3
Biometric	Pronunciation Biometric System	1	2	PHI
Biometric	Keystroke Biometric System	4	5	BART1-2,CUR1-3,NGO,RIT,TAP2,VIL1-2
Biometric	Mouse Movement Biometric System	2	2	WEI
Biometric	Stylometry System	2	2	GOO
Biometric	Iris, Handwriting Style, and Other Biometric Systems	*	*	CHA2-3,CHO1-3, MAN1-3,YOO1-5
Biometric	Theoretical and Other Studies	*	*	CHA1,GIB1-4,THO
QA	Quality Assurance/Maintenance Tools	5	9	APU,FUS,LEO,MCK,VIT

the Internet. This project originated from an internal university need by the environmental department, and it provides an information database for potential data mining and research studies of local weather information.

The **Online Patient Medical Data Entry System** is a web-based database system that originated externally from a need for collecting multiple pieces of information from individual research subjects over a continuing period of time by the Eating Disorders Research Unit of the New York State Psychiatric Institute at Columbia University Medical Center. This project led to a doctoral dissertation entitled "A Model for HIPPA Security Compliance" which concerned the confidentiality and information assurance aspects of this kind of system.

The **Hospice Nurse Telemedicine System** originated from an external need by the Hospice Unit of Phelps Memorial Hospital for such a system and the donation of equipment (PDA clients and a server) by a small local technology company. This pervasive system facilitates the collection of patient clinical data on the PDAs by hospice nurses during home visits and the uploading of the data to the central database on the server upon return to the hospital. This project led to a dissertation entitled "Usability Field Study of Older Adults Using Multi-modal Home Health Monitoring Devices" by a doctoral student who participated in the user-interface design of the project system, and a dissertation entitled "An Integrated Model of Technology Acceptance for Mobile Computing" by a doctoral student interested in the use of PDAs by college students.

The **Cluster and Grid Computing Systems** originated from a student's request and he became the team project leader. The team developed a high performance computing facility that created a virtual computing pool by co-opting idle and/or underutilized computer workstations. During the first semester, the team constructed a cluster computer consisting of five PCs and demonstrated a substantial speed improvement of the cluster over a single PC performing the calculations of a standard ray-tracing problem in computer graphics. For the second semester, the team developed a grid computer for molecular calculations by choosing a computation-intensive molecular simulation package and running tests in the student computer-lab facility that is highly used by students during peak hours. Here, depending on the nature of the simulation with respect to the number of atomic interactions that need to be calculated in real time, it was demonstrated that the more compute nodes attached to the simulation the less intrusive the job was to the user of any workstation in the grid. Although these systems have not been utilized for research, there is certainly potential research in this area.

The **Project Group Assignment System** originated from the need by one of the authors to create teams (groups) automatically for project work of the type described in this paper. This Web-based system addresses problems that arise in the usual, manual team-creation process, which can be tedious, time consuming, perceived as unfair, and may not result in teams with a good mix of expertise. In the automated system, the project managers (in industry or academia) enter the project information: project descriptions, suggested team size; customer information; and parameter weights for team candidates' project preferences, availability, geography, and experience. Potential team members complete an online survey to record their project preferences, preferred availability times/locations for team meetings, and their academic and/or professional experience. The project manager then executes an AI greedy-search algorithm that groups the candidates into teams. An exhaustive search for the optimal solution is not possible for more than a small number of projects, and the search algorithm obtains a near-optimal solution. Although this problem has not been undertaken by a dissertation student, it has that potential for students interested in AI optimization heuristics.

The **Interactive Visual System – Flower Identification Application**, which originated at Rensselaer Polytechnic Institute, investigated the role of human-computer interaction in applications of pattern recognition where higher accuracy is required than is currently achievable by fully automated systems, but where there is enough time for a limited amount of human interaction relative to aspects like segmentation at which humans tend to be better than machines. This topic has so far received only limited attention by the research community. Our success in recognizing flowers established a methodology for continued work in this area. We have extended this approach to the interactive recognition of flags and other pattern recognition systems where segmentation is an issue. Offshoots of this work included two doctoral dissertations and several external publications.

The **Keystroke Biometric System**, a faculty originated project, was developed for long-text input applications such as identifying perpetrators of inappropriate e-mail and imposter online test takers. A Java applet collects raw keystroke data over the Internet, long-text-input features are extracted, and a pattern classifier makes identification decisions. The first project was a preliminary investigation that developed the applet and initiated work in this area. The second was a complete system but was not user friendly and not successfully used. The third system, after one semester of work, was used in a feasibility study of a copy typing task that resulted in a dissertation entitled "Long-Text Keystroke Biometric Applications Over the Internet." This third system, after the second semester of development, was used for a study involving 118 subjects using two input modes (copy and free-text input) and two keyboard types (desktop and laptop keyboards), and resulted in a dissertation entitled "Keystroke Biometric Identification Studies on Long-Text Input." The fourth system was developed with an emphasis on missing or

insufficient statistical information, such as too few instances of infrequent letter keys, by a student currently working on his doctoral dissertation. These projects and related research also resulted in four external publications.

