Review Article

Neurobotics for Women Recruitment and Retention

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1. Introduction

Girls and women often try to stay as far away as possible from being associated with the word "robot" for a good reason. Socially, boys with sophisticated robots may become popular, while girls with robots may be labeled as geeks [1]. In college, women who are capable of performing equally with men may purposely do worse in math and engineering when a stereotype threat exists [2]. Even if women overcome these stereotype issues and pursue robotics research, a male dominant workplace is awaiting to make the already difficult tasks of balancing career and family an even harder task. For these reasons, there are very few women in the field of robotics, and because of the lack of role models, it makes it even more intimidating for women to enter the field. This is a viscous cycle that needs to be broken in order to recruit and retain women in the field of robotics.

There is a general trend that women (and girls) are more encouraged to pursue a career if they know that it may lead to the path of helping people in the future. Robots, unfortunately, have the image of being cold metallic objects that do not have much to do with human warmness. If there is a way to alter the image of robotics so that it is linked closely with helping elderly, babies, or disabled people, there is a better chance of recruiting and retaining more women. Luckily, more robotic researchers are pursuing these new research areas in robotics. For example, robotic research is starting to make impacts in rehabilitation and assistive robotics for injured, paralyzed and aging people [3-6].

This paper outlines the sub-field of robotics called Neurobotics. Neurobotics is aims at developing a better scientific understanding of the human body and using it to rehabilitate and assist people through robotic devices. Because of its societal ramifications, Neurobotics can both be used to *recruit* women who want a career that mixes technology and humans and to *retain* women who want a career that is worth having even if it means that the time is spent away from their own children because they are also helping and changing other people's lives.

2. Neurobotics

The field of Neurobotics focuses on the algorithms and designs of a robot-human closed loop system to alter the neural control of movement as a way to rehabilitate, assist, and enhance human motor control and learning capabilities. The primary target population is individuals with strokes,

spinal cord injuries, traumatic brain injuries, and other injuries that inhibit daily activities. While the cutting edge research focuses on fundamental scientific questions and developing engineering tools, the field of Neurobotics is intimately connected with immediate applications of current techniques to immediately affect disabled people.

Neurobotics requires a multidisciplinary approach. First, the sensorimotor control mechanisms in the central nervous system are modeled through psychophysical experiments on human subjects and through mechanical and computer simulations. Second, using these experimental/modeling results, assistive and rehabilitative robotic devices are designed and constructed to intimately interact and interface with the users. These devices include haptic, prosthetic, implantable, and wearable devices. Finally, the neural control alterations due to the robot-human closed loop control are investigated. Recent findings suggest that animals/humans are capable of performing tasks that are normally impossible when they are provided with artificial neural feedback. In Neurobotics, neuromuscular parameters of human subjects are extracted, manipulated externally, and then fed back to the human through artificial force or electrical feedback. Experiments can then be performed to determine the effect of artificial feedback on human motor control and learning.

The area of Neurobotics needs and attracts students and researchers with a variety of backgrounds. Example backgrounds are: mechanical, electrical, and biomedical engineering, physics, math, computer science, cognitive science, neuroscience, art, and medicine. It is typical to collaborate with a variety of medical institutions including rehabilitation hospitals, sports medicine, orthopedic surgery, neurosurgery, and more.

3. Outreach and Education for Recruitment

The Women's Experiences in College Engineering

Figure 1. A wearable robotic hand device was developed by a group of undergraduate and graduate students. A quadriplegic student used it to eat soft food on his own for the first time since his injury.

(WECE) Project, funded by the NSF and the Alfred P. Sloan Foundation, revealed that pre-college exposure to engineering, especially by women who are active in the field, encourages young girls to pursue the field of engineering [7]. This encouragement should not only be done through giving guest lectures for elementary and secondary schools, but through hands on experiences. As one example, Society of Women Engineers (SWE) sponsors a workshop called "Engineering Your Future (EYF)" at Carnegie Mellon University to introduce engineering to over 100 inner-city girls in grades 8 to 12 every year [8]. The projects change every year to encourage participation in multiple years. As one of the projects, students constructed a simple prosthetic robotic arm that is controlled by their

own muscle activities.

Using Neurobotics, it is possible to help disabled people while recruiting women into the field of robotics at the same time. For example, to encourage interaction between engineering and motor-impaired students, a team that consisted of several undergraduate and graduate students was formed to help a quadriplegic student who lived on campus. The disabled student made a robotic "wish list" that he thought would enable him to be more independent. The team of students worked with the disabled student to tackle these problems. From this activity, a wearable robotic device was constructed to allow the disabled student to grab soft food on his own and eat it (Fig. 1) [4].

Through these outreach and educational programs, it is possible to change the perception of robots from cold metallic objects to technology that improves quality of life for disabled and elderly people.

4. Societal Impact for Retention

Suppose we successfully convince high school girls to pursue robotics engineering. Maybe they even decide to go to grad school, get a PhD, and get a job doing research in robotics. But how do we convince them to stay after having a family when they have family/children to take care of? The best way to retain women in the field of robotics is to make sure that the work is rewarding enough, that women will choose to devote their precious time to it, even though it means time away from their kids and husbands. It has to be something that women want to come back to after (potentially multiple) maternity leaves, allows flexible working hours, and most importantly, feels like it is changing the world and people in a way that nobody else can. To have the field of robotics be a place where women are retained, subfields such as Neurobotics can be a great example because it can provide immediate societal impact. Through Neurobotics, women engineers and scientists can continue to assist those who cannot communicate with others, move without assistance, or generally improve the quality of life for those who need it the most.

As the elderly population increases, the need for assistive and rehabilitative technology will only increase. It is thus a great time to recruit and retain many women in the field of robotics and start changing stereotypes so that girls who pursue robotics are envied by everyone, in the same way as girls who become doctors are today.

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