

*Embedded System, Internet of Things*

Animal Protection System Cats and Dogs Approaching The Substance With The Mini Computer

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A B S T R A C T

Litter bins that do not have lids, as well as the time span of garbage collection, especially when garbage is accumulating, can attract animals to enter the bin, some of the animal patterns are to carry garbage out of the bin, so that it can be consumed by dogs/cats. The purpose of this problem is to help the community in preventing and minimizing animals that litter and prevent the spread of diseases in animals due to consuming garbage, for example diseases caused by bacteria from garbage, namely rabies. This final project results in the detection of cats and dogs using YOLO with 90% accuracy, when a cat or dog is detected the system will issue an output so that the animal does not get closer and out of the trash, the output will continue to be issued until the animal is no longer detected by the camera.

INTRODUCTION

Based on research carried out in the city of Palembang by reviewing the 18 existing municipalities, there are 3 types of garbage tanks namely concrete tanks, fiber tanks and container tanks.

Material Bak TPS	Kekurangan	Keunggulan
Bak Beton	1) Tidak dapat dipindahkan 2) Harus memiliki lahan yang cukup memadai 3) Sulit dikontrol tingkat kebersihannya 4) Dari segi estetika kurang baik	1) Tidak mudah rusak dan tahan terhadap panas dan hujan 2) Dapat menampung sampah dengan volume besar 3) Tidak mudah ilang 4) Dapat dibuat menyesuaikan kebutuhan lahan 5) Dalam dan atas material mudah diperbaiki 6) Mudah diperbaiki
Bak Fiber	1) Mudah pecah dan getas 2) Tidak tahan terhadap pencucian kimia 3) Tidak cukup untuk menampung sampah dengan volume besar 4) Tingkat keamanan kurang baik karena mudah ilang 5) Produktifitas tinggi	1) Mudah dibawa dan dipindahkan oleh armada truck sehingga mempermudah volume sampah 2) Biaya pengisian murah 3) Mudah dikontrol tingkat kebersihannya
Bak Kontainer	1) Biaya pengisian mahal 2) Tidak tahan terhadap zat kimia yang beresifat korosif 3) Perlu lahan yang luas 4) Sulit dikontrol tingkat kebersihannya	1) Mudah dibawa dan dipindahkan oleh armada truck sehingga mempermudah volume sampah 2) Dapat menampung volume sampah yang besar 3) Tidak sulit untuk diperbaiki

Figure 1. The weaknesses and advantages of each trash.

Concrete tubes have more advantages, as well as the shape of concrete tubes is not as high as container tubes and still there are those that do not have a cover, so it is more likely for animals to enter it, then from that on this discussion choose concrete trash tubes to be used as a place of laying tools to be made [1].

The garbage in the concrete trash can be interrupted and consumed by animals when the animal smells of food waste, because the trash can have no cover, and a cleaning schedule that has a certain time range can result in garbages accumulating.

So from such problems can result in polluted environment and can endanger animal health like can be attacked by rabies disease.

According to a study conducted by widiantoro dkk in a national seminar entitled "Differences in the behavior of managing garbage in residents of female and male specialty mansions" by way of interviews, so this study is qualitative, there is only one student who cleans the mansion more often than other friends, the students are willing to separate organic (moist) and non-organic (dry) waste [3].

There are several causes of scattered garbage, i.e. the condition of the TPS is still messy, the garbages are located apart because of insufficient space provided[4]. Based on research carried out by Ryan Aditya Pratama pattern of behavior people dumping garbagematers at the highest TPS, throwing the trash by dumping from above the vehicle rather than descending from the vehicle and stacking the trash to TPS [4]. Waste that is not transported within a certain period of time tends to be scattered because it is traced by rollers or animals that roam around the landfill [5].

Based on the pattern of society's custom to dispose of garbage without sorting causes garbages to be mixed and rapidly rot, the food residue that is in the trash can attract the attention of the animal to go to the trash, so the need for prevention so that the animal does not come to the waste can, the research carried out by Bugi Angriawan comes from the University of

Muhammadiyah Surakarta, an animal expulsion device that uses microcontroller as instrument control, ultrasonic sensors as bird detection is inaccurate because of the lack of accuracy in the field of measurement and power resources of acetic batteries and solar cells controlled by uncertain weather, so that solar panels do not work to the maximum [5].

METHOD

Xiaovv USB Camera Webcam Vlogging 1080p

A Webcam is a video camera that provides a real-time stream of images connected to software on a computer via a USB or serial port



Figure 2. Xiaovv USB Camera Webcam Vlogging 1080p [12]

Here are the specifications of Xiaovv USB Camera Webcam Vlogging 1080p summarized in a table.