The **Quality Assurance/Maintenance Tools** projects originated from the need for quality assurance of the systems developed in courses having a substantial number of projects. These teams provided ongoing quality assurance for the other project systems. All deliverables from the other projects were examined, validated against customer specifications, and tested for usability, correctness, and robustness. Although these projects have not led to actual research, there is potential research in this area, such as in testing, metrics, and version control.

The remainder of this section discusses the nature of project work, project teams, and how projects are set up and managed. Project work uses known technology to develop systems according to specified customer requirements. We have our students develop real-world computer information systems for actual customers, thereby serving the internal university community, the greater university community, the external non-profit local community, and the external research institutions.

A team project focuses on developing a computer information system that meets an actual customer's real needs. Once the project is underway, we recommend teams interact once a week in addition to the work done individually. Such interactions can be through one or more of the following modes of communication: e-mail, online discussion, chat, face-to-face, etc. Except for extenuating circumstances, to avoid confusion, communication between the team and the instructor must be through the team leader. Similarly, communication between the team and the customer must be coordinated by the team leader.

A team is a group of individuals that has the responsibility to accomplish jointly an objective, and here the objective is to successfully complete a student project. Educators assert that teamwork enhances learning by creating an "active learning process." Student teams have been found particularly effective when the students actually need each other to complete the project. It is also the norm for employees to work in teams, and teams are used in all kinds of organizations, such as in industry, education, and government. For these projects a team of 2-5 students typically assumes four roles: an Architect-Designer, one or two Implementers, a Quality Officer, and a team Coordinator-Liaison. For small teams several roles are combined. At least one team member, usually the Coordinator-Liaison, must be a good communicator for customer and instructor interactions. Although the requirements for the projects come from the customers, the course instructor is the "Chief Executive Officer" of the project teams – that is, the person who makes all the major decisions and adjudicates personnel problems.

The instructors solicit and interact with potential customers to set up new projects, work with the university computer support personnel to assure the presence of the required project development software and computing infrastructure, and monitor the systems' development process. Projects come from faculty and dissertation students interested in developing systems to further their research, from other departments or schools of the university needing computer information systems, from non-profit community institutions such as local hospitals, from local research institutions, and from interests of the project students. The instructor sizes and shapes each project to be an appropriate systems development experience for the students, forms the student teams, and assigns each team to a project.

Student/Faculty Research

The Doctor of Professional Studies in Computing program enables computing and information technology professionals to earn a doctorate in three years through part-time study while continuing in their professional careers (Merritt et al 2001, Merritt et al 2004). The program emphasizes research, which we define as original, rigorous work that advances knowledge, improves professional practice, and/or contributes to the understanding of a subject. To graduate, each doctoral student is required to complete an original investigation presented as a dissertation. The masters-level thesis also gives students the option performing research and completing a dissertation during their last year of studies. Research methods depend upon the nature of the inquiry: controlled experiment, empirical studies, theoretical analyses, or other methods as appropriate. We require research work to be of sufficient strength to be able to distill from it a paper worthy of publication in a refereed journal or conference proceedings.

For dissertation work at the doctoral and masters levels we introduce the student to the research process. In our doctoral program the students' first step is to select a suitable research area. We highly recommend that they choose an area of research in which they have extensive knowledge and preferably expertise. For the doctoral students this is possible because they must be seasoned computing professionals with a minimum of five years experience in industry to enter the program. Compared to traditional doctoral programs, into which many students matriculate directly from their undergraduate/masters-degree school and have to come up to speed in their research area, this alone can save several years of effort. The second step is to select a suitable research problem. This and most of the following steps are accomplished through an agile evolutionary process of independent work by the

student, interactions with the student's advisor, and presentations and discussions in research seminars with active participation of faculty and classmates. Most importantly, the students are encouraged to choose an area of research and a problem about which they are enthusiastic. The third step is to review of the literature. Similar to the traditional dissertation approach, each student independently reviews the literature relevant to their problem. In our doctoral program, however, the students must then present their literature review in the context of an idea paper which is a brief (agile) version of the traditional research proposal. The idea paper is scrutinized and typically undergoes revision through the agile evolutionary process of presentations and discussions in research seminars. During the evolution of the idea paper the student chooses an advisor and committee. The fourth step is to develop an increasingly detailed investigation plan which is incorporated into the idea paper as a growing working document. The fifth step is to conduct the research which is done with frequent interactions (weekly recommended) with the student's advisor. During the third year, when the students are engaged in their research and no longer taking classes, we conduct Saturday dissertation status sessions, three per semester, where the usual student presentation format is a brief "elevator-ride" description of one's research problem, what was done since the last session, what is currently being done, and what will be done by the next session. The final step is completing the writing of the dissertation. Although we listed the steps sequentially, this is an evolutionary process that typically has several iterations, with backtracking and restarts, and the process is different for each student. However, in each case the idea paper, begun early in the process, is expanded into an end-to-end document and continually developed until it eventually becomes the dissertation.

