Reducing the Littering Activity using Artificial Intelligence Technology

Nyayu Latifah Husni[1,*], Dewi Permata Sari[2], Yeni Irdayanti[3], Ade Silvia Handayani[4], Rein Aisyah[5], Charina Mutiara Chairunnisa[6]

[1-6] Politeknik Negeri Sriwijaya, Palembang 30139, Indonesia
nyayu_latifah@polsri.ac.id

Abstract. Abstract. Littering has become a major concern for the preservation of the public health and aesthetics of cities. The aim of this research is to show that an AI-based device can be one of the alternatives in reducing the littering in the public environment. This research proposes an AI-based platform that allows users to obtain information about littering. Inputs sensors, such as HC-SR04, DHT 11, MQ-7, MQ7, and HW-028 are integrated to the Arduino that acts as the processor. This Arduino is connected to the Mini PC that will process the littering monitoring program. When the littering is detected by the system, the device will send the information to the users through the cloud server. The output of the system is also connected to the LCD and speaker. This allows the system to warn the doer not to do littering through the sound that it generates. The research can be implemented in the public areas in order to reduce the littering.

Keywords: Artificial Intelligence, Littering, Public Environment, Mini PC.

1 Introduction

In simple terms, garbage is a side effect of various human activities. In this case, society coexists with garbage. That way, the disposal of garbage that is not in place is always a polemic toward a healthy environment [1]–[6]. This indiscipline of throwing the garbage in its place interfere with cleanliness, health, and aesthetics in the surrounding environment. The increase in garbage is not balanced with environmentally friendly management and may cause environmental damage and pollution [7].

One of the biggest challenges of Palembang City is littering. Some society in Palembang managed the garbage by burning, throwing to the ditch and tributary of the Musi River. These behaviors show the lack of public awareness of green environmental sustainability, especially the Musi River is so closed to the people's lives.

This research is one of the attempts that could be the way to solve the issue, namely by implementing environmental revitalization that focuses on reducing the number of littering. This research is supposed to be an effective solution to overcoming garbage problems in Palembang City.

This littering is not far from the understanding and behavior circulating in the community. The cause for the littering could be a lack of community participation and consideration to the consequences of throwing the garbage not in its place. Therefore,

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this research is supposed to understand human behavior patterns regarding littering by using the help of artificial intelligence to recognize and classify littering activities.

Thus, the research "Reducing the Littering Activity using Artificial Intelligence Technology" will be carried out using a system of monitoring littering in real-time in the public environment. The existence of program, it may establish the community's awareness of these poor demeanor since the government is directly monitoring these actions.

Besides camera, in this research Internet of Things (IoT)-based technology is also needed. It is used to identify human activities of littering remotely through websites and Wi-Fi from further place. An approach of artificial intelligence, namely Convolutional Neural Networks (CNN) and You Only Look Once (YOLO), is required in this research. This method has high accuracy in image processing and object identification.

2 State of The Art.

Object identification or recognition is a part of the field of computer vision, which describes an object based on the matching characteristics of the object [8]. Object identification works automatically to identify and recognize one or more entities based on the video or image data that have given from multiple scaled feature maps [9]. Object detection also aims to regress the boundary boxes from the input image [10]. The video or image of objects are captured by various sensors at different platforms and provide the data in order to match the object detection [11].

Image processing is a method intended for processing data or information in the form of two-dimensional images as input and output results are in the form of images that have been processed information. However, image output has processed by the computer technology. Image processing can manipulate the sharpness of an image, analyse the movement of objects in the image, and convert data in the image. Image processing tends to be beneficial in improving the quality of data obtained by computers so that they can be read easily by humans. Research on the introduction and classification of human activities is shown in Table 1.