Table 1. Xiaovv USB Camera Webcam Vlogging 1080p [12]

Resolusi FPS	1080P/ 30fps
Bidang Pandang Diagonal	150° wide-angle view
Lensa	Superior quality glass lens
Line length	150 cm
Piksel	200 W
Daya	5V
Ukuran	100 x 25 x 50 mm

Based on previous research on mask and body temperature detection systems as access controls, the Raspberry Pi 4 is based on the use of Xiaovv USB Webcam as face and mask detection. Based upon testing, it is known that using the Xiaomi camera it can detect objects at a maximum distance of 200 cm with a minimum light intensity of 20.83 lux. [13]

Raspberry Pi 4B

The required Raspberry Pi is capable of processing data quickly, has enough RAM for the data, the processing device also requires connection to other devices.

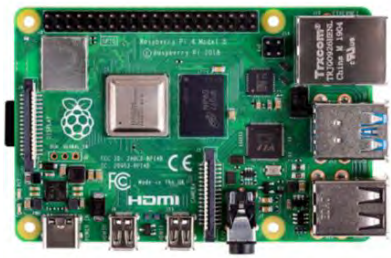


Figure 3. Raspberry Pi 4B

Table 2. Specification Raspberriypi 4B [10]

Processor	Broadcom BCM2711, quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
Memory	1GB, 2GB, 4GB or 8GB LPDDR4 (tergantung model) dengan on-die ECC
Konektivitas	2.4 GHz and 5.0 GHz IEEE 802.11b/g/n/ac wireless LAN, Bluetooth 5.0, BLE Gigabit Ethernet 2 × USB 3.0 ports 2 × USB 2.0 ports.
GPIO	Standard 40-pin GPIO header
Video & Suara	2 × port mikro HDMI (mendukung hingga 4Kp60) Port tampilan MIPI DSI 2 jalur Port kamera MIPI CSI 2 jalur Audio stereo 4 kutub dan port video komposit
Multimedia	H.265 (dekode 4Kp60); H.264 (dekode 1080p60, encode 1080p30); OpenGL ES, grafis 3.0
Dukungan kartu SD	Slot kartu Micro SD untuk memuat sistem operasi dan penyimpanan data
Daya masukan	5V DC melalui konektor USB-C (minimal 3A1) 5V DC melalui header GPIO (minimal 3A1) Power over Ethernet (PoE)–diaktifkan (memerlukan PoE HAT terpisah)
Lingkungan	Suhu pengoperasian 0–50°C

The conclusion derived from data sheets and previous research is that raspberry pi 4b is a processing device that meets the requirements of this system because it has been proven with high accuracy values from previous researches.

Nozzle Spray



Figure 4. Nozzle Spray [17].

A nozzle is a device that functions as a regulator of the flow of water and to increase the speed of water according to a given pressure [18].

The specification of the original TH280 high-pressure water spray nozzle is that it has a high water pressure, and the material is made of a high-strength aluminum mixture, a body-wide oxidation patch, acid and alkaline resistant and non-ridden [19].

So this Nozzle Spray is thought to be effective in putting pressure on the water outlet in evicting animals which has been proven by previous research that nozzles can decrease the intensity of flea attacks on plants.

Based on information from the compass.com site, there are several ways to expel dogs, one of which is by spraying water using an automatic plant sprayer towards the dog [17].

Speaker

The speaker is used as a sound generator output that will work when an object is detected by producing sound that is loud enough with a frequency of more than 16kHz to scare the animal.



Figure 5. Speaker Advance [22]

Speakers are needed as an output device to drive out animals through the sound by having a large volume. This advance speaker has a voltage of 5V 600mA, has a frequency of 25Hz-20Khz. It's a fairly large frequencies, Separation: $\geq 40\text{dB}$, SNR: $\geq 80\text{dB}$ This is good in stating the quality of the information signal [22].

From the references obtained, the speaker is a tool that can function as an output. The system is equipped with speakers that contain dog bells that are deadly enemies of pig pests, so can drive out pigs, technological advances can be used to promote human work based on control [23].

Table 1. Spesifikasi Speaker Advance [18]

<i>Output</i>	3W
<i>Frekuensi</i>	25Hz-20KHz
<i>Channel</i>	2.0
<i>Ukuran Produk</i>	62*62*74mm x 2
<i>Separation</i>	>=40dB
<i>SNR</i>	>=80dB
<i>Material</i>	Plastic

YOLO (You Only Look Once)



Figure 6. YOLO

The YOLO algorithm can be used in object detection, YOLO can detect objects with bounding boxes, this makes it easier in the detection of objects because it will measure how accurately the system can detect the objects. YOLO can recognize objects from video and realtime. This algorithm uses the Python programming language [24].

The study focused on objects recognition in fast food images using You Only Look Once (YOLO). The obtained YOLO model was later used to recognize objects from video and real-time webcam, the accuracy of identification of pizza objects on video was 99% [25].

So on this system can be used YOLO as an object detection, because YOLO implements bounding boxes that can measure the accuracy of the object detected.