The agile dissertation process, which incorporates high levels of peer involvement and faculty mentoring, is special to our program. Similar to software development work, we use the agile methodology throughout the dissertation process. In particular, we use the Extreme Programming (XP) method of small releases and fast turnarounds in roughly two-week iterations to make incremental advances. For software, the hallmarks of agile methodology are starting small (with the simplest thing that can work), incremental releases, and constant testing (and completed tasks are highly valued). The dissertation process starting with a small idea paper, entails its incremental development, and requires successive drafts to be presented for review to peers and/or the advisor.

Doctoral students' classmates, the cohort group, contribute frequently by making helpful suggestions in the meetings and by helping to find relevant literature and related material. This is an important part of the agile dissertation process and all students are expected to participate and help their colleagues. The power of the community is strong. Beginning in the second year we use the Socratic method of clarification through confrontational dialogue. This forces students to think for themselves and to vigorously defend their position. Because this method works best when the student is adequately prepared, the student is strongly advised to put substantial effort and thinking into his/her preparation for the group sessions. We find that the better the student is prepared, the more the student benefits from these interactions. From the Wikipedia the Socratic Method is, "… asking a series of questions surrounding a central issue, and answering questions of the others involved. Generally this involves the defense of one point of view against another and is oppositional."

We also emphasize writing, and we do this for several reasons. First, only by expressing their ideas in writing do students get a good grasp on them. Second, the written form of ideas is easily amenable to iterative refinement which we recommend. Third, this is the best way for a student to communicate their ideas with their advisor and discuss them point by point. In addition, we recommend that students maintain a dissertation notebook as a repository of ideas, thoughts, and data – the only place that they write, diagram, or doodle about their dissertation. We also recommend, usually to get a student focused, the submission of a paper for conference presentation while dissertation work is still underway. Early in the program we teach the Strunk and White style of writing clearly and succinctly (Strunk and White 2000).

Benefits of the Research and Project Activity Interplay

There are many benefits of the research and project activities. The real-world projects provide valuable systems for the customers, allow the students to develop technical and value skills, utilize student-centered team learning, foster interdisciplinary collaboration, encourage student involvement in the university and local communities, support student and faculty research, and enhance relationships between the university and local technology companies. Overall, these projects result in a beneficial outcome for all concerned.

The research students learn the required individual skills necessary to conduct a research study. They learn how to perform literature searches to gain general knowledge about an area and to determine what previous work has been done on a specific problem. They learn organizational and critical thinking skills, how to be innovative and creative, and how to structure and perform their research studies. By serving as a customer of a student project that develops supporting infrastructure for them, they learn important management and leadership skills. Finally, in

writing their dissertations they learn how to set their research in a proper context, to describe their methodology and findings, and to estimate its potential impact.

For the project students as individual technologists, as team members, and as maturing computing professionals, developing real-world systems for actual customers is a stellar real-world learning experience. Individually, the students learn the technology skills necessary to develop real-world computer information systems. Students learn the importance of a systematic approach in the process of developing robust systems, the management of projects, how to interact with customers and conduct requirements analysis, and the associated soft skills. Emphasis is placed on developing skills and knowledge in technical areas that have realistic value in the workplace. Through project reviews and team presentations, the students also learn about the various technologies used in the other projects, and they especially appreciate the exposure to projects involving cutting-edge technology and research. Working in teams, the students learn fair-mindedness, intellectual humility, intellectual integrity, and the ability to work with others to produce useful systems and to take responsibility for them. Because most of the students are employed full time in various areas of computing, they bring their knowledge and expertise to bear in their project work, and by exchanging information they learn from each other in this student-centered learning environment. As maturing professionals, the students learn how to act in the computing field not only as technologists but also as value providers. By working with real customers in developing their project systems and focusing on human-centered computing, the students learn important value skills (Denning & Dunham 2001). This learning paradigm fosters lifelong habits for learning and the application of critical thinking and value skills.

A side benefit is the presentation and publication activities that enhance communication skills. We have both the research and project students produce papers for publication, which is a novel aspect of our teaching approach. For the dissertation student we encourage publication, even if only for an internal conference or workshop, soon after the student obtains preliminary results. We have established a yearly internal conference, called "CSIS Research Day," complete with a review process and proceedings, for this purpose. We have found this helpful because it is much easier to begin by writing a small paper than a large dissertation, it solidifies the problem statement and general approach with some preliminary results, it ensures that the student and advisor have a common understanding of the problem and methodology and that the advisor buys into the process, and it generates ideas and motivation for extending the work into a significant research study acceptable as a dissertation. We have found that working to produce publications is a strong motivating factor for the students. The publications also enhance the external image and identity of our programs.

