Signal and Image Processing Letters
Vol. 5, No. 2, 2023, pp. 28-37
ISSN 2714-6677
https://simple.ascee.org/

Automatic Tourism Waste Selection Using Image Digital and Artificial Intelligence (AI)

Muh Janwar Bakir [a,1], Haris Imam Karim Fathurrahman [a,2,*]

[a] Department of Electrical Engineering, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[2] haris.fathurrahman@te.uad.ac.id
* corresponding author

ARTICLE INFO

Keywords
Image Digital
Arduino
Object detection
Waste
Artificial intelligence

ABSTRACT

Garbage is leftovers or discarded items that are no longer used and are no longer used by their owners. Waste is generally divided into two, namely organic and inorganic waste. Both of these wastes have benefits for us, but they also have an impact on the environment. Organic waste is waste that comes from the remains of living creatures (nature) such as animals, humans, plants that are experiencing decay or weathering. This waste is classified as environmentally friendly waste because it can be broken down by bacteria naturally and quickly. The research object studied in this research is camera detection on a waste detection tool using a camera which aims to detect types of tourism waste, where in this research I will conduct research on the detection of organic and non-organic tourism waste. The waste problem in Indonesia is caused by an increase in waste produced by the community, a lack of rubbish disposal sites (TPS), the spread of insects and rats due to rubbish, as well as environmental pollution through land, water and air pollution. So it is hoped that this tool will be able to reduce the waste problem in Indonesia, especially in the tourism environment. In this study, an average value of 0.83% was obtained, where the results were in accordance with the initial target when starting training and carrying out detection. This makes it possible to move the servo more accurately because the detection results have a high value. From the test results above, an accuracy of 90% was obtained, and the results of the servo movement were in accordance with the detection results, where if the results were organic waste detection, the servo would rotate 90 degrees and if the detection results were non-organic, the servo would not move or remain in the 0 degree position. There was no error in servo accuracy, but the error in detection was 10% from 20 samples which resulted in the servo moving in the direction of the servo movement in the error detection direction.

1. Introduction

Garbage is leftovers or discarded items that are no longer used and are no longer used by their owners. Waste is generally divided into two, namely organic and inorganic waste. Both of these wastes have benefits for us, but they also have an impact on the environment. Organic waste is waste that comes from the remains of living creatures (nature) such as animals, humans, plants that are experiencing decay or weathering. This waste is classified as environmentally friendly waste because it can be broken down by bacteria naturally and quickly.

Waste is an unsolved problem in human life. Many of the problems caused by waste actually come from humans' attitudes that don't care about the environment. Several solutions have been proposed to solve and avoid the problem of this waste, one of which is creating waste detection that can be applied directly to certain devices.

The waste problem is never-ending. The problems being faced are not only in Indonesia, but throughout the world. Waste production continues to increase along with population growth, changes in consumption patterns and people's lifestyles. Identified problems include increasing the amount of waste generation, types and diversity of waste characteristics.

The next problem is related to the community's paradigm towards waste (management), to the existence of regulations related to waste management. In developed countries, various efforts have been made to overcome this problem. The birth of the 3R concept which was adopted by Indonesia to become the 3M Principles [1]. In Indonesia, the waste problem is caused by the increase in waste produced by society. lack of rubbish disposal sites (TPS), the spread of insects and rats due to rubbish as causes of disease. then environmental pollution through land, water and air pollution which causes reduced public health.

Environmental problems are an issue that cannot be avoided. Currently, waste is a very serious environmental problem faced by Indonesian society in general. It could be said that waste is produced every day by housewives, both organic and inorganic waste. However, what is worrying is that the waste produced is thrown carelessly in various places, and the effect will damage the surrounding environment. The amount of waste produced each year will increase along with the increase in population. The current government has tried in various ways to overcome the waste problem. Especially the problem of inorganic waste. However, it has not yet reached the point of perfection. This is because the amount of waste in Indonesia is very high. So, the government has difficulty determining the right way to solve it.

Awareness and concern for handling waste by the hamlet community is still very lacking. The habit of burning rubbish is still ingrained in village communities in dealing with rubbish problems. Apart from that, people feel that burning rubbish is the quickest way to deal with this problem. Not only that, there are still people who throw their rubbish directly into water bodies without thinking about the accumulation of rubbish downstream of the water body and also the pollution in the water body due to the rubbish they throw away. The availability of large and large amounts of empty land also makes people lulled into not managing their waste and only relying on that land to handle their waste [2].

