2006-7 SIE Capstone Project Descriptions

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Our ultimate goal in this project is to design and construct a prototype system for search and surveillance that endows a single operator (or a limited number of operators) with the ability to remotely supervise multiple autonomous robots. Many recent research efforts focused on distributed coordination for peer-to-peer networks operate under the assumption that a high capacity communications network is available. In this project we shall implement a Bayesian scheme for distributed search by a network of robots without extensive requirements for communication. We shall construct our testbed by assembling 'small robots' which basically consist of small computers or 'motes' mounted on RC cars. We shall make use of open source software developed at University of California, Berkeley (see Cotsbots at http://www-bsac.eecs.berkeley.edu/projects/cotsbots/).
Client: Diabetes Technology Center, University of Virginia

Faculty Advisor: Marc D. Breton

Description:

The diabetes Technology Center at UVa is interested in the mathematical modeling of physiological phenomenon associated with Diabetes. To pursue its goals and participate to the research on an ever growing disease, the DTC designs and runs complex clinical trials, providing data to its own analysts but also to a wide network of researchers around the world. The data from these trials can be very complex, mixing information from numerous sources and of different nature: some quantities are measured every 5 minutes for several hours (for example blood glucose, insulin, several hormones, capillaries recruitment, hear rate), others pertain to the subject characterization (age, height weight, medical screening results). The organization and sharing of this complex and sensitive (HIPAA regulations) data requires the design of a special database with numerous functionalities, ranging from connections management to signal matching.

The goal of this project is to design such a data system, knowingly adapting it to a variety of users (medical doctors, research assistants, statisticians and system engineers).

The DTC developed an internet managed data system in the last 4 years and the new system will be merged in this older system. Thus technologies choices are restricted: MYSQL database, JAVA and HTML (JSP: java server page) programming languages.
Client: Micron Technology, Inc.
Faculty Advisor: Ginger Davis
Description:
This project presents a unique opportunity for the engineering student to collaborate with the Darden School (faculty and M.B.A. students) in a joint research project. Engineering and business skills will be combined in order to create a solution for Micron Technology, Inc. regarding the location of a future high volume memory device fabrication facility.

The fabrication of high volume commodity semiconductor memory devices, both dynamic random access memories (DRAMs) and Nand flash memories is a highly competitive business where device cost and quality are the key differentiators in the market. If a company does not consistently produce its devices at a competitive cost and at an equivalent quality then it will not be able to maintain the market share that allows for sufficient revenue and cash flow to support the capital investments and R&D to remain a top competitor in the business. One may ask how Micron Technology, Inc. has been able to continue to grow its market share in this highly competitive industry over its twenty-eight year existence while other major semiconductor producers such as IBM, Texas Instruments and Toshiba have left the business. Major emphasis on creativity and innovation combined with a relentless focus on cost per device are the trademarks of Micron and its history.

Decisions that control the final cost of the memory devices are made every day. They include decisions made in manufacturing such as the purchase of direct and indirect materials, equipment and consumables, in design and test, in marketing and in organizations that support manufacturing. Across the company a unifying culture of being the lowest cost producer is embedded in every major functional organization in the company.

The cost of manufacturing is also controlled by external economic forces that are less controllable by Micron but are potentially significant cost factors that need to be understood and incorporated into the overall decision process. Factors include the long term operating costs of doing business in the location of the manufacturing facilities. Operating costs include local, state and federal taxation, cost of construction, local costs of utilities, labor and training, and the cost of having sufficient human capital to run a high technology manufacturing facility.

Today there are several countries around the world and states in the United States that are aggressively competing for new semiconductor manufacturing facilities through various means. The approaches include the creation of long term taxation holidays, grants to fund capital investments, performance grants based upon investment and hiring plateaus, training assistance grants, land grants, utility cost freezes, and a variety of other attractive operating cost reduction opportunities. By understanding the most attractive locations in the world where economic incentives are being offered and their affect on the long term operation of a high volume memory fabrication facility we would be able to make more educated decisions for future capacity expansions by the company.