The various customers benefit from the systems created for them by the students, sometimes receiving systems they might not obtain under ordinary circumstances. The primary inducement for the customers' involvement with the student team is the anticipation of receiving a useful system, although they are warned that the chief purpose of the projects is to provide the students with a good educational experience and that not all projects are successfully completed. The customers include the research students, the faculty, the internal and greater university communities, and the community non-profit and technology organizations. In some cases, this amounts to a monetary savings, because the customers do not have to outsource the projects. The university itself benefits by having small projects completed by students.

The projects promote interdisciplinary collaboration and university and local community involvement. The projects involve two communities: the university community and the local community external to the university. Within the university community, many of the projects involve interdisciplinary collaboration with other departments, such as the medical projects with the nursing school, the online survey project with the assessment department, and the involvement with the business school and the department of information technology. The work with other universities, such as the Rensselaer Polytechnic Institute, extends our collaboration to the greater university community. The projects also extend into the local community, involving three local hospitals, the IBM speech and pen computing groups, and a small company, to provide the students with off-campus experiences and to foster an extended community for learning and growth. Because project customers come from the local community as well as from the university community, the project work brings to light how knowledge of computing and information technology connects with personal and social responsibility.

Conclusions

We have found in our School of Computer Science and Information Systems at Pace University an exciting and productive interplay between research and project activities. The main benefits have been to increase faculty research productivity, facilitate the three to four year completion of the doctorate program for gainfully employed information technologists, and strengthen capstone classes in the masters and baccalaureate programs by replacing "canned" software construction projects with actual customers who need real systems. The mechanism has been

using research to provide projects, and using projects to supply software. We term this symbiotic relationship the research/project interplay.

The benefits of this interplay extend beyond faculty and doctoral students getting the software they need to conduct their investigations and project students getting real-world development experience. Doctoral students gain skills in project management; project students gain insights into the nature of research, and all students gain communication skills as doctoral students are encouraged to publish early results and project students are encouraged to publish reports. Even more, this research/project interplay reaches into the university community and civic community at large, bringing its benefits further. We have described the workings of this interplay, described the benefits, and documented the 63 research-related projects supervised by the authors over the last six years and their related research with 15 doctoral dissertations and a total of 132 publications**.**

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Appendix

Table 5. Publications, external ones highlighted with a shaded background.

