Parking Occupancy Detection from CCTV Images

Jule Valendo Halim -1425567

GEOM90038 - Advanced Imaging

Parking Occupancy Detection from CCTV Images

Contents

Introduction

Recent developments in data has undergone significant changes from data processing into machine learning due to increased volumes of readily available data (Khan and Al-Habsi (2020)). The introduction of image-based neural network architecture has allowed the field of computer vision to flourish. Computer vision leverages the power of machine learning to derive meaningful information from visual data, which allows them to take actions and recommendations when they detect issues. Powerful advances in machine learning such as the widely popular transformer model that Chat-GPT is based on has also been adapted to be trained on visual information (El-Nouby et al. (2021)). Figure 1 provides a representation of a neural network, which consists of multiple layers. The input layer is the initial data, and hidden layers calculate the weights of each of these data and propagates them forward to other hidden layers. Finally, the output layer provides probabilities of the desired output (e.g., some classification label).

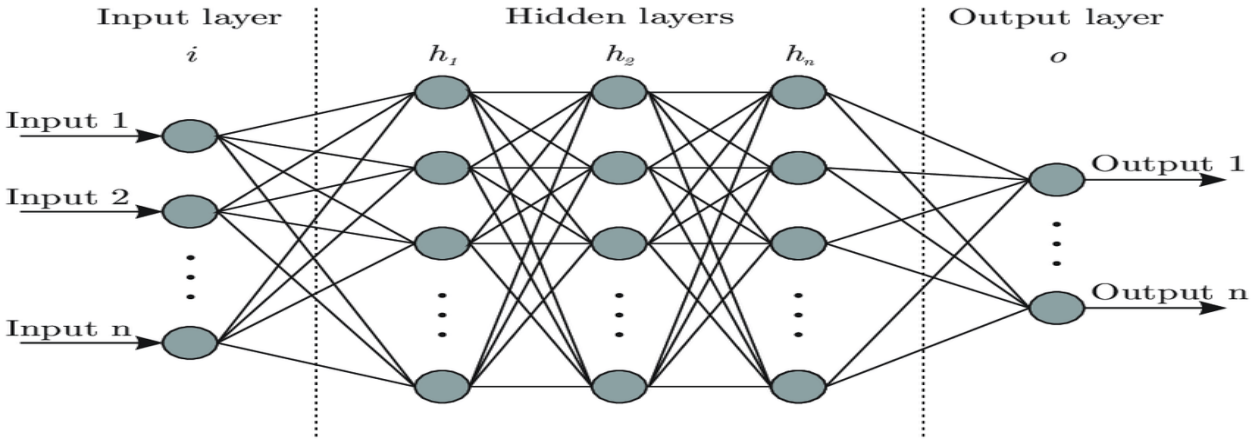

Figure 1

Visual Representation of Layers That Makes Up a Neural Network (Shukla (2019))

Figure 2 provides a simplified neural network architecture for visual data. The visual data that is placed into the input layer depends on the specific architecture and design. In the case of figure 2, a section of the image is placed into the input layer. It is then propagated forward towards additional layers before finally obtaining the results of the output layer, which in this case, attempts to classify the image into four possible species.