In particular we are interested in understanding the economic gap that exists between the Commonwealth of Virginia and the most attractive locale in the world. A better understanding of the economics surrounding this gap and the analysis of its affect on the long term operating costs of a high volume fabrication facility would allow us to work more effectively with the Commonwealth of Virginia to make it a more competitive environment for the placement of future facilities. Your research and analyses of the key factors contributing to differential costs
around the world and the creation of a model for understanding the present value of the long
term operating costs should enable you to recommend where a fabricator should be located
now. These facts will allow you to consider and recommend actions that the Commonwealth of
Virginia can take to be a more competitive business environment for the location of future
semiconductor fabrication facilities.
2007-04  FORCE-FEEDBACK SIMULATION FOR OPERATORS IN VIRTUAL SURGERY AND DISSECTION TASKS

Client: Dr. Marcus Martin, Chairman, Dept. of Emergency Medicine at UVa
Faculty Advisor: Greg Gerling

Description:

Laparoscopic and virtual surgery techniques are employed increasingly in hospitals today. In fact, the University of Virginia Health System owns and operates a DaVinci Surgical Simulator which it uses on a daily basis. These advanced surgical robots allow a high level of dexterity via multiple degree of freedom motion. Basically, these types of surgery significantly improve patient outcomes and reduce risks because it is not necessary to completely open the body cavity.

However, many of the robots (and training simulators) do not provide haptic feedback, i.e. mechanical resistance as the operator presses against different tissues in the body. Also problematic is a lack of readily available training. Training via simulated scenarios can and does improve task performance. Graded levels of task difficulty, immediate and post performance feedback to users, and a range of anatomically and disease accurate scenarios are all important considerations in addition to being human-machine interaction issues.

The goal of this project is to design, implement, and test a series of surgical simulations with a Sensable OMNI force-feedback, robotic device. The resultant simulations will help train UVa medical students and residents.

The systems analysis and development tasks that can be grouped into the following categories:

a. analyze robot-operator interaction “in the loop,”
b. analyze current part-task simulators and the use of animals for training medical students,
c. determine anatomical and physiological properties of relevant tissues and organs,
d. program the device (in C/C++, Matlab, and OpenGL),
e. setup a control theory model of the force-feedback robot device,
f. test the developed simulations with medical students and residents, and
g. synthesize and present the results.

Throughout the project, the team will consult with Dr. Martin in addition to selected professors and doctors at UVa in the Departments of Surgery and Biology. There may also be an opportunity to present findings at an additional conference in simulation away from UVa.
Client: Virginia Governor’s Office of Commonwealth Preparedness (OCP)

Faculty Advisor: Yacov Y. Haimes with Kenneth G. Crowther, Ph.D. Candidate

Description:

Approximately three decades ago White and Haas [1975] collaborated to publish a classical assessment of natural disaster research wherein they reported escalating costs to lives, property, and the economy of disasters despite the current research. They explain that technical disaster research has failed to result in a significant impact on regional preparedness due to a lack of social, economic, and political factors that would lead to the adaptation of such research, and they interestingly illustrate their ideas with anecdotes that seem frighteningly familiar. More recent assessments echo these needs for tighter integration of research and decisionmaking to avoid not-unlikely natural and man-made disasters. Strategic preparedness in this project connotes a decision process and its associated actions, implemented in advance of a natural or man-made disaster, aimed at reducing disaster consequences (e.g., recovery time and cost) and/or likelihood to a level considered acceptable, through the decisionmakers’ implicit and explicit acceptance of various strategic risks and tradeoffs. It is harmonious with the risk assessment and management process guided by the two sets of triplet questions presented by Kaplan and Garrick [1981] and Haimes [1991].

The focus of this capstone project is to use, develop, and deploy risk modeling, assessment, and management methodologies [Haimes 2004] to create a collaborative risk-based approach to assess the level of strategic preparedness in the Commonwealth of Virginia. The adaptive multi-player hierarchical holographic model (AMP-HHM) [Haimes and Horowitz 2004] will be deployed primarily as a methodology to elicit and integrate measures that reflect various preparedness capabilities of agencies in the Commonwealth of Virginia.

The capstone team will focus their analyses on two specific types of incident scenarios – hurricane and pandemic flu. Analyses will be conducted pertaining to the scenarios and the resulting modes of failures to the surrounding critical infrastructures in terms of physical damage, recovery time, and impacts on workforce and availability of essential goods/services. The capstone team will work closely with the faculty advisors and a steering committee representing the project sponsors (OCP) and other relevant agencies. The team will conduct interviews with contact persons (e.g., agency preparedness directors) and conduct site visits, as needed. Through this project the team will develop and transfer tools to the policy-makers of VA, which will equip them with a repeatable methodology for conducting systemic risk analyses for other scenarios.