CNN (Convolutional Neural Network)

Convolutional Neural Network is a type of neural network that is commonly used to detect images. CNN can process two-dimensional data so it can be implemented on image processing.

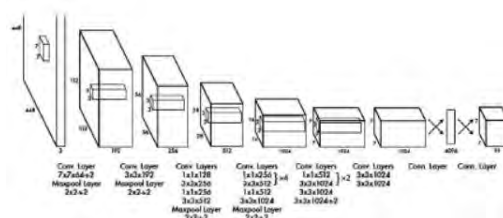


Figure 7. CNN-based YOLO architecture [22]

The study will use the deep learning convolutional neural network (CNN) method to detect masks. The device uses two parameters: a camera detects someone wearing a mask or not, and a body temperature sensor that detects a person's body temperature. A tool programmed with raspberry pi 4, its output is an open door or not that is driven by a servo focus. As for the highest mask detection accuracy, kn95 mask with a 99.95% accurate temperature detection at a distance of 2 cm, resulting in a 0.05% error [22].

Thus based on the results of research in object detection using CNN has a high accuracy and can classify objects well.

General System Design

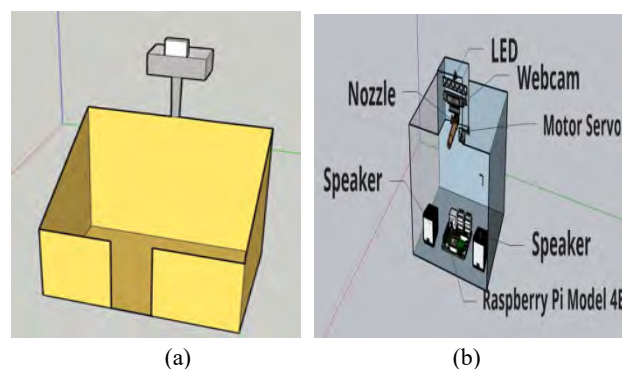


Figure 8. General System Design

Based on figure 3.1 above, the system will be placed on top of the garbage can. The system built has a container to

accommodate the components used, a system container measuring 30 cm wide and 15 cm high. Webcams with a slope of approximately about 30 facing down, LEDs, as well as the Nozzle are at the top, while components in the box consist of the Raspberry Pi and the Speaker.

Process Design

The design of the tools created on this system is done by describing the workflow functions of the devices created, ranging from the detection of objects with a webcam, the processing or processing of data performed by raspberry pi as well as the outputs issued through speakers and nozzles. The equipment is made to work for 20 hours, only when the garbage is in the trash, and for the remainder of 4 hours is counted with the transportation of the trash by the sanitary officer and also as the time interval from the garment transported in the period until the presence of the waste is in a trash back. Here is a general picture shown in the flowchart on Figure 3.2:

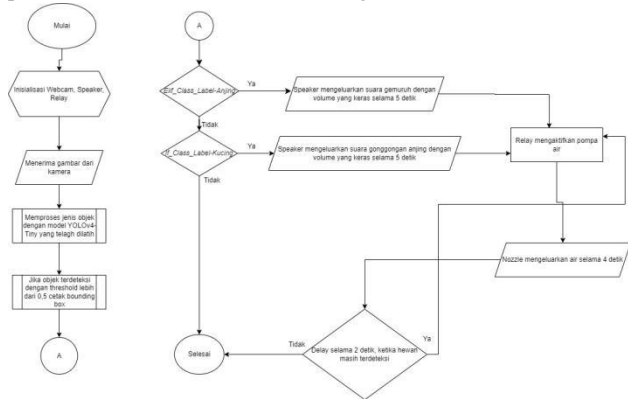


Figure 9. Flowchart of General System Design

Based on the flowchart image created, the following is an explanation of the process to run the system:

1. The process will begin with a real-time camera capture, a live stream that is distributed to the Raspberry Pi via the camera.
2. Identification will be done on the Raspberry Pi using YOLO, the type and shape of the animal will be identified based on the available datasets.
3. Once the identification process is successful, then the object will be classified according to the class of the object that has been specified.
4. Based on the existing Class if the object is dog-echoed then the output from the system will emit loud noise from the speaker for 3 seconds and also remove water from the nozzle.
5. Next, if a cat is detected then the output from the system will remove the dog bells from the speaker for 3 seconds and also remove water from the nozzle.
6. If the camera does not detect an animal, then the device will not give a response so that on the flowchart image when the undetected object goes directly to the completed process.

7. The system will continue to produce outputs if the object is detected and will stop when the animal is not detected by the webcam.