Table 1. Recent Research on Human Activity Recognition and Classification

No.	Implementation	Component	Method	Ref.
1.	2D and 3D Object	Image	CNN	[10]
2.	Human Activities	Sensor and Camera-	CNN	[12]
3.	Human Activities	Video	CNN	[13]
4.	Human Activities	RGBD video	3D CNN	[14]
5.	Body Postural	Video	CNN	[15]

The use of CNN in [10] helps researchers to recognize the objects such as cat, car, and bird based on the image. In reference [12], the author conducted research on analysing activities according to the dataset which has given. The dataset is in the form of sitting, standing, laying, and walking using CNN methods. The datasets were recorded by sensor and camera based. Meanwhile in [13] researchers detected human activity, such as boxing, clapping, headshaking, jumping, hand waving, checking watch, punching, etc. Another research to recognize the human action using Red-Green-Blue-Depth (RGBD) video with Bag-of-Features approach and K-Nearest Neighbor method The activities were tested by various datasets using CNN method [14]. In [15] whole-body postural assessment using CNN method. It learns about identification of body parts e.g. head, trunk, legs, arms, twists, etc according to the video.

YOLO (You Only Look Once) is a CNN (Convolutional Neural Network) based object detection algorithm in performing image classification. YOLO computes the bounding boxes and classes. The implementation of YOLO tends to be because this algorithm has a proven speed in real-time object detection and is more precise because it has high accuracy. The principle of the human eye that sees anything directly is a foundation for how a YOLO algorithm works. If there is an object that would observe, then the output is in the form of detection coordinates. The YOLO algorithm also uses the principle of grid cells in dividing images into smaller images. Thus, each grid cell will produce output in the form of predictions of location coordinates and object classes [16].

The Channel and Spatial Reliability Tracker (CSRT) method is a tracking algorithm that could track objects in form of videos and a series of images contained in OpenCV. In this research, the CSRT is also used. The CSRT works with procedure within a domain, application channels, and spatial reliability. The application channel is concerned with the colour and intensity of the object, while spatial reliability tends to the object position in the image. The background model is one of the functions implemented and utilized by CSRT in estimating the background of objects. It may operationalize to reduce false positives and improve the accuracy of object tracking. In addition, spatial reliability maps also to identify parts of objects that could rely on to perform track based on spatial location and similarity of the appearance of an object [12].

3 Methods

The input sensors in this research consist of HC-SR04, DHT 11, MQ-7, MQ7, and HW-028. Each sensors have special role in detecting different environmental parameters. Those sensors are connected to Arduino that is connected to a Mini PC. The output of the system will be displayed on the 20×4 LCD screen. The block diagram of the littering monitoring is shown in Fig. 1.

Fig. 2(a) shows the flowchart of the system. It begins with Start, then the software takes the existing dataset in the form of three types of videos, namely: videos of carrying nothing (no garbage), videos of littering, and videos of carrying garbage but not littering. On this dataset, training data and data testing are carried out. For the first

process, the data training process is carried out, then the dataset will be trained to produce the YOLO model.

