Research Assessment #1

Date: 3 September 2021

Subject: Computer Science, Artificial Intelligence, Neural Networks

MLA Citation:

Staroverov, Aleksey, et al. "Real-Time Object Navigation with Deep Neural Networks

and Hierarchical Reinforcement Learning." *IEEE Xplore*, Institute of Electrical and

Electronics Engineers, 28 Oct. 2020,

ieeexplore.ieee.org/abstract/document/9241850.

Wang, Tingwu. "Semantic Segmentation." www.cs.toronto.edu. 3 Sept. 2021,

www.cs.toronto.edu/~tingwuwang/semantic_segmentation.pdf.

Assessment:

My goal is to use computer science in close conjunction with physical applications so that my work has a strong physical counterpart. To me, this immediately brought the field of robotics or artificial intelligence to my mind. In fact, I'm still not sure how much of the computer science side of robotics is *not* artificial intelligence-related algorithms, so that's something that would be a good question for me to think about throughout my research and interview process.

After some initial high-level research about neural networks and computer vision, the article and much of the terminology is still something that I need more knowledge to fully master. I do know enough to get through it and understand most of the concepts and message, but some of the finer terminology and references to well-known

processes required me to do some extra research on the side. Clearly, unless I dramatically expand my knowledge, a robot as my final project would likely be out of the question.

However, the discussion in the article was still incredibly interesting to me. I was surprised to learn that tasks that we take for granted, such as recognizing and exploring an unfamiliar room, is such a difficult procedure to create in a robotic format. Various computer vision methods are used throughout the field, although in this article semantic segmentation is used (Staroverov et. al). As a result, the robot was not just trying to classify objects, but delineate their borders and judge their relationship with other objects (Wang). It seemed to me that the robot must have a large amount of processing power to classify each pixel through this method, but after doing extra research, I learned that newer models of convolutional neural networks (CNNs) have been developed to increase the speed of these classifications.

As somebody who has not had much experience in creating robots, I didn't even consider the number of factors that need to be considered and the continuous processing required for a robot to do even the simplest of tasks. Furthermore, the article pushed me to think about how outside factors, such as light noise and operational noise, could affect the robots performance. This was a huge shift in thinking for me because, throughout my computer science classes, I have gotten used to the isolated nature of an IDE. As a result, I was not accustomed to physical factors from outside of the program affecting its success. This led me to the question, if many methods for localization are affected by variations in lighting, noise, etc., what methods could help mitigate these and what are the tradeoffs of using them? Also, what accommodations in

algorithms themselves and node weightage could be made to account for these variations?

The use of neural networks in layers is also something that seems very useful to me. Since robot navigation requires determination of position of the robot, other objects, distances, speed, planned path and other values, simultaneous processing of algorithms seems to be necessary. As a result, multiple layers of networks would probably be needed to calculate these values fast enough for the robot to act in an efficient manner. Does this take up more processing power than one large network that would calculate these values?

One of the huge takeaways for me was that neural networks need sufficient inputs and simulation quality— without these things, the model won't be accurate enough and won't perform as well (Staroverov et. al). This means that there is likely a relatively high barrier-to-entry in this type of testing, since high quality simulations need similarly high-quality processing machines. This makes me wonder, what is the baseline of equipment required for the development of neural networks?

Throughout my research, neural networks have been the most prominent way of creating a model that I've seen. What other artificial intelligence methods could be used to create similar models for autonomous navigation?

Clearly, much of the scope of the article was from the standpoint of an engineer. However, I was able to learn a lot about the role of neural networks in robotics and the different ways that they can be leveraged. In order to gain a better understanding, however, I feel that it is necessary to learn more about the types of neural networks and how they interact with each other. Furthermore, learning about different subsets of

machine learning and their applications will be helpful in broadening my understanding of the field as a whole. For example, I could focus on how neural networks and deep learning is used in the manufacturing industry. Either way, I now feel that I have a direction in which I can continue my research so that I can implement the knowledge that I learn into an original work and final product.