Berdasarkan Gambar 10 dapat dilihat bahwa inti dari sistem ini terdapat pada kondisi waktu dan setelah itu akan dilanjutkan ke dalam subproses kondisi pembersihan dan hujan yang nantinya di dalam subproses ini akan terdapat beberapa subproses lagi. Awalnya sistem dimuai dengan melakukan inisialisasi, NodeMCU ESP8266, sensor cahaya BH1750, sensor hujan FC-37, modul sensor INA219, dan beberapa variabel yang dibutuhkan dalam perkondisian di dalam sistem nantinya. Selanjutnya akan masuk ke proses pengaksesan NTP untuk mendapatkan waktu. Selanjutnya jika waktu NTP sesuai dengan kondisi waktu yang ditetapkan untuk pengambilan data maka sistem akan melanjutkan ke proses berikutnya sampai batas waktu yang ditetapkan.

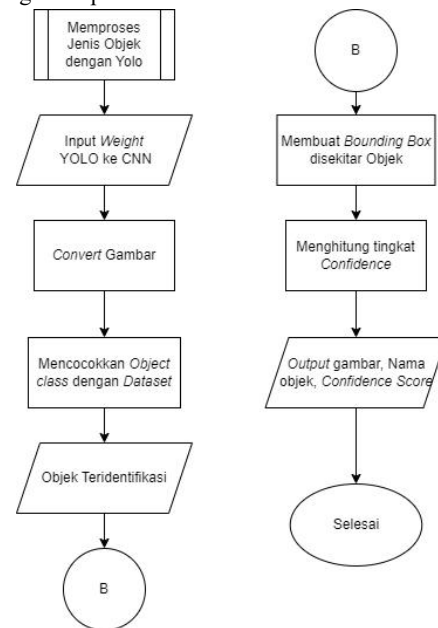


Figure 10. Object Detection Flowchart with YOLO

The above picture describes the YOLO model process that will be built on this system. Here's a description of the process:

1. YOLO Pre-Train data (weight) is inserted into the convolutionary nerve network. (CNN).
2. The image received from the camera is configured to be the size because YOLO works by creating a grid on the image being processed.
3. Match the class of objects seen in the image with the dataset.
4. When the detected object has the same class as the dataset then the object will be identified.
5. The bounding box is used to predict the height, width and class of an identified object.
6. After the object is identified with the bounding box, then look at the confidence level or similarity of the object identified to the model.

7. The resulting image output is the output with the name of the detected object as well as the matching level (confidence score).

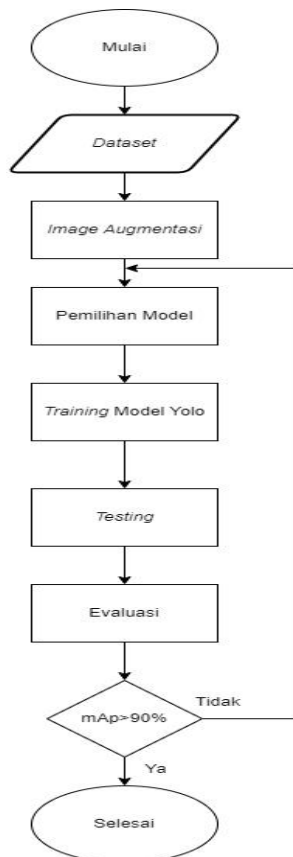


Figure 11. Flowchart of Object Detection Model Building Process Design

The development flowchart of this model was built using the YOLO CNN model for its classification, the purpose of which is for the system to recognize the objects detected by the training and testing stages.

Figure 3.4 explains about the model development process, the first thing done is to obtain the dataset obtained from Kaggle with the name of the search data set is paint, dog, then enter the image augmentation process is the process to recognize objects in various different positions, Augmentation is a process of modifying or manipulating an image, this process of augmentation can be used to multiply the data. Then after it is determined the class of the object model set with the yolo model, then after the training process will be performed testing / reviewing of the model that has been trained before if it has reached the target of mAP at least 85%, then the model will be implemented on real-time detection through the webcam connected with the Raspberry Pi. This is a procedure that is done to get the classification of the already built model.

Detailed Design of System Components

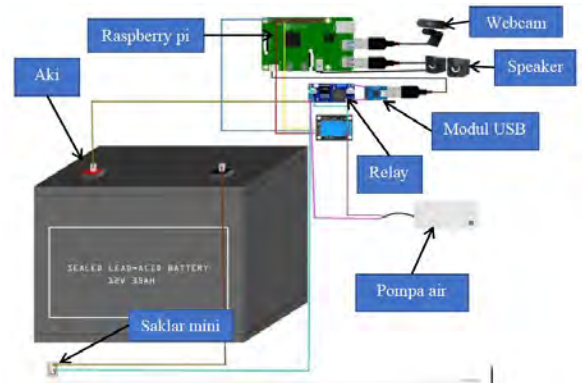


Figure 12. Use Case Diagram

Description

- Webcam connected with raspberry pi USB port
- Speaker connected by USB port and audio raspberry Pi
- Relay :

Input : Vcc, GND, Input connected to GPIO raspberry pi pin

Output : Com connected in positive stepdown input, No connected into the pump.

