Applying Computer Vision to Foster the Common Good in Rural Areas of Developing Countries

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The purpose of this research project was to investigate the potential application of computer vision technology to mitigate multidimensional poverty in rural, developing areas. Through extensive background research on computer vision and multidimensional poverty, I decided to focus on using computer vision to mitigate one specific pillar of poverty, malnutrition. According to the Oxford Poverty and Human Development Initiative, malnutrition is one of the most severe "capability deprivations" created by poverty. To mitigate malnutrition, I tried to advance the agricultural capabilities of smallholder farmers by using computer vision technology. In rural areas, smallholder agriculture is an essential source of employment and overall lifestyle. However, these farms often suffer the most from weeds, pests, and disease. These challenges decrease crop yields and quality, which in turn drives malnutrition. Thus, I theorized that advancing these farmers' capabilities with computer vision would help better tackle malnutrition and the overall problem of multidimensional poverty.

To test the potential of computer vision to bolster the production capabilities of smallholder farms in these areas, I created two no-code computer vision models using various online CV applications. Data, in the form of images, was collected on two subjects: yellow daylily flowers and various garden weeds in the Bowdoin Organic Garden. The BOG served as a good case study because its size is comparable to typical smallholder farms (< 2 ha). After data was collected, I uploaded these images to a CV platform, Roboflow, and annotated the images using bounding boxes. I then augmented the data. The data was divided into training, validation, and testing groups. Finally, I trained the models with the MS COCO v7 Roboflow software. One model aimed to detect and locate the presence of blooming yellow daylilies in images. The other model aimed to detect and locate the presence of weeds in images.

Promising results suggest that easy-to-use, no-code computer vision tools can be used to create deployable models. The final bloomed yellow daylily flower model achieved an mAP value of 96.9%, a precision value of 92.7%, and a recall of 93.0%. So, in most of the tested images, the model correctly located all the blooming yellow daylily flowers. The Weed Detection Model achieved an overall mAP value of 73.0%, a precision value of 75.5%, and a recall of 66.7%. While the overall mAP for the weed model is weaker than the flower model, it is important to understand that detecting weeds of various species in complex and sometimes very busy images is a much harder task to accomplish. To detect the presence of ⅔ of all the weeds in each image on average is still a noteworthy result. The weed detection model in particular could be useful in bolstering production on small farms. In theory, when applied, this model could warn farmers of weed overgrowth in specific spots, making it less likely that weeds hinder crop growth. More research is needed on the actual implementation of these detection models on real farms when paired with other technologies like field cameras or unmanned aerial vehicles. Additionally, the implementation of this technology may be challenged by social and technological issues such as the agency of residents and the lack of digital architecture in rural, developing areas.

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References

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