Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4

By

Vincent Lee Wen Sheng

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR INFORMATION SYSTEMS (HONOURS)
INFORMATION SYSTEMS ENGINEERING
Faculty of Information and Communication Technology
(Kampar Campus)

MAY 2023

UNIVERSITI TUNKU ABDUL RAHMAN

REPORT STATUS DECLARATION FORM

Title: Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4

Academic Session: MAY 2023

I VINCENT LEE WEN SHENG

(CAPITAL LETTER)

declare that I allow this Final Year Project Report to be kept in

Universiti Tunku Abdul Rahman Library subject to the regulations as follows:

1. The dissertation is a property of the Library.
2. The Library is allowed to make copies of this dissertation for academic purposes.

Verified by,

(Author's signature)

(Supervisor's signature)

Address:

60, LORONG 2/SS9

BANDAR TASEK MUTIARA

14120 SIMPANG AMPAT

DR. AUN YICHIET

Supervisor's name

Date: 01/09/2023

Date: 15 Sep 2023

Universiti Tunku Abdul Rahman			
Form Title : **Sample of Submission Sheet for FYP/Dissertation/Thesis**			
Form Number: **FM-IAD-004**	Rev No.: **0**	Effective Date: **21 JUNE 2011**	Page No.: **1 of 1**

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

UNIVERSITI TUNKU ABDUL RAHMAN

Date: 01/09/2023

SUBMISSION OF FINAL YEAR PROJECT /DISSERTATION/THESIS

It is hereby certified that VINCENT LEE WEN SHENG (ID No: ***17ACB01268***) has completed this final year project/ dissertation/ thesis* entitled "Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4" under the supervision of DR. AUN YICHIET (Supervisor) from the Department of Computer and Communication Technology, Faculty of Information and Communication Technology.

I understand that University will upload softcopy of my final year project / dissertation/ thesis* in pdf format into UTAR Institutional Repository, which may be made accessible to UTAR community and public.

Yours truly,

(*Vincent Lee Wen Sheng*)

*Delete whichever not applicable

DECLARATION OF ORIGINALITY

I declare that this report entitled "**Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4**" is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

Signature : ______________________

Name : Vincent Lee Wen Sheng

Date : 01/09/2023

ACKNOWLEDGEMENTS

I would like to express my sincere thanks and appreciation to my supervisors, Dr Aun Yichiet who has given me this bright opportunity to engage in this YOLOv4 machine learning project. Besides that, I wanted to take a moment to express my sincere gratitude for lending me the drone, I am truly appreciating the generosity and willingness of Dr Aun to share me the equipment. It is one of my biggest steps to establish a career in machine learning field. A billion thanks to you.

To a very special person in my life, Soo Pei Ling, for her patience, unconditional support, and love, and for standing by my side during hard times. Finally, I must say thanks to my parents and my family for their love, support, and continuous encouragement throughout the course.

ABSTRACT

This project aims to develop a custom YOLOv4 detector model that can accurately detect vacant and occupied parking spaces on UTAR Kampar Campus. The motivation behind this project is to address the parking issues faced by students and staff on campus, which include difficulties in finding parking spots, illegal parking, and wasted time and fuel in search of parking. To gather data and identify the extent of the problem, a questionnaire survey was conducted among 10 random students on campus. Based on the results, up to 90% of the surveyors find it difficult to find parking on campus, and 80% have been late to or missed classes due to parking issues, impacting their academic performance. To improve the accuracy of the custom detector model, the project focuses on data preprocessing and augmentation, which involves collecting and labelling images of parking lots in various conditions, including lighting, weather, and vehicle types. The accuracy of the bounding box predictions is targeted to be above 70% for the whole image. If the targeted accuracy is not achieved, the data preprocessing process will start over again with the addition of new data sets.

The proposed custom YOLOv4 detector model will benefit students and staff by providing the latest information on parking lot availability, reducing the time spent searching for available parking spots, promoting eco-friendliness by reducing fuel consumption and carbon emissions, and reducing instances of illegal parking that can lead to fines and contribute to congestion in the parking lot. Overall, this project presents a promising solution to the parking issues faced by UTAR Kampar Campus, with the potential for future expansion and application in other campuses or public areas. The result of this project is able to accurately predict the bounding box of vacant and occupied parking lots in UTAR Kampar Campus.

TABLE OF CONTENTS

LIST OF FIGURES

Figure Number and Title **Page**

LIST OF TABLES

Table Number and Tittle **Page**

LIST OF ABBREVIATIONS

YOLOv4	You Only Look Once version 4
YOLOv3	You Only Look Once version 3
CNN	Convolutional Neural Network
R-CNN	Region- based Convolutional Neural Network
GPU	Graphic Processing Unit
OPENCV	Open Source Computer Vision Library
CUDA	Compute Unified Device Architecture
API	Application Programming Interface

CHAPTER 1

Introduction

Finding a car park in the parking lot of UTAR Kampar Campus is always a formidable challenge for UTAR Kampar Campus students and staff. This is because personal vehicles, such as cars, are a more convenient mode of transportation in Kampar as compared to public transport or bicycles. Besides that, the issue of locating a parking spot poses a significant challenge for students, often leading to tardiness or missed classes. Some may even opt to skip classes altogether due to unable to secure an available parking space for their vehicles. It is important to note that failing to park in designated areas may result in fines. Despite the numerous benefits of personal vehicles as a mode of transportation for UTAR Kampar Campus students and staff, the persistent problem of locating an available parking spot within the campus parking lot poses a significant challenge to their academic success. This issue not only leads to tardiness or missed classes but can also result in higher levels of stress, frustration, and decreased satisfaction with their overall campus experience. Additionally, the limited availability of parking spaces may deter prospective students from attending UTAR Kampar Campus, adversely affecting its enrolment rates and reputation. As such, there is a critical need to explore the underlying causes of parking difficulties and identify effective solutions that can improve the accessibility and convenience of parking for students, staff, and visitors at UTAR Kampar Campus.

1.1 Problem Statement and Motivation

The primary issue is that students or staff driving cars face difficulty in identifying and locating vacant parking lots as they can only spot them while driving past them. Moreover, the high demand and low supply of parking lots at UTAR Kampar Campus means that even if students or staff spot a vacant parking lot, it may already be occupied by the time they arrive. Additionally, another issue arises when drivers are unaware of the occupancy status of parking lots in the area, causing them to enter the parking lot and search for a vacant spot, leading to traffic congestion, difficulty in finding a spot, and even failed to find a vacant spot.

The purpose of this project is to address the issue of students and staff struggling to find vacant parking lots at UTAR Kampar Campus. The problems to be resolved include the challenges in identifying and locating vacant spots, the possibility of spots being occupied by the time they arrive, and the uncertainty of parking lot occupancy status in the area. The reason to solve this problem is because this issue not only leads to tardiness or missed classes but can also result in higher levels of stress, frustration, and decreased satisfaction with their overall campus experience. This project aims to solve this problem by developing a vacant parking space detector for UTAR Kampar Campus by using YOLOv4 custom detector model.

1.2 Project Scope

The primary objective of this project is to provide a reliable and efficient solution to the problem faced by students and staff of UTAR Kampar Campus in locating a vacant parking space. The proposed solution is to develop a custom detector model based on the YOLOv4 architecture that can accurately detect the occupancy status of a parking lot in latest information. The model will be trained on a large and diverse dataset, ensuring its effectiveness in various conditions and parking lot layouts.

Upon the successful completion of this project, the vacant parking space detector will be a valuable tool for the students and staff of UTAR Kampar Campus. With the detector, they will no longer have to waste time circling around the parking lot or settling for a distant and inconvenient parking space. The detector will provide up-to-date information about the occupancy status of the parking lot, allowing the users to quickly identify a vacant spot for their car. This, in turn, will lead to a more efficient and stress-free parking experience for everyone at UTAR Kampar Campus.

Furthermore, the vacant parking space detector can also contribute to the overall sustainability efforts of the campus. By reducing the time and fuel wasted on searching for parking spaces, the detector can help to lower carbon emissions and promote eco-friendliness. It can also reduce the instances of illegal parking, which can lead to fines and contribute to congestion in the parking lot.

In summary, the development of a YOLOv4 custom detector model for accurately detecting vacant parking spaces at UTAR Kampar Campus is a crucial project that can provide numerous benefits to the students, staff, and environment of the campus.

1.3 Project Objectives

The proposed project seeks to tackle the issue of parking difficulties faced by students and staff at UTAR Kampar Campus. The project aims to develop a custom detector model using the YOLOv4 framework that can accurately detect vacant and occupied parking lots in an image of the campus parking lot. Moreover, the project will also focus on counting the total number of vacant and occupied parking lots in an image of the campus parking lot using the developed custom detector model.

To train the YOLOv4 custom detector model to achieve the desired accuracy in detecting vacant and occupied parking lots in UTAR Kampar Campus, the project requires a good and substantial amount of data. The data will be used to train and validate the model's performance in detecting the correct status of parking lots. Data collection will involve taking images of the campus parking lot under various conditions such as during peak hours, non-peak hours, weekends, and weekdays. The images collected will include a variety of angles, lighting conditions, and weather conditions.

Once a sufficient amount of data has been collected, the next step will be to train and optimize the YOLOv4 custom detector model. The training process will involve dividing the dataset into training and validation sets and then training the model using various techniques. The model's performance will be evaluated on the validation set, and adjustments will be made to optimize its performance.

In conclusion, this project aims to develop a YOLOv4 custom detector model that can accurately detect vacant and occupied parking lots in an image of UTAR Kampar

Campus parking lot. The project's success will significantly benefit students and staff by providing latest information on parking lot availability and reducing the time spent searching for available parking spots.

1.4 Impact, significance, and contribution

The proposed project aims to offer an effective solution to the parking woes of UTAR Kampar Campus students and staff by providing latest information on the availability of parking spaces. The YOLOv4 custom detector model, which accurately detects vacant and occupied parking spaces in the campus through image processing, will play a crucial role in making this possible.

By providing up-to-date information on parking availability, the proposed project can help students and staff save precious time and reduce the frustration and stress associated with searching for parking spots. The use of the custom detector model will not only lead to a more efficient use of campus parking resources but also promote eco-friendliness by reducing the carbon emissions generated by cars idling while searching for a spot.

Another significant benefit of the proposed project is the potential to reduce illegal parking instances on campus, which can contribute to congestion in the parking lot and lead to hefty fines. By offering an effective way to find available parking spots, students and staff are less likely to engage in illegal parking, ensuring the smooth flow of traffic in the parking lot.

Overall, the proposed project offers a holistic solution to the parking challenges faced by students and staff at UTAR Kampar Campus. By leveraging the power of the YOLOv4 custom detector model and latest information, the project can significantly enhance the parking experience on campus, leading to increased productivity and overall satisfaction.

1.5 Background information

The proposed project aims to develop a YOLOv4 custom detector model that can accurately detect a vacant parking space in UTAR Kampar Campus.

YOLOv4 (You Only Look Once version 4) is an object detection algorithm that uses a single convolutional neural network (CNN) to predict the bounding boxes and class probabilities for multiple objects in an image. The YOLOv4 algorithm is known for its high accuracy and fast speed, making it a popular choice for object detection tasks.

In recent years, object detection has become a crucial component in various industries, including self-driving cars, security systems, and even social media applications. The technology has also been used to develop smart parking solutions in cities, universities, and other public spaces.

UTAR Kampar Campus is no exception to the growing demand for smart parking solutions. The campus has faced challenges in providing adequate parking spaces for its students and staff, leading to frustration and tardiness. The proposed YOLOv4 custom detector model aims to address this issue by accurately detecting vacant parking spaces, allowing for efficient parking and reducing instances of illegal parking.

Prior to this project, various object detection algorithms have been developed, including YOLOv3, Faster R-CNN, and Mask R-CNN. However, the YOLOv4 algorithm has shown to outperform these models in terms of accuracy and speed.

It is important to understand that these technologies involve teaching computers to recognize and classify images based on patterns and features. A key concept in object detection is the bounding box, which is a rectangle that surrounds an object in an image. The YOLOv4 algorithm uses convolutional neural networks to predict the location and size of these bounding boxes, as well as the class of object within them.

Overall, the YOLOv4 custom detector model for vacant parking lots in UTAR Kampar Campus has the potential to revolutionize the campus parking system and improve the overall parking experience for students and staff.

