Shurjo Banerjee

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RESEARCH INTERESTS

I am a 5th year PhD at the University of Michigan working for Dr. Jason Corso. I am interested in deep learning and its applications to deep reinforcement learning, incremental learning and vision-and-language-navigation (VLN) problems.

EDUCATION

University of Michigan   Ann Arbor, Michigan, USA
Ph.D. program in Electrical Engineer (Robotics thread)   *Sept. 2015 – Present*
- ·   *Masters***:** Received masters degree in May 2017
- ·   *Courses:* Advanced Computer Vision, Natural Language Processing, SLAM
- ·   *Academics:* Curriculum GPA: **3.89/4.00**

The Georgia Institute of Technology   Atlanta, Georgia, USA
Bachelor of Engineering in Computer Engineering   *Sept. 2011 – May 2015*
- ·   *Courses:* Computer Vision, Data Structures, Embedded Programming
- ▪   *Teaching***:** Matlab Teaching Assistant for 1000+ undergraduates (7 semesters)
- ·   *Academics:* GPA: **3.93/100**

Papers

S. Banerjee, J. Thomason and J. J. Corso, *"The RobotSlang Benchmark: Dialog-driven robot Localization and Navigation", arxiv*
Accepted at The Conference on Robot Learning, 2020.

B. Sakelaris, Z. Li, J. Sun, **S. Banerjee**, V. Booth and E. Gourgou, *"Mathematical model of chemosensory circuit that mediates learning in T-mazes through monitoring C. elegans locomotion", submitted to PLOS Computational Biology*

S. Sekeh, M. R. Ganesh*,* **S. Banerjee**, J. J. Corso, and A. Hero, *"A Geometric Approach to Online Streaming Feature Seletion", arxiv*

V. Dhiman, **S. Banerjee**, J. M. Siskind, and J. J. Corso, *"Learning Goal-Conditioned Value Functions with one-step Path rewards rather than Goal-Rewards", openreview*

V. Dhiman, **S. Banerjee**, J. M. Siskind, and J. J. Corso, *"Floyd-Warshall Reinforcement Learning: Learning from Past Experiences to Reach New Goals", arxiv*

S. Banerjee*, V. Dhiman*, B. Griffin, J. M. Siskind, and J. J. Corso, *"A Critical Investigation of Deep Reinforcement Learning for Navigation"*, *arxiv*

S. Banerjee*, V. Dhiman*, B. Griffin and J. J. Corso, *"Do Deep Reinforcement Learning Algorithms really learn to Navigate?"*, *NuerIPS Deep Reinforcement Learning Workshop, 2017*

N. Sebkhi, D. Desai, A. Khan, N. Prasad, **S. Banerjee**, J. Eng, K. Wilson, and M. Ghovanloo, *"Towards a wireless multimodal speech capture system"*, *IEEE Biomedical Circuits and Systems Conference, 2016*

WORK EXPERIENCE

University of Michigan, COGLAB, EECS   Ann Arbor, MI, USA
Graduate Student Research Assistant (GSRA) with Jason Corso   *Sept. 2015 – present*
Specialty: Computer Vision, Reinforcement Learning, Robotics, VLN

Georgia Institute of Technology, GT Bionics Lab, ECE   Atlanta, GA, USA
Undergraduate Student Research Assistant with M. Ghovanloo   *May. 2013 – May. 2015*
Teaching Assistant teaching Matlab to 1000+ undergraduates   *Jan 2012 – May. 2015*

Software Engineering Internship, Panasonic   Atlanta, GA, USA
Human Machine Interaction, Automotive Systems Co of America   *June 2013 – Aug.. 2013*

Software Development Internship, Cognizant   Calcutta, West Bengal, INDIA
Workload Automation, Cambridge Learning Management System   *May 2012 – July.. 2012*

PROFESSIONAL ACTIVITIES

Organizer, UM Computer Vision Reading Group
             Annotation Team for Human-Robotic Navigation and Language Acquisition (12 members)

Mentor,   *Masters student(s)*   :   Zongyu Liu and Jiawei Sun
            Undergraduates student(s)   :   Matthew M. Dorrow
            High School student(s)   :   Aryan Seth

Reviewer: CVPR 2018, ECCV 2020

AWARDS

President's   Undergraduate   Research   Award,   The   Tongue   Tracking   System 2013/2014
(The Georgia Institute of Technology)|

SELECTED RESEARCH EXPERIENCE

Foundational Computer Vision (Incremental Learning/Texture Dependence)   UM COG
LAB *Supervisors: Dr. J. J. Corso*   *May 2020 –*
present
Collaborators: Parker Koch, Madan R. Ganesh and Dr. V. Dhiman

- Highly interested in the problem of *catastrophic forgetting* in neural networks. Specifically working on using memory modules efficiently for the task of Incremental Learning. Work in progress replaces images with *exactly sparse* activation maps allowing for the efficient re-use of working memory for incremental learning tasks; no additional complexity is incurred with significant increases in accuracy. Interested in applying these concepts to *Deep Reinforcement Learning* and *Experience Replay Memory*.
- Interested in removing the over-reliance of image classification networks on texture information. While current solutions limit the size of the receptive field of neural networks or perform style transfer to make new datasets without texture information entirely, we are interested in approaches that can be directly applied to convolutional neural networks. We are investigating the use of a min-max loss formulation that minimizes small patch information (usually correlated with texture) while maximizing classification accuracy.

