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REPORT – GROUP 3

Member Names:

No	Full Name	Matric No	Group
1	SUE CHEN XIANG	B032010034	S1G1
2	FATIN NAJDAH BINTI NAJMI ISMAIL	B032010201	S1G1
3	NUR AFIQAH BINTI ANUAR	B032010114	S1G1
4	KEN PRAMESWARI CAESARELLA	B032010461	S1G2
5	MOHAMMAD IRSYAD BIN MOHD SHAHRIL	B032010242	S1G2

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Supervisor Name : Dr. Zuraini binti Othman

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ABSTRACT

A smart convenience store system is a retail system that combines traditional convenience store operations with advanced technology such as Machine Learning and computer vision to create a more efficient, secure, and personalized shopping experience for customers. Machine learning algorithms can be used to predict consumer demand, optimize product placement, and provide personalized product recommendations. Computer vision can be used for tasks such as people counting, object detection, and item recognition, which can be used for security and marketing purposes. The system can also include features such as self-checkout and mobile payments, making the shopping experience more convenient for customers. In addition, the system can also provide valuable insights to store managers, helping them make data-driven decisions, such as which products to stock, and when to restock them. Overall, a smart convenience store system aims to improve the efficiency and convenience of retail operations, while providing customers with a personalized and secure shopping experience, using advanced technologies.

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CHAPTER I: INTRODUCTION

1.1 Introduction

In Malaysia, we can see that convenience stores have become one of the crucial facilities in the housing area. However, these convenience stores can be crowded at certain times, especially at the cashier's counter. So, having automation in convenience stores may help to overcome the chock-a-block situation.

Upon an entrance of a convenience store, there will usually be a closed-circuit television (CCTV) surveillance that will record all real time movements with security guards. However, there is no functionality which can help users with their shopping experience even though the CCTV is working all day long. Most of the cases, when customers spend more time in the store, it indicates that they are encountering a problem but there is nothing to notify the workers to help customers with, which then makes them remain in the store for a longer time.

Nonetheless, customers may have difficulties with selecting products in store especially when they have allergies to certain ingredients. This may take more time as they need to check the list of ingredients one by one to ensure that the product is allergen free for the respective person.

In recent times, self-checkout counters are being popularized in Malaysia as we can find them in nearly every physical supermarket but not in convenience stores yet. In-store self-checkout has also become a preferable option as the consumers do not have to wait until the cashier line is free, thus lessening the shopping time. To improvise the idea of in-store self-checkout, instead of having customers or staff scan the barcodes on their own, we let the machine do the task with the power of artificial intelligence. Customers can place everything on the counter, and once everything is on the bill, they may proceed with the payment.

Smart Convenience Store is developed to increase automation systems in convenience stores to overcome the efficiency of a convenience store. This product will help convenience store owners manage the store in term of monitoring and buying in their store. There are three main features in the system which are product classification, detection and recognition, real-time people counting for security purposes, and price calculation and checkout.

1.2 Problem Statement

1. Current issues, there are so many problems in convenience stores. As we can see, when the customers want to pay for their product, they need to wait in the cashier line and the cashier will scan the barcode one by one. Manual product scanning can take a long time, and customers may have to wait in a long line, particularly during peak hours.
2. Customers with allergies have a difficult time going through the product ingredients because they are not highlighted on the packaging.
3. During business hours, the administrator must keep an eye on the store's CCTV.

1.3 Objectives

1. To reduce the amount of time customers, spend queueing during peak hours.
2. To help customers with allergens that may be present in a product.
3. To improve the method of customer surveillance

1.4 Project Scope

1. Module to be developed
 - i. Module 1: Product Detection and Recognition
 - ii. Module 2: Real Time People Counting and Security
 - iii. Module 3: Price Calculation and Checkout
 - iv. Module 4: Desktop Application
 - v. Module 5: Product Healthiness Classification
2. Target User
 - i. Cooperative/Convenience store owner
 - ii. Customers