1.6 Report Organization

This report is organized to 5 chapters: Chapter 1 Introduction, Chapter 2 Literature Review, Chapter 3 Proposed Method/Approach, Chapter 4 Study Review, Chapter 5 Conclusion. The first chapter is the introduction of this project which include Problem statement and motivation, Project scope, Project objectives, Impact, significance, and contribution, and Background information. Chapter 2 is the Literature Review of this project which include Literature review, Fact finding, and Critical remarks of previous works. Chapter 3 is Proposed method/approach of this project which include Design specifications, System design/overview, Implementation issues and challenges, and timeline. Chapter 4 is Study review of this project which include Preliminary study, and Extensive study. Chapter 5 is the Conclusion of this project.

CHAPTER 2

Literature Review

2.1 Literature Review

The literature review conducted showed that YOLOv4 is an effective object detection model that has been widely used in various applications such as traffic management and object tracking. It is known for its high accuracy and efficiency compared to another available detector model. Most approaches in existing research on detecting parking spaces are generally categorized into three types: Counter-based, sensor-based and vision-based.

Counter-based system illustrates the counter for the cars that enter the parking and count the number of cars. The counter calculates the number of cars that enters and subtract with the number of cars that exits [1]. The system is designed to detect vehicles using infrared red and the counter is added into the "vehicle count" and the signals will show on a display [2].

Sensor-based system rely on ultrasonic or wireless-magnetic based sensors installed above each parking space to detect a vacant parking space in a parking lot [3]. When applied in a parking system, it provides a real-time availability of vacant parking spots in parking lot [4]. The example of Sensor-based system is as shown in figure 1.

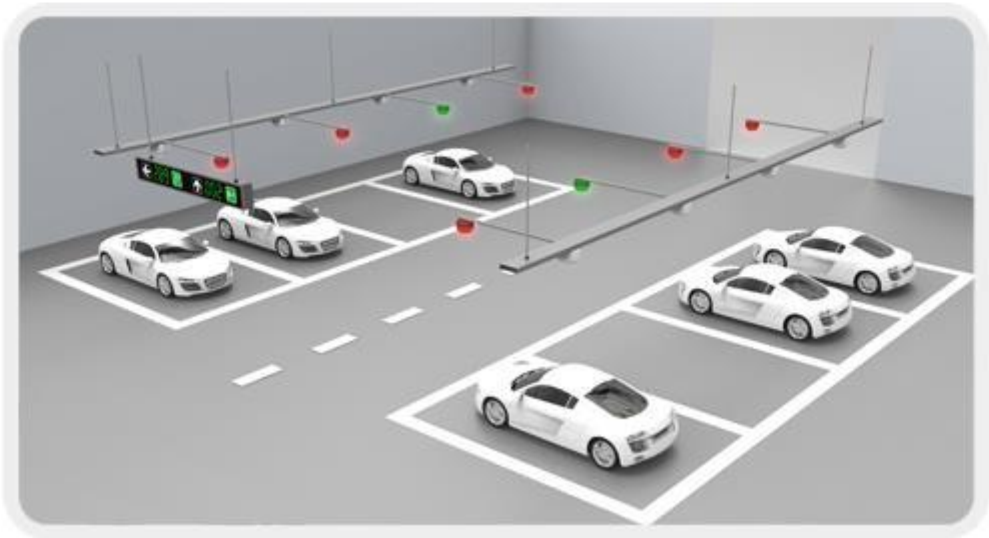


Figure 1 Sensor-based system [5]**.**

Vision-based system was developed to handle parking lot management usually used in shopping malls and other public parking spaces to detect number of vacant spaces in a lot. The computerized vision operates by reading information using images to accurately inspect the data and apply in various task like automation, data gathering and data decoding. Overall, it works like how human vision can do by understanding and observing the data collected in the programme [6]. [7] showed that application of vision-based system is comparatively cost-effective and practical to utilize. In this study YOLOv4 as one of a vision-based system is utilized to accurately detect available parking spaces. It is a deep learning-based parking space detection that observes the entire image during training and test time as shown in figure 2. Another study by [3] demonstrated a trained model utilizing YOLOv4 producing result of detecting vacant street parking as high as 82% of precision at a threshold of 50% overlap between bounding boxes.

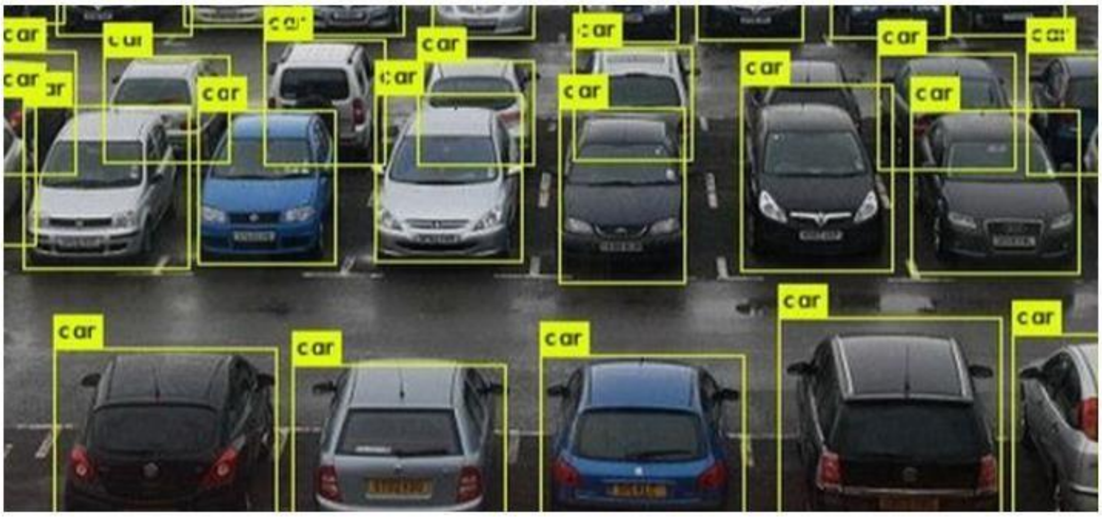
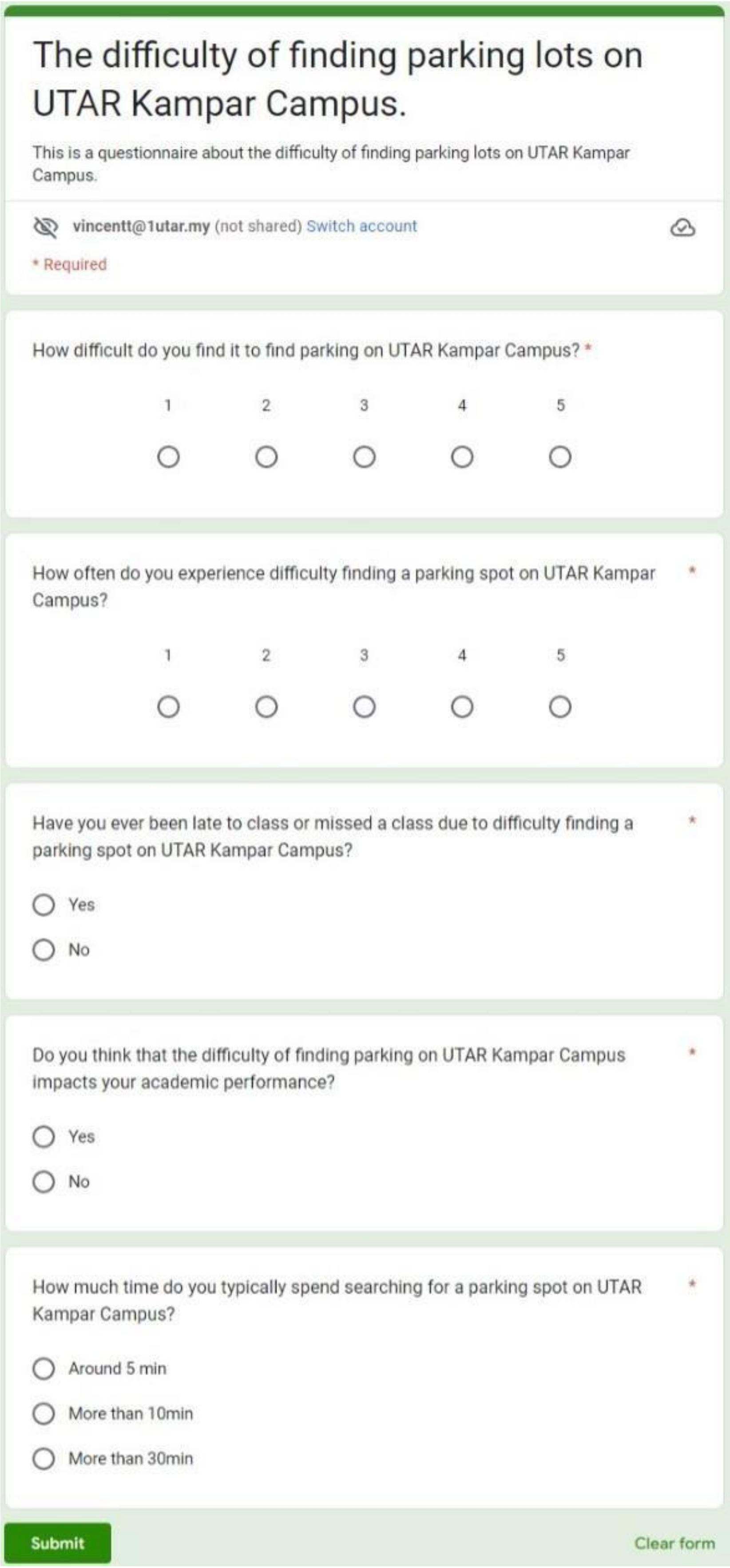


Figure 2 Vision-based system [8]**.**

2.2 Fact Finding

The scientific methodology used for fact-finding and analysis in this project involves the use of a questionnaire. The questionnaire includes five questions, as shown in Figure 1. These questions aim to gather information on the difficulty that students face when trying to find parking on UTAR Kampar Campus. The first question asks about the level of difficulty students experience when looking for parking, while the second question focuses on the frequency of these difficulties. The third question explores whether students have ever been late to or missed classes due to parking issues, while the fourth question asks about the impact of parking difficulties on academic performance. Finally, the fifth question aims to determine the average amount of time students spend searching for parking on campus.


The difficulty of finding parking lots on UTAR Kampar Campus.

This is a questionnaire about the difficulty of finding parking lots on UTAR Kampar Campus.

vincentt@1utar.my (not shared) Switch account

* Required

How difficult do you find it to find parking on UTAR Kampar Campus? *

1 2 3 4 5

How often do you experience difficulty finding a parking spot on UTAR Kampar Campus? *

1 2 3 4 5

Have you ever been late to class or missed a class due to difficulty finding a parking spot on UTAR Kampar Campus? *

- Yes
- No

Do you think that the difficulty of finding parking on UTAR Kampar Campus impacts your academic performance? *

- Yes
- No

How much time do you typically spend searching for a parking spot on UTAR Kampar Campus? *

- Around 5 min
- More than 10min
- More than 30min

Submit

Clear form

Figure 3 Questionnaire.

The questionnaire is a critical tool in understanding the difficulties faced by students when it comes to finding a parking space at UTAR Kampar Campus. It was created using Google Forms and randomly distributed to 10 students for the survey purpose. The results obtained from the survey will be analysed to gain a better insight into the problems students face and improve the development of a custom YOLOv4 detector model that can accurately detect vacant and occupied parking spaces on UTAR Kampar Campus.

The questionnaire survey results were collected and analysed using the graph generated by Google Forms. According to the results shown in Figure 4, an overwhelming 90% of the survey respondents found it challenging to find parking on UTAR Kampar Campus. This highlights the pressing need to address the parking problems on campus. Figure 5 shows that 90% of the survey respondents also experience difficulty finding parking very often, indicating that the problem is not a one-time occurrence, but a recurring issue.

The survey also sought to determine the impact of parking problems on academic performance. As shown in Figures 6 and 7, 80% of the total survey respondents had been late to class or missed a class before due to finding a parking spot on UTAR Kampar Campus. Additionally, 80% of the survey respondents believed that the difficulty of finding parking had a negative impact on their academic performance. This is a concerning issue that requires attention to improve student's academic performance.

Finally, the survey aimed to determine the amount of time spent searching for parking on campus. As indicated in Figure 8, 70% of the survey respondents typically spend more than 10 minutes to find a parking spot in UTAR Kampar Campus. 10% of the respondents take more than 30 minutes to find a parking spot. This information indicates that students spend a considerable amount of time searching for parking, which not only wastes time but also adds to carbon emissions on campus.

In conclusion, the results of the questionnaire highlight the pressing need to improve parking facilities at UTAR Kampar Campus. The survey provides valuable data to develop a custom YOLOv4 detector model that can accurately detect vacant and occupied parking spaces on campus.

