



Creating Undergraduate Applied Research Opportunities for Engineering Technology Students in Healthcare Robotics

Dr. Saeed Khan, Kansas State University, Salina

Saeed Khan is an associate professor with the Electronic and Computer Engineering Technology program at Kansas State University at Salina. Dr. Khan received his Ph.D. and M.S. degrees in Electrical Engineering from the University of Connecticut, in 1989 and 1994 respectively and his B.S. in Electrical Engineering from Bangladesh University of Engineering and Technology, Dhaka, Bangladesh in 1984. Khan, who joined KSU in 1998, teaches courses in telecommunications and digital systems. His research interests and areas of expertise include antennas and propagation, novel materials for microwave application, and electromagnetic scattering.

Mr. Lee J. Gatton, Gatton Research and Development

Lee Gatton is the president and senior research engineer at Gatton Research and Development. He received his Associate of Engineering technology from Kansas State University, Salina Kansas, in 1971, B.S. in Electrical Engineering from Southern Methodist University, Dallas Texas, in 1975, and a Master of Management in Information Systems from Friends University, Wichita, Kansas in 2001. Gatton, who has 39 years of computer engineering experience, started Gatton Research and Development in 2008 to pursue his interest in developing Socially Assistive Robots.

Mrs. Beverly Gatton, Fidelity Information Services

Beverly Gatton is the IT project manager at Fidelity Information Services Beverly Gatton manages software implementations of commercial banking systems across the United States. She received her B.S. in Business from the University Of Texas at Dallas in 1977, her associate's of Engineering Technology from Kansas State University in Salina in 1986, and a master's of Management in Information Systems from Friends University in Wichita, Kansas in 1998. Gatton's has built her career in the application of Information Technology to the business world.

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Abstract

This paper is a model of collaboration between entrepreneurs and academics in which a key goal is to create undergraduate research (UR) opportunities by forming industry-academe partnerships in applied research. Any successful UR program requires a certain amount of faculty expertise, proper funding, and challenging projects that are good motivational drivers for students. The paper describes a yearlong effort to develop an applied research partnerships with entrepreneurs in the healthcare industry while at the same time jointly seeking external funding from government and non-government entities. As a case in point, the paper will document the early stage of an exciting project that is designed to inexpensively enhance eldercare, the demand for which is skyrocketing in today's aging society, using robotic platforms. This project addresses a real-world need while providing students the opportunity to make an "original intellectual or creative contribution," having all the elements that that drive quality research and attract faculty, student, and entrepreneurial interest alike. It is motivated by the need to control home healthcare costs, improve the quality of life for an aging population and their caregivers, allow patients to be more involved in their own care, help prevent premature hospitalization or long stays in assisted living facilities, and provide an avenue for social engagement through a conversational interface using socially assistive robots (SAR). It expounds on efforts to create a research infrastructure through research and collaborative grant writing.

Introduction

According to the Council on Undergraduate Research (CUR), *undergraduate research is an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution*¹. If there is a consensus that all undergraduate education can be enhanced by research opportunities, then it is especially so for engineering technology (ET) majors whose programs are designed to balance theory with practice. While experts agree that undergraduate research should be incorporated into the curriculum because it enhances student engagement, recruitment and retention, there is a difference of opinion as to whether an undergraduate research (UR) project should be conceived by student-faculty interest with some real-world application in mind, or be driven by a real-world need from the start². The fact that there is a need to fund UR projects some way in order to obtain necessary equipment, buy out faculty time, and support undergraduates who participate -- make real-world drivers particularly compelling.

This paper is a documentation of efforts to build a research infrastructure for UR in an engineering technology department within the broad field of healthcare robotics³⁻⁵. The following sections list some key considerations for setting a partnership with entrepreneurs (Fig.

1) that support that support applied research initiatives in general and the robotic healthcare initiative in particular.



Figure 1 Resulting benefits from collaboration shown in surrounding circles

Infrastructure Considerations (IC)

Currently the project collaborators consist of the authors and a faculty member from the University's Center for Aging. It is important to state that the long term goal is to provide important and lasting benefits to the research infrastructure of ET department. The following list provides a look at some key infrastructure considerations (IC1-IC6) involved:

- IC1. In order to improve UR capabilities within the targeted Department one has to recognize the need to match the proclivities and interests of its faculty who are the key players in any UR initiative.
- IC2. Faculty from the three major programs in the Department, the electronic and computer engineering technology (ECET), the Computer Systems Technology (CMST), and the Mechanical Engineering Technology (MET) should be able find enough interest to collaborate in future ventures related to this initiative.
- IC3. Traditionally, ET faculty, prefer to work in real-world oriented applied projects and this should be an important underlying consideration in any selection process designed benefit the UR environment.
- IC4. Selected project must be in an area where there is a realistic chance for grants and contracts to obtain funding for necessary equipment, buy out of faculty time, and support for undergraduate students who participate.
- IC5. The UR considerations for the project must be front and center in the selection process; in other words, students under faculty guidance must be able to conduct *an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution*.
- IC6. Appropriate consideration should be given to motivational aspects. A project that creates a sense of purpose for students and faculty alike will certainly help move the research forward. Such motivation can be found in projects that benefit society and fill a local, regional, and national need.