References:


Client: Virginia Department of Transportation/Virginia Transportation Research Council (VDOT/VTRC)
Faculty Advisor: Yacov Y. Haimes and Joost R. Santos

Description:
The objective of this Capstone project, in the context of homeland security, is to integrate the consideration of resilience, protection (robustness and redundancy), and security for enhancing risk management of critical Virginia transportation infrastructures for major catastrophes (e.g., hurricane and pandemic). The project will address the enhancement of interoperability, which is the ability for public safety personnel to have access to important operational data on-demand and whenever necessary. Interoperability supports operational resilience from inter-communications that enable more effective incident management (tactical) and emergency management (strategic) activities. The project will focus on a particular VDOT Traffic Center and describe the extent to which it can support continuity of operations and functions during emergencies and catastrophic events. A VDOT Traffic Center is responsible for operating the devices for monitoring traffic incidents (e.g., cameras) and implementing actions to alleviate the consequence (e.g., deployment of variable messaging signs and issuance of travel advisories through the 511 system). The project will provide recommendations to enhance the interoperability of the selected VDOT Traffic Center in terms of identifying: (i) new design features that would add resilience to the Traffic Center as a system (e.g., automatic failure recovery features, and back-up modes); (ii) functions and capabilities that, if added to the current designs of the Traffic Center System, would significantly contribute to effective responses to the scenarios of risk under consideration (e.g., hurricanes, pandemic); (iii) develop a rough order of magnitude of cost estimates for promising risk management options; and (iv) develop ranking of risk management options based on their cost and contribution to risk reduction.

The Capstone team will work closely with the faculty advisors and a steering committee representing the project sponsors (VDOT/VTRC) and relevant agencies. The team will conduct interviews with contact persons (e.g., infrastructure operators) and conduct site visits, as needed. Through this project the team will develop and transfer tools to the policy-makers of VA, which will equip them with a repeatable methodology for conducting systemic risk analyses for other critical infrastructures.
IVY GROUNDWATER ASSESSMENT AND MAPPING

Client: Albemarle County Dept. of Community Development – Groundwater Office
Faculty Advisor: Garrick E. Louis

Description:
Access to a safe and reliable water supply is a requirement for development in any area, including Albemarle County. Private wells provide the primary source of drinking water for County residents, and a drilled well permit is a requirement for a new residential building permit in Albemarle County. In fact, thirty-eight of Virginia's 95 counties depend entirely on groundwater for their water supply. Fifty-five counties draw more than half of their public water supplies from groundwater. Of the 2,500 public water supply systems in Virginia, 2,300 use groundwater. In 60 counties of Virginia, the majority of households obtain water from their own private wells. Ninety-two percent of households using private wells also use septic tanks, 31 percent of them live on lots that are 1 acre or smaller, and 35 percent of them use fuel oil as their heating source. This combination of factors poses grave concern about the quality of groundwater, and the health of those who depend on it for the drinking water supply. Yet, in spite of the importance of groundwater to residential development in Albemarle and other Virginia Counties, there is no established policy or practice linking development planning to knowledge of the availability and quality of groundwater in areas not served by a public water supply.

This project continues work begun by last year's Capstone 2006#7 to assess and map the quality and availability of water from private wells in the Ivy subdivision of Albemarle County. The goal of this project is to create a model for development planning in rural areas that is based on an assessment of the availability and quality of groundwater in those areas. The model will be developed in the Ivy subdivision of Albemarle County.

The project goal will be achieved through three objectives; i) consolidating and mapping existing data on PWW quality and flow rate in Ivy, ii) supplementing the existing data with new data on the location and quality of PWW in Ivy obtained by field testing of selected wells in the area, and iii) publishing the PWW data on the internet for use by the County Board of Supervisors and citizens of the County in making decisions about development in Ivy, and ultimately the County as a whole.