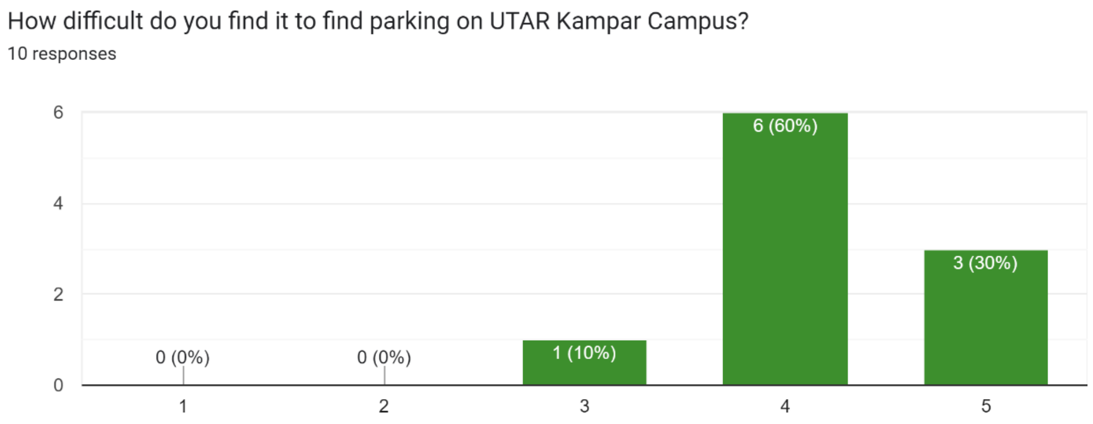


Figure 4 Questionnaire question 1.

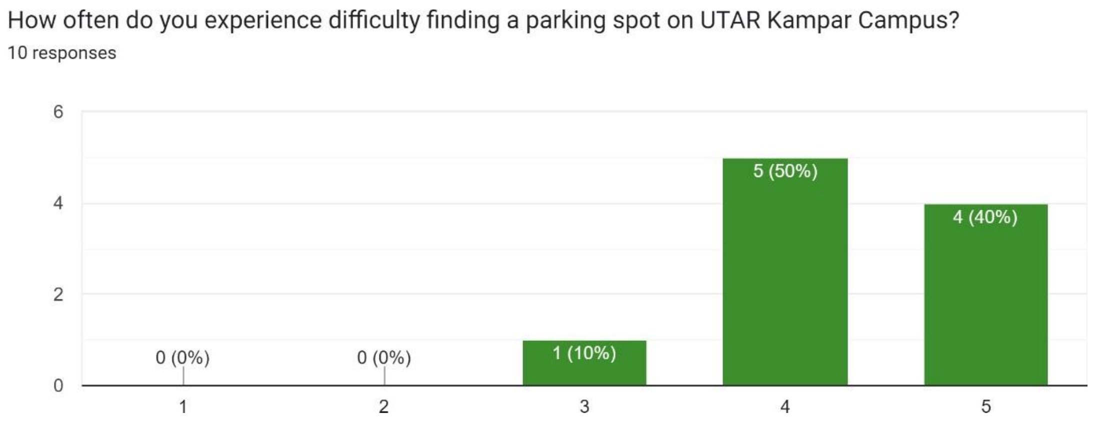


Figure 5 Questionnaire question 2.

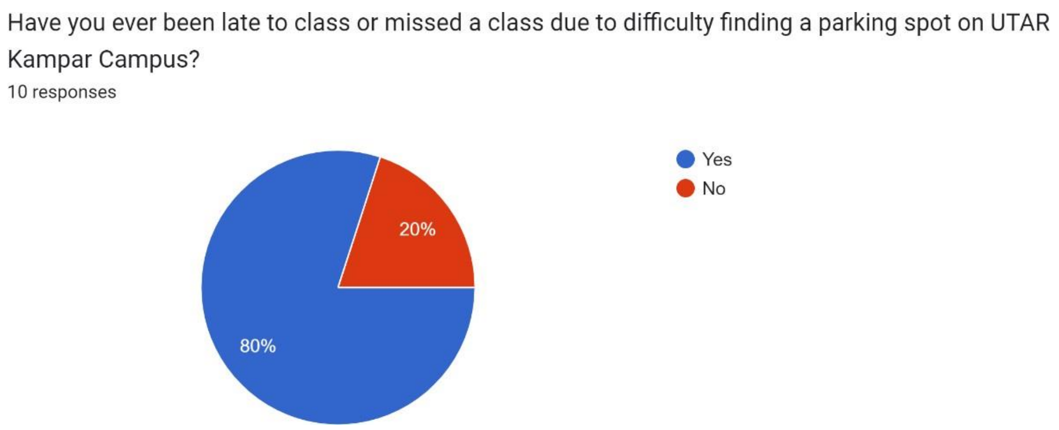


Figure 6 Questionnaire question 3.

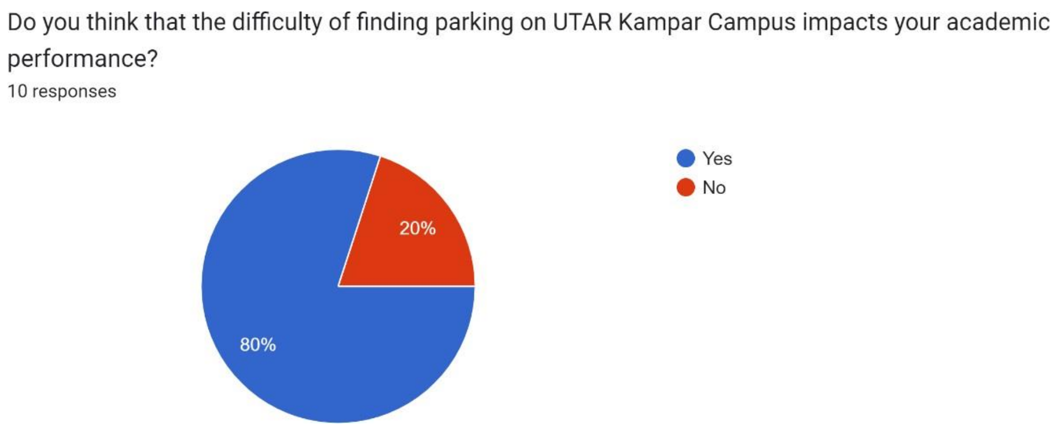


Figure 7 Questionnaire question 4.

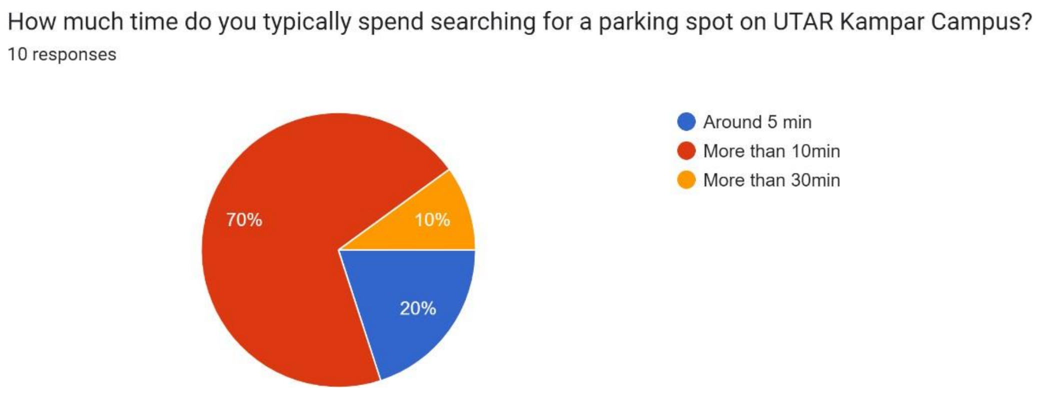


Figure 8 Questionnaire question 5.

2.3 Critical Remarks of previous works

System	Strength	Weakness	References
Counter-based	▪ Help to get most out of parking spaces.	▪ Expensive to install and maintain. ▪ Individual parking occupancy status cannot be determined.	[9]
Sensor-based	▪ Low-cost. ▪ Real-time system.	▪ Sensors are high power consumption. ▪ Weak signal when placed under cover plate.	[3] [4] [10]
Vision-based	▪ Cost effective. ▪ Lower false detection of background images. ▪ Strong spatial constraint on bounding box prediction. ▪ High precision.	▪ Lack of specialties for deep knowledge. ▪ require regular monitoring.	[7] [3] [11]
Proposed method	▪ Low cost. ▪ Time efficient. ▪ High accuracy. ▪ Powerful GPU. ▪ Large database.	▪ Need a camera or drone to capture image. ▪ Require some programming language knowledge.	

Table 1 strength and weakness

CHAPTER 3

Proposed Method/Approach

The proposed approach is a novel and innovative solution to solve the challenging problem of finding a vacant parking spot for vehicles in the UTAR Kampar Campus. The method is based on developing a custom YOLOv4 detector model that can accurately identify both vacant and occupied parking lots in the area. The model will be trained using a large and diverse dataset that is specifically collected for this project, which will ensure that it is optimized for the unique characteristics of the UTAR Kampar Campus parking lot.

YOLOv4, or "You Only Look Once version 4," is a state-of-the-art object detection algorithm that has gained popularity in recent years due to its high accuracy and efficiency. It is a deep learning-based approach that utilizes a single neural network to simultaneously predict the class and location of objects in an image. This allows for real-time object detection with high accuracy, making it an ideal choice for detecting parking spaces in a crowded and dynamic environment such as the UTAR Kampar Campus.

Overall, the proposed method represents a cutting-edge approach to solving the problem of parking space detection in a crowded and challenging environment. By leveraging the power of deep learning and the YOLOv4 algorithm, this project aims to provide a highly accurate and efficient solution to the parking space detection problem in the UTAR Kampar Campus.

3.1 Design Specifications

The development of a custom YOLOv4 detector model involves several key steps. The first step is data collection, which involves gathering a dataset of images or videos that represent the objects that the model will be trained to detect. This can involve collecting data from various sources, such as online databases or by capturing images and videos using a camera. Once the data has been collected, the next step is data preprocessing. This involves preparing the data for training by resizing the images, normalizing the pixel values, and creating annotation files that define the location and size of the objects in each image. After the data has been preprocessed, the model can be trained using the Darknet framework and YOLOv4 architecture. This involves setting the hyperparameters of the model, such as the learning rate and batch size, and optimizing the model to minimize the loss function during training. Finally, the model must be evaluated to determine its performance and accuracy. This involves using a test set of images to evaluate the model's ability to detect objects and compute metrics such as precision, recall, etc. Overall, the methodology for developing a custom YOLOv4 detector model involves a series of iterative steps that involve data collection, data preprocessing, model training, and model evaluation. The process requires careful attention to detail and a deep understanding of the underlying principles of deep learning and computer vision. The YOLOv4 architecture are as figure 9 and the results of YOLOv4 are as figure 10. Tool to use in this project for data collection are a drone to capture the image of parking lot, besides that, for the tool to use in data preprocessing is “labellmg” software to draw bounding boxes in image. Moreover, for model training and model evaluating, the tool to use are “Google Colab” and “Google Drive”, user need a “Google” account to using the “Google Colab” and “Google Drive” service. The YOLOv4 architecture are as in Figure 9, and the comparison of YOLOv4 with YOLOv3 and the others object detection are in Figure 10.