The authors believe that the broad area of “healthcare robotics” is an example of a field ripe with collaborative opportunities that can satisfy all of the above criteria. It should be noted that at this initial stage the collaboration has partly consisted of developing a Small Business Innovation Research (SBIR) proposal for the National Institute of Health (NIH). The next section describes the project from the entrepreneur/collaborator perspective. Sections that follow describe how the criteria listed above are benefited by this collaborative initiative. The last two sections describe the motivational aspects from the entrepreneur’s point of view and is followed by a conclusion.

Project Description

The purpose of this project is to develop a mobile robotic platform to study Human-Robotic Interaction and Socially Assistive Robotics^{3, 6-9} (SAR) as they apply to remote health care monitoring. Socially Assistive Robots have the potential to provide better and cost effective in-home health monitoring by engaging the user through the use of a versatile conversational user interface in monitoring and tracking physiological parameters such as blood pressure, blood oxygen content, weight, and activity level (Fig. 1).

This addresses the situation where an out-patient is required to monitor their blood pressure, blood oxygen level, etc., and have this data transmitted to a healthcare professional. The SAR project that we are working on will keep the user engaged in the measuring and monitoring process which over time can become tedious. This will also reduce the frequency that a healthcare professional would have to visit the patient in their home, thus reducing healthcare costs.

Dr. Mataric', director of the Center for Robotics and Embedded Systems at the University of Southern California, defines Socially Assistive Robots as robots that "focuses on helping human users through social rather than physical interaction⁷." She also maintains that "The robot's physical embodiment is at the heart of SAR's assistive effectiveness, as it leverages the inherently human tendency to engage with lifelike (but not necessarily human-like or animal-like) social behavior³." Her research has shown that patients become more engaged in their in own healthcare when working with a socially assistive robot¹⁰.

In this project we will build upon this ideal and take advantage of this anthropomorphism or the tendency of humans to project human characteristics on to objects. By adding conversational capability to a mobile robotic platform that will engage the user with verbal reminders, encouragement, and feedback in a conversational manner, the users will be more likely to continue taking and recording their blood oxygen level, blood pressure, weight, and physical activity levels. These reading will then be stored and be available for viewing or transmission to a health healthcare professional. There are already commercially available wireless health monitors on the market that can be utilized in this project.

This project will provide undergraduates students with valuable experience that can be leveraged into a career. This type of experience will give the graduating a student higher visibility to prospective employers.

This project will also provide an avenue for reducing in-home healthcare costs which according to the Centers for Medicare & Medicaid Services¹¹ are projected to more than double between 2008 and 2019 to a level of \$154 Billion.

This project will also create a platform that can be used to develop future projects that will expand the platform by adding more wireless physiological sensors as they become available on the commercial market. This platform can also be a basis for refinement of the conversational interface to areas beyond healthcare.

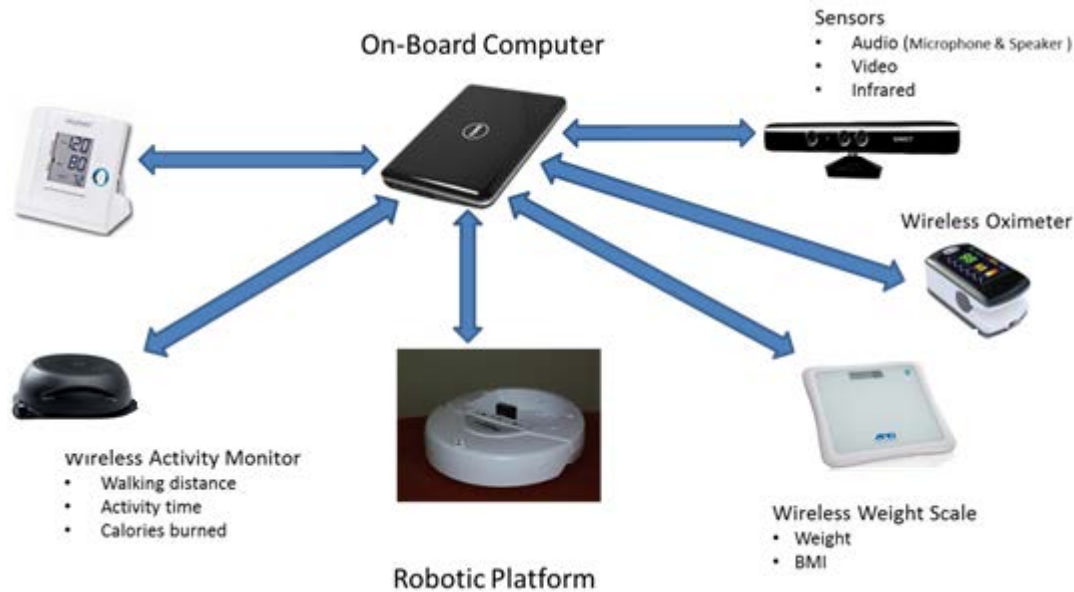


Figure 2 Robotic Platform, Sensing Devices, and Communication Scheme

Impact of Project on Infrastructure

A long term goal of this project is to serve as a catalyst for a research infrastructure that promotes UR. One way to measure the positive impact is to study how infrastructure considerations (IC1-IC6) are influenced.