Apart from that, trash also becomes a living place for germs. One of the most important objects in waste management is tourism objects. Where in Indonesia you really need to pay attention besides the tourist attractions that make Indonesia proud in the eyes of the world. The problem of waste at tourist attractions has from the past until now is still a hot topic in the world of tourism. The impact of the accumulation of rubbish in tourist areas is felt by the surrounding environment. Starting from pollution of marine ecosystems, air pollution, to direct impacts on human health. If this waste is just left there, it will have a bad impact in the future. If you look at Republic of Indonesia Law Number 10 of 2009 concerning Tourism, it is stated that everyone is obliged to maintain and preserve tourist attractions. Apart from that, everyone is also obliged to participate in helping to create a safe, orderly, clean atmosphere, behave politely, and maintain the environmental sustainability of tourism destinations [3]. One of the obstacles in Indonesia is the difficulty of sorting types of waste, one of which is organic and inorganic waste which makes waste processing difficult. The waste disposal methods that are still commonly used in Indonesia are open dumping and landfill, but these methods are not optimal [4].

2. Methods

The research methodology used in this research uses artificial intelligence[5]–[20] and digital image[9], [14], [21]–[26] by utilizing object detection. The proposed system uses a unique data processing strategy, which includes sampling data multiple times, to develop a robust model with fewer annotations, and a single-stage object detection model, YOLOv8 (You Only Look Once Version 8)[27], [28].This research process is generally depicted in Fig. 1.

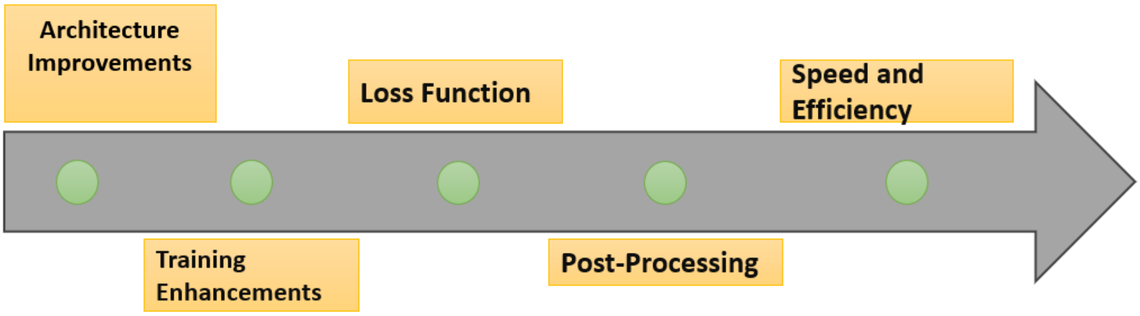


Fig. 1. Method YOLOv8 Detection

2.1. Architecture Improvements

Architecture Improvement is grouped into 3 parts, namely:

- **Efficient Backbone Network:** The backbone network is responsible for feature extraction from images. YOLOv8 utilizes an optimized backbone, often based on CSP (Cross Stage Partial) connections, which enhance gradient flow and reduce the number of parameters.
- **Feature Pyramid Networks (FPN):** These are used to better handle objects at different scales by combining features from different layers.
- **Spatial Pyramid Pooling (SPP):** This layer helps in aggregating global context information without losing spatial resolution.

2.2. Training Enhancements

Architecture Improvement is grouped into 3 parts, where in this process the block diagram is included in this part, namely:

- **Label Smoothing:** This technique prevents the model from becoming overly confident about its predictions, which can help improve generalization.
- **Mosaic Data Augmentation:** This augmentation technique stitches together four different images during training, which improves the model's robustness to various object sizes and occlusions.
- **Adaptive Training Strategies:** YOLOv8 uses advanced training strategies that adjust learning rates and other hyperparameters dynamically during training for better convergence. block diagram can be viewed in Fig. 2. flowchart can be viewed in Fig. 3. wiring can be viewed in Fig. 4.