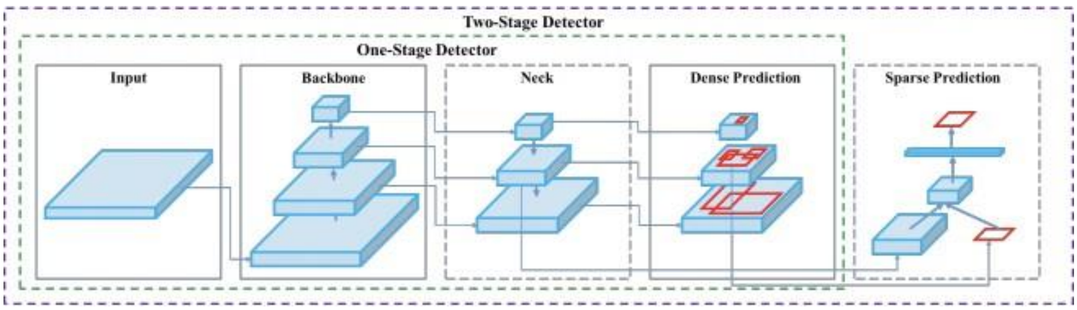


Figure 9 YOLOv4 architecture [12]**.**

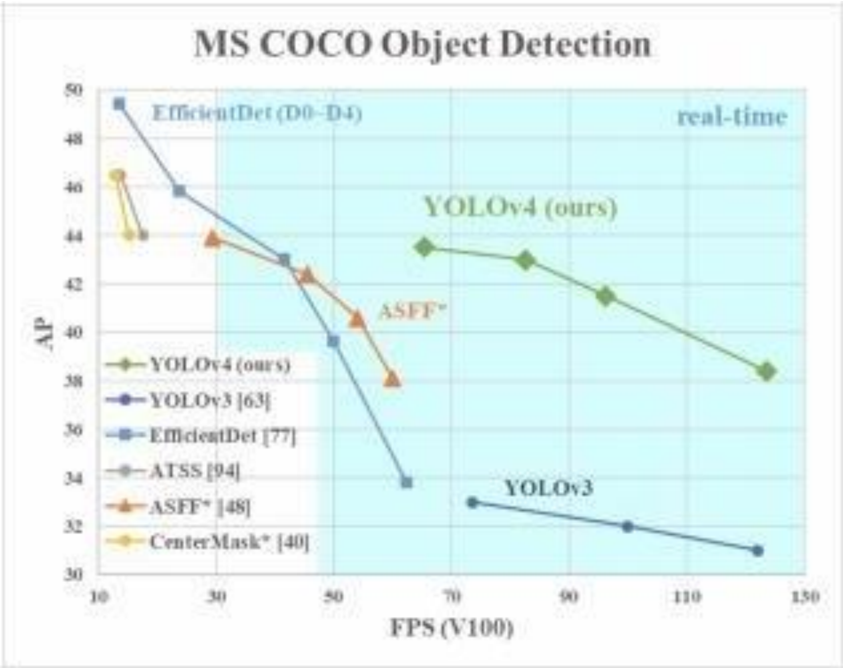


Figure 10 YOLOv4 results [12]**.**

To train the YOLOv4 custom object detector model, the implementation in "Google Colab" is very important. The implementation in "Google Colab" starts with changing the Hardware accelerator of runtime type to a GPU as in the Figure 11 below.

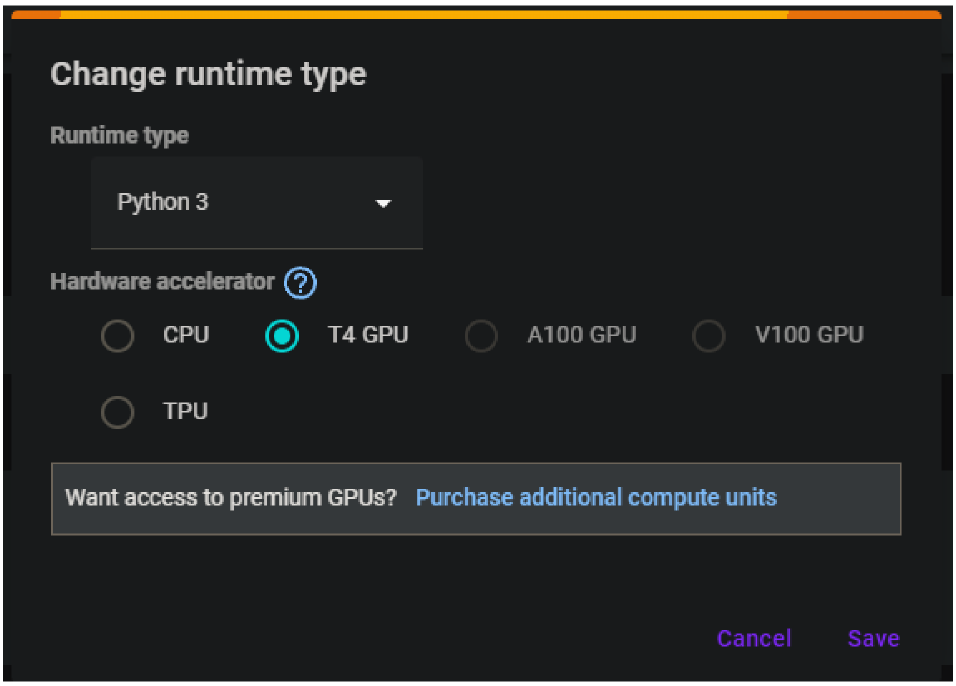
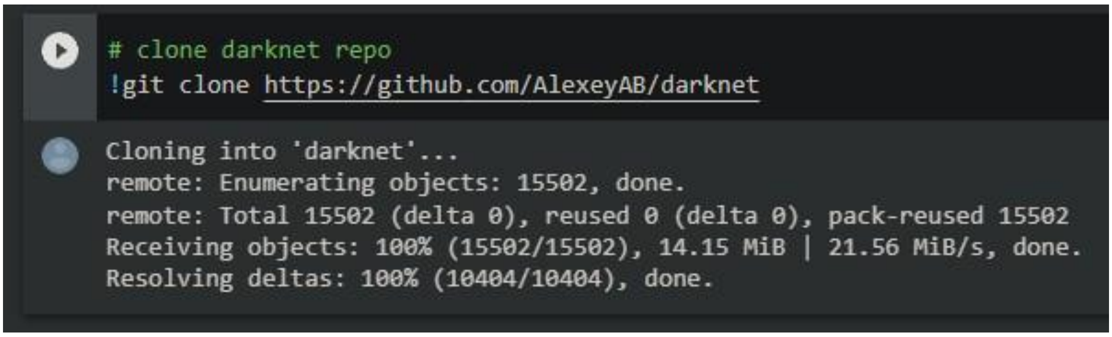


Figure 11 runtime type.

After that, clone the darknet repo to the "Google Colab" and the result should show as in Figure 12 below.

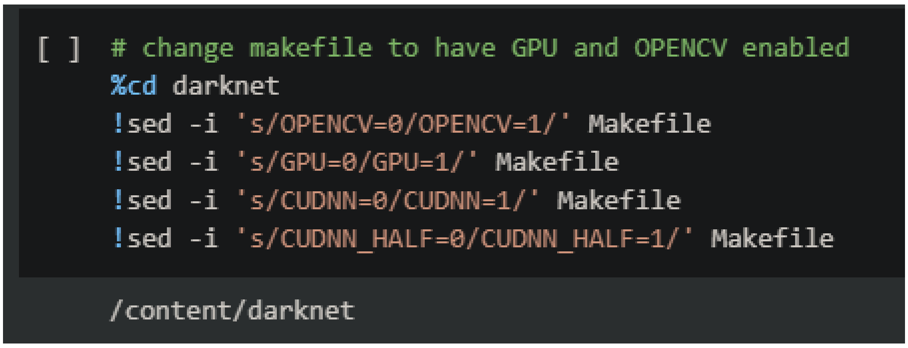


```
# clone darknet repo
!git clone https://github.com/AlexeyAB/darknet

Cloning into 'darknet'...
remote: Enumerating objects: 15502, done.
remote: Total 15502 (delta 0), reused 0 (delta 0), pack-reused 15502
Receiving objects: 100% (15502/15502), 14.15 MiB | 21.56 MiB/s, done.
Resolving deltas: 100% (10404/10404), done.
```

Figure 12 clone darknet.

Next, change the "makefile" to have GPU and OPENCV enabled, this is to allow GPU and OPENCV enabled for the build of YOLOv4 later. The result should show as in Figure 13 below.



```
[ ] # change makefile to have GPU and OPENCV enabled
    %cd darknet
    !sed -i 's/OPENCV=0/OPENCV=1/' Makefile
    !sed -i 's/GPU=0/GPU=1/' Makefile
    !sed -i 's/CUDNN=0/CUDNN=1/' Makefile
    !sed -i 's/CUDNN_HALF=0/CUDNN_HALF=1/' Makefile

    /content/darknet
```

Figure 13 change makefile.

Next step is to verify the CUDA in "Google Colab", CUDA, Compute Unified Device Architecture is a parallel computing platform and application programming interface (API) developed by NVIDIA. It allows developers to harness the power of NVIDIA GPUs for general-purpose processing tasks beyond just graphics rendering. The result should show as in the Figure 14 below.

```
# verify CUDA
!/usr/local/cuda/bin/nvcc --version

nvcc: NVIDIA (R) Cuda compiler driver
Copyright (c) 2005-2022 NVIDIA Corporation
Built on Wed_Sep_21_10:33:58_PDT_2022
Cuda compilation tools, release 11.8, V11.8.89
Build cuda_11.8.r11.8/compiler.31833905_0
```

Figure 14 verify CUDA.

Next step is to start building the darknet, darknet is built for executable file to run or train object detectors. The process could take a several minutes and the result should start like the Figure 15 below.

```
[ ] # make darknet (builds darknet so that you can then use the darknet executable file to run or train object detectors)
    !make

    mkdir -p ./obj/
    mkdir -p backup
    chmod +x *.sh
    g++ -std=c++11 -std=c++11 -Iinclude/ -I3rdparty/stb/include -DOPENCV `pkg-config --cflags opencv4 2> /dev/null || pkg-
    ./src/image_opencv.cpp: In function ‘void draw_detections_cv_v3(void**, detection*, int, float, char**, image**, int,
    ./src/image_opencv.cpp:946:23: warning: variable ‘rgb’ set but not used [-Wunused-but-set-variable]
      946 |                 float rgb[3];
          |                       ^~~
    ./src/image_opencv.cpp: In function ‘void draw_train_loss(char*, void**, int, float, float, int, int, float, int, char
    ./src/image_opencv.cpp:1147:13: warning: this ‘if’ clause does not guard... [-Wmisleading-indentation]
     1147 |             if (iteration_old == 0)
          |             ^~
    ./src/image_opencv.cpp:1150:10: note: ...this statement, but the latter is misleadingly indented as if it were guarded
     1150 |          if (iteration_old != 0){
          |          ^~
    ./src/image_opencv.cpp: In function ‘void cv_draw_object(image, float*, int, int, int*, float*, int*, int, char**)’:
    ./src/image_opencv.cpp:1444:14: warning: unused variable ‘buff’ [-Wunused-variable]
     1444 |         char buff[100];
          |              ^~~~
    ./src/image_opencv.cpp:1420:9: warning: unused variable ‘it_tb_res’ [-Wunused-variable]
     1420 |     int it_tb_res = cv::createTrackbar(it_trackbar_name, window_name, &it_trackbar_value, 1000);
          |         ^~~~~~~~~
    ./src/image_opencv.cpp:1424:9: warning: unused variable ‘lr_tb_res’ [-Wunused-variable]
     1424 |     int lr_tb_res = cv::createTrackbar(lr_trackbar_name, window_name, &lr_trackbar_value, 20);
          |         ^~~~~~~~~
    ./src/image_opencv.cpp:1428:9: warning: unused variable ‘cl_tb_res’ [-Wunused-variable]
     1428 |     int cl_tb_res = cv::createTrackbar(cl_trackbar_name, window_name, &cl_trackbar_value, classes-1);
          |         ^~~~~~~~~
    ./src/image_opencv.cpp:1431:9: warning: unused variable ‘bo_tb_res’ [-Wunused-variable]
     1431 |     int bo_tb_res = cv::createTrackbar(bo_trackbar_name, window_name, boxonly, 1);
          |         ^~~~~~~~~
```

Figure 15 make.

Next, define the helper functions in “Google Colab” to amplify the steps later. The helper functions are shown in the Figure 16 below.

```
[ ] # define helper functions
    def imShow(path):
      import cv2
      import matplotlib.pyplot as plt
      %matplotlib inline

      image = cv2.imread(path)
      height, width = image.shape[:2]
      resized_image = cv2.resize(image,(3*width, 3*height), interpolation = cv2.INTER_CUBIC)

      fig = plt.gcf()
      fig.set_size_inches(18, 10)
      plt.axis("off")
      plt.imshow(cv2.cvtColor(resized_image, cv2.COLOR_BGR2RGB))
      plt.show()

    # use this to upload files
    def upload():
      from google.colab import files
      uploaded = files.upload()
      for name, data in uploaded.items():
        with open(name, 'wb') as f:
          f.write(data)
          print ('saved file', name)

    # use this to download a file
    def download(path):
      from google.colab import files
      files.download(path)
```

Figure 16 helper function.

Next, link the “Google Colab” to the “Google Drive”. The result should show as in Figure 17 below.

```
[ ] %cd ..
    from google.colab import drive
    drive.mount('/content/gdrive')

    /content
    Mounted at /content/gdrive
```

Figure 17 link colab to drive.

Next, create a symbolic link so that the path “/content/gdrive/My\ Drive/” is equal to “/mydrive” to make the coding cleaner. The result should show as in the Figure 18 below.

```
[ ]  # this creates a symbolic link so that now the path /content/gdrive/My\ Drive/ is equal to /mydrive
     !ln -s /content/gdrive/My\ Drive/ /mydrive
     !ls /mydrive

     Yolo
```

Figure 18 symbolic link.