- Step down

Positive input connected on mini switches and output com relay
Negative input connects to azimuths and pumps positive and negative output connections to USB modules

- Mini switch connections to stepdown and Azimuths.
- USB module connectivity to Type-C raspberry pi.

RESULTS AND DISCUSSION

Hardware Implementation

In the hardware implementation that has been done, the author made some changes to the cover part of the tool, components, and some of the position of the components. In the cover section the author initially used only acrylic material aimed at protecting components from weather such as rain or heat and no too strong impact, then at the time of implementation the author added a box of panel boxes using a 12.5 cm thick iron plate material to be able to better protect some components in the system.

If viewed in terms of dimensions, dimensions or size of the cover undergoes a slight change from one square with a whole set of components in it that is 15 cm tall and 30 cm wide then at the time of implementation is applied i.e. acrylic as camera protector trapezoidal elbow-shaped with a height of 7 cm and a width of 12 cm, acryl protector speaker has a heights of 2 cm and widths of 6.5 cm, iron panel box with height 30 cm width 20 cm and wide 12,5 cm, as well as 100 cm pillar height that can be adjustable height.

In addition, the author also carried out the positioning of the components of the system, this positioning is done so that the tool is easier to implement and can better protect the existing components. The location of the webcam that was originally placed in the box when the implementation was placed on the toolpole to maximize webcam detection coverage and

inclination. Then for the Nozzle that was originally in the container box when implementation its position was placed under the webcam attached to a pillar to facilitate implementation when the nozzle drains water and is avoided from the exposure of water to other components. The speaker that was initially also placed in a container along with the other component when implemented its position is above the nozzle attached on the pillar so that the output sound is clear and easy to implement, as seen in the following figure 4.1



Figure 13. Hardware Implementation (a) front view of the system (b) rear view of the system

Software Implementation

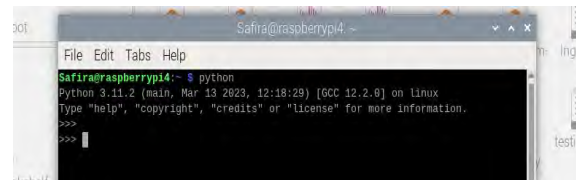
Implementasi Python

The Python implementation used on this system is the Python programming language version 3.11.2. The implementation performs image processing and object classification using OpenCV and numpy libraries, performs time-sharing such as setting execution pauses, monitoring time, and performing time-based operations using library time, playing audio as output on the system in file.mp3 format using the pygame library, as well as controlling pumps using relays connected with GPIO pins on raspberry pi using the RPI.GPIO library.

The implementation of the version of the Python programming language used by the system can be seen in Figure 4.4 below as follows,

Website monitoring dirancang menggunakan *framework* Node.js dan ditulis menggunakan bahasa program JavaScript. *Website* ini sendiri berada pada jaringan *localhost* yang artinya hanya dapat diakses ketika server hidup dan berada pada satu jaringan. *Website* ini dibuat agar pengguna dapat lebih mudah memahami data yang dihasilkan oleh sistem *monitoring* penyerapan daya dan perawatan panel surya, sehingga dapat dijadikan sebagai bahan penelitian selanjutnya.

Fitur – fitur dari *website monitoring* dapat dilihat pada gambar – gambar berikut.



Gambar 15. Home Page

Figure 4.4 shows a version of python that has been installed on raspberry pi through the menu on the command prompt displayed.

Implementasi Pengumpulan Dataset

The implementation of the cat and dog object dataset begins with the collection of data sets that are self-taken from videos from different locations where dogs and cats are found, then converted into images containing objects as well as additional images of objects from Kaggle (<https://www.kaggle.com/datasets/tongpython/cat-and-dog>) of approximately 300 dog and cat images for different classes. The video is produced as many as 50 videos with a video duration of 30 seconds - 4 minutes and converted to a.jpg image with a frame rate value every 0.5,0.8/1,0 seconds so that the resulting image contains moving images so the system can recognize the object.

The total total image generated is then selected as a data set to use as much as 2,000 images. The video result obtained in the data set capture can be seen in Figure 4.5 as follows,

Pada Gambar 18 dapat dilihat *home page* atau halaman utama dari *website monitoring*. Pada halaman utama ini petugas dapat langsung *me-monitoring* intensitas cahaya matahari, daya yang dihasilkan oleh panel surya, cuaca dan apa saja yang dikerjakan sistem. Tiga kolom atau *card* di atas akan menampilkan tanggal dan waktu secara *realtime*, untuk intensitas cahaya dan daya akan di-*update* setiap satu menit. Lalu kolom di bawahnya ditampilkan tabel yang di-*update* setiap 30 menit dan ketika perubahan cuaca. Dari halaman utama ini juga dapat dilihat ada beberapa fitur lain seperti *search bar*, *sorting* pada kolom “Time”, kalender, *button* “Previous” dan “Next”.