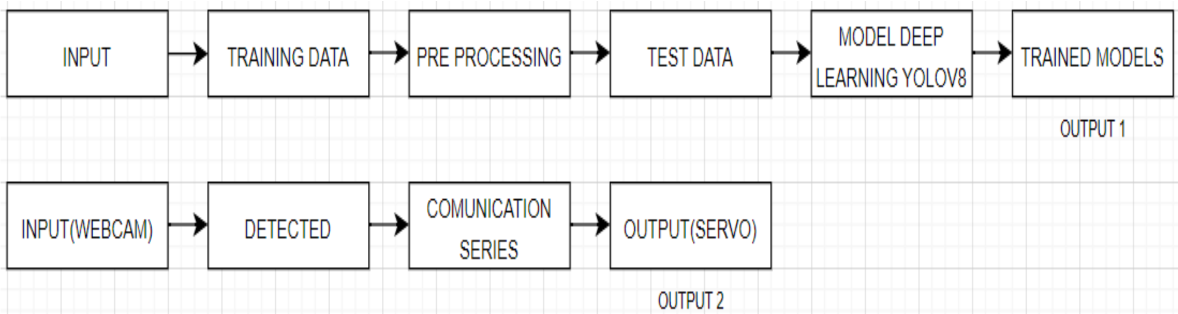


Fig. 2. Block diagrams

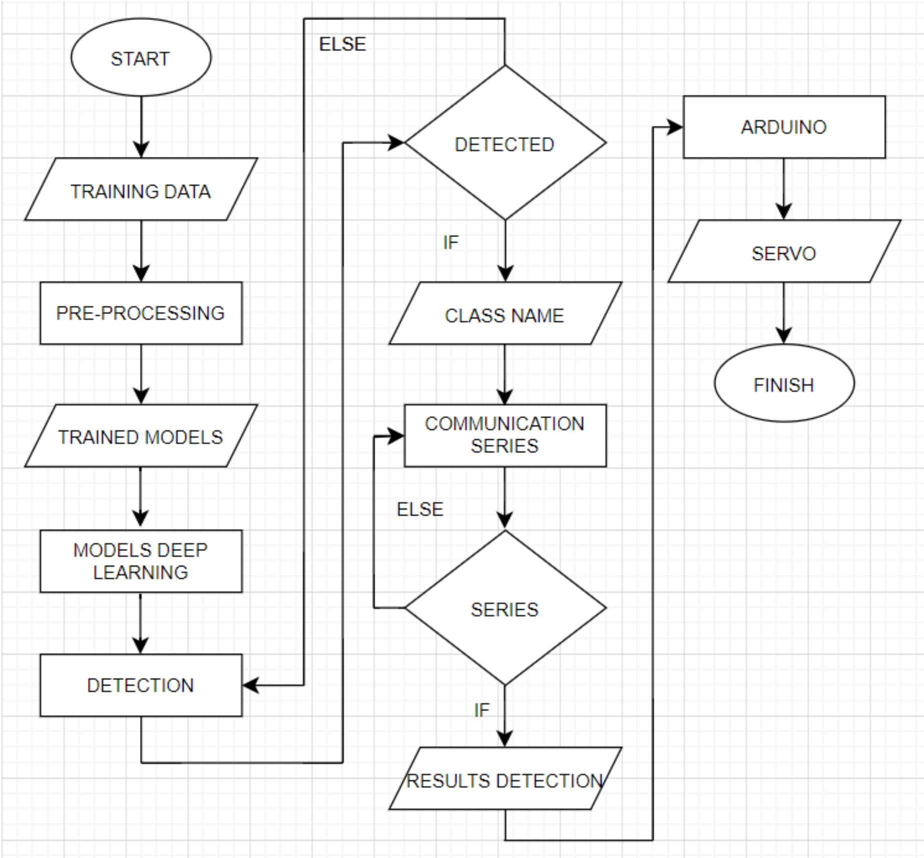


Fig. 3. Flowchart

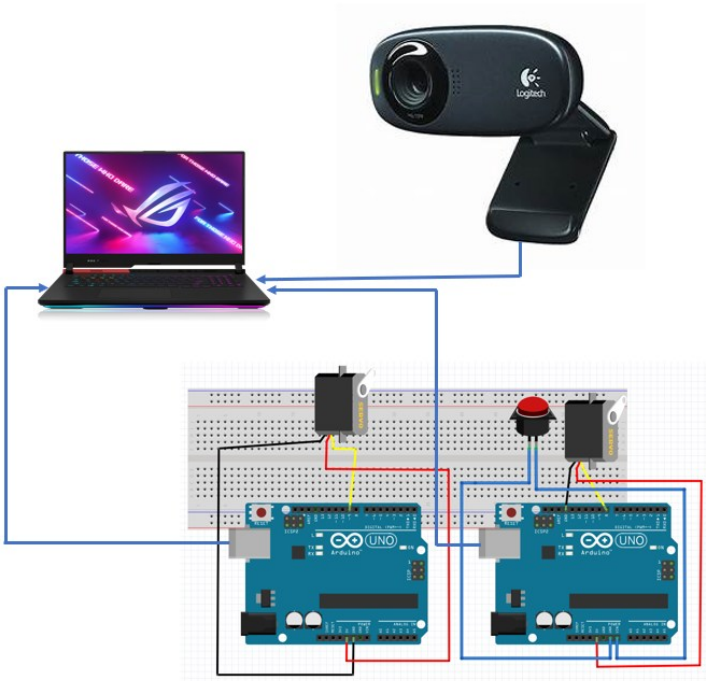


Fig. 4. Wiring detection and move servo

2.3. Loss Function

YOLOv8 employs a sophisticated loss function that balances classification, localization, and confidence loss. This ensures that the model not only detects objects accurately but also precisely localizes them. Loss function can be viewed in Fig. 5.

(a) (b)

Fig. 5. Loss function

2.4. Post-Processing

- **Non-Maximum Suppression (NMS):** This technique is used to remove duplicate detections of the same object. YOLOv8 uses improved NMS algorithms to handle overlapping boxes more effectively.