Capstone 2006#7 developed a model for groundwater assessment, mapping, and representation via internet maps. This year’s project will extend the well water sampling from 2006 into Southern Ivy, consolidate data sources from the major government agencies involved into a standard Access database, and generate internet-based maps of the consolidated groundwater data on the internet. The team will also conduct testing of users of the groundwater maps to determine how accurately they interpret the information, and how it influences their attitudes and decisions about regional planning in rural Albemarle County.
Client: Virginia Department of Criminal Justice Services
Faculty Advisor: Donald Brown
Description:
The University of Virginia, through previous capstone efforts, has developed the Web-based Crime Analysis Toolkit (WebCAT) for the Virginia Department of Criminal Justice Services. WebCAT enables police and other government agencies to share and analyze criminal incident data. Until this summer, WebCAT's analysis capabilities were limited to incident data only. Recently, the WebCAT repository has been enhanced to store data on arrests, warrants, people, traffic accidents, and calls for service. These additional data enable more analyses to be performed using WebCAT. The goal of this year's capstone is to design and implement new analysis tools to exploit these data. Team members will work with crime analysts from all over the state to capture their requirements. The team will design and implement analysis tools to satisfy these needs. This capstone will be of interest to students who want to work on all aspects of information systems design and implementation from interfaces and visualization to information security, web services, and databases. Students selected for this team will have the opportunity to work with all levels of law enforcement and will have the satisfaction of knowing that their efforts will have near instantaneous impact on statewide safety.
Through an ongoing research grant from the Navy, the University of Virginia has developed an approach for predicting the growth of corrosion using state-of-the-art data modeling methods. The predictions generated using this model will be used as an input for life prediction and condition-based maintenance codes for equipment. Specifically, this model could be used to help develop an efficient and safe maintenance plan for a fighter aircraft or an aircraft carrier. This modeling approach is currently being enhanced and extended. As a part of this research, there are extensive image and data processing components. Processing the data requires registering images, identifying important characteristics within the image, simulating corrosion growth, comparing actual growth to simulated growth and baseline model predictions, and reporting the results of the analysis. Currently, the processing component is largely manual and requires frequent attention from the analyst. The goal of this year’s Capstone team will be to streamline this process by developing automation tools for processing the data. This project will be of interest to students interested in image processing, probabilistic modeling, simulation, and developing automation tools. Students selected for this team will have the opportunity to work with researchers in the Materials Science and Systems & Information Engineering Departments and will witness all aspects of this research activity.
Mining Unstructured Data

Structured data includes numbers entered into a spreadsheet or database, binary yes/no answers, and categorical data. Unstructured data encompasses free-form data, such as text messages intercepted from a terrorist organization or satellite imagery. This data is not easily parsed or organized, and domain understanding and business intelligence is required to use it. The ability to mine text, images, sound files, etc. would allow large datasets to be sorted, summarized, and visualized, unleashing the knowledge held within.

Text mining is currently the “Wild West” of data mining (and techniques for mining images and sounds are even less well-developed). This rapidly emerging interdisciplinary field draws on data mining, machine learning, statistics, and natural language processing to gather useful information from free-form text. The applications have great commercial potential because so much data is stored in an unstructured format. Only by consolidating, organizing, and analyzing this data does it become useful.

According to analysts (http://www.b-eye-network.com/view/2098):
- 80 percent of business is conducted on unstructured information (Gartner Group).
- 85 percent of all data stored is held in an unstructured format (Butler Group).
- Unstructured data doubles every three months (Gartner Group).
- 7 million web pages are added every day (Gartner Group).

The Project

ERI and the Capstone team will obtain use of all leading commercial and academic software tools for mining unstructured data and provide an unbiased, deep evaluation and critique:
- Mapping the space of tools and needs
- Comprehensively listing qualities and features
- Evaluating their effectiveness on a suite of real problems
- Advising vendors on improvements and next steps
- Guiding potential users to the tool(s) appropriate for their needs

The Promise

A high-quality, deep review will be of enormous value to the industry. A similar review of data mining tools for structured data by ERI in 1998 is still the “#1 download in data mining” (and a Capstone version of the project focused on desktop tools remains in demand even many years later; see http://datamininglab.com/toolcomp.html). Vendors will enhance their products, and users will gain the confidence to select and use the best tools, leading to breakthroughs in many fields.

Elder Research, Inc., Charlottesville, VA (www.datamininglab.com) is a leader in the practice of Data Mining -- discovering useful patterns in data and successfully harnessing the information gained. Since 1995, ERI researchers have solved problems in wide-ranging fields including investment timing, credit scoring, image recognition, text mining, homeland security, customer relationship management, and fraud detection.
Client: One of three integrated projects on Wireless Sensor Support for Infrastructure Surveillance sponsored by the Systems Technology Integration Lab

Faculty Advisor: Jerry Learmonth

Description:
Recent advances in wireless communications and scalable computing have made it possible to build low-cost, low-power sensing devices that can be scattered in a geographic area for remote monitoring of the environment. Applications of this “sensor networking” technology include environmental monitoring, air/vehicular traffic control, manufacturing, military, and homeland security applications. This capstone project is one of three integrated projects that will focus on infrastructure surveillance applications of Wireless Sensor Networks (WSNs) such as may arise in homeland security or urban operations.