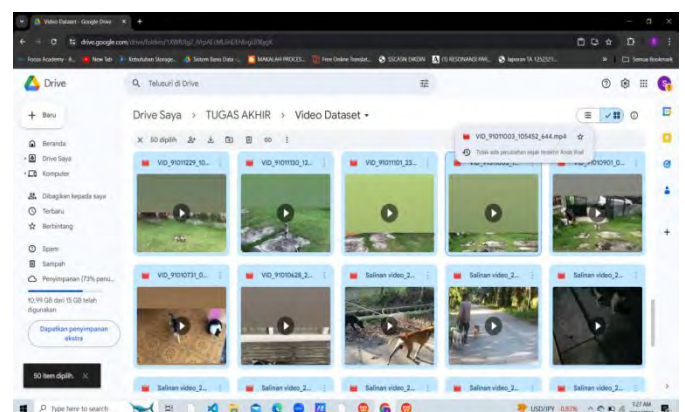


Figure 16. Result Video retrieval Dataset

After the video is converted into an image in .jpg format, the image is labeled or annotated according to the name of the object class in the labeling. This preprocessing or labeling stage is done by labeling or predicting the bounding box that indicates each type of object to be trained. The result of the image

labeling stage with the YOLO format is a.txt file containing class points x,y and w,h, or as follows,

<class><x><y><width><height>

Dataset Training Implementation

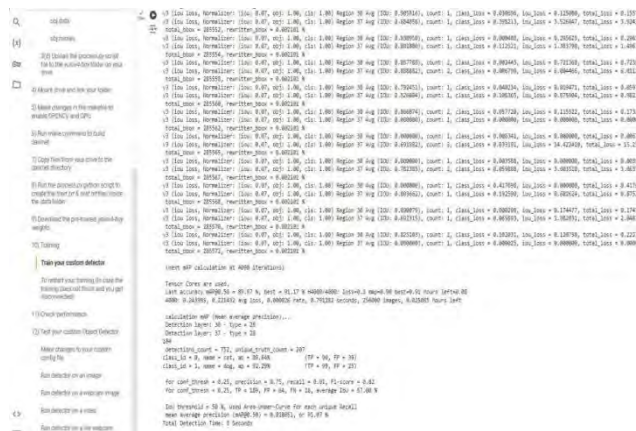


Figure 17. Implementation of Training Process Architecture and Training Report Dataset Obj

Figure 4.9 shows the architectural results of the dataset training process, when training, the detection results for cat objects are 89.84% with a true positive value of 90 objects, dog objects are 92.29% with a true positive value of 99 objects.

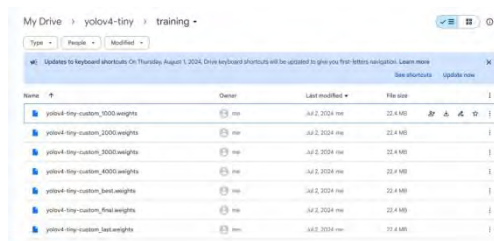


Figure 18. Implementation of YOLO Modeling Results

After the training process based on the YOLO training results model which can be seen in Figure 4.11, the best model can be implemented to classify obstacle objects in realtime on the system via webcam and python programming on raspberry pi.

Implementasi Model Deteksi Objek Yolo

After passing the YOLO model dataset training stage, the resulting model is applied using the python programming language and the openCV, numpy, time, pygame, RPI.GPIO libraries on the raspberry pi. Each image capture in the frame on the live webcam will be compared with the YOLO model that has been trained before.

There are two files used for the implementation of the YOLO model in the realtime classification process on the webcam, namely the YOLO model file that has been trained and the YOLO configuration parameter file as a neural network architecture used for image matching with the model, namely with the name "yolov4-tiny-custom.cfg" and "yolov4-tiny-custom_best.weights".

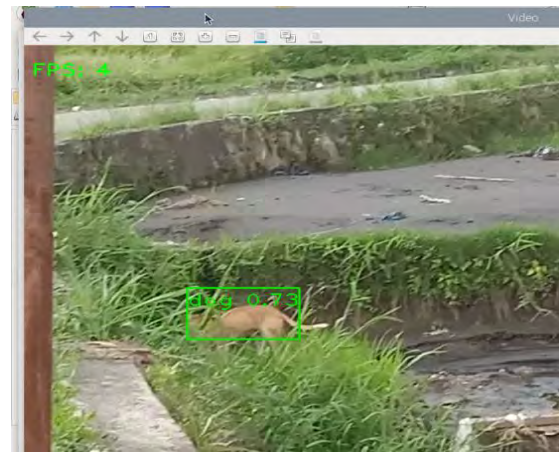


Figure 19. YOLO Implementation on Raspberry Pi

Figure 4.12 is an example of the implementation of the YOLOv4-Tiny model detection on a dog object. The object is successfully identified and marked with a bounding box which also displays the confidence score value of the object detection.