1.5 Software and Hardware Requirement

1. Software Requirements

Description	Tools
Operating System	Windows 10 or newer
Database	MySQL 8.0.x or newer
Programming Language	Python, Java

2. Hardware Requirements

Description	Minimum Requirements
Processor	1 Ghz or more
Memory	4 GB or higher
Hard Disk	5 GB of available hard disk space
Resolution	1024 x 768 or higher

1.6 Project Significance

1. Motivation and inspiration for the project.

The motivation and inspiration to build this project is induced by experiencing the long queue in the convenience store near our housing area at peak hour. Whether during picking up product from the shelves, or during checking out the product, we took quite long time to buy something from the store.

2. The importance of having this project.

This project focuses on the user experience of in-store shopping. The camera instalment upon arriving at the front door of the store will ensure the number of people in the store at current time. This functionality can cater to safety issues so no one will be left alone in the store once it is closing time. Other than that, we may know what the time with the highest number of customers and this info may help with decision making. Plus, this will help with customer shopping experience and overall satisfaction. Moreover, the allergy checker will allow users to check the allergy content of a product, therefore consumers can double check whether they can have

the product safely or not. Another significance of this project is it will allow consumers to have a blissful experience during in store shopping checkout as they do not have to wait in a long line just to get their needs and wants home. They also do not have to experience a cashier's struggle of scanning each product's barcode which they did not get used to.

1.7 Summary

A Smart Convenience Store System is a new retail concept that combines advanced technologies such as Machine Learning and computer vision to improve the shopping experience for customers and optimize store operations. This system provides real-time inventory management, consumer behaviour analysis, self-checkout, mobile payments and security. These features help to enhance customer convenience, reduce waiting times, improve customer service, and increase store efficiency. The overall goal of the smart convenience store system is to provide a more efficient, secure, and personalized shopping experience for customers while providing valuable insights to store managers.

CHAPTER II: METHODOLOGY

2.1 Intelligent System Development Methodology

The goal of this project is to develop a system that can handle people counting, barcode scanning, allergen detection and special privilege by certain users. Before development of this project, the team must discuss alongside our supervisor on what methodology we should use on our project. There are several methodologies we can use to approach this project. The team decided to use the waterfall model as it follows a linear and sequential approach in which is easy to use.

The Waterfall model is defined by a sequence of discrete phases, each of which builds upon the previous phase, and which does not occur simultaneously. The following is the stages to which how the Waterfall model applies:

