

PRISM: Planning a Center for Perceptual Robotics, Intelligent Sensors and Machines

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1. INTRODUCTION

The multidisciplinary nature of robotics research requires collaborations among researchers with expertise in robotics, artificial intelligence, computer vision, wireless communication, advanced sensors and mechanical design. Robotics research and education at the City College of New York (CCNY) is currently scattered in several departments (EE, CS and ME) of the School of Engineering (SOE). The goal of the MII project (NSF grant No. CNS-0424539) is to develop a plan for the establishment of the *Center for Perceptual Robotics, Intelligent Sensors and Machines (PRISM)* in order to enhance the comprehensive robotics research infrastructure and to group researchers together to carry out nationally competitive research in these fields.

From an educational point of view, one of the major challenges at CCNY is student retention. However, failing and dropping out should not be confused with lack of motivation or ability. CCNY is an urban institution without dormitories. The student body consists of 1/3 African-Americans and 1/3 Hispanic-Americans, and the majority of students hold part time jobs. Even though they commute long distances and face financial and social hurdles, many of them are highly motivated. Robotics has been proven to be a very effective tool to recruit and keep talented students from these under-represented groups, but unfortunately CCNY does not have such a research program of adequate scale. Therefore, the establishment of the PRISM Center will definitely contribute to meeting this challenge at CCNY.

The planning tasks under consideration include six issues: (1) Identify research themes/threads; (2) Organize a multidisciplinary team and study methods for faculty involvement; (3) Develop new courses and outreach activities; (4) Enrich academic exchanges; (5) Building the infrastructure; and (6) Develop an evaluation plan. We will briefly describe our experiences in dealing with each of the above six issues, sharing our problems as well as some pleasant surprises in the course of this one-year effort.

2. RESEARCH THEME AND THREADS

The first issue is to identify a research theme in order to foster collaborative research in distributed robotics, computer vision, networking, and mechanical design among faculty members at CCNY. Faculty members involved in this effort have had active research projects in cooperative

robots, wall-climbing robots, video mosaicing, scene representation, automatic target recognition, multimodal sensors, and ad hoc networks. In the last few years, we have obtained considerable research grants from the NSF, ARO, AFRL, ONR, industry and CUNY. Leveraging our previous research expertise in the related fields, the main theme of the PRISM Center we have identified in the next five years will be *intelligent mobile sensor networks in a 3D space*. Around this theme, three research threads will be initiated: 1) *Perceptual Robotics* (mobile sensor network, sensing, control, and planning of robot teams in a 3D space); 2) *Intelligent Sensors* (multimodal sensors for target recognition, subject tracking, and event understanding); and 3) *Smart Machines* (human-robot interaction, visual scene representation, and human interfaces in a large sensor network). Based on the current experiences, we foresee that our research activities will keep growing to approach our goal of creating a center of excellence in the field of distributed robotics and computer vision at CCNY.

3. FACULTY INVOLVEMENT

The second important issue is the support of the PRISM center and faculty involvement. From the previous MII grant Center for Minorities in Information Processing Systems (CMIPS) at CCNY (1991-1997), we found that it was very difficult to increase the faculty involvement in student mentoring. The PIs had to do a large volume of mentoring work beyond their regular workload. The major reason was that the majority of the MII funds went to equipment and student support with very limited funds for faculty support. Now, we have more than 15 professors whose research is related to the goal of the center, but the amount of the external funding we anticipate from the NSF CISE CRI program (which replacing the MII program) is more competitive and is limited from our experiences in the last few years. Thus, we will select 4-6 faculty members as the core of the Center to coordinate multidisciplinary efforts. Meanwhile, the Center will design small focus research and/or education projects that call for proposals from related faculty members. Partial solutions to the funding issue may include cultivating a supportive environment by offering course release time (for which we have obtained strong support from SOE), and actively seeking external funding that could support faculty research, with the strong backup of the proposed Center. Nevertheless, this is the part where we face most of the problems and challenges.