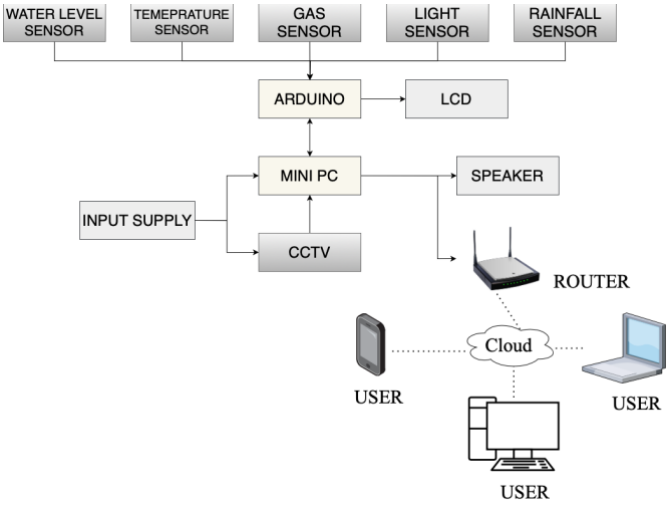

Fig. 1. Block Diagram

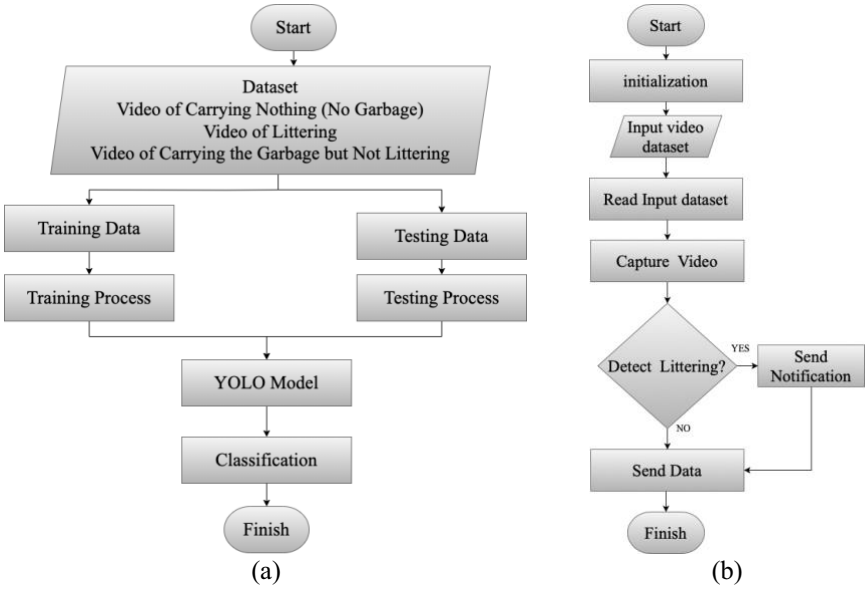

Fig. 2. Flowchart

Fig. 2 (b) shows the flowchart of how the system works. It begins with Start, then the initials of the system and the initials of the sensor, in which then sensor

readings and image taking. If there is a suspicious detection, the system will send a notification and send data.

4 Result

The experimental result of the research was obtained by testing the device in Sekanak river and Jeramba Karang Park. Two of them are shown in Fig 3. The device can detect the Garbage and the human well. Table 2 shows the experiment of detecting number of littering that can be predicted by the proposed device. Although some of them was still misinterpreted, however the device shows that it could work well. Table 3 show the data for the environmental monitoring. The data was obtained in July 23, 24, and 25, 2023 sequentially.

(a) Sekanak River

(b) Jerambah Karang Park

Fig. 3. Testing in the real location

Table 2. Testing result

Location	Date	Time (WIB)	Number of Littering
River	23 July 2023	08.00 – 20.45	7
	24 July 2023	08.00 – 20.45	4
	25 July 2023	08.00 – 20.45	1
Park	23 July 2023	06.00 – 18.45	5
	24 July 2023	06.00 – 18.45	3
	25 July 2023	06.00 – 18.45	0

Table 3. Environmental Data

Location	Time (WIB)	Temp (°C)	Humidity (%)	Air (PPM)	Intensity (Lux)	Weather
River	08.00	28	88	89	39.1	Sunny
	08.33	28	90	88	7.2	Sunny
	08.48	26	95	121	9.0	Rain

Location	Time (WIB)	Temp (°C)	Humidity (%)	Air (PPM)	Intensity (Lux)	Weather
Park	06.10	27	80	81	5.3	Sunny
	06.33	28	81	79	5.9	Sunny
	06.44	25	95	80	5.6	Sunny

5 Conclusion

The proposed devised can monitor the environment well. In addition, based on the model that has been made, the accuracy rate has an accuracy value of 98.3% for the human class, 95.1% for the garbage class, and 96.7% for the average accuracy for both classes. The results of the real-day time test accuracy that has been carried out for the human class are 100%, the garbage class is 80%, and the average accuracy of both classes is 90%.

The detection of human activities of littering is also influenced by the intensity of light, the shape of plastic bags in the form of bloating or not bloating, the colour of plastic bags, and the speed of objects when passing through vision sensing. Thus, a more varied dataset is needed so that detection during the real tests is more accurate in terms of accuracy and bounding box.

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