This project will design and develop a simulation testbed the purpose of which is to explore the capabilities and limitations of wireless sensor networks as they may be deployed in multi-building surveillance situations. The testbed will combine both live (human-in-the-loop) and simulated components. The live portion of the testbed involves physically deploying a wireless sensor network and operating it in experimental situations with human role-playing actors (intruders, security officers, commanders). The simulated portion of the testbed adds additional (virtual) buildings and role-playing actors. The simulation testbed will integrate real-time information from the live portion with simulated information from the virtual environment.

The project will be tightly coupled with two other projects, one which is concerned with information management and the other with capturing, compressing, and distributing images. Both the live and simulated environments must account for inherent system constraints: limited battery energy/power, bandwidth, computational capacity, and end-user (human) cognitive capacity. Because surveillance situations are dynamic and highly unpredictable, a simulation testbed capable of supporting a rich and easily reconfigurable set of experiments is required.

Because this capstone project will contribute to the efforts of a larger U.S. Army and Joint Forces-sponsored research project, prototype implementation, live demonstrations, and experimental validation will be a major part of the integrated capstone group's activities. The simulation testbed will be developed in JAVA, therefore experience, or the willingness to quickly come up to speed, with this language is desirable.
Client: One of three integrated projects on Wireless Sensor Support for Infrastructure Surveillance sponsored by the Systems Technology Integration Lab

Faculty Advisor: Michael DeVore

Description:
Recent advances in wireless communications and scalable computing have made it possible to build low-cost, low-power sensing devices that can be scattered in a geographic area for remote monitoring of the environment. Applications of this “sensor networking” technology include environmental monitoring, air/vehicular traffic control, manufacturing, military, and homeland security applications. This capstone project is one of three integrated projects that will focus on infrastructure surveillance applications of Wireless Sensor Networks (WSNs) such as may arise in homeland security or urban operations.

Information systems that collect, process, and disseminate visual information are the primary focus of this part of the integrated capstone project. The goal is to devise and implement an embedded system for: (1) Capturing visual imagery (video or still photographs); (2) Extracting information relevant to surveillance applications, (3) Encoding that information to a user-specified fidelity; (4) Delivering the encoded information to a surveillance client; and (5) Collecting the information from multiple imaging processors at a single client to present a single integrated and timely portrayal of a complex environment.

The key challenge is that the system is to be implemented on a miniaturized, battery operated computing platform. While these devices offer tremendous computational capabilities for their size, the desire to preserve battery life necessitates a usage strategy that only selectively exploits their full capacity. Also, since a large number of these devices may attempt to deliver information over the same wireless network, it is imperative that only the most important information be transmitted and that as efficiently as possible. In short, this project involves the task of maximizing the value of visual information delivered while minimizing the expenditure of electrical power, computational effort, and network utilization.

Since this capstone project will contribute to the efforts of a larger Army and Joint Forces-sponsored research project, prototype implementation, live demonstrations, and experimental validation will be a major part of the integrated capstone group’s activities. While programming is not a central focus of the project, the work will necessarily involve some JAVA coding; a willingness to develop this skill is expected.
Client: One of three integrated projects on Wireless Sensor Support for Infrastructure Surveillance sponsored by the Systems Technology Integration Lab

Faculty Advisor: Stephen Patek

Description:

Recent advances in wireless communications and scalable computing have made it possible to build low-cost, low-power sensing devices that can be scattered in a geographic area for remote monitoring of the environment. Applications of this “sensor networking” technology include environmental monitoring, air/vehicular traffic control, manufacturing, military, and homeland security applications. This capstone project is one of three integrated projects that will focus on infrastructure surveillance applications of Wireless Sensor Networks (WSNs) such as may arise in homeland security or urban operations.

Information management is this primary focus of this part of the integrated capstone project. Our goal is to devise systems that manage to get the right sensor information to the right users at the right time in support of mission goals, reconciling the diverse needs and capabilities of all participants. A number of factors make this difficult in urban operation settings: (i) wireless sensor systems are severely resource constrained in terms of sensing capacity, battery energy/power, bandwidth, computational capacity, and even end-user cognitive capacity and (ii) urban operations are inherently dynamic and information requirement are highly time and situation-varying.