System Functional Testing and Analysis

Webcam Quality Testing

A. Testing Based on Webcam Height and Distance

Tabel 4. 1 Testing Based on Webcam Height and Distance

Tinggi Webcam	Jarak Webcam dengan objek	Jarak antara bak sampah dengan objek	Objek	
			Anjing	Kucing
100 cm	100 cm	50 cm	Terdeteksi	Terdeteksi
	130 cm	80 cm	Terdeteksi	Terdeteksi
	150 cm	100 cm	Terdeteksi	Terdeteksi
	>180 cm	>130 cm	Terdeteksi	Terdeteksi
110 cm	100 cm	50 cm	Terdeteksi	Terdeteksi
	130 cm	80 cm	Terdeteksi	Terdeteksi
	150 cm	100 cm	Terdeteksi	Terdeteksi
	>180 cm	>130 cm	Terdeteksi	Terdeteksi
120 cm	100 cm	50 cm	Terdeteksi	Terdeteksi
	130 cm	80 cm	Terdeteksi	Terdeteksi
	150 cm	100 cm	Terdeteksi	Terdeteksi
	>180 cm	>130 cm	Terdeteksi	Terdeteksi

B. Testing Based on Light Intensity

Tabel 4. 2 B. Testing Based on Light Intensity

	Anjing	18.59		Terdeteksi
	Kucing	19.20		Terdeteksi
	Anjing	18.35		Terdeteksi
	Kucing	17.40		Terdeteksi

A. Analysis of Test Results Based on Webcam Height and Distance

Webcam testing is at a height of 100-120 cm, this is because the height of the system pole only reaches 120cm. Objects can be detected at a webcam height of 100 - 120cm with a distance of 100 to more than 180 cm because the captured object is in accordance with the trained dataset, so that in this system when the object will approach the trash can, the system can issue an output to prevent the animal from being right in the trash can.

B. Analysis of Testing Based on Light Intensity

Light intensity testing is carried out from low lux, namely 1 to the highest 3402 can still detect objects, it can be seen from the testing table based on light intensity that the webcam can still detect objects from lux light 1 to 10 which is classified as low, but for distances of more than 150 cm objects cannot be detected. The author also compares the Xiaovv USB Camera Webcam with the logitech C270 Webcam at low lux, for the xiaovv webcam with the longest distance range of 150 cm can still detect objects while the logitech C270 webcam in the 80 cm - 150 cm distance range cannot detect objects.

Speaker Testing

Jarak Speaker	Gambar		Keterangan	
	Untuk Anjing	Untuk Kucing	Objek Anjing	Objek Kucing
80cm			Meninggalkan bak sampah	Meninggalkan bak sampah
120 cm			Tidak meninggalkan bak sampah	Meninggalkan bak sampah
150 cm			Tidak meninggalkan bak sampah	Tidak meninggalkan bak sampah
200 cm			Tidak meninggalkan bak sampah	Tidak meninggalkan bak sampah

The analysis obtained from the test, that the speaker output at a distance of 30 - 120 cm can still surprise or make animals run away / do not want to approach the trash can, this is because the closer the distance between the animal and the system, the greater the decibels released by the speaker and vice versa, in this test the system with effective sound output makes animals surprised or not approach the trash can at a distance of 30 - 120 cm. So it can be concluded that decibels determine the effectiveness of the system in preventing or repelling animals from the trash can, not from the type of sound, because based on tests that have been carried out by the author with random sounds that dogs will not approach the trash can when the system outputs a dog barking sound at a distance of 80 cm.

Spray Nozzle Testing

Jarak	Keterangan	
	Kucing	Anjing
100 cm	Meninggalkan bak sampah	Meninggalkan bak sampah
120 cm	Meninggalkan bak sampah	Tidak meninggalkan bak sampah
130 cm	Meninggalkan bak sampah	Tidak meninggalkan bak sampah
150 cm	Meninggalkan bak sampah	Tidak meninggalkan bak sampah

Based on the test results of the predetermined parameters, the nozzle can spray water as far as 160 cm, the water released is not maximal due to the limited power source from the battery, so the resulting pressure is not tight. Based on internet searches that the flow and pressure of water can be higher according to the pump used. This system is made using a regular mini pump with a DC voltage of 3-5V, Max.Current: 0.18A, Max. Power: 0.91W, Max. Flow Rate: 100L/H. Judging from the specifications of this mini pump, it does not have enough criteria to emit further and faster due to the limited resources of the system, which should get a voltage of 3 - 5V due to limited resources, the voltage from the battery which is regulated by a step down voltage to the pump is only 2.8 V and also the specifications of the water pump itself.

At a distance of 100 to 150 cm is a distance that is not too close to the garbage can so that the water output from this nozzle can repel animals before they are right in the garbage. Measurements are made by measuring the distance from the nozzle on the system to the object on the surface of the system.