The first question to be resolved is whether or not the SAR project can peak the interests of non-participating faculty triggering new collaborative research activities that match their proclivities and interests (IC1). The answer here is probably yes. Even prior to starting their collaborative venture, the authors detected a palpable interest among faculty for the general area of robotics through the development of new courses. Very recently, there has been some work in developing the curriculum for a certificate program in Robotics. The current proposal (SBIR) is more focused on the development of conversational interface which requires meticulous selection of components followed by their proper integration into the SAR platform. In addition to the challenges on electronic and mechanical side, the project has significant programming requirements. The technical dimensions of the project in its current state can involve all the disciplines within ET in a real-world oriented project (IC2, IC3).

A broader goal of the proposed research that goes beyond the current SBIR proposal (conversational interface) is to further investigate additional innovative, practicable, and

affordable solutions to in-home eldercare using socially assistive robots (SAR). Moving to the next stage will require in-depth knowledge of electronic sensors, wireless communications, and artificial intelligence will create more opportunities for faculty who have expertise in these areas.

Moving to the next stage will require additional proposals and funding requests be made. One advantage performing applied research for real-world applications is that funding requests do not have to be limited to government organizations but also private sources can be considered (IC4).

In the process of developing the current proposal the authors have kept in mind the need to find funds that support UR experiences for students. The current SBIR proposal has provision for student support and it is expected that all future public and private proposals from this initiative will continue to have this component (IC5).

Finally, as far as motivation is concerned, healthcare robotics sells itself (IC6). Inexpensive socially assistive robots (SAR) can significantly control home healthcare costs and positively impact the quality of lives for an aging population and their caregivers. Home healthcare costs have followed the National Health Expenditure (NHE) trends which have doubled over the past decade (cms.gov). This business/academic collaboration is aimed at researching viable eldercare options that utilize available information and communication technologies to inexpensively deliver, monitor, and provide interactive care services using a robotic platform with limited human intervention.

Motivational Drivers from the Entrepreneurs Perspective

In the previous sections we have discussed the motivational drivers for the academic department. At this point it's appropriate to try and understand what motivates them to collaborate with academia. Gatton Research and Development, LLC (GRD) is an engineering research firm specializing in the development of Socially Assistive Robots (SAR). These types of robots are mobile platforms whose goal is to assist a user through social interaction instead of physical interaction. At GRD we work at helping the user by engaging them through a versatile conversational interface.

The reasons for working with a university through the mechanism of federal Small Business Innovation Research grants (SBIR) are three-fold. First, the SBIR grant allows my company to provide real-world research experience to engineering technology undergraduate students. As a prospective employer I would put a premium on this type of experience. This type of experience implies that the student has been exposed to some degree of project management, report writing, and hands on troubleshooting experience. It also implies that less training on the company's part is required to transform the new employee into a productive employee.

The second reason for working with the engineering technology department of a university is that it gives a small business access to the engineering technology resources without incurring the cost of salaries, benefits and human resource expenses.

These resources include high quality research experience, wide range of expertise, and in some cases specialized equipment.

The third reason is access to research resources that are available at a university. Resources such experiences and contacts in conducting pre-clinical trials, access to research resources in departments outside of the technology departments as in this case the Center for Aging in the Ecology department.

Through the SBIR grant program all of these types of resources are available that would normally be beyond the practical reach of a small business

Summary

The preceding documentation focuses on the win-win relationship that can be formed when an academic partners with entrepreneurs in research initiatives. From the point of view of the academic, entrepreneurs may provide interesting real-world applied research opportunities. These opportunities can be used to enhance the research infrastructure, funding, and UR. Another important point, while a close working relationship among partners is critical to the success of any project, from a faculty viewpoint, working with a small number of entrepreneurs has decisive advantages as far as commitment, access, flexibility, communication, and dependability are concerned.

From the point of view of the entrepreneur, academia is able to provide research resources that are available at a university and out of reach of the average small business. The university has experts in many different areas and can be a one-stop-shop for collaborators from the entrepreneurial perspective.

As discussed in the section relating the impact of the project on infrastructure, the choice of healthcare robotics seems to be a good one that manages to satisfy all conditions set for growing a research program. Also notable are the funding opportunities that come with a real-world oriented project.

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