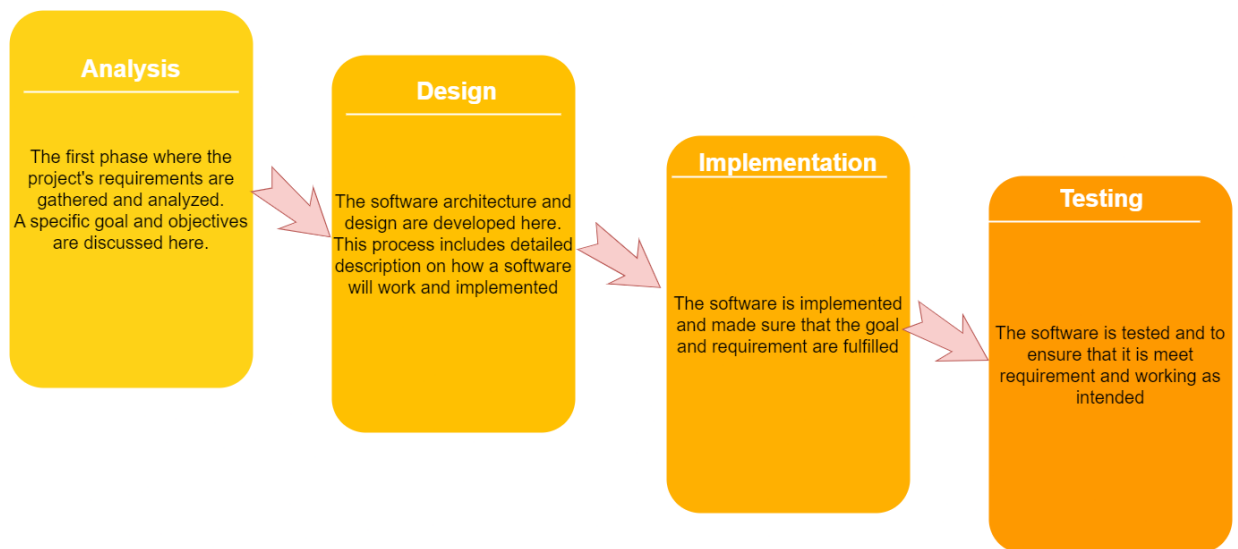


Figure 1: Waterfall Model

There are, however, additional step to the Waterfall model which includes Deployment and Maintenance. Despite that, the project includes no customer for Deployment and maintenance is not necessary for this project. Hence, two of the steps are obsolete.

2.2 Intelligent System Development Technique

2.2.1 Analysis

In the analysis stage, we need identify the goal and objectives here. We found out, as we explore, a list of objectives to reach. The main objectives are to ensure that the software can do counting of people, barcode scanning, calculation in checkout, product recognition and a compatible interface. Here we also gather datasets for product recognition. All datasets are images and converted to computer understanding. The custom dataset consists of around 700 training images for each product taken from different angle. The products consist of 'Apollo Chocolate Cake', 'Apollo Chocolate Wafer Cream', 'Chips More Mini', 'Gardenia Cream Roll', 'Maggi Curry' and 'Oral B Toothbrush'. The total training images used is 4900 and the total testing images are 453. The neural network model is trained with 200 epochs.

2.2.2 Design

In the design stage, we need to design a detailed description of how the software must work and take how the user will approach the software into consideration. We designed a Figma user interface where we visualize on how the user will see our project and potentially how they approach it:

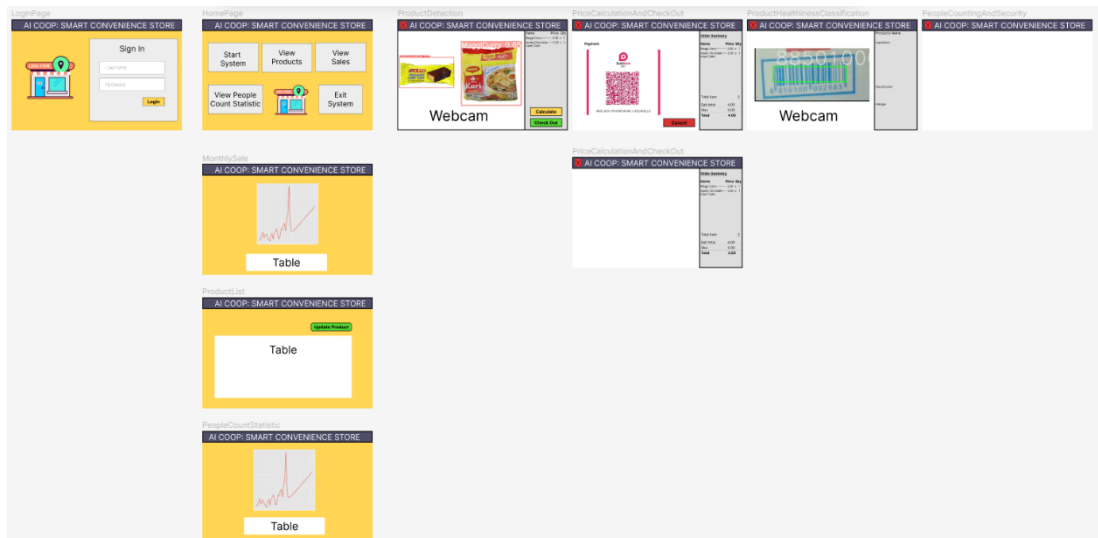


Figure 2: Draft GUI using Figma

Here we designed the flow of our design, The simplistic nature of the design allows the user to better