ABR1	C. Abrams, S. Cha, M. Gargano, C. Tappert, "Semantic Geometric Features: A Preliminary Investigation of Automobile ID," *Proc. CSIS Research Day 2005* .
ABR2	C. Abrams, S. Cha, C. Tappert, "Shape Matching with Ordered Boundary Points Using a Least-Cost Diagonal Method," *Proc. WORLDCOMP 2006* .
ABR3	C. Abrams, S. Cha, C. Tappert, "Shape Matching with Ordered Boundary Points Using a Least-Cost Diagonal Method," *Proc. CSIS Research Day 2006* .
ABR4	C. Abrams, S. Cha, C. Tappert, "Analyzing Shape Context Using the Hamiltonian Cycle," CSIS Tech. Rep., 2006.
ABR5	C. Abrams, "Shape Matching with Ordered Boundary Point Shape Contexts Using a Least Cost Diagonal Method," Doc. Dis., 2006.
AHM1	B. Ahmed, S. Cha, C. Tappert, "Language Identification from Text Using N-gram Based Cumulative Frequency Addition," *Proc. CSIS Research Day 2004* .
AHM2	B. Ahmed, S. Cha, C. Tappert, "Nationality Identification from Names Using N-Gram Based Cumulative Frequency Addition," *Proc. WMSCI 2005* .
AHM3	B. Ahmed, S. Cha, C. Tappert, "Detection of Foreign Entities in Native Text Using N-gram Cumulative FrequencyAddition," *Proc. CSIS Research Day 2005* .
AHM4	B. Ahmed, "Detection of Foreign Words and Names in Written Text," Doc. Dis., 2005.
APU	J. Apuzzo, N. Nwana, S. Varghese, "Quality is About Testing Early and Testing Often," *Proc. CSIS Research Day 2005* .
AVH	A. Avhad, X. Li, S. Agrawal, "Rockefeller State Park Website," *Proc. CSIS Research Day 2003* .
BAK	W. Baker, A. Evans, L. Jordan, S. Pethe, "User Verification System," *Proc. MASPLAS 2002* .
BAKS	R. Baksh, R. Frank, "An Experiment: A File Management System that Simulates ISAM.," *Proc. CSIS Research Day 2006* .
BAR	C. Barbosa, N. Pandey, O. Pavlenko, P. Cunning, S. Pramod, "A Web-Based Genealogy Application System," *Proc. MASPLAS 2002* .
BART1	G. Bartolacci, M. Curtin, M. Katzenberg, N. Nwana, S. Cha, C. Tappert, "Applying Keystroke Biometrics for User Verification and ID," *Proc. MCSCE-MLMTA 2005* .
BART2	G. Bartolacci, M. Curtin, M. Katzenberg, N. Nwana, S. Cha, C. Tappert, "Long-Text Keystroke Biometric Applications," *Proc. CSIS Research Day 2005* .
BAS1	R. Bassett, P. Gallivan, X. Gao, E. Heinen, A. Sakalaspur, "Development of an Automated Coin Grader," *Proc. MASPLAS 2002* .
BAS2	R. Bassett, "Machine Assisted Visual Grading of Rare Collectibles Over the Internet," *Proc. CSIS Research Day 2003* .
BAS3	R. Bassett, "Computer-based Objective Interactive Numismatic System," Doc. Dis., 2003.
BIS1	G. Bishop, S. Cha, C. Tappert, "Identification of Pottery Shapes and Schools Using Image Retrieval Techniques," *Proc. CAA 2005* .
BIS2	G. Bishop, S. Cha, C. Tappert, "A Greek Pottery Shape and School Identification and Classification System," *Proc. CSIS Research Day 2005* .
BIS3	G. Bishop, S. Cha, C. Tappert, "Identification of Pottery Shapes and Schools Using Image Retrieval Techniques," *Proc. MCSCE-CISST 2005* .
BIS4	G. Bishop, "Classification of Greek Pottery Shapes and Schools Using Image Retrieval Techniques," Doc. Dis., 2006.
BOO	G. Boodhoo, X. Gao, .B. Ramamurthy, "A Web Based Complaint Desk," *Proc. CSIS Research Day 2003* .
BRA1	K. Bravo, "Information Systems Security: A Model for HIPAA Security Compliance," *Proc. CSIS Research Day 2005* .
BRA2	K. Bravo, "A Model for HIPAA Security Compliance," Doc. Dis., 2005.
CAP	E. Capriolo, "Depth-wise Hashing with Deep Hashing Structures," *Proc. CSIS Research Day 2003* .
CHA1	S. Cha, C. Tappert, "Assessing the Discriminatory Power of Biometric Verifiers," *Proc. CSIS Research Day 2006* .
CHA2	S. Cha, S. Yoon, C. Tappert, "Handwriting Copybook Style Identification for Questioned Document Examination," *J. Forensic Doc. Examiners* , 2007.
CHA3	S. Cha, S. Yoon, C. Tappert, "Computer Assisted Handwriting Style Identification in Questioned Document Examination," *Proc. Electronic Imaging 2005* .
CHA4	S. Cha, S. Yoon, C. Tappert, "Enhancing Binary Feature Vector Similarity Measures," CSIS Tech. Rep., 2005.
CHA5	S. Cha, C. Tappert, S. Srihari, "Optimizing binary feature vector similarity measure using genetic algorithm and handwritten character recog," *Proc. ICDAR 2003* .
CHA6	S. Cha, C. Tappert, "Automatic Detection of Handwriting Forgery," *Proc. IWFHR* 2002.
CHA7	S. Cha, C. Tappert, M. Gibbons, Y. Chee, Automatic Detection of Handwriting Forgery using a Fractal Number Estimate of Wrinkliness, *Int. J. Pat. Rec. & AI* , 2004.
CHE1	H. Chen, S. Cha, Y. Chee, C. Tappert, "The Detection of Forged Handwriting Using a Fractal Number Estimate of Wrinkliness," *Proc. IGS 2003* .
CHE2	H. Chen, "Forged Handwriting Detection," *Proc. CSIS Research Day 2003* .
CHO1	S. Choi, S. Yoon, S. Cha, C. Tappert, "Use of Histogram Distances in Iris Authentication," *Proc. CSIS Research Day 2004* .
CHO2	S. Choi, S. Yoon, S. Cha, C. Tappert, "Use of Histogram Distances in Iris Authentication," *Proc. MCSCE-MLMTA 2004* .
CHO3	S. Choi, "A Study on the Iris Biometric Authentication," M.S. Thesis, 2005.
CHU	T. Chu, D. Mangano, V. Rudrapatna, "An Electronic Medical Patient Form System," *Proc. CSIS Research Day 2003* .
CLA	C. Clarke, L. Marino, R. Pachigolla, "Creating A Virtual Computing Facility: Emulating Grid Services Reference Model," *Proc. MASPLAS 2002* .
CUR1	M. Curtin , C. Tappert, M. Villani, G. Ngo, J. Simone, H. St. Fort, S. Cha, "Keystroke Biometric Recog on Long-Text Input," *Proc. CSIS Research Day 2006* .
CUR2	M. Curtin, C. Tappert, M. Villani, G. Ngo, J. Simone, H. St. Fort, S. Cha, "Keystroke Biometric Recog on Long-Text Input: A Feasibility Study," *Proc. IWSCCS 2006* .
CUR3	M. Curtin, "Long-Text Keystroke Biometric Applications Over the Internet," Doc. Dis., 2006.
DES	D. Desai, S. Laxman, "ReferenceVoice XML Application Design Issues," *Proc. MASPLAS 2001* .
DOY	K. Doyle, S. Kroha, A. Palchowdhury, W. Xu, "Project Group Assignment System," *Proc. MASPLAS 2002* .