- **Soft-NMS:** An enhancement over traditional NMS, which reduces the confidence of overlapping boxes instead of discarding them outright, leading to better performance in crowded scenes.

2.5. Speed and Efficiency

YOLO models are known for their real-time performance, and YOLOv8 continues this tradition by optimizing the inference speed without significant loss of accuracy. This makes YOLOv8 suitable for applications where both speed and accuracy are crucial, such as autonomous driving, surveillance, and robotics. In this section, implementation will be carried out to determine detection accuracy can be viewed in Fig. 4.

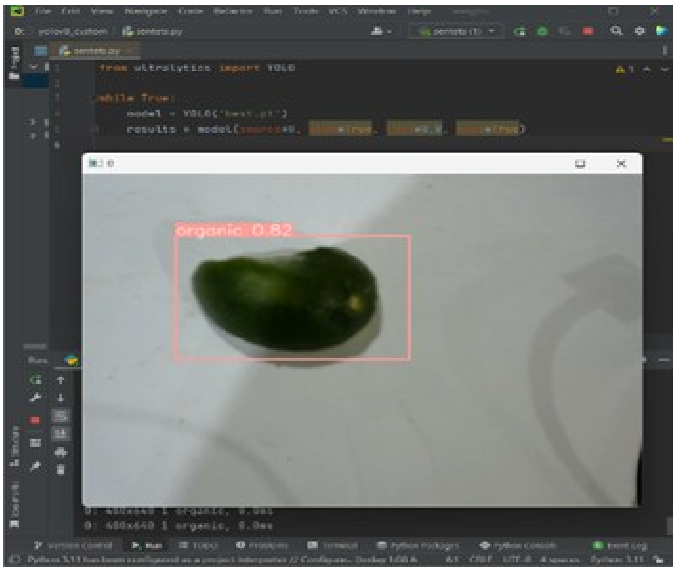
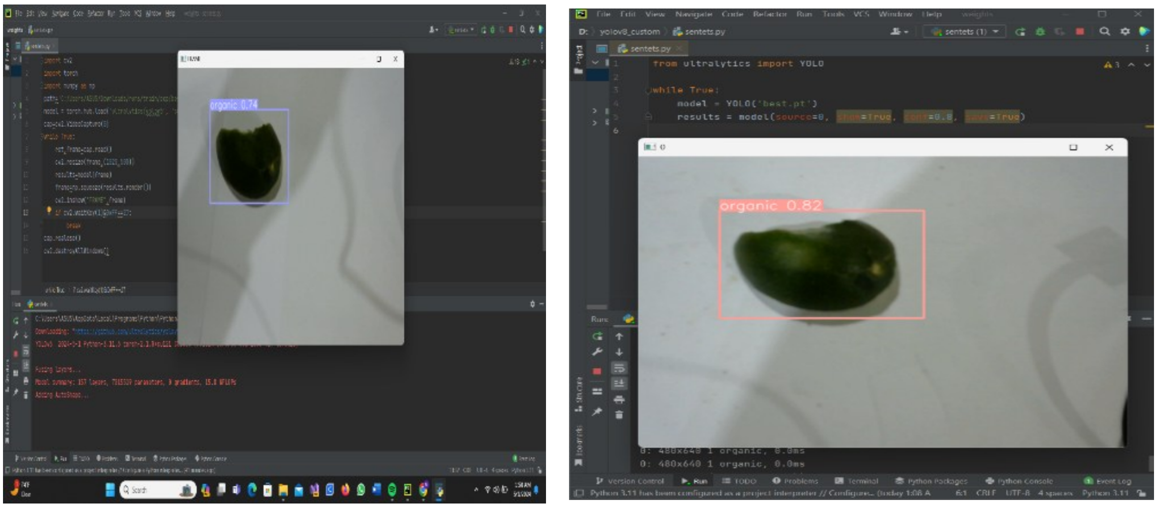


