Discussion

Competitor Analysis

Previous models that also specialize in defect detection were compared to the syringe model. Comparisons to models that are officially used in manufacturing environments can help evaluate the viability of this model in real-world environments. One particularly recent example of this is a screw defect detection system that has been officially implemented in screw manufacturing industries (Kuo et al., 2020). The model was found to have a 97% mAP score. On the other hand, as shown by the growth in Figure 2, the syringe model reached a mAP score of 92%. While not far off the accuracy of the state-of-the-art screw detection model, the syringe model can be improved further to reach these levels of efficiency. Manufacturers will be more willing to trust a model with high accuracy, especially when it comes to products in the medical industry which must be in top-notch condition before use. Increasing the size of the dataset would be the best way to accomplish this.

Future Research

For the future of this project, accuracy can be improved by augmenting the dataset to include more data related to needles and their defects. This is the category of data that has the most potential to be improved, as shown by the confusion matrix in Figure 3. However, the other classes of detection can also be augmented with more data for even better performance. hese improvements will help boost the mAP to even further extents. Additionally, a physical implementation of the manufacturing process must be created, which contains a camera elevated above a conveyor belt. As syringes on the conveyor belt pass by the camera, the camera will take a top-view picture of the syringe and send it to the CNN to process for defects.

Conclusion

The syringe defect model presented in the paper effectively met its objectives, offering a practical solution for real-time quality assurance in manufacturing. With an average inference time of 1.748 seconds, the model can analyze syringes quickly on the assembly line, preventing any potential slowdowns in the manufacturing process. High recall rates for torn plungers and bent needles (92% or greater) shows the model is very reliable when it comes to accurate defect detection, but augmentations can still be made to the training dataset to improve the detection accuracy of good needles. As shown through competitor analysis, the model performed at a high level with a 92% mAP score, but it can be improved even more by increasing the size of the dataset, a part of the future steps for this project. Through the future implementation of this model into assembly environments, manufacturers can ensure that only high-quality needles ever reach hospitals, preventing any injury to patients.