What is needed, and what this project will develop, is a systematic (efficient and fair) approach to resolving the conflicting needs of diverse applications running over a common set of sensor resources. The work can be divided into three main categories: architectures, information management policies, and prototype implementation and testing. Architectural considerations include addressing basic questions like: (i) What elements of the system should control the flow of information, sensors, users, or both? (ii) If the sensors have decision-making authority, should each sensor act independently, or should the flow of information be managed by sensors coordinating with one another? Information management policies are the decision-rules that govern the actual flow of information based on available data about resources and the opportunity to transmit new sensor data. The predominant approach so far has been to formulate the problem as one of utility optimization, subject to constraints on bandwidth and energy. A major component of the work on information management policies will be to design a system wherein individual users or groups of users can easily assess and communicate their utility for sensor data of various types.

Since this capstone project will contribute to the efforts of a larger Army and Joint Forces-sponsored research project, prototype implementation, live demonstrations, and experimental validation will be a major part of the integrated capstone group’s activities. While programming is not a central focus of the project, the work will necessarily involve some JAVA coding; a willingness to develop this skill is expected.
This capstone project will investigate how the Virginia Department of Rail and Public Transportation can proceed to develop and maintain a statewide database and mapping model that depicts current public transit routes of the Commonwealth of Virginia. There are 44 local fixed-route systems served by buses. The model will have various uses including traveler navigation, statewide metrics of transit accessibility and performance, and long-range planning for capacity expansion of intermodal and multimodal transportation. The capstone team will gain experience with resources and staff of local transit agencies around the Commonwealth, geographic information systems, transportation operations and planning, and database management.
Client: TBR (To Be Revealed) at First Team Meeting

Faculty Advisor: William T. Scherer

Description:

Are you:

• open-minded,
• take initiative,
• self-motivated,
• out-of-the-box thinker,
• enjoy ambiguity,
• a risk taker,
• interested in new businesses and entrepreneurially inclined,
• interested in information technology driving organizations,
• tough,
• willing to be fired,
• very bright and innovative,
• a hard worker, and
• an even harder worker?

Then this might be the project for you. You’ll be part of a GO (Growth Opportunities) Team (i.e., see “Capital One: Exploiting an Information-Based Strategy,” Clemons and Thatcher, IEEE, 1998). You’ll be working real-time for the clients, with considerable client interaction.

This project will require extensive, hard work – unlike any other course you’ve taken. Don’t sign-up unless you’re willing to be serious and make this the focal point of your fourth-year. This effort level will be expected and required -- but what you take away from this experience will be well worth the effort!

This project will require all students to sign non-disclosure agreements (NDAs).
Client: Steve Bolton, MBDC
Faculty Advisor: Reid Bailey
Description:
Did you know that a world-leader in designing sustainable products is based right here in Charlottesville? MBDC – located just off the downtown mall – keeps a fairly low local profile for a company at the cutting edge of reducing the environmental impact of engineered products and systems.

If you have been searching for a way to apply your systems skills to do something about the impact of engineered products and processes on human health and the environment, then this is the right project for you. MBDC needs your help to push their innovative work even further.

MBDC <www.mbdc.com> is a Charlottesville-based firm that works with product manufacturers to help them redesign their products to be safe for human health and the environment, as well as fully recyclable or compostable, a concept known as Cradle to Cradle. Instead of merely minimizing waste in product manufacturing and use, MBDC is moving towards eliminating the concept of waste itself. This 7-person firm is looking for students to help improve the functionality of databases the firm uses to collect and manage data about product ingredients that manufacturers purchase from suppliers.

Specifically, MBDC needs assistance enhancing the functionality of its existing supplier database to ideally: 1) create visual maps/trees of ingredient relationships among manufacturers and suppliers (i.e., who produces what material for a specific product, tracing all of the way back to raw materials), to support internal and external data tracking; 2) allow additional questions to be asked of manufacturers or suppliers (e.g., “what percent of your energy use is from renewable sources?”) and included with their ingredient data; and 3) track progress in data collection and overall project administration.