Fig. 6. Implementation

3. Result and Discussion

3.1. Comparison of Training and Detection of YOLOv8 and YOLOv5

The results of this research were concluded using the yolo5 and yolov8 methods where detection comparison is shown in Table 1. The reading and training results using the yolov8 and yolov5 methods are shown in the Fig. 7. Based on Fig. 5, detection will continue to run in real time with a sample test of 20 objects.



(a) (b)

Fig. 7. Comparison YOLOv5 and YOLOv8, (a) mAP 50 YOLOv5: 0.995, mAP 50-95 YOLOv5: 0.828 and (b) mAP 50 YOLOv8: 0.995, mAP 50-95 YOLOv8: 0.855

Table 1. Comparison Detection accuracy data

Yolov8	Yolov5	Difference
0.82	0.74	0.08
0.83	0.29	0.54
0.82	0.36	0.46
0.80	0.48	0.32
0.83	0.44	0.39
0.86	0.45	0.41
0.80	0.76	0.04
0.81	0.36	0.45
081	0.42	0.39
0.80	0.51	0.29
0.81	0.82	0.01
0.91	0.81	0.10
0.84	0.38	0.51
0.82	0.83	0.01
0.80	0.41	0.45
0.86	0.40	0.40
0.89	0.59	0.30
0.83	0.52	0.31
0.84	0.63	0.21
0.82	0.39	0.42
Average		0.3045

Fig. 8 shows a comparison of the accuracy of the yolov5 and yolov8 methods. using yolov8 can increase detection accuracy as shown in Fig. 8.