Next, cd back into the darknet folder to run detections. The result should show as in the Figure 19 below.

```
[ ]  # cd back into the darknet folder to run detections
     %cd darknet

     /content/darknet
```

Figure 19 cd back to darknet.

Next, copy the datasets that processed and ready in the "Google Drive" file into the root directory of the "Google Colab" virtual machine. The code is shown as in the Figure 20 below.

```
[ ]  # copy over both datasets into the root directory of the Colab VM
     !cp /mydrive/Yolo/obj.zip ../
```

Figure 20 datasets.

Next, unzip the datasets and their contents to the "/darknet/data/" folder. This process could take a few minutes if the datasets is huge, and the result should start like the Figure 21 below.

```
[ ] # unzip the datasets and their contents so that they are now in /darknet/data/ folder
    !unzip ../obj.zip -d data/
    #!unzip ../test.zip -d data/

    Archive:  ../obj.zip
      inflating: data/obj/1.jpg
      inflating: data/obj/1.txt
      inflating: data/obj/2.jpg
      inflating: data/obj/2.txt
      inflating: data/obj/3.jpg
      inflating: data/obj/3.txt
      inflating: data/obj/4.jpg
      inflating: data/obj/4.txt
      inflating: data/obj/A1.jpg
      inflating: data/obj/A1.txt
```

Figure 21 unzip datasets.

Next, upload several files to the “Google Colab” virtual machine from “Google Drive”. The results are shown in Figure 22 below.

```
[ ] # upload the custom .cfg back to cloud VM from Google Drive
    !cp /mydrive/Yolo/parkinglot.cfg ./cfg
    !cp /mydrive/Yolo/parkinglot.weights ./

[ ] # upload the obj.names and obj.data files to cloud VM from Google Drive
    !cp /mydrive/Yolo/obj.names ./data
    !cp /mydrive/Yolo/obj.data  ./data

[ ] # upload the generate_train.py and generate_test.py script to cloud VM from Google Drive
    !cp /mydrive/Yolo/generate_train.py ./
    #!cp /mydrive/Yolo/generate_test.py ./
```

Figure 22 upload several files.

Next step is to train the custom detector, if the detector model is hard to train, this process could take more than few days and the training is needed to continue start from where it last saved because “Google Colab” has the set the limit of GPU usage for the free user, and when the GPU usage is finish, the free user can only get to continue to use the GPU the next 24 hours or more. The coding is shown in the Figure 23 below.

```
[ ] # train your custom detector! (uncomment %%capture below if you run into memory issues or your Colab is crashing)
    #%%capture
    #!./darknet detector train data/obj.data cfg/parkinglot.cfg parkinglot.weights -dont_show -map -clear

[ ] # kick off training from where it last saved
    !./darknet detector train data/obj.data cfg/parkinglot.cfg /mydrive/Yolo/backup/parkinglot_last.weights -dont_show
```

Figure 23 training.

3.2 System Design / Overview

This project is design for when a user input an image of parking lot into the custom YOLOv4 detection model, the output will be an image same with the image user input but with some bounding box prediction of vacant or occupied parking lot. To develop the custom YOLOv4 detector model, a series of steps will be taken, including data collection, data preprocessing, model training, and model evaluation. The data collection process involves gathering a large number of images of the parking lot area, both with and without cars present. The data is collected with a drone, for example DJI Mavic Mini in figure 24 is used in this project and in figure 25 Block N parking lot with cars is presents as the images of parking lot with cars and figure 26 Block N parking lot without cars is presents as the images of parking lot without cars. Data preprocessing involves preparing the data for use in the model training process. This may involve tasks such as resizing images, normalizing pixel values, splitting the dataset into training and testing sets and label the image to indicate the location and status of each parking space is empty or occupied in the image. For example, in figure 27 Block N with cars labelled and figure 28 Block N without cars labelled, the cars in the figures are surround with blue color box to present as the parking lot is already occupied, and the empty parking lots in the figures are surround with orange color box to present as the vacant parking lot, the software uses for labelling the image is “labellmg”. The model training process involves using the prepared data to train the custom YOLOv4 detector model. This process involves configuring the network architecture, defining the loss function, and adjusting hyperparameters such as the learning rate and batch size. Finally, the model evaluation process involves testing the trained model on a separate dataset to measure its accuracy and performance. This allows for fine-tuning of the model and further refinement of the model parameters. All of the process involves in training process and evaluation process are done in “Google Colab” as it offers free and powerful GPU and has large storage space that can store datasets and trained models, “Google Drive” also included in the process for saving the “Google Colab” file and link the “Google Colab” to “Google Drive” to save some input or output file. Users need to have a “Google” account to use the “Google Colab” and “Google Drive” service. The model training process is start by building the darknet on “Google Colab” to use the darknet executable file to run or train object detectors, then upload the prepared custom configure file, train and test data into the “Google Colab” and finally train the model to able to detect the vacant and occupied parking lot. The detail code to train the model in "Google Colab" are refer to [13] and a video of [14]. The project is targeted to have at least 70% accuracy of detecting the empty and occupied parking lots in UTAR Kampar Campus. User also need some basic knowledge of how to code the YOLOv4 in "Google Colab" to generate results. The verification plan of this project could be the details on the types of input images that need to be tested, for example images of different parking lot, images of different angle, and image of different resolutions. Besides that, the expected bounding box predictions, and confidence scores for each object in the image could also be part of the verification plan. The aim of this project is to achieve a high level of accuracy in the bounding box predictions, with a target of 70% accuracy across the entire image. In order to ensure that this target is met, a thorough data preprocessing process will be employed. If the targeted accuracy is not achieved, the process will be repeated with the addition of new data sets. This iterative approach will allow for continuous improvement of the model and ultimately result in a more accurate YOLOv4 custom detector for vacant parking lots on UTAR Kampar Campus. The Block Diagram of the system are as figure 29.

Figure 24 DJI Mavic Mini.

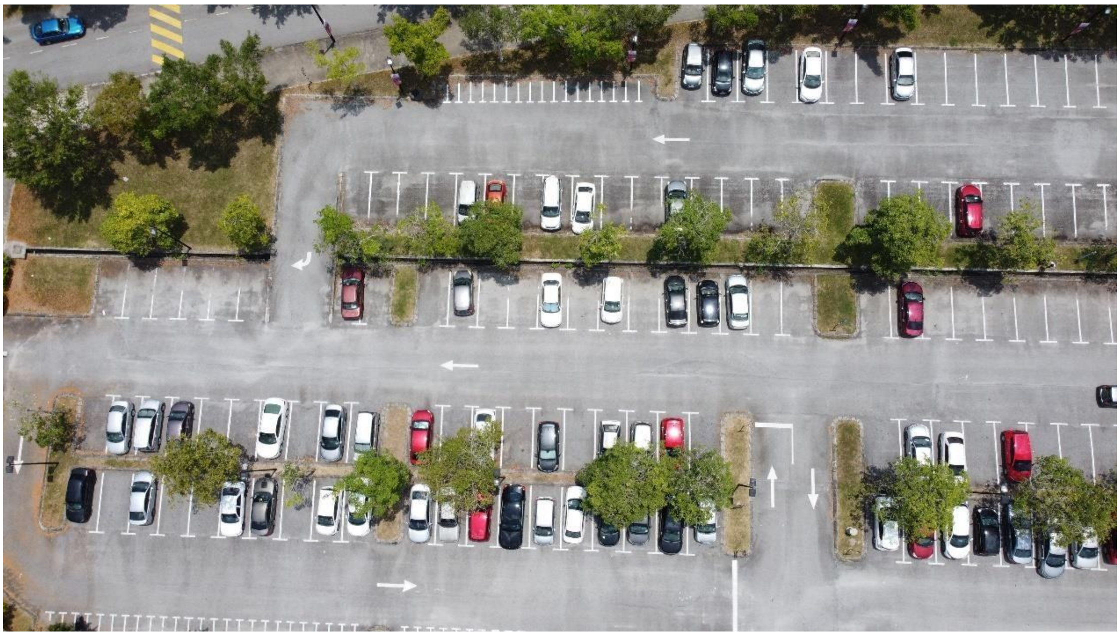


Figure 25 Block N parking lot with cars.

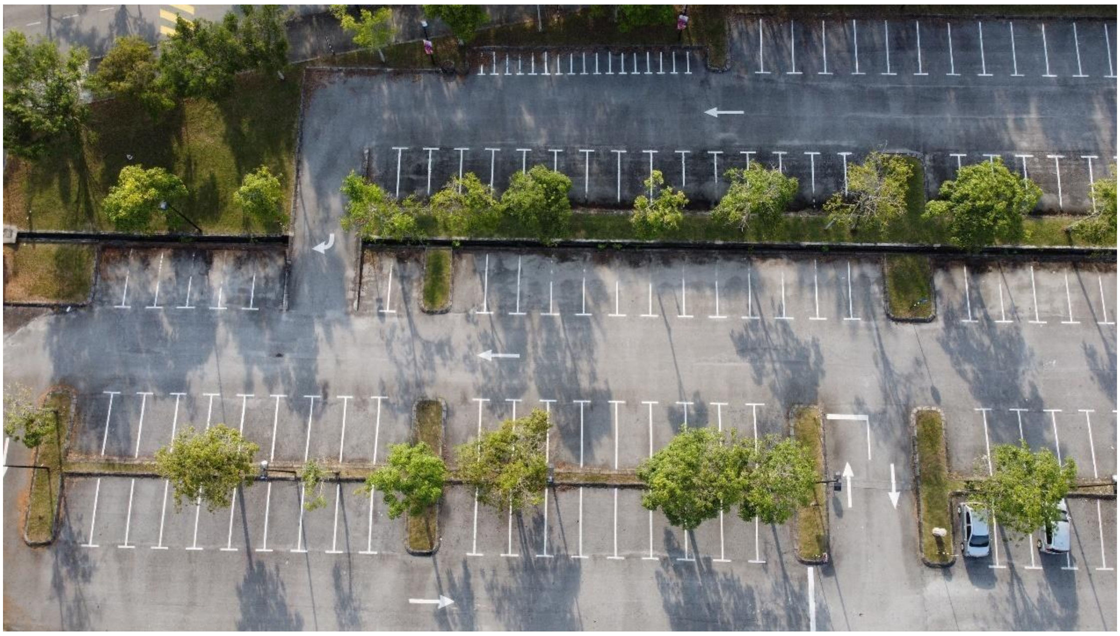


Figure 26 Block N parking lot without cars.

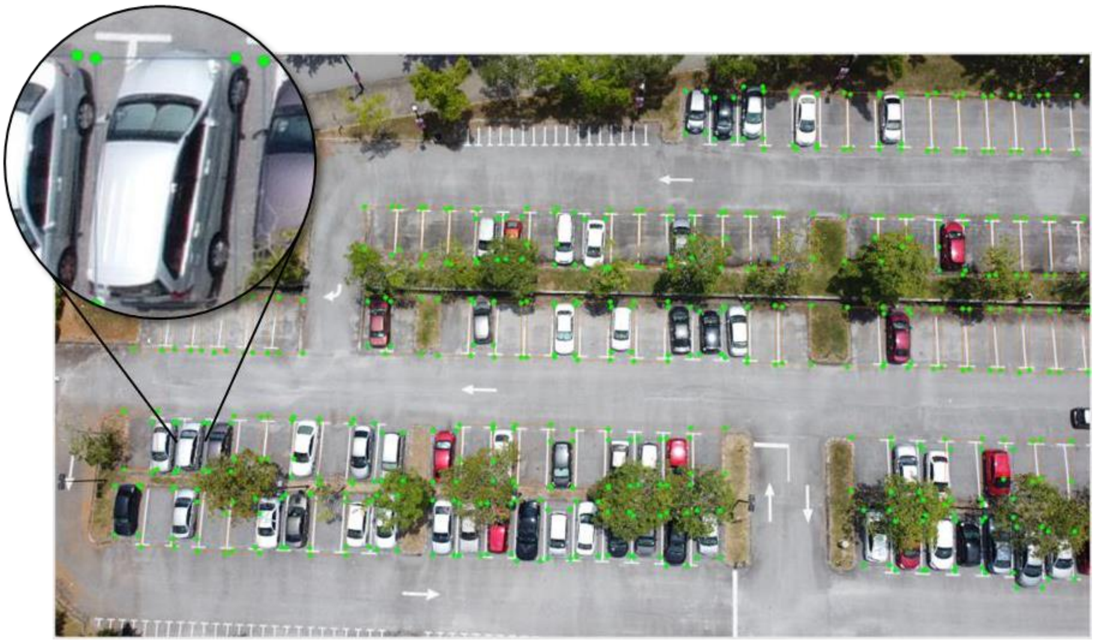


Figure 27 Block N with cars labelled.