This project will require all students to sign non-disclosure agreements (NDAs).
Client: Tom von Hemmert, Criminal Justice Planner for Charlottesville/Albermarle Region

Faculty Advisor: Co-advised by Reid Bailey and Mike Smith

Description:

When a police officer arrests someone that they determine may suffer from a mental illness and not necessarily have criminal intent, the current procedure is to bring the detainee to the UVa Emergency Department and then wait up to 8 hours or more for an evaluation by a psychiatrist. Because the person is being detained, the police officer must wait at the Emergency Room for the entire time. This is very unproductive time for police officers.

The objective is to divert such mentally ill persons from the court (criminal justice) system and refer them for treatment of their illness. In addition to increasing the productivity of police officers, an improved system would improve the quality of treatment given to individuals with mental illness, reduce shootings involving individuals with mental illness, reduce costs to the criminal justice system, and reduce the number of individuals with mental illness in jail.

While this project focuses on the Charlottesville/Albermarle region, it is a project with national importance as other cities are struggling with this same issue (see [http://www.pima.gov/bondelection2006/](http://www.pima.gov/bondelection2006/) for how Tucson, AZ, is approaching the problem).

The capstone would involve analyzing current procedures, modeling that system, proposing alternative procedures, possibly simulating the proposed alternatives and recommending a solution. This project is ideal for students wanting to apply classical systems engineering approaches to a social system.

Students may have to sign non-disclosure agreements to work on this project.
Client: NASA Langley Research Center
Faculty Advisor: Peter A. Beling
Description:
Recent years have seen considerable research activity in the area of coordination of mobile autonomous agents. The typical setting involves a group of robots that have homogenous capabilities and share a common objective. One interesting example is the case of a game of soccer played by two teams of autonomous robots. Robotic soccer has attracted considerable attention in the literature and has evolved into a standard testbed application for control and coordination algorithms and for robotic sensing and communication methods and hardware. Tournaments are held regularly to allow researchers to demonstrate their best hardware and software in a competitive environment, and a challenge has been put forward to field, by the year 2050, a robotic team that is capable of beating the best human players.

Last year a Systems Capstone group investigated an abstract problem in which independent agents must work together to retrieve stationary targets containing reward. The problem considered by the group is modeled in a network environment consisting of arcs along which each agent may travel on its way to a node representing a target location. Success in this context consists of maximizing the reward collected in total by the group of agents. At each decision epoch, each agent is aware of the rewards that have yet to be collected in the network, and their positions, and the position of every other agent.

Last year the Capstone group designed and tested a suite of decision-making algorithms that varied in their degree of centralization and in the quality of their solutions. Test results reveal that the impact of centralized decision making is negligible compared to the benefits of added complexity and intelligence in coordination algorithms. Testing was performed using a JAVA-based simulation environment that features a software architecture that allows algorithms to be written and incorporated in a modular fashion.

The goal of this year’s reward-collection project would be to adapt the abstract reward collection formulation to a hardware environment consisting of small, motorized robots with on-board microprocessors. The Capstone team will have access to about 50 robots, examples of which can be seen here:

http://www-bsac.eecs.berkeley.edu/projects/cotsbots/

As with last year’s project, a major focus of the research will be measuring the loss of performance associated with moving from centralized to decentralized control and with decreasing sensing or communication capabilities of the individual agents. Last year the range of performance experiments was limited only by theoretical assumptions about the information available to each agent. This year our performance tests will be constrained to match the capabilities that we can actually manage to implement in the hardware environment. This constraint, though, should make performance tradeoffs all the more poignant as it will be possible to correlate them with tradeoffs in implementation difficulty and hardware complexity.

This project will involve programming and may require occasional travel to the NASA Langley Research Center in Hampton Roads, VA.
Client: FIPSE/CAPES
Faculty Advisor: Ellen Bass
Description:

**Special Note: Please do not select this project unless you have already coordinated with Professors Guerlain or Bass**

This capstone is open to students interested in doing a semester abroad in Brazil, working on a human factors-related project with students from Brazil, sponsored by Petrobras, a Brazilian petrochemical company. Prerequisites for working on this capstone are a working knowledge of Portuguese, and application to the capstone in the second or third year, due to the extra planning and preparation required for spending a semester abroad that requires foreign language skills.

Note: This year’s fourth year students in the program are already working on this project and will be joined by two Brazil students who will arrive Spring semester). Next year’s students are already applying, as they will have to take Port 1 in the fall and move their courses around to accommodate the semester abroad in the fall of their fourth year.