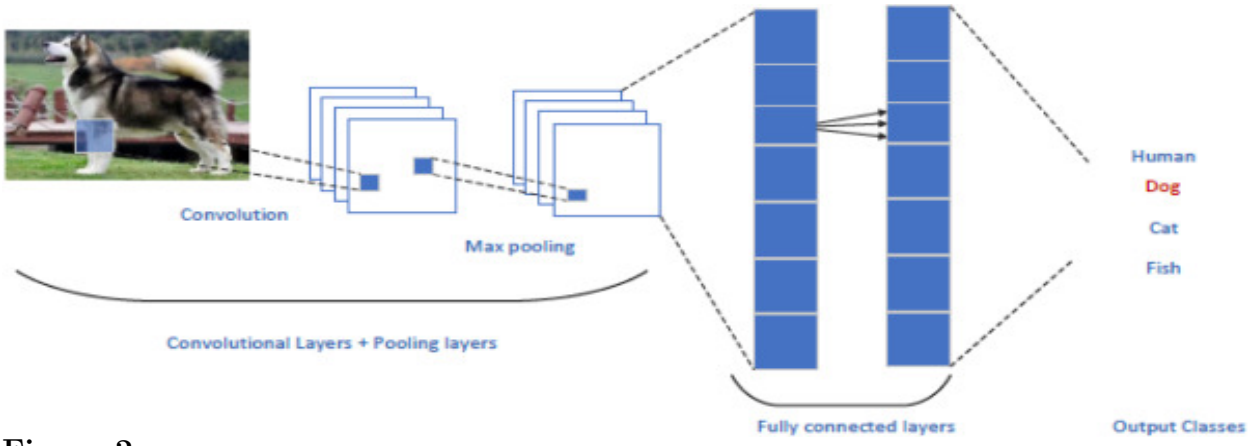

Figure 2

Sample Architecture of Machine Learning Being Used in Computer Vision (Chai et al. (2021))

The use of computer vision has been applied to wide range of different fields. For example, Esteva et al. (2021) discussed the way medical imaging applications in multiple medical areas such as pathology and dermatology has enhanced the level of care provided. Another field in which machine learning has enhanced computer vision is in the automation and digitization of fruit quality measuring and maintainence (Rathnayake P et al. (2022)). Figure 3 shows how computer vision can be used to detect cars and humans in images. These detections are generated post-training, where multiple images are provided for training the neural network. The trained neural network can then be given new images or even real time video to detect what they were trained to. However, as seen in figure 3, such neural networks are not perfect, and can misclassify or not detect parts of the image that they are supposed to (e.g., the model did not successfully classify one of the humans walking).

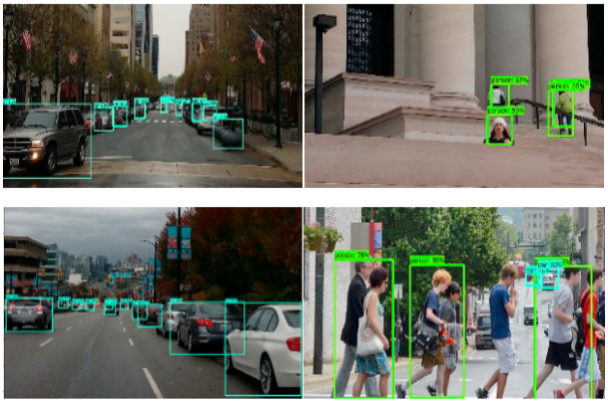

Figure 3

Sample Image Detection Results of Cars and People Using Deep Learning and RCNN Models(Khan and Al-Habsi (2020))

In this report, I aim to

Methods and Results

Visualizing Dataset

Creating Car Detector

Automatic Delineation of Parking Spaces

Evaluation

Improving Accuracy

Discussion

Accuracy Evaluation

Improvement Based on Assumptions

Challenges and Shortcomings

Scopes of Improvement

Conclusions and Future Directions

Appendix

References

Chai, J., Zeng, H., Li, A., & Ngai, E. W. (2021). Deep learning in computer vision: A critical review of emerging techniques and application scenarios. *Machine Learning with Applications*, *6*, 100134. https://doi.org/https://doi.org/10.1016/j.mlwa.2021.100134

El-Nouby, A., Neverova, N., Laptev, I., & Jégou, H. (2021). Training vision transformers for image retrieval.

Esteva, A., Chou, K., Yeung, S., Naik, N., Madani, A., Mottaghi, A., Liu, Y., Topol, E., Dean, J., & Socher, R. (2021). Deep learning-enabled medical computer vision. *npj Digital Medicine*, *4*, 1–10. https://doi.org/https://doi.org/10.1038/s41746-020-00376-2

Khan, A. I., & Al-Habsi, S. (2020). Machine learning in computer vision [International Conference on Computational Intelligence and Data Science]. *Procedia Computer Science*, *167*, 1444–1451. https://doi.org/https://doi.org/10.1016/j.procs.2020.03.355

Rathnayake P, W., D, G. D., Punchihewa G, A., Anjana G, N., Suriya Kumari, P. K., & Samarakoon, U. (2022). Certimart: Use computer vision to digitize and automate supermarket with fruit quality measuring and maintaining. *2022 4th International Conference on Advancements in Computing (ICAC)*, 36–41. https://doi.org/10.1109/ICAC57685.2022.10025119

Shukla, L. (2019). Designing your neural networks. *Towards Data Science*. https://towardsdatascience.com/designing-your-neural-networks-a5e4617027ed