4. EDUCATION AND OUTREACH

In addition to improving the research environment and enhancing faculty research productivity, building a strong robotics educational program is another goal of the MII project with equal importance. We will introduce new courses, reshape senior capstone design courses, develop nurturing and outreach activities, and create a “pipeline” to attract high school students to CISE disciplines, to retain and timely graduate minority undergraduates, and to prepare and support talented minority students with their graduate education. We have successfully developed several capstone design courses in the last few years, and we plan to develop joint design courses among CS, EE and ME in distributed perceptual robotics. For outreach, the plan includes further enhance the cooperation with the NYC-LSAMP (Louis Stokes Alliance for Minority Participation) program, New York Academy of Sciences’ (NYAS) Summer Research Training Program (SRTP), and New York/New Jersey FIRST, where the Center will serve as a major research-training site. Prof. Xiao has track record of achievement in organizing robotics outreach activities involving student in mentored research project. During the project, he is mentoring 2 high-school SRTP interns working with 3 undergraduates and 1 graduate student to prepare for the CLAWAR climbing robot competition to be held in Sept. 2005 in London. This “affinity mentoring” model will be further evaluated. He also mentored 2 high-school teams participating 2005 FIRST robotics competition, both teams entered the quarter-finals and one team was the New York City regional finalist. We are in the process to create a school-wide Robotics Club to attract talented students to the CISE disciplines.

5. ACADEMIC EXCHANGES

In addition to the support from the MII Planning grant, we got funding investment from SOE to launch the Lecture Series on Computer Vision, Robotics and HCI (http://www-cs.ccny.cuny.edu/~zhu/CvcvL/html/ccny_lecture_series.html). The purposes are to excite interest within CCNY, foster collaboration among institutions, and increase the visibility of the research and education of computer vision and robotics at CCNY. We have invited 4 world-renowned researchers and educators in these fields to give lectures last spring, and more are under scheduled. This turns out to be very successful and will be continued.

We have received positive and warm responses accepting our invitation to serve on the advisory committee from UIUC, University of Minnesota, UMass Amherst and MSU. The advisory panel will be expanded to include more professionals from both academia and industry. We have also visited some places with successful robotics and vision programs, including UMass, USC, UCSD and UIUC, presenting our work and ideas, and getting feedback for establishing the Center. The visits to other institutions (including MIs) are being planned. Combining the strong research with the MI status of CCNY, we have attracted great interest in multi-institutional collaborations. The PIs

have collaborated or are actively pursuing collaborations with researchers at many of these institutions in multiple NSF and DoD proposals, which was quite a pleasant surprise in the current stage of planning the Center.

6. INFRASTRUCTURE ESTABLISHMENT

The existing equipment at CCNY includes: SCARA robots with vision system, a flexible manufacturing cell, a CIM unit, Cartesian robots, mobile robots, various low-end and high-end sensors (color cameras, thermal cameras, laser vibrometers) and computing facilities. The infrastructure we will request for these research directions under the PRISM Center will include: various sensors (omnidirectional and PTZ cameras, stereo camera heads, IR cameras, acoustic sensors, etc); purchase and/or fabrication of various robots (AUV, ground mobile robots, wall-climbing robots); visualization devices (graphics workstations, large screen displays, stereo display systems) and update of computing facilities. The establishment of the PRISM Center by the support of the requested infrastructure will enable us to group the researchers together to carry out nationally competitive research in robotics and relevant fields. We will explore the opportunities of robotics and vision research in applications with high national priorities, such as surveillance, security and advanced e-learning, particularly for serving the under-represented students at CCNY.

7. EVALUATION PLAN

To ascertain the impact of the proposed robotics research and educational program, an evaluation process must be envisioned. Thus an evaluation plan encompassing the research achievement metric and educational effectiveness metric will be developed, based on the corresponding NSF guidelines. Possible metrics may include immediately tangible research results seeded by the funding (e.g., student participation in conferences, joint faculty/student publications), improvement of minority students’ retention rates, and number of students entering graduate schools, etc. The plan is still under development and will be refined during the course of the Center under plan.

8. CONCLUSIONS

Based on internal examination in the SOE at CCNY and feedback from external committee members, we performed a one-year study on several implementation issues of the planned PRISM Center. We are very confident in excelling our research and innovating the minority educational programs under the theme of the PRISM center. We have realized that hardware infrastructure is important, but with the current trends of technologies it is not the determining factor of the success of the Center. The most challenging issue is to figure out mechanisms to motivate talented researchers and educators to devote to our dream - that is to make CCNY a center of excellence in cutting-edge research and a national urban model for minority education in the fields of robotics and computer vision.