Vol. 5, No. 2, 2023, pp. 28-37

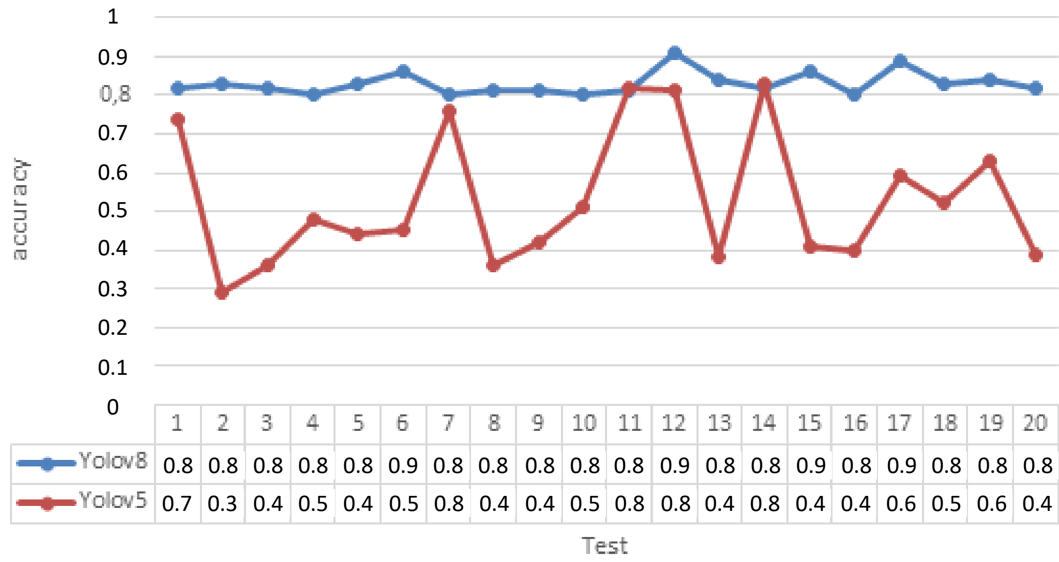


Fig. 8. Grafic accuracy comparison

3.2. Testing Trash Object Detection with YOLOv8

Object detection testing based on waste type was carried out to determine the accuracy value of the datasheet values of 240 images. The experiment was carried out with 20 samples to regulate the servo rotation which functions to open the trash box door. using yolov8 can increase detection accuracy as shown in Fig. 9. The results of this research were concluded using the yolov8 methods where detection is shown in table 2. Fig. 10 shows the results of yolov8. using yolov8 can improve detection accuracy as shown in Fig. 10.

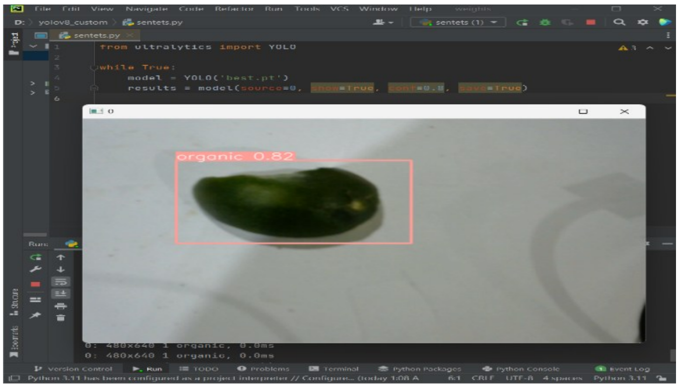


Fig. 9. Object detection

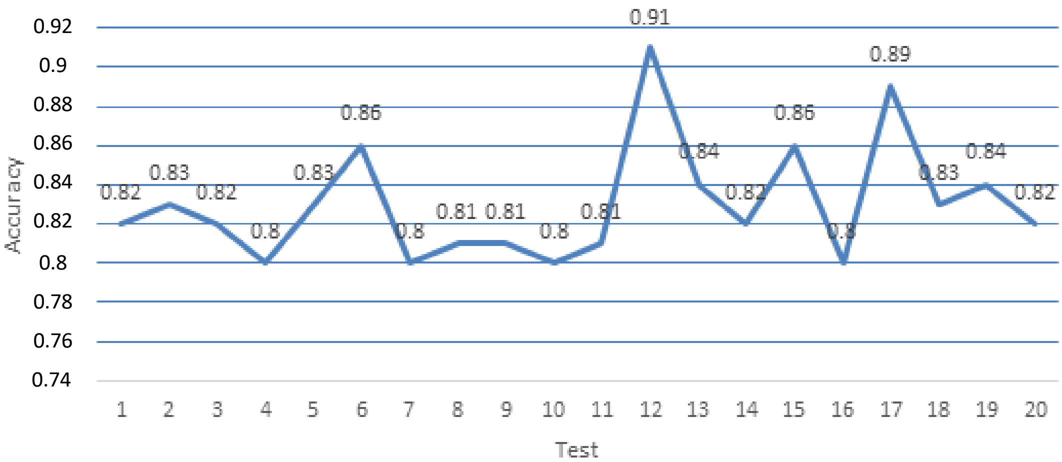


Fig. 10. Grafic accuracy

Table 2. Results using YOLOv8

No	Results detection
1	0.82
2	0.83
3	0.82
4	0.80
5	0.83
6	0.86
7	0.80
8	0.81
9	0.81
10	0.80
11	0.81
12	0.91
13	0.84
14	0.82
15	0.80
16	0.86
17	0.89
18	0.83
19	0.84
20	0.82
Average	0.83

