Chapter 7

Conclusion and Recommendations

This chapter discusses the final conclusion of the research project through various sections as well as recommendations for future researchers in the same field of study.

7.1 Training the YOLOv5 Model

The results of the YOLOv5 model we trained with COCO 2017 annotations and manual annotations did not perform as well as the ideal benchmark scores. For mAP test 0.5:0.95, mAP val0.5:0.95, and mAP val 0.5, our trained model only had scores of: 0.324, 0.329, and 0.534 respectively. Many factors could have been the reason as to why our model was not able to have good performance scores. One would be the difference in the image quality between the streetview images and the COCO 2017 Dataset. The COCO 2017 Dataset were more detailed compared to that of the streetview images we collected from the Google Street View API. Aside from image quality, images from the COCO 2017 Dataset were also focused on the specific object, whereas the streetview images were focused on the street itself and not on the object in particular. The model also performed poorly on objects that might appear ambiguous such as *cracked pavement* and *curb ramp*. The time of day, harsh lighting conditions, and shadows on the streetview images also affect the clarity of the object being detected. With these, it can be said that when training the YOLOv5 model, not only do the number of images per class or number of instances per class matter in achieving higher performance scores, but also the image quality and consistency of how the object appears to look on each image of the dataset. We would also like to highlight that despite the low mean average precision scores of our model, it was still successful in detecting Philippine specific objects on the sidewalk.

To further improve the performance of the YOLOv5 model when training on a custom dataset, we recommend future researchers to train the model more than once, given the luxury of time. If the model overfits early, the training could be improved by reducing the number of epochs. Hyperparameter tuning can also be performed to reduce and delay overfitting, resulting to higher final mAP scores. The consistency and accuracy of the labels and the quality of the images may also improve the YOLOv5 model to properly learn the objects during training.

7.2 Crowdsourcing

Previous works such as Project Sidewalk (Saha et al., 2019) have heavily relied on crowdsourced data to support research purposes. Similarly, we have contributed to this method by creating our own crowdsourcing platform which we have introduced to dozens of new users, as well as to multiple academic institutions through email campaigns. The results we have obtained contribute to our understanding of crowdworkers' quality of work and motivation. One of the objectives of Project Sidewalk was to compare the quality of work between volunteers and paid workers from Amazon Mechanical Turk (Saha et al., 2019). The number of users and annotations drastically increased when we announced the mechanics for the annotation competition, but it did not have a clear effect on the quality of work.

Our online crowdsourcing platform distributed through social media was able to garner 70 unique users, but only 48 of them actually contributed to our research. Through these users we were able to collect 5047 annotations, these were eventually reduced to only 2,476 annotations since those were the only ones we could provide sidewalk widths for in the given time span. The crowdsourcing platform which performed reliably throughout the crowdsourcing phase is one of our major contributions to the field of sidewalk accessibility and crowdsourcing. Atlas served as a consistent platform despite only being developed to its minimum capacity using bare bones features. Developing a custom crowdsourcing platform can be challenging given the obscurity of research projects which require specific features and functions, so we recommend a stricter time frame when building platforms such as these. We also recommend future researchers to build on the features of our crowdsourcing platform to encourage more people to register as users. It would be very beneficial to gather users who have experienced the challenges of using mobility aids to travel. Gamification and streetview traversal can be added to create a more immersive experience which would also promote more accurate accessibility scores for whole sidewalks rather than just sidewalk segments seen in static images. Finally, we recommend having multiple iterations of crowdsourcing to allow for the improvement of the crowdsourcing platform in between iterations.

7.3 Modeling Sidewalk Accessibility

In modelling sidewalk accessibility, we affirm previous literature from the likes of (AYRES, 2017), (Santos, 2018), and the (United States Department of Justice, 2010) that the perception of sidewalk accessibility is positively impacted by a more considerate sidewalk width, the presence of non-slip surfaces, and the minimization of obstructions and irregularities on the sidewalk. We have contributed to study of sidewalk accessibility by including positively impacting objects in creating our model. Previous studies have covered positively impacting objects such as pedestrian signs and crosswalks, but since we did not try to influence user accessibility scores while crowdsourcing we have captured an unbiased pedestrian perspective on these positive objects. In general, more developed areas usually have higher sidewalk accessibility scores. Underdeveloped areas contain factors which hinder accessibility such as obstructions caused from unfinished construction, irregularly parked vehicles due to lack of parking space, and poorly planned infrastructure which get in the way of the pedestrian path. The data we gathered on sidewalk widths also provide key insights on the state of Filipino sidewalks. The Department of Public Works and Highways (DPWH) issued in Order 37, Series of 2009, that busy sidewalks should have a minimum dimension of 1.3 meters for the sake of wheelchair users (Ebdane Jr., 2009). Our findings indicate many sidewalks far smaller than that number; urban planners should consider this regulation for renovation purposes and for the creation of new sidewalks the next time around.

For future technical studies regarding sidewalk accessibility, we recommend looking into the continuity of sidewalk networks within urban areas. We believe that determining the accessibility of a single sidewalk segment does not capture the level of accessibility in the general area, and that the high quality of the entire sidewalk should be upheld from landmark to landmark. Given the impact of sidewalk width to its accessibility, we recommend utilizing more sophisticated means of gathering width data to improve the efficiency of the research pipeline as well as the quality of the results. Surface types are almost just as significant in this project, future researchers may consider breaking surface types down into surface materials instead to specify the structure of the sidewalk in the image.

Additionally, future studies could use the perceived sidewalk accessibility scores and predicted sidewalk accessibility through a city map. This can provide insights on the varying levels of sidewalk accessibility in the Philippines. The visualization could also be used to evaluate the accuracy of the sidewalk accessibility model. Lastly, the crowdsourcing platform could be used to collect accessibility scores on other cities of Metro Manila. This can be extended into a comparative study on the sidewalk accessibility of different cities in Metro Manila.