Python Testing

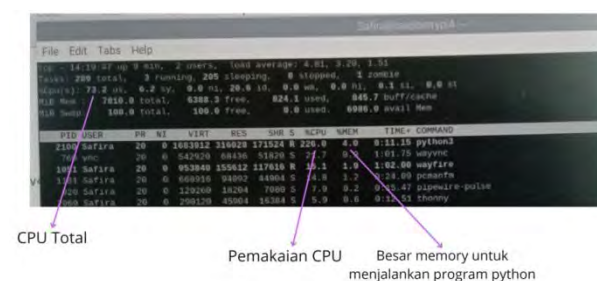


Figure 19. CMD view of raspberry pi

Based on the test results in 4. It can be seen that the total memory usage for running the python program on the system is 4.0% which is related to the execution of the python program.

Memory usage refers to the extent to which RAM is used to allocate memory to store variables and objects, while CPU usage refers to the extent to which the Raspberry Pi processor is used in running the system, namely related to computing and operating on the program.

However, in python programming this system requires a large CPU usage to run the system simultaneously, which is 226.0% of the total CPU usage of the Raspberry Pi, which is 73.2% in running the python program process simultaneously and intensively, so that the computational process is heavy when displaying frames in the YOLO detection image processing program.

Testing the Object Detection Process

Model	Tangkapan webcam	FPS
Tanpa Model		15
		13
		14
YOLOv4-Tiny		1
		1
		1

Based on the test results to measure the fps value on live webcam streaming in table 4.4, it can be seen that large CPU usage is also related to object classification as evidenced by the fps test which indicates the model requires heavy computation. Tests were conducted based on two parameters, namely without the YOLOv4-tiny model, and with the YOLOv4-tiny model for object classification as many as two classes of obstacle objects. In live video without the YOLO model, video streaming can run

smoother with fps worth 11-15, so that objects captured by the webcam are more realtime or not too broken.

Furthermore, when video streaming is done by applying the YOLO model to compare the results of webcam capture with obstacle objects that have been trained in order to issue system output. Video streaming seen in the frame runs quite slow and broken. The results of the low fps value are also due to the limited computing power of the Raspberry pi in image processing and the speed of the GPU which is less powerful because the program is run in multi thread.

However, the object can still be immediately detected again properly, even though the display is broken, but it still runs properly to recognize the type of object in front of the system.

Overall Testing of Tools Against Objects

Tempat	Deteksi Webcam	Output Spekaer	Output Nozzle
 Bak sampah 1	Kucing	On "suara gongongan anjing"	Menyala
 Bak Sampah 2	Kucing	On "suara gongongan anjing"	Menyala
 Bak Sampah 3	Anjing	On "suara gemuruh"	Menyala
 Halaman Rumah Warga	Anjing	On "suara gemuruh"	Menyala

In trash can 1 there is only one type of object, namely cats, so that when the detection process is carried out on the raspberry pi, the object is immediately detected as a cat according to the real object in trash can 1, after the object is detected the system will issue its output.

In trash can 2 there are also only cats so that the camera that has also been implanted with the YOLO model immediately detects the object is a cat and is true according to the real object, after the object is detected the system will issue its output.

In the 3rd trash can there is only a dog object, when the system detects, the first time the system detects the object is a cat, after 30 seconds the system can detect the object correctly, so that at the beginning of the detection the system can be said to have detected the wrong object.

In the 4th place, not in the trash can but in the yard of a resident's house where there is a dog, here the author also tries the whole test of the tool, in order to observe again how the object responds to the system that the author made, when the system detects the presence of the object, the detection display on the frame that is done incorrectly detected is a cat but after 8 seconds later the system can detect the object correctly.

CONCLUSIONS

1. The system can detect dogs and cats in the trash can area using the YOLO (You Only Look Once) algorithm with a distance range of more than 80 cm and the lowest light lux of 1 lux, so that when the animal is detected more than 80 cm, the animal is not yet in the trash can and the system outputs to evict the animal.
2. The system can startle the animal through the speaker with a distance range of 80 - 100 cm when the animal is detected by the webcam.
3. This system outputs water from a nozzle connected to a water pump, controlled by a relay, when an object is detected then the relay will be HIGH to turn on the water pump.
4. The FPS obtained is different from the planned target, the maximum fps obtained when the whole system is running is 6 fps, this is influenced by how much computation on the raspberry pi and the quality of the existing network.

ADVICE

1. Using more appropriate resources for the system, so that the performance of each component is maximized, because this system works outdoors which must have its own resources.
2. Using an additional GPU or device that has its own GPU so that the image processing process on CUDA runs faster and produces higher fps.
3. The cover for each component is made to be more weatherproof and also the impact and safety needs to be considered again, because the placement of the system is

in a public place. Adding stepper motors to the system so that the wipers can move better.

4. Adding outputs for dog objects, such as making system outputs with movements that can be controlled by servo motors so that dogs are afraid or surprised. So that the system is more maximal in repelling dogs that approach the trash can.

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