3.3. Servo Motion and Accuracy Testing Based on Detection Results

Servo movement and accuracy testing based on detection results is carried out to determine the accuracy value of the detection test value, so as to regulate the rotation of the servo which functions to open the trash box door where the first door will open based on the detection results, namely if the organic waste detection results, the servo will rotate 180 degrees and if the detection results are non-organic then the servo will not move or remain in the 0 degree position. The servo motion test results are shown in Fig. 11. From the test results above, an accuracy of 90% was obtained, and the results of the servo movement were in accordance with the detection results, where if the results were organic waste detection, the servo would rotate 90 degrees and if the detection results were non-organic, the servo would not move or remain in the 0 degree position. There was no error obtained in servo accuracy, but the error in detection was found to be 10% from 20 samples which resulted in the servo movement moving in the direction of the servo movement in the error detection direction.

(a) (b)

Fig. 11. The servo motion test results

4. Conclusions

Based on the results of this test, we get optimal accuracy and results, shown in detection results which are not far from training accuracy. The hope is that the next development will be more complex with a higher version of Yolo.

Acknowledgment

The author would like to express his deepest gratitude to the Electrical Engineering Study Program at Ahmad Dahlan University for its support in providing a computer environment and automation laboratory access, especially to the supervisor in this research. The author also would like to thank all colleagues who helped accompany this research process.

References

[1] A. M. Zaid *et al.*, "IoT-based Smart Hydroponic System Using Nutrient Film Technique (NFT) for Lettuce Plant," *2023 IEEE 12th Global Conference on Consumer Electronics (GCCE)*, pp. 976-980, 2023.

[2] V. Novianti, I. W. Sumberartha, and M. Amin, “Production and Waste Management for Initiation of Green Campus Program at Universitas Negeri Malang,” In *IOP Conference Series: Earth and Environmental Science*, vol. 276, no. 1, p. 012039, 2019.

[3] T. B. Dangi and J. F. Petrick, “Augmenting the role of tourism governance in addressing destination justice, ethics, and equity for sustainable community-based tourism,” *Tourism and Hospitality*, vol. 2, no. 1, pp. 15-42, 2021.

[4] S. Nanda and F. Berruti, “Municipal solid waste management and landfilling technologies: a review,” *Environmental chemistry letters*, vol. 19, no. 2, pp. 1433-1456, 2021.

[5] W. Xiao, J. Yang, H. Fang, J. Zhuang, Y. Ku, and X. Zhang, “Development of an automatic sorting robot for construction and demolition waste,” *Clean Technologies and Environmental Policy*, vol. 22, pp. 1829-1841, 2020.

[6] M. Tamilselvi, G. Ramkumar, G. Anitha, P. Nirmala and S. Ramesh, "A Novel Text Recognition Scheme using Classification Assisted Digital Image Processing Strategy," *2022 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI)*, pp. 1-6, 2022.

[7] M. Malik, S. Sharma, M. Uddin, C. L. Chen, C. M. Wu, P. Soni, and S. Chaudhary, “Waste classification for sustainable development using image recognition with deep learning neural network models,” *Sustainability*, vol. 14, no. 12, p. 7222, 2022.

[8] A. Oumina, N. El Makhfi and M. Hamdi, "Control The COVID-19 Pandemic: Face Mask Detection Using Transfer Learning," *2020 IEEE 2nd International Conference on Electronics, Control, Optimization and Computer Science (ICECOCS)*, pp. 1-5, 2020.

[9] H. Wang, Y. Li, L. M. Dang, J. Ko, D. Han, and H. Moon, “Smartphone-based bulky waste classification using convolutional neural networks,” *Multimedia Tools and Applications*, vol. 79, pp. 29411-29431, 2020.

[10] W. L. Mao, W. C. Chen, C. T. Wang, and Y. H. Lin, “Recycling waste classification using optimized convolutional neural network,” *Resources, Conservation and Recycling*, vol. 164, p. 105132, 2021.

[11] L. Rosyidi, A. Prasetyo and M. S. Romadhon, "Object Tracking with Raspberry Pi using Histogram of Oriented Gradients (HOG) and Support Vector Machine (SVM)," *2020 8th International Conference on Information and Communication Technology (ICoICT)*, pp. 1-6, 2020.

[12] B. Kocacinar, B. Tas, F. P. Akbulut, C. Catal and D. Mishra, "A Real-Time CNN-Based Lightweight Mobile Masked Face Recognition System," in *IEEE Access*, vol. 10, pp. 63496-63507, 2022.

