SHURAN SONG

Teaching Statement

In hindsight, I do not think I would have ever gone to graduate school, nor become an active researcher, had I not taken Greg Turk's course on computer graphics during my third year at Georgia Tech. His simple yet inspiring lecture about the potential of 3D Kinect data sparked the beginnings of my journey in 3D computer vision and later robotics. As someone whose entire research career was born in the classroom, I wholeheartedly believe that teaching is one of the best ways to facilitate growth in any research field.

My research covers a wide range of other topics, including robotics, computer vision, and machine learning. This interdisciplinary background enables me to develop and teach intellectually rich and comprehensive courses. Aiming to be an aspiring educator, I hope to design courses that are not only approachable but also inspiring in order to energize students to pursue deeper interests in the subject(s) and related research fields. The following sections elaborate on my teaching experience and philosophies.

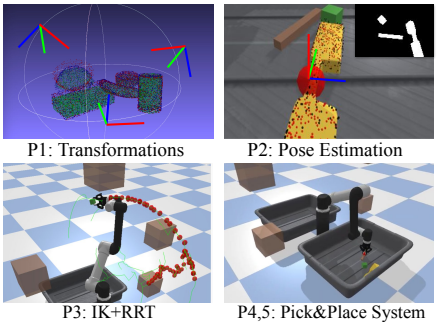

Fig. 1: I designed COMS473 to center around a series of programming assignments that start by implementing major modules of a pick-and-place system (PA 1-3) and culminating in a final system with all modules developed throughout the semester (PA 4,5).

Undergraduate Teaching. At Columbia, I teach the introductory course for robotics (COMS473). This course is a gateway course that introduces students to the field of robotics and engineering in general. I am a strong advocate of *learning by doing* - the best way to encourage students to understand an algorithm and its limitations is to implement and test the algorithm themselves. Therefore, I designed this course to center around a series of programming assignments (PAs) start by implementing major modules of a pick and place system, and culminating in a final system with all modules developed throughout the semester. In the last assignment, students re-implement the pick-and-place system, but with an end-to-end machine learning framework. The educational goal for the series of assignments are:

- **Develop full-stack system building skills.** Robotics systems are often intricate and complex, making them seemingly unapproachable for students entering the field. Through a series of programming assignments, we hope to break down a complex robotics system into approachable submodules and basic concepts. By doing these assignments, students could step-by-step learn fundamental concepts through practice, gain experience in developing each of the modules, and eventually build a **complete** and **practical** robotics system by connecting the dots. We hope this experience will give students both technical skills and confidence in developing other complex engineering systems in the future.
- **Critical thinking in system design.** The last two assignments are purposely designed to tackle the same pick-and-place task but with two very different approaches: one with a modularized approach and the other using an end-to-end learning approach. In this way, students can compare both approaches side-by-side and critically think about the pros and cons between these two approaches – not only comparing their performance but also carefully analyzing their failure modes, robustness to new scenarios, and contrast the difference in the development process (e.g., data collection, training time, and parameter tuning). Through this process, we hope to have students learn to think critically when making design decisions and systematically evaluate a robotics system, which are essential skills to acquire for their future careers.

The course receives feedback from students such as: *"The structure of the class is great, there are very interesting topics covered, and I love that Professor Song listened to the needs of her students." "To be honest, I felt very nervous to take this course since I didn't have any prior knowledge about robotics yet it turns out to be an interesting course for me. Thanks for Prof Song's efforts."*

Graduate Teaching. At the graduate level, I have launched a new graduate-level course in Robot Learning. This course can be taken as a continuation of the undergraduate course or by itself for graduate students. The main objective of the course is to prepare students for independent research in robotics or related areas, which requires a unique set of skills often overlooked in traditional curricula, such as identifying a research problem, designing experiments, or even responding to criticisms. In each class, we will discuss one research paper where students are randomly divided into one of three roles: Author, Critic, and Learner. By acting out the role of an "Author", the students practice how to present a paper that highlights the research contributions and summarizes the research results. The author also needs to prepare to respond to criticisms raised by the critics. By acting out the role of the "Critics", the students learn how to carefully examine the paper and identify unsupported claims, unrealistic assumptions, or unfair comparisons. Finally, by acting out the role of the "Learner", the students are encouraged to think creatively, come up with possible extensions, applications, or implications from the discussed paper, and draw additional insights that may have been overlooked. Through this interactive process, students can sharpen their research skills and develop their individual research tastes.

The course receives feedback from students such as: *"Professor Shuran Song has been instrumental in helping us to develop a mindset that helps us analyze research papers and thus think critically about our own research." "I now feel like I can approach research problems with much greater confidence and get a feel for what the critical problems in this space are" "The class' environment is very friendly, collaborative and supportive at the same time as being structured and disciplined."*

Advising and Mentoring Over the past three years, I have been fortunate to be the advisor and mentor of 9 Ph.D. students 7 undergraduate and 9 master's students, many of whom have continued to join top graduate programs. Through my experiences, I have come to believe that the key to successful mentoring comes from the right balance between motivation and guidance. Critically, this balance should be adjusted for different students at different stages. For example, for junior students, we often start with a more well-defined problem with more hands-on guidance, where the goal is to help them get familiar with the research process and establish good research practices. However, after the first project, the student should start to take the leadership role in defining their own research and project directions. This mentoring strategy has shown promising results demonstrated by successful junior/undergraduate student research outcomes, and senior students who have become the leading experts in their own research area and are recognized by the research community through research awards and external fellowships.

The collaborative culture is central to our group. Different from other research fields, developing robotics systems often requires diverse expertise. Reflected in our group, we have team members from very different backgrounds and research interests, such as computer vision, machine learning, and mechanical engineering. Students also bring in expertise that goes beyond technical skills such as photography and 3D design which all bring unexpected and valuable perspectives to our research. Thanks to their diverse expertise and strengths, students often enjoy and benefit from working together to solve complex problems or build complicated systems. In my lab, it is common to see students sharing the same hardware infrastructure, framework, and tools for different projects. I believe the combination of diverse expertise and collaborative culture is the core energy that fuels our research creativity.

Community and Outreach. I am actively involved in STEM education and outreach activities with the goal of increasing the accessibility of STEM education. In the past few years, I have worked with the AI4All program at Columbia – first as part of the admissions committee, then as an instructor, and recently as the co-director. In 2022, I served as DEI Chair at CVPR and help to improve the inclusion and accessibility of the conference by overseeing the review process and organizing outreach events that engage local students (New Orleans). For example, we successfully hosted the first CVPR Academy workshop and a high-school Expo Tour in collaboration with STEM NOLA. More details about my experience and plans for future DEI efforts can be found in the diversity statement.