Figure 28 Block N with cars labelled.

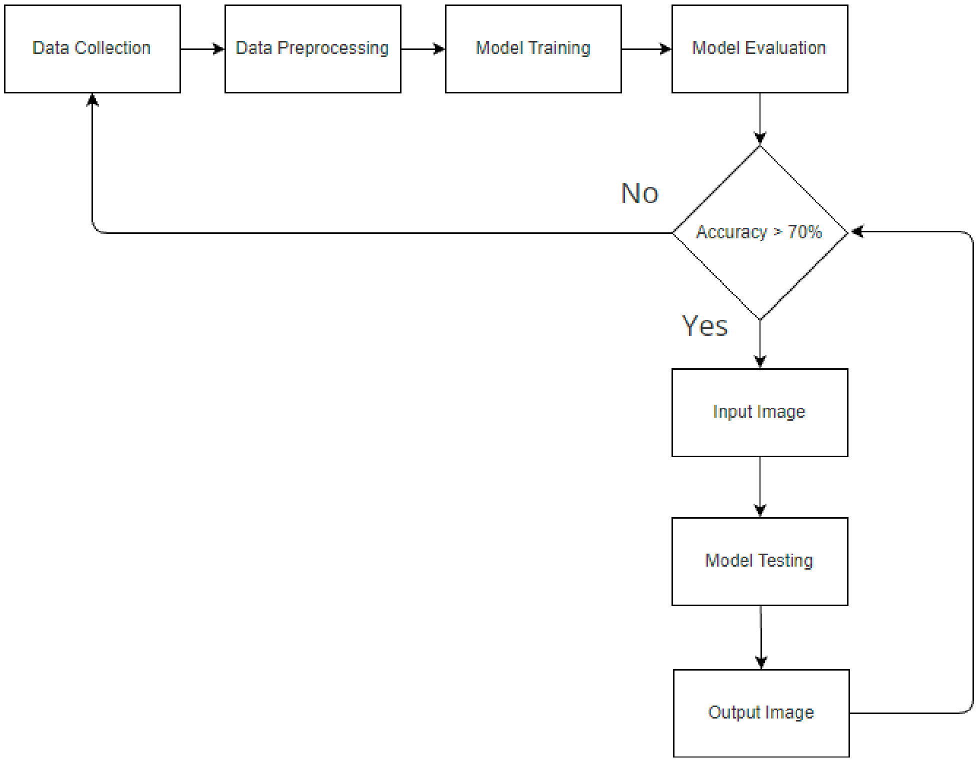


Figure 29 Block diagram.

3.3 Implementation Issues and Challenges

The development of any project can present various challenges and issues that need to be addressed in order to ensure its success. In the case of developing a custom YOLOv4 detector model, there are several challenges that can arise throughout the process.

One of the main challenges faced by developers in this type of project is the need to collect a large and diverse dataset of images or videos for training the model. This can be a time-consuming and complex process, especially when dealing with objects that are huge to capture. Additionally, the quality of the data can have a significant impact on the performance and accuracy of the model, which means that careful attention must be paid to data preprocessing and cleaning. Another challenge that can arise is related to the training and optimization of the model. This can involve choosing the right hyperparameters, selecting appropriate loss functions, and balancing the trade-offs between accuracy and speed. Additionally, debugging and optimizing the code can be a time-consuming and difficult process, especially when dealing with large and complex models like YOLOv4. Overall, developing a custom YOLOv4 detector model requires a significant amount of skill, expertise, and perseverance. While there may be challenges and issues along the way, overcoming these obstacles can ultimately lead to the development of a powerful and effective tool for object detection and classification.

3.4 Timeline

When developing a project, creating an estimated timeline for deliverables and milestones is a critical aspect of ensuring that the project is completed on time and within budget. There are various stages involved in the development of a custom YOLOv4 detector model, including data collection, data preprocessing, model training, and model evaluation. Each stage can take a different amount of time to complete, and it is important to consider these timelines when developing an overall project plan.

Before starting the development of the project, it is recommended to conduct a meeting with the supervisor to discuss the project's scope and requirements. This meeting typically takes about two weeks to complete, and it can help to ensure that the project is aligned with the supervisor's expectations and goals. The data collection process is a critical stage in the development of the model, as it involves gathering a large and diverse dataset of images or videos for training the model. This process can take up to two weeks to complete, as it requires careful planning and execution to ensure that the data is relevant and of high quality. The data preprocessing stage involves cleaning and preparing the data for use in training the model. This stage can take up to two weeks to complete, as it involves a variety of tasks such as data augmentation, normalization, and balancing. The model training process is the most time-consuming stage in the development of the model, as it involves running the model on the training data to optimize its parameters and weights. This process can take up to three weeks to complete, as it requires a significant amount of computational resources and careful monitoring to ensure that the model is converging to the optimal solution. Finally, the model evaluation stage involves testing the model on a separate dataset to assess its accuracy and performance. This stage can take up to two weeks to complete, as it involves a variety of tasks such as calculating precision and recall metrics, visualizing the model's outputs, and comparing its performance to other state-of-the-art models.

Overall, creating an estimated timeline for deliverables and milestones in the development of a custom YOLOv4 detector model requires careful planning and consideration of the time required for each stage of the project. By taking a structured and organized approach to the project, it is possible to ensure that the project is completed on time and within budget while achieving its intended goals and objectives. Planning for current semester is complete a demo version which can test with an input image of parking lot of UTAR Kampar Campus and a successful prediction of at least 70% of accuracy on vacant and occupied parking lots, and able to count and print out the total numbers of vacant parking lots in the image.

Chapter 4

Study Review

4.1 Preliminary Study

In developing a custom YOLOv4 detector model, the preliminary work done, and the results obtained are crucial to assessing the effectiveness and accuracy of the proposed method. One example of such results may involve using the custom model to detect vacant and occupied parking lots in an image, as shown in Figure 30. The confidence level of the bounding box prediction is an important factor in evaluating the accuracy of the model, and in this case, the confidence level is consistently high, around 0.99 or 1, indicating a high degree of accuracy.

However, it is important to note that the accuracy of the model may be affected by various factors, such as the resolution and lighting conditions of the input image, as well as the presence of objects that may obstruct the view of the parking lot. In the case of Figure 30, the input image has a clear resolution and good lighting conditions, and there are relatively few obstructions such as trees that may block the view of the parking lot. As a result, the accuracy of the detection in this image is considered to be 100% as the model detector able to detect every vacant and occupied parking lot in this image.

To further evaluate the effectiveness of the proposed method, it may be necessary to conduct additional experiments using a variety of input images with varying resolutions, lighting conditions, and obstructions. This will help to determine the robustness of the custom YOLOv4 detector model and identify any limitations or areas for improvement. By carefully analyzing the preliminary results and conducting further experiments, it is possible to refine the proposed method and develop a custom YOLOv4 detector model that is accurate, effective, and practical for real-world applications.

Figure 30 Block N result.

4.2 Extensive Study

To enhance the model's accuracy and broaden its ability to predict parking availability across various locations within UTAR Kampar Campus, an expanded dataset was collected. This dataset included images captured from different parking lots on campus. Prior to model training, these images underwent thorough data preprocessing to ensure uniformity and quality.

Through an iterative process involving multiple rounds of data collection, preprocessing, and model training, significant progress was achieved. The model has now become proficient at accurately predicting parking availability in several specific parking lots on UTAR Kampar Campus.

Among these lots, Block N (Figure 31), Block M (Figure 32), Block H (Figure 33), Block B (Figure 34), and Block A (Figure 35) demonstrated notably higher accuracy compared to other parking areas. Particularly, Block N displayed the highest accuracy among them, indicating that the model excels in assessing parking availability in this specific lot.

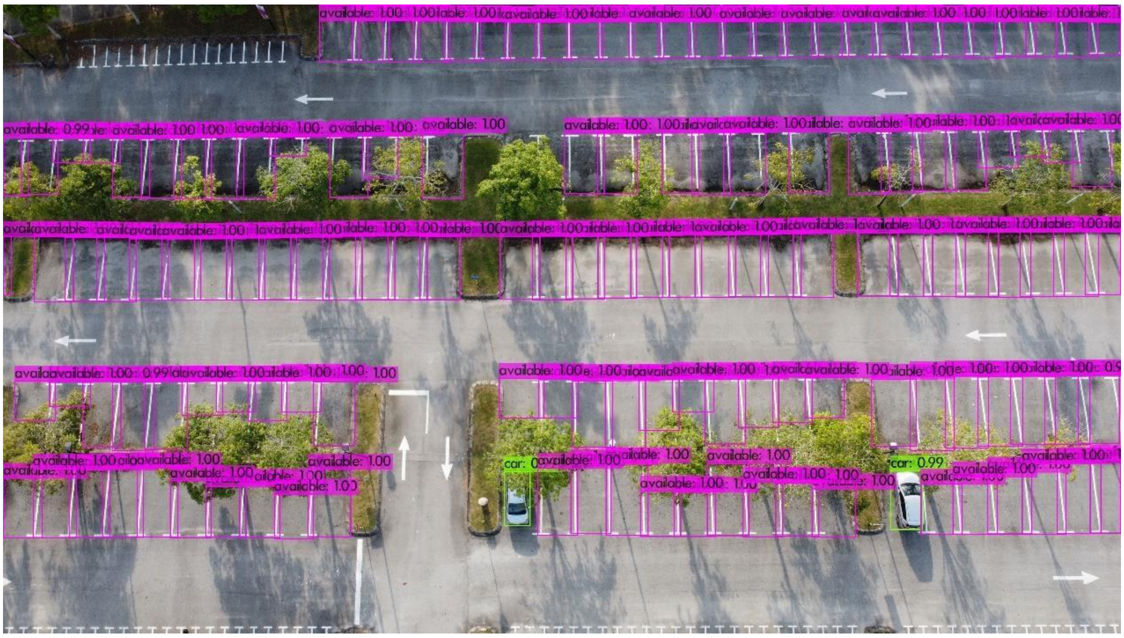


Figure 31 Block N without cars result.

Figure 32 Block M.

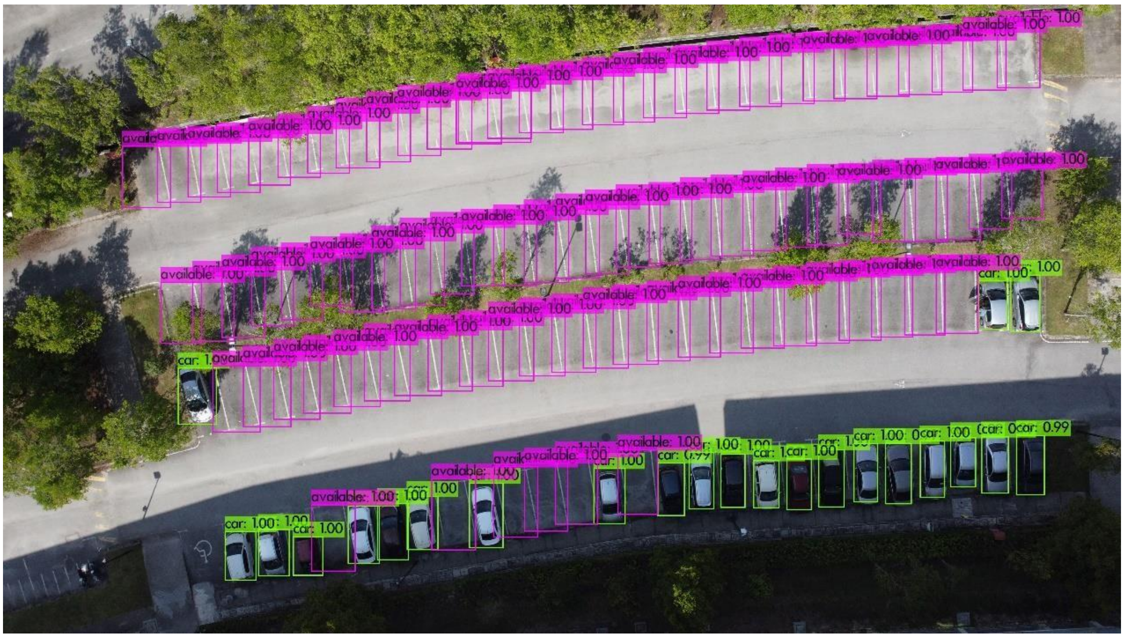


Figure 33 Block H.

Figure 34 Block B.

Figure 35 Block A.