Quantifying the Spatial Navigational Abilities of C. *elegans* Worms   UM COG LAB
Collaborators: Dr. E. Gourgou, Jiawei Sun, Zongyu Li   *June 2019 –*
present

- Working with UM Mechanical Engineering and the UM Institute of Gerontology on applications of Computer Vision to biological tasks: specifically the tracking of C.elegans worms that navigate T-Mazes.
- C. *elegans* are nematodes (worms) that possess only 302 neurons. They particularly useful for genetic studies as their entire genealogy is mapped out. Though they possess very few neurons, they possess many remarkable abilities including the ability to remember and navigate t-mazes while searching for food. We are interested in applying simple tracking based approaches to quantify the differences between worms with different genetic markers so as to correlate genetic differences with spatio-navigational abilities. Presented at *International C. elegans Conference* in June 2020.

RobotSLANG: Unified Vision-Language Training for Robotics   UM COG LAB
Supervisors: Dr. J. J. Corso and Dr. J. M. Siskind   *May 2016 –*
present
Collaborators: Dr. V. Dhiman

- Created the RobotSLANG (Simultaneous Localization, Mapping and Language Acquisition dataset) tabletop maze dataset; the intention of the dataset was to collect data for human-robotic collaborative navigation in new environments.

- Required extensive embedded design and software engineering to make a live interface between the web and a tabletop robot; Trials required two humans, a *commander* and *driver*. The commander was provided a map of the environment and a designated set of navigation goals. The driver controlled the robot but had no access to the objectives. The commander and driver were tasked with reaching the goals in a desired order. The only line of communication was a chat window - we thereby gathered plenty of un-templated unstructured language instructions related to goal directed navigation. Teams were incentivized to complete the trial as quickly as possible.
- Organized a team of 12 annotators collecting over 181 trials between participants with an average runtime of 7 minutes. Sentences were large requiring 6.8 words per sentence on average. 1.6 million frames of sensor data were collected in along with more than 36000 words of interaction.

Deep Reinforcement Learning for Navigation   UM COG LAB
Supervisors: Dr. J. J. Corso and J. M. Siskind   *May 2018 – present*
Collaborators: Dr. V. Dhiman and Dr. B. Griffin
- Investigated the abilities of Deep Reinforcement Learning for Navigation tasks. Deep Reinforcement Learning has been considered by some as a potential alternative to SLAM and is attractive due to functional changes that must be made to algorithms themselves when applying them to navigation tasks.
- Quantified the generalizational abilities of Deep Reinforcement Learning for navigation in unknown environments; trained agents on 1000 mazes and tested them on never before seen new mazes - agents were not found to possess any significant navigational abilities in the new mazes based on standard SLAM metrics such as traversing along the shortest path available to previously seen goals.

The Tongue Tracking System (TTS)   GT Bionics Lab
Supervisors: Dr. Maysam Ghovanloo and Dr. Sarah Ostabaddas   *May 2013 – May 2015*
Collaborator: Justin Eng, Dhyey Desai, Aamir Khan, Nordine Sebkhi
- The Tongue Tracking System projected intended to track the tongue of a patient suffering from speech related issues; the resultant information was provided to Speech Language Pathologist to research whether tongue tracking information could help with speech rehabilitation.
- The tongue was tracked by placing a magnet on the tip of the tongue: we modelled interactions of the magnets as a noisy magnetic dipole and localized the tongue using a multitude of approaches including a Kalman Filter, Particle Filter and a Nelder-Mead based optimization approach.
- Created a 3D printed chassis for housing embedded magnetic sensors connected to an FPGA for highly parallelizable capture of sensor information; made a QT based GUI for patients to use for data collection.
- Helped write proposals for Institutional Review Board (IRB) requirements. Performed Human Testing during data collection.

PROFICIENCY AND SKILLS

Technical Skills: PyTorch, Python, Tensorflow, C/C++, Linux, Git, LaTeX, Matlab, HTML, CSS, JS, Java

Languages: English (proficient), Bengali (native) and Hindi (native)
Alternative Skills: Data organization and experimentation, Improvisational Comedian

REFERENCES

Prof. Jason Corso,   Professor, University of Michigan, jjcorso@umich.edu
Dr. Jesse Thomason, Assistant Professor, University of Southern California,
Prof. Salimeh Sekeh, Assistant Professor, University of Maine, salimeh.yasaei@maine.edu
Dr. Eleni Gourgou,   Assistant Research Scientist, University of Michigan, egourgou@umich.edu
Dr. Vikas Dhiman,   PostDoc, Contextual Robotics Institute, UC San Diego, vdhiman@ucsd.edu
Dr. Brent Griffin,   Research Assistant, University of Michigan, griffb@umich.edu