Table 5. Publications (cont).

ESH	S. Eshak, S. Kannan, J. Thomas, K. Thangavelu, A. Wong, R. Hubert, "Developing a PDA to Assist Nurses on Hospice Visits," *Proc. CSIS Research Day 2005*.
EVA1	A. Evans, J. Sikorski, P. Thomas, "Interactive Visual System," *Proc. CSIS Research Day 2003*.
EVA2	A. Evans, J. Sikorski, P. Thomas, S. Cha, C. Tappert, J. Zou, A. Gattani, G. Nagy, Computer Assisted Visual Interactive Recognition Technology, *Proc. EIT 2005*.
FAN	Y. Fang, I. Stuart, "A Web-Based Genealogy System," *Proc. CSIS Research Day 2003*.
FRA	R. Frank, "An Antique Engineering Filing System for Personal Use and as a DBMS Case Study," *Proc. ISECON 2005*.
FU	J. Fu, "Design of Dialog Systems using VoiceXML," *Proc. MASPLAS 2001*.
FUS	A. Fusco, B. Clementi, "IT691 Projects: Quality Assurance, Testing, and Maintenance," *Proc. CSIS Research Day 2007*.
GAL1	J. Galatti, S. Cha, M. Gargano, C. Tappert, "Applying AI Techniques to Problems of Incomplete Info: Optimizing Bidding in Bridge," *Proc. CSIS Research Day*
GAL2	J. Galatti, R. Hackman, N. Hinkle, T. Reese, V. Simpson, "A Bridge Bidding Practice System," *Proc. CSIS Research Day 2007*.
GAL3	J. Galatti, S. Cha, M. Gargano, C. Tappert, "Applying AI Techniques to Problems of Incomplete Info: Optimizing Bidding in Bridge," *Proc. MCSCE-ICAI 2005*.
GALL	P. Gallivan, Q. Hong, L. Jordan, E. Li, G. Mathew, Y. Mulyani, P. Visokey, "VoiceXML Absentee System," *Proc. MASPLAS 2002*.
GIB1	M. Gibbons, S. Yoon, S. Cha, C. Tappert, "On Evaluating Open Biometric Identification Systems," *Proc. CSIS Research Day 2005*.
GIB2	M. Gibbons, S. Yoon, S. Cha, C. Tappert, "Biometric Identification Generalizability," *Proc. AVBPA 2005*.
GIB3	M. Gibbons, S. Yoon, S. Cha, C. Tappert, "Analyzing Open Biometric Identification Systems," *Proc. MCSCE-MLMTA 2005*.
GIB4	M. Gibbons, "On Evaluating Open Biometric Identification Systems," M.S. Thesis, 2005.
GOO	R. Goodman, M. Hahn, M. Marella, C. Ojar, S. Westcott, "The Use of Stylometry for Email Author Identification," *Proc. CSIS Research Day 2007*.
GUS	R. Gust, S. Hessami, M. Lee, "A Study of Jeff Hawkins' Brain Simulation Software," *Proc. CSIS Research Day 2007*.
HAM	B. Hammond, S. Cha, C. Tappert, "A Computer Vision Tangible User Interface for Natural HCI: an Application to Mixed Reality Billiards," submitted to *TEI 2008*.
HAR1	E. Hart, S. Cha, C. Tappert, "Interactive Flag Identification Using a Fuzzy Neural Technique," *Proc. CSIS Research Day 2004*.
HAR2	E. Hart, S. Cha, C. Tappert, "Interactive Flag Identification Using a Fuzzy-Neural Technique," *Proc. ACM SIGMM Int. Workshop Multimedia Info. Ret. 2004*.
HAR3	E. Hart, S. Cha, C. Tappert, "Interactive Flag Identification using Image Retrieval Techniques," *Proc. MCSCE-CISST 2004*.
HER	K. Hernandez, "Reasoning and Learning under Uncertainty Using Dynamic Probabilistic Models For Real Time Problem Determination," Doc. Dis., 2004.
HUB1	W. Huber, S. Cha, C. Tappert, V. Hanson, "Use of Chatroom Abbreviations and Shorthand Symbols in Pen Computing," *Proc. CSIS Research Day 2004*.
HUB2	W. Huber, V. Hanson, S. Cha, C. Tappert, "Common Chatroom Abbreviations Speed Pen Computing," *Proc. HCI 2005*.
HUB3	W. Huber, S. Cha, C. Tappert, V. Hanson, "Use of Chatroom Abbreviations and Shorthand Symbols in Pen Computing," *Proc. IWFHR 2004*.
HUBT1	R. Hubert, "Usability Field Study of Home Health Monitoring Devices Used by Older Adults," *Proc. CSIS Research Day 2006*.
HUBT2	R. Hubert, "Usability Field Study of Older Adults Using Multi-modal Home Health Monitoring Devices," Doc. Dis., 2006.
KAL1	S. Kalia, C. Tappert, A. Stix, F. Grossman, "A Pervasive Computing Solution to Asset, Problem and Knowledge Management," *Proc. E-Learn 2002*.