To present parking lot information efficiently to users, it is more convenient if the system can autonomously calculate and display the total count of available parking lots. The code presented in Figure 36 is specifically designed to fulfil this task. It enables the system to automatically tally and present the total number of cars and available parking lots within the "after predicted" image. Furthermore, this information is saved as a text file for reference to display to the user.

For instance, Figure 37 illustrates the resulting text file generated from the image showcased in Figure 31. This file showcases the calculated totals for both cars and available parking lots. This functionality simplifies the process of conveying critical parking information to users, making the system more user-friendly and informative.

```
import json

with open('result.txt', 'r') as f:
    results = json.load(f)

classes = {}

for result in results:
    for obj in result['objects']:
        class_name = obj['name']
        if class_name not in classes:
            classes[class_name] = 1
        else:
            classes[class_name] += 1

with open('predictions.txt', 'w') as f:
    for class_name, count in classes.items():
        f.write(f"Total {class_name}: {count}\n")
        print(f"Total {class_name}: {count}")

print("Predictions saved to predictions.txt.")
```

Figure 36 functions.py.

```
Total car: 2
Total available: 137
```

Figure 37 Block N text file.

CHAPTER 5

Conclusion and Recommendations

In conclusion, the project aims to solve the problem of difficulty in finding parking spots on UTAR Kampar Campus. The motivation behind this project is to reduce the time, fuel wasted, and difficulty on searching for parking, lower carbon emissions, and promote eco-friendliness. The proposed solution is the development of a custom YOLOv4 detector model that accurately detects vacant and occupied parking spaces on the campus. The project methodology includes the use of a questionnaire to gather data on the extent of the parking problem. The collected data will be used to improve the accuracy of the detector model. The project's success will provide benefits for students and staff by providing the latest information on parking lot availability, reducing the instances of illegal parking, and improving academic performance by reducing the number of missed classes due to parking difficulties. Overall, the project presents a practical solution to a prevalent problem on the UTAR Kampar Campus.

In terms of recommendations, if the intention is to implement this project in real-world scenarios, UTAR Kampar Campus could consider installing cameras strategically placed around the parking lots. These cameras could capture images at regular intervals, say every 5 minutes, and compile them into a single image where all parking lots are clearly visible without any overlap. This compiled image could then be forwarded to a computer system that has the model installed for automated detections. To further enhance the accuracy of the vacant parking space detector, it is advisable to repeat the data collection, data preprocessing, and model training phases. However, in this revised approach, the initial data collection process could be substituted with the utilization of the compiled image that offers a comprehensive view of all parking lots without overlap. This method could potentially streamline the data collection process and improve the overall efficiency of the system to detect the status of parking lots in UTAR Kampar Campus.

REFERENCES

[1] M. Z. Abidin and R. Pulungan, "A Systematic Review of Machine-vision-based Smart Parking Systems," *Scientific Journal of Informatics*, vol. 7, no. 2, pp. 213–228, 2020.

[2] M. Muzhafar, A. Kadir, M. N. Osman, A. Othman, and K. A. Sedek, "IoT based Car Parking Management System using IR Sensor," 2020.

[3] T. Bazzaza *et al.*, "Automatic Street Parking Space Detection Using Visual Information and Convolutional Neural Networks," in *Digest of Technical Papers - IEEE International Conference on Consumer Electronics*, Institute of Electrical and Electronics Engineers Inc., 2022. doi: 10.1109/ICCE53296.2022.9730584.

[4] A. Tatti, "Sensor Based Smart Parking System," 2018. [Online]. Available: www.ijisrt.com

[5] AKE, "Ultrasonic series indoor parking guidance system-AKE," 2020. https://www.akeparking.com/parkingsolutions/indoorparkingguidance/UltrasonicSeries/list/37.html (accessed Apr. 15, 2023).

[6] N. Vishnumurthy Ravipati, V. R. Narasimharao Mondreti, S. K. Satti, C. S. Gurugunti, and V. N. S. Lalitha Jakkampudi, "Computer Vision-Based System for Locating and Counting Vacant Parking Lot," in *IEEE International Conference on Data Science and Information System, ICDSIS 2022*, Institute of Electrical and Electronics Engineers Inc., 2022. doi: 10.1109/ICDSIS55133.2022.9915916.

[7] Y. Song, J. Zeng, T. Wu, W. Ni, and R. P. Liu, "Vision-based parking space detection: A mask R-CNN approach," in *2021 IEEE/CIC International Conference on Communications in China, ICCC 2021*, Institute of Electrical and Electronics Engineers Inc., Jul. 2021, pp. 300–305. doi: 10.1109/ICCC52777.2021.9580236.

[8] S. Mudiam, "Custom Object Detection with YOLO — Parking Lot Occupancy Model," 2020. https://www.clairvoyant.ai/blog/custom-object-detection-with-yolo-parking-lot-occupancy-model (accessed Apr. 15, 2023).

[9] V. Paidi, H. Fleyeh, J. Håkansson, and R. G. Nyberg, "Smart parking sensors, technologies and applications for open parking lots: A review," *IET Intelligent Transport Systems*, vol. 12, no. 8. Institution of Engineering and Technology, pp. 735–741, Oct. 01, 2018. doi: 10.1049/iet-its.2017.0406.

[10] nwave, "Pros and Cons of Smart Parking Systems," *https://www.nwave.io/pros-and-cons-of-smart-parking-systems/*, 2019.

[11] Simplilearn, "What Is Computer Vision: Applications, Benefits and How to Learn It," *https://www.simplilearn.com/computer-vision-article#:~:text=Here%20are%20a%20few%20limitations,to%20train%20computer%20vision%20systems.*, 2023.

[12] roboflow, "YOLOv4 Darknet Object Detection Model," 2022. https://roboflow.com/model/yolov4 (accessed Apr. 17, 2023).

[13] The AI Guy, "YOLOv4_Training_Tutorial.ipynb - Colaboratory." https://colab.research.google.com/drive/1_GdoqCJWXsChrOiY8sZMr_zbr_fH-0Fg?usp=sharing (accessed Apr. 14, 2023).

[14] The AI Guy, *YOLOv4 in the CLOUD: Build and Train Custom Object Detector (FREE GPU) - YouTube*, (Jun. 30, 2020). Accessed: Apr. 14, 2023. [Online Video]. Available: https://www.youtube.com/watch?v=mmj3nxGT2YQ&t=1185s

APPENDIX

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: May 2023	**Study week no.: 2**
Student Name & ID: Vincent Lee Wen Sheng 17ACB01268	
Supervisor: Dr Aun Yichiet	
Project Title: Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4	

1. WORK DONE [Please write the details of the work done in the last fortnight.] Meeting with supervisor about the development of the project.
2. WORK TO BE DONE Increase data collection.
3. PROBLEMS ENCOUNTERED
4. SELF EVALUATION OF THE PROGRESS

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: May 2023	**Study week no.: 6**
Student Name & ID: Vincent Lee Wen Sheng 17ACB01268	
Supervisor: Dr Aun Yichiet	
Project Title: Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4	

1. WORK DONE [Please write the details of the work done in the last fortnight.] Data collection, data preprocessing, model training.
2. WORK TO BE DONE Learn to code.
3. PROBLEMS ENCOUNTERED Cannot connect the code to the system.
4. SELF EVALUATION OF THE PROGRESS Learn to code.

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: May 2023	**Study week no.: 10**
Student Name & ID: Vincent Lee Wen Sheng 17ACB01268	
Supervisor: Dr Aun Yichiet	
Project Title: Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Done the python coding.

2. WORK TO BE DONE

Model Evaluation, evaluate the test result and try to optimize the model.

3. PROBLEMS ENCOUNTERED

Stuck in some coding about optimizing the model.

4. SELF EVALUATION OF THE PROGRESS

Learn new coding language knowledge.

Supervisor’s signature

Student’s signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: May 2023	**Study week no.: 11**
Student Name & ID: Vincent Lee Wen Sheng 17ACB01268	
Supervisor: Dr Aun Yichiet	
Project Title: Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Model Evaluation done and able to output a pretty result.

2. WORK TO BE DONE

Report writing.

3. PROBLEMS ENCOUNTERED

Finding some information source.

4. SELF EVALUATION OF THE PROGRESS

Learn about writing skills and more detail information about the machine learning.

Supervisor's signature

Student's signature

POSTER

Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4

1.0 Abstract

This project aims to develop a custom YOLOv4 detector model that can accurately detect vacant and occupied parking spaces on UTAR Kampar Campus. This project is to address the parking issues faced by students and staff on campus, which include difficulties in finding parking spots, illegal parking, and wasted time and fuel in search of parking. A questionnaire survey was conducted among 10 random students on campus. Based on the results, up to 90% of the surveyors find it difficult to find parking on campus, and 80% have been late to or missed classes due to parking issues. The project focuses on data preprocessing and augmentation, which involves collecting and labelling images of parking lots in various conditions, including lighting, weather, and vehicle types. The accuracy of the bounding box predictions is targeted to be above 70% for the whole image. If the targeted accuracy is not achieved, the data preprocessing process will start over again with the addition of new data sets.

2.0 Project scope

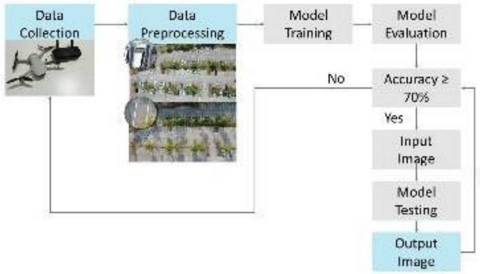
1) Develop a custom detector model based on YOLOv4 to accurately detect the occupancy status of parking lots at UTAR Kampar Campus
2) Train the model on a large and diverse dataset to ensure its effectiveness in various conditions and parking lot layouts
3) Provide a vacant parking space detector as a valuable tool for the students and staff to quickly identify a vacant spot, leading to a more efficient and stress-free parking experience
4) Contribute to the overall sustainability efforts of the campus by reducing time and fuel wasted on searching for parking spaces, reducing instances of illegal parking, and promoting eco-friendliness

3.0 Objectives

1) To develop a custom detector model using the YOLOv4 darknet framework
2) To count and print the total number of vacant and occupied parking lots in an image of the campus parking lot using the developed custom detector model
3) To train the YOLOv4 custom detector model to achieve the desired accuracy in detecting vacant and occupied parking lots in UTAR Kampar Campus

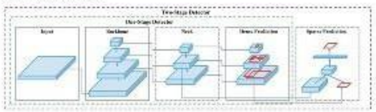
4.0 Methodology

4.1 Flow Chart

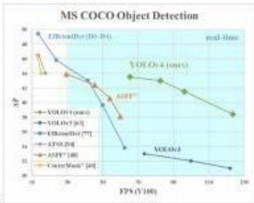


4.2 System Design

The development of a custom YOLOv4 detector model involves data collection, preprocessing, training, and evaluation. Data is collected by gathering a dataset of images or videos, which is then preprocessed by resizing, normalizing, and annotating the data. The model is trained using the Darknet framework and YOLOv4 architecture, and hyperparameters are optimized to minimize loss. The model is evaluated using a test set of images and computing metrics such as precision, recall, and F1 score. Data can be collected using a drone and preprocessed using the "labelImg" software, while model training and evaluation can be done using Google Colab and Drive.