[13] C. Shi, C. Tan, T. Wang, and L. Wang, “A waste classification method based on a multilayer hybrid convolution neural network,” *Applied Sciences*, vol. 11, no. 18, p. 8572, 2021.

[14] H. L. Lai, V. F. Gallucci, D. R. Gunderson, and R. F. Donnelly, “Age determination in fisheries: methods and applications to stock assessment,” In *Stock Assessment*, pp. 82-178, 2023.

[15] S. -Y. Chen, Y. -C. Cheng, W. -L. Yang and M. -Y. Wang, "Surface Defect Detection of Wet-Blue Leather Using Hyperspectral Imaging," in *IEEE Access*, vol. 9, pp. 127685-127702, 2021.

[16] L. Jiao *et al*., "New Generation Deep Learning for Video Object Detection: A Survey," in *IEEE Transactions on Neural Networks and Learning Systems*, vol. 33, no. 8, pp. 3195-3215, 2022.

[17] A. Kumar, A. R. Tripathi, S. C. Satapathy, and Y. D. Zhang, "SARS-Net: COVID-19 detection from chest x-rays by combining graph convolutional network and convolutional neural network," *Pattern Recognition*, vol. 122, p. 108255, 2022.

[18] T. J. Sheng *et al*., "An Internet of Things Based Smart Waste Management System Using LoRa and Tensorflow Deep Learning Model," in *IEEE Access*, vol. 8, pp. 148793-148811, 2020.

[19] M. Szemenyei and V. Estivill-Castro, "Fully neural object detection solutions for robot soccer," *Neural Computing and Applications*, vol. 34, no. 24, pp. 21419-21432, 2022.

[20] R. Raj, S. S. Nagaraj, S. Ritesh, T. A. Thushar, and V. M. Aparanji, " Fruit Classification Comparison Based on CNN and YOLO," In *IOP Conference Series: Materials Science and Engineering*, vol. 1187, no. 1, p. 012031,2021.

[21] Y. Wahyu, "A Performance evaluation of ESP32 Camera Face Recognition for various projects," *Internet of Things and Artificial Intelligence Journal*, vol. 2, no. 1, pp. 10-21, 2022.

[22] V. Meghana, B. S. Anisha and P. Ramakanth Kumar, "IOT based Smart Traffic Signal Violation Monitoring System using Edge Computing," *2021 2nd Global Conference for Advancement in Technology (GCAT)*, pp. 1-5, 2021.

[23] A. V. Vaganov, O. S. Krotova, and L. A. Khvorova, "Processing and analysis of botanical micro-and macroobjects using computer vision technologies," In *Journal of Physics: Conference Series*, vol. 2142, no. 1, p. 012003, 2021.

[24] H. S. Munawar, F. Ullah, S. Qayyum, S. I. Khan, and M. Mojtahedi, "UAVs in disaster management: Application of integrated aerial imagery and convolutional neural network for flood detection," *Sustainability*, vol. 13, no. 14, p. 7547, 2021.

[25] A. Bamisaye *et al*., "Eco-friendly de-lignified and raw Celosia argentea waste solid biofuel: Comparative studies and machine learning modelling," *Fuel*, vol. 340, p. 127412, 2023.

[26] V. Priyadarshni, A. Nayyar, A. Solanki, and A. Anuragi, "Human age classification system using K-NN classifier," In *Advanced Informatics for Computing Research: Third International Conference, ICAICR 2019, Shimla, India, June 15–16, 2019, Revised Selected Papers, Part I 3*, pp. 294-311, 2019.

[27] A. B. Handoko, V. C. Putra, I. Setyawan, D. Utomo, J. Lee and I. K. Timotius, "Evaluation of YOLO-X and MobileNetV2 as Face Mask Detection Algorithms," *2022 IEEE Industrial Electronics and Applications Conference (IEACon)*, pp. 105-110, 2022.

[28] A. Aboah, B. Wang, U. Bagci, and Y. Adu-Gyamfi, "Real-time multi-class helmet violation detection using few-shot data sampling technique and yolov8," In *Proceedings of the IEEE/CVF conference on computer vision and pattern recognition*, pp. 5349-5357, 2023.