KAL2	S. Kalia, "A Study of the Pervasive Computing Solution to Asset, Probleem and Knowledge Management," Doc. Dis., 2002.
KAR	P. Karmarkar, A. Roda, B. Nolan, "XML Based Learning System," *Proc. CSIS Research Day 2004*.
LAP	P. Lapczynski, "An Integrated Model of Technology Acceptance for Mobile Computing," Doc. Dis., 2004.
LAW1	J. Law, Z. Wang, C. Tappert, "Corpus Collection Framework Using VoiceXML," Proc. AVIOS 2002.
LAW2	J. Law, "Designing a Multi-lingual Corpus Collection System," *Proc. MASPLAS 2002*.
LAW3	J. Law, "An Efficient First Pass of a Two-Stage Approach for Automatic Language Indentification of Telephone Speech," Doc. Dis., 2002.
LAW4	J. Law, Z. Wang, C. Tappert, "Data-Fusion of Static and Delta Cepstral Scores with Application to Language Detection," *Proc. Int. Conf. Speech Proc. 2002*.
LEE1	K. Lee, "Combining Multiple Feature Selection Methods," *Proc. MASPLAS 2002*.
LEE2	K. Lee, "An efficient Procedure to Select a Near-Optimal Subset of Pattern Classification Features," Doc. Dis., 2002.
LEF	L. LeFever, "Reengineering a Mobile Nursing Information System," *Proc. CSIS Research Day 2003*.
LEO	J. Leonardo, M. Auguste, R. Mehrotra, "Providing a Separate QA Team for a Project-Oriented Software Engineering Seminar," *Proc. CSIS Research Day 2003*.
LOM1	T. Lombardi, "The Classification of Style in Fine-Art Painting," *Proc. CSIS Research Day 2005*.
LOM2	T. Lombardi, S. Cha, C. Tappert, "Lightweight Image Retrieval System for Paintings," *Proc. Electronic Imaging 2005*.
LOM3	T. Lombardi, S. Cha, C. Tappert, "A Graphical User Interface for Fine-Art Painting Image Retrieval Sys," *Proc. ACM SIGMM Workshop Multimedia Info. Ret. 2004*.
LOM4	T. Lombardi, "The Classification of Style in Fine-Art Painting," Doc. Dis., 2005.
MAN1	M. Manfredi, S. Cha, S. Yoon, C. Tappert, "Handwriting Copybook Style Analysis of Pseudo-Online Data," *Proc. CSIS Research Day 2005*.
MAN2	M. Manfredi, S. Cha, S. Yoon, C. Tappert, "Similarity-Based Copybook Style Analysis Using Pseudo-Online Handwriting," *Proc. IGS 2005*.
MAN3	M. Manfredi, "Copybook Style Determination of Pseudo-Online Handwriting Data," Doc. Dis., 2005.
MCK	T. McKee, A. Chandra, J. Sohn, S. Nayak, "Quality Assurance and Maintenance Tools," *Proc. CSIS Research Day 2004*.
NGO	G. Ngo, J. Simone, H. St. Fort, "Developing a Java-Based Keystroke Biometric System for Long-Text Input," *Proc. CSIS Research Day 2006*.
NI	D. Ni, "Application of Neural Networks to Character Recognition," *Proc. CSIS Research Day 2007*.
ORD	B. Ordona, "A System for Effective Ear Training," *Proc. CSIS Research Day 2003*.
PAL	S. Palmer, N. Panchee, J. Sullivan, K. Thabet, S. Westgard, "Migrating an Application to Java2 Micro Edition: From Port to Portability," *Proc. MASPLAS 2002*.
PAR	H. Park, J. Pastore, C. Tappert, "Wireless technologies in pre-hospital communications: an analysis for Northern Westchester Hospital," CSIS Tech. Rep., 2002.
PAS	M. Pasacrita, "Astronomy Imaging System," *Proc. CSIS Research Day 2006*.
PAZ	D. Pazmino, M. Filippone, P. Mundra, S. Iyengar, "Pervasive Telemedicine System," *Proc. CSIS Research Day 2004*.
PER	F. Perkins, L. Meadows, J. Salomon, "Weather Station Website for Pace University Environmental Center," *Proc. CSIS Research Day 2006*.
PET	S. Pethe, W. Baker, N. Brown, R. Hennings, S. Misra, "Online Course Opinion Survey System," *Proc. MASPLAS 2002*.
PHI	A. Phidd, P. Thimmappa, R. Sauther, S. Vijayakumar, "Speech Database/Tool System and Preliminary Accent Recognition Study," *Proc. CSIS Research Day 2005*.
REN	J. Rennard, C. Tappert, "A Web-Based Genealogy System," *Proc. CSIS Research Day 2007*.