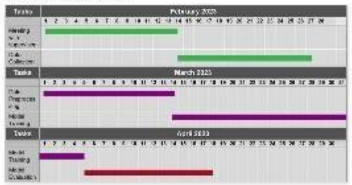


YOLOv4 architecture



YOLOv4 results

4.3 Project Timeline



Gantt chart

5.0 Preliminary Work

An example image of output in Block N

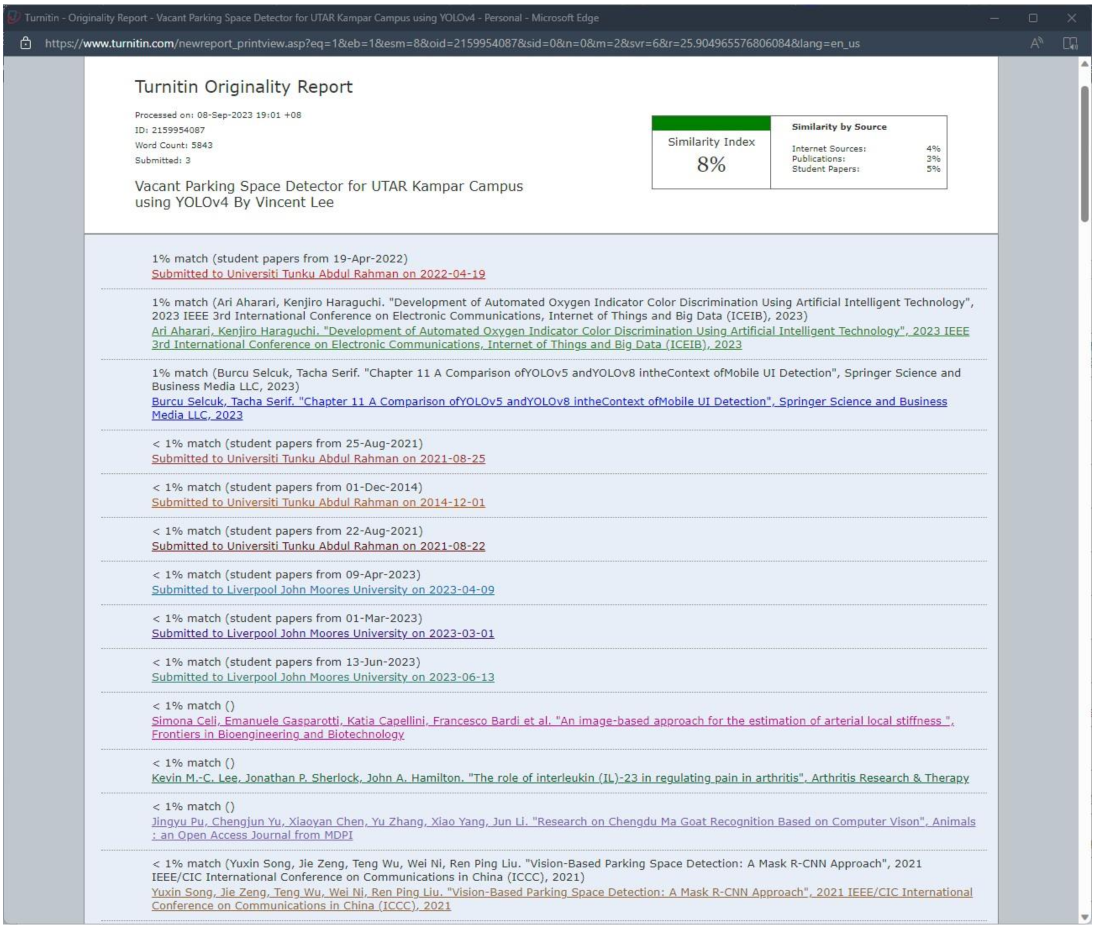
1) the confidence level is consistently high, around 0.99 or 1, indicating a high degree of accuracy
2) the accuracy of the detection in this image is considered to be 100% as the model detector able to detect every vacant and occupied parking lot in this image

6.0 Conclusion

1) The proposed solution is the development of a custom YOLOv4 detector model that accurately detects vacant and occupied parking spaces on the campus
2) The project's success will provide benefits for students and staff by providing the latest information on parking lot availability, reducing instances of illegal parking, and improving academic performance by reducing the number of missed classes due to parking difficulties
3) Overall, the project presents a practical solution to a prevalent problem on the UTAR Kampar Campus

Vincent Lee Wen Sheng | 17ACB01268 | Dr Aun Yichiet

PLAGIARISM CHECK RESULT



Turnitin - Originality Report - Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4 - Personal - Microsoft Edge

https://www.turnitin.com/newreport_printview.asp?eq=1&eb=1&esm=8&oid=2159954087&sid=0&n=0&m=2&svr=6&r=25.904965576806084&lang=en_us

Turnitin Originality Report

Processed on: 08-Sep-2023 19:01 +08
ID: 2159954087
Word Count: 5843
Submitted: 3

Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4 By Vincent Lee

Similarity Index	Similarity by Source	
8%	Internet Sources:	4%
	Publications:	3%
	Student Papers:	5%

1% match (student papers from 19-Apr-2022)
Submitted to Universiti Tunku Abdul Rahman on 2022-04-19

1% match (Ari Aharari, Kenjiro Haraguchi. "Development of Automated Oxygen Indicator Color Discrimination Using Artificial Intelligent Technology", 2023 IEEE 3rd International Conference on Electronic Communications, Internet of Things and Big Data (ICEIB), 2023)
Ari Aharari, Kenjiro Haraguchi. "Development of Automated Oxygen Indicator Color Discrimination Using Artificial Intelligent Technology", 2023 IEEE 3rd International Conference on Electronic Communications, Internet of Things and Big Data (ICEIB), 2023

1% match (Burcu Selcuk, Tacha Serif. "Chapter 11 A Comparison ofYOLOv5 andYOLOv8 intheContext ofMobile UI Detection", Springer Science and Business Media LLC, 2023)
Burcu Selcuk, Tacha Serif. "Chapter 11 A Comparison ofYOLOv5 andYOLOv8 intheContext ofMobile UI Detection", Springer Science and Business Media LLC, 2023

< 1% match (student papers from 25-Aug-2021)
Submitted to Universiti Tunku Abdul Rahman on 2021-08-25

< 1% match (student papers from 01-Dec-2014)
Submitted to Universiti Tunku Abdul Rahman on 2014-12-01

< 1% match (student papers from 22-Aug-2021)
Submitted to Universiti Tunku Abdul Rahman on 2021-08-22

< 1% match (student papers from 09-Apr-2023)
Submitted to Liverpool John Moores University on 2023-04-09

< 1% match (student papers from 01-Mar-2023)
Submitted to Liverpool John Moores University on 2023-03-01

< 1% match (student papers from 13-Jun-2023)
Submitted to Liverpool John Moores University on 2023-06-13

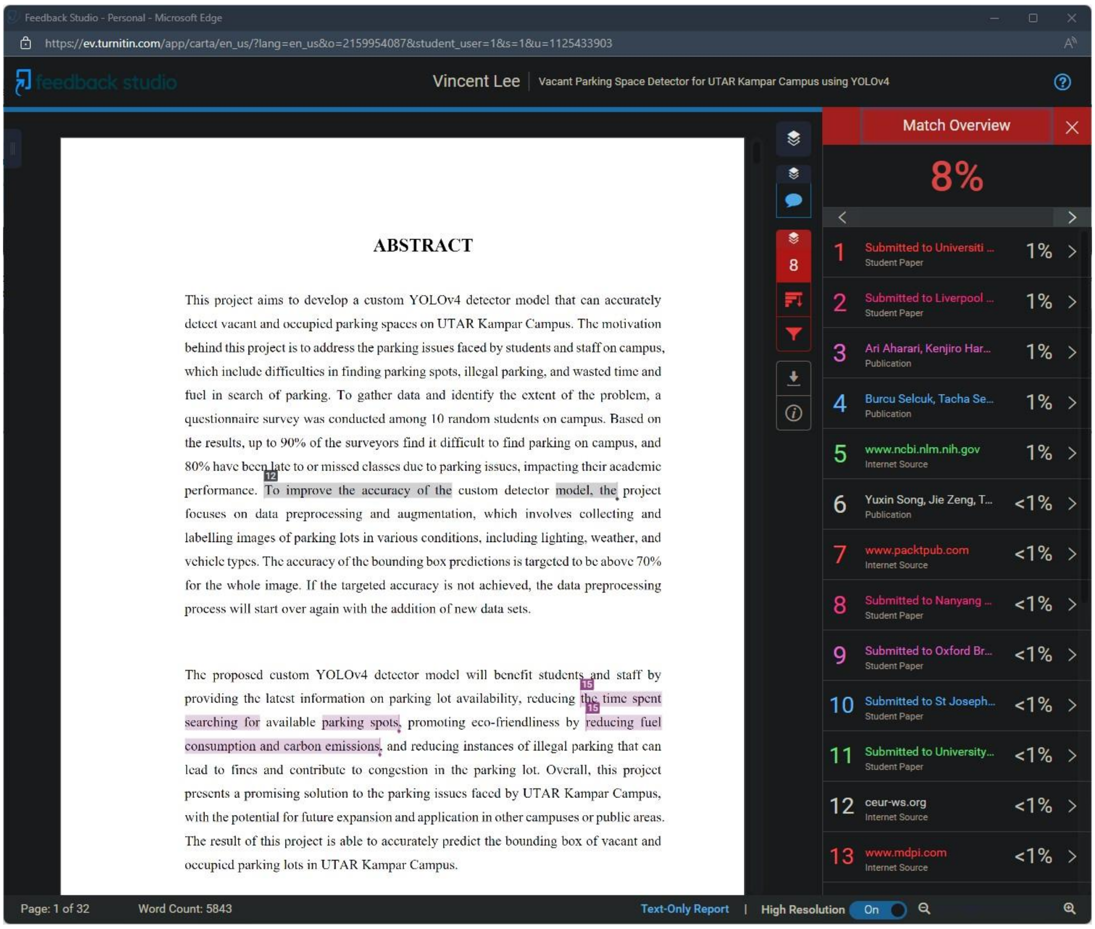
< 1% match ()
Simona Celi, Emanuele Gasparotti, Katia Capellini, Francesco Bardi et al. "An image-based approach for the estimation of arterial local stiffness ", Frontiers in Bioengineering and Biotechnology

< 1% match ()
Kevin M.-C. Lee, Jonathan P. Sherlock, John A. Hamilton. "The role of interleukin (IL)-23 in regulating pain in arthritis", Arthritis Research & Therapy

< 1% match ()
Jingyu Pu, Chengjun Yu, Xiaoyan Chen, Yu Zhang, Xiao Yang, Jun Li. "Research on Chengdu Ma Goat Recognition Based on Computer Vison", Animals : an Open Access Journal from MDPI

< 1% match (Yuxin Song, Jie Zeng, Teng Wu, Wei Ni, Ren Ping Liu. "Vision-Based Parking Space Detection: A Mask R-CNN Approach", 2021 IEEE/CIC International Conference on Communications in China (ICCC), 2021)
Yuxin Song, Jie Zeng, Teng Wu, Wei Ni, Ren Ping Liu. "Vision-Based Parking Space Detection: A Mask R-CNN Approach", 2021 IEEE/CIC International Conference on Communications in China (ICCC), 2021

PLAGIARISM CHECK RESULT



PLAGIARISM CHECK RESULT

Form Title: Supervisor's Comments on Originality Report Generated by Turnitin for Submission of Final Year Project Report (for Undergraduate Programmes)			
Form Number: FM-IAD-005	Rev No.: 0	Effective Date: 01/10/2013	Page No.: 1of 1

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Vincent Lee Wen Sheng
ID Number(s)	17ACB01268
Programme / Course	IA
Title of Final Year Project	Vacant Parking Space Detector for UTAR Kampar Campus using YOLOv4

Similarity	**Supervisor's Comments (Compulsory if parameters of originality exceed the limits approved by UTAR)**
Overall similarity index: 8 **%** **Similarity by source** Internet Sources: 4 % Publications: 3 % Student Papers: 5 %	
Number of individual sources listed of more than 3% similarity: 0	

Parameters of originality required, and limits approved by UTAR are as Follows:

(i) Overall similarity index is 20% and below, and

(ii) Matching of individual sources listed must be less than 3% each, and

(iii) Matching texts in continuous block must not exceed 8 words

Note: Parameters (i) – (ii) shall exclude quotes, bibliography and text matches which are less than 8 words.

Note: Supervisor/Candidate(s) is/are required to provide softcopy of full set of the originality report to Faculty/Institute

Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

Signature of Supervisor	Signature of Co-Supervisor
Name: Aun Yichiet	Name:
Date: 15 Sep 2023	Date:

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY (KAMPAR CAMPUS)

CHECKLIST FOR FYP2 THESIS SUBMISSION

Student ID	17ACB01268
Student Name	Vincent Lee Wen Sheng
Supervisor Name	Dr Aun Yichiet

TICK (√)	DOCUMENT ITEMS Your report must include all the items below. Put a tick on the left column after you have checked your report with respect to the corresponding item.
√	Title Page
√	Signed Report Status Declaration Form
√	Signed FYP Thesis Submission Form
√	Signed form of the Declaration of Originality
√	Acknowledgment
√	Abstract
√	Table of Contents
√	List of Figures (if applicable)
√	List of Tables (if applicable)
	List of Symbols (if applicable)
√	List of Abbreviations (if applicable)
√	Chapters / Content
√	Bibliography (or References)
√	All references in bibliography are cited in the thesis, especially in the chapter of literature review
√	Appendices (if applicable)
√	Weekly Log
√	Poster
√	Signed Turnitin Report (Plagiarism Check Result – Form Number: FM-IAD-005)
√	I agree 5 marks will be deducted due to incorrect format, declare wrongly the ticked of these items, and/or any dispute happening for these items in this report.

*Include this form (checklist) in the thesis (Bind together as the last page)

I, the author, have checked and confirmed all the items listed in the table are included in my report.

____
(Signature of Student)
Date: 01/09/2023