Ajay Anand

anandaj@seas.upenn.edu• (215) 200-1718 • linkedin.com/in/ajay-anand01

Robotics engineer with experience in robot design, perception, and control. Primary work in the field of medical robotics developing semi-autonomous social robot systems to perform robot augmented telerehabilitation and developing computer vision based diagnostic tools to perform rehab progress tracking.

EDUCATION

University of Pennsylvania — **Philadelphia, PA**

MSE - Robotics and Artificial Intelligence — May 2022

Student Activities: Director of Fund Management, Graduate and Professional Student Assembly (managed over 250,000$ in funding for student groups); Robotics Department Representative at Graduate Student Engineering Government; Ranked in Top 25% of class; Institute of Electrical and Electronics Engineers (IEEE) - Robotics and Automation Society (RAS).

Manipal University — **Dubai, UAE**

Bachelor of Technology - Mechatronics, Robotics and Automation. — Oct 2019

Student Activities: Awarded academic achievement award 2018,2019; Academic scholarship recipient; Ranked in Top 5% of class; Mechatronics representative to student oversight council; Institute of Electrical and Electronics Engineers (IEEE) - Robotics and Automation Society (RAS).

WORK EXPERIENCE

Rehab Robotics Lab - University of Pennsylvania — **Philadelphia, PA**

Research Engineer — July 2022-Present

- Worked as a full-time robotics engineer to carry out all the tasks required to build and maintain novel robotics systems for rehabilitation.
- Modelled robot components in SolidWorks for prototyping and integration.
- Assisted with control design, implementation, and integration of motors and local controllers (Dynamixel motors with embedded controllers)
- Built the full software stack for the Operator control of robot, semi-autonomous navigation (SLAM), serial communication to local controllers (RS485), and position control of motors (interfaced via ROS).
- Developed, assembled, and tested prototype robots to assess functionality and feasibility for chronic upper extremity rehabilitation.
- Carried out clinical trials of robot augmented telepresence rehabilitation to test a variety of experimental hypotheses.
- Wrote up results of research for presentation in conferences and journal publications. (Perspectives of Stakeholders towards Usability and Deployment Locations of a Social Robot Assisted Telepresence System for Telerehabilitation)
- **Tool stack: Python, C++, ROS, Solidworks.**

Graduate Research Assistant — April 2021-May 2022

- Upgraded humanoid robot for social robot assisted rehabilitation to augment telepresence interactions with clinicians.
- Developed computer vision and deep learning-based models to detect rehab effectiveness and progress in upper extremity impaired individuals.
- Conducted research trials to test the impact of a socially assistive robot on telepresence rehabilitation care. (Comparing Rehabilitation Interactions Using Social Robot Augmented Telepresence)

PROJECTS

Design of Socially Assistive Robot for Upper Extremity Rehabilitation (Ongoing)

- **Objective:** To design a socially assistive robot for upper extremity motor assessment and rehabilitation in the community via telepresence.
- **Challenges:** Size, weight, cost, and power consumption constraints on the robot eliminated many typical components from being used in the system. The robot needed to be able to function in clinical environments and be resistant to the hazards inherent therein. Safety was also an issue of prime importance as the robot would directly interact with human subjects within its reachable workspace.
- **Key Design Decisions:** Integration of compliant materials in and tendon actuation of the end effector (underactuated gripper based on the yale openhand project model T) were crucial in improving subject safety while minimizing cost and weight. Dynamixel MX64 and XL430 motors were selected for their reliability and price to performance ratio.

Human Pose Detection for Impairment Prediction in Clinical Rehabilitation Environments

- **Objective:** To detect subject poses in cluttered clinical environments and to subsequently create a model that correlates pose data with clinical test scores.
- **Challenges:** Separation of subject from background proved to be difficult, multiple subjects often impeded results, strong correlation between upper extremity reachable workspace and fine motor skill clinical tests may not exist.
- **Methods:** Image frames from subject video processed through OpenPose to obtain raw joint positions which were smoothed using Kalman filtration to get final joint positions.
- **Performance:** Peak model performance at <2 Mean Average Error in classifying subjects into classes of no-low impairment, mild impairment, moderate impairment, and severe impairment.

Counting Machine Parts: Segmenting Dense Objects in Occluded Environments

- **Objective:** To count machined parts in poorly lit workshop environments.
- **Challenges:** Environment highly prone to occlusions and other optical hindrances such as shadows which further complicated the challenging task of counting large numbers of objects in a single image.
- **Methods:** Traditional image processing techniques using Hough transforms (CV2), instance segmentation (Mask-RCNN) and a state of the art few shot density estimation technique (M. Ranjan et al.)
- **Performance:** Mean Average Error <2 in poorly lit, highly occluded environments containing over 40 object instances per image.

Linear Quadratic Regulator Minimum Snap Trajectory Planning for Quadrotor in ROS

- **Objective:** To generate minimum snap trajectory for quadrotors
- **Method:** A* path planner used to get dense waypoints, Douglas-Peucker algorithm to produce sparse waypoints. Produced waypoints used to set up constraints for a quadratic program with the cost equal to integral of snap squared to produce a minimum snap trajectory.
- **Testing:** Python quadrotor simulation and in ROS Gazebo environment (Hector quadrotor model)

TECHNICAL SKILLS

Python, C++, MATLAB, Deep Learning (PyTorch), Science Libraries (NumPy, Pandas), Machine Learning (Scikit Learn), Robot Operating System (ROS), Docker Containers, CATIA, Solid Works, Apache Spark, MySQL, Simulink, LabVIEW, Microcontrollers, Microprocessors, Oracle Cloud CLI, AWS CLI, Git, Bash, Build Tools, Serial Communication Protocols (TTL, RS485), Siemens PLC Logic design, SCADA System Design.