RIT	M. Ritzmann, L. Weinrich, "Strategies for Managing Missing or Incomplete Data in Biometric and Business Applications," *Proc. CSIS Research Day 2007*.
SEG	R. Segal, T. Markowitz, W. Arnold, "Fast Uncertainty Sampling for Labeling Large E-mail Corpora," *Proc. CSIS Research Day 2007*.
SIK	J. Sikorski, "Identification of Malignant Melanoma by Wavelet Analysis," *Proc. CSIS Research Day 2004*.
STL	J. St. Louis, D. Brown, A. D'Onofrio, M. Pasacrita, "Developing a PDA to Assist Nurses on Hospice Home Visits," *Proc. CSIS Research Day 2006*.
STU1	I. Stuart, S. Cha, C. Tappert, "A Neural Network Classifier for Junk E-Mail," *Proc. CSIS Research Day 2004*.
STU2	I. Stuart, S. Cha, C. Tappert, "A Neural Network Classifier for Junk E-Mail," in *Lecture Notes in CS*, Vol. 3163, Marinai & Dengel, Springer, 2004.
TAP1	C. Tappert, J. Ward, "Shorthand Handwriting Recognition for Pen-Centric Interfaces," *Proc. CSIS Research Day 2007*.
TAP2	C. Tappert, M. Villani, M. Curtin, G. Ngo, J. Simone, H. St. Fort, S. Cha, "Keystroke Biometric Recog Studies on Long-Text Input," *Proc. Int. Biometric Conf. 2006*.
TAP3	C. Tappert, S. Cha, "Handwriting Recognition Interfaces," Chap. 6, in *Text Entry Systems*, MacKenzie & Tanaka-Ishii (Eds.), Morgan Kaufmann 2007.
THO	J. Thompson, "Biometrics and Its Use in Forensics," *CSIS Tech. Rep.,* 2005.
TRA1	Z. Trabelsi, S. Cha, D. Desai, C. Tappert, "A Voice and Ink XML Multimodal Arch for Mobile e-Commerce Sys," *Proc. ACM Int. Workshop Mobile Commerce* 2002.
TRA2	Z. Trabelsi, C. Tappert, D. Desai, "Integrated VoiceXML and InkXML Gateway", *Proc. AVIOS 2002*.
TRI1	N. Trilok, "Establishing the Discriminative Power of Biometric Data with Application to Speaker and Language Individuality," *Proc. CSIS Research Day 2003*.
TRI2	N. Trilok, S. Cha, C. Tappert, "Establishing the Uniqueness of the Human Voice for Security Applications," *Proc. CSIS Research Day 2004*.
TRI3	N. Trilok, "Assessing the Discriminative Power of Voice," M.S. Thesis, 2004.
VIJ	P. Vijayakumar, R. Qureshi, V. Gaonkar, "Pace University Weather Station Website," *Proc. CSIS Research Day 2004*.
VIL1	M. Villani, C. Tappert, G. Ngo, J. Simone, H. St. Fort, S. Cha, "Keystroke Biometric Recog Studies on Long-Text Input under Several Conditions," *Proc. CVPR*
VIL2	M. Villani, "Keystroke Biometric Identification Studies on Long-Text Input," Doc. Dis., 2006.
VIT	S. Vittal, R. Basavaraju, A. Varghese, H. Lin, "Software Engineering and Quality Assurance Comparison of Tools and Techniques," *Proc. CSIS Research Day*
WAL	B. Walsh, J. Cohen, M. Patankar, "An Electronic Clinical Research System," *Proc. CSIS Research Day 2004*.
WEI	A. Weiss, A. Ramapanicker, P. Shah, S. Noble, L. Immohr, "Mouse Movements Biometric Identification: A Feasibility Study," *Proc. CSIS Research Day 2007*.
YAL	G. Yalamanchi, S. Ravi, "Project Group Assignment System," *Proc. CSIS Research Day 2003*.
YOO1	S. Yoon, S. Choi, S. Cha, Y. Lee, C. Tappert, "On the Individuality of the Iris Biometric," *Int. J. Graphics, Vision & Image Processing*, 2005.
YOO2	S. Yoon, S. Choi, S. Cha, Y. Lee, C. Tappert, "On the Individuality of the Iris Biometric," *Proc. ICIAR 2005*.
YOO3	S. Yoon, S. Choi, S. Cha, Y. Lee, C. Tappert, "Combining Multiple Iris Biometric Verifiers," *Proc. WMSCI 2005*.
YOO4	S. Yoon, S. Cha, C. Tappert, "Combining Multiple Iris Biometric Verifiers," *Proc. WMSCI 2005*.
YOO5	S. Yoon, S. Cha, C. Tappert, "On Binary Similarity Measures for Handwritten Character Recognition," *Proc. ICDAR 2005*.
YOO6	S. Yoon, S. Choi, S. Cha, C. Tappert, "Writer Profiling Using Handwriting Copybook Styles," *Proc. ICDAR 2005*.