Mathews Jacob is from the UVA’s ECE department and in the *Generative AI for Faster and Better MRI* talk, he discusses using generative AI in order to make better MRI’s. Some of the problems he describes in the talk is that current MRI technology tends to be very slow and noise/artifacts can be introduced during the process. A couple of solutions were proposed. One approach was to compress the amount of sensor data collected by alternating minimization approach by alternating between the conjugate step and the denoiser. The second approach was to recover images using a deep learning algorithm which would be fast but requires lots of training. Diffusion models which train a denoising model by iteratively denoising an image was also proposed but the approach is still under FDA approval and may not fully sample data. Some of the challenges for making better MRIs include requiring a lot of data that is hard to acquire and current models are not robust enough for more unusual cases. Therefore, Jacob’s research team proposes to join a pretrained model with another model. The model will pre-learn the energy model for the image recovery and trains a combination of energy models. They also propose a single algorithm that has multiple energy steps, one energy function, and trained on multiple noise levels. Possible extensions and limitations with the proposed approach includes segmentation for various body parts, motion compensation, silence, cardiac MRI, and pseudo-3D speech MRI. One thing I thought was insightful was the use of machine learning model for something like an MRI machine, especially using a diffusion model to recover an image. It is quite interesting and a new way to perceive diffusion models. Perhaps instead of only generating images, it could also be used to make images more clearer.

The talk is *Robot Navigation in Complex Indoor and Outdoor Environment* by Dinesh Manocha from UMD. Manocha’s talk describes challenges that affect autonomous robots today which are that robots cannot travel freely in a static or dynamic environment, computing a smooth and safe trajectory is difficult to do, and social navigation for environments with lots of humans are extremely difficult. Specifically, humans are the most dangerous obstacles because of their unpredictability. Additionally, Manocha divides two different types of terrains: indoor and outdoor. Indoor environment is generally flat but typically has a lot of people while outdoor terrain is rough and has vegetation. Current state-of-the-art requires someone to remotely monitor the robot during its operation and take control when something goes awry. Manocha describes his research regarding his work for both indoor and outdoor environments. For the indoor environment, Manocha and his team created a crowd simulator in which 70% consisted of groups. Then, his team created a deep reinforcement learning (rl) algorithm with geometric learning that looks at the velocity of humans and predicts their locations. Their deep rl method uses predictions to create “freeze” zones which are essentially areas that the robot should avoid. For the outside environment, Manocha and his team developed an algorithms that uses a vegetation classification called VERN which is used for the robot to determine which vegetation it can move through. Another approach that was considered was using proprioceptive estimation where the robot feels its environment to determine whether it can run on it or not. Finally, Manocha and team are working on an autonomous excavator which uses computer vision algorithms for construction purposes. There are a couple of key ideas and highlights that I learned, and think is important. It was interesting to learn that if a robot were to navigate through someone’s house, the most difficult room would be the bathroom due to all the mirrors and shiny surfaces. This thought never occurred to me but after thinking about it, it made sense. Another interesting highlight was distinguishing between indoor and outdoor environments. I have never thought of it in that way.

The research seminar presented by Alia Umrani, a PhD student from College Cork, Ireland. In Umrani’s talk, the main motivation for her research was that current solutions to solve sign-and-encrypt schemes was very computationally heavy. Her research proposes a hybrid signcryption scheme that uses a digital signature, encryption, symmetric and asymmetric cryptography, and proves more efficient. Her hybrid signcryption scheme is known as AMCLHS where before communication, the algorithm first generates public parameters, master secret key, master public key, and a partial private key. The registration authority generates an sk\_RA and pk\_RA for verification. Additionally, N users perform both signcryption and unsigncryption. AMCLHS was tested against two types of adversarial attacks: Type I and Type II. For the Type I attack, the malicious actor will not have access to the master security key or the partial private key. During a Type II attack, the malicious actor won’t be able to compute the private key. Additionally, Umrani’s research proves that AMCLHS has indistinguishability and unforgeability. When running a performance analysis on the AMCLHS algorithm, she found that the runtime was (2n+5)M where M is the designated receivers. The bottleneck was found to be during the multiplication and exponent portion of the algorithm. She also found that signcryption has a linear runtime while unsigncryption was constant. A couple things I learned was a way to check that an algorithm follows all the requirements for security which I have never learned before. As I understand, it is primarily done by have a competition between a sender and a hacker to see how long it takes until the hacking is done. I was able to dip my toes into the waters of theoretical computing which I found to be quite interesting. It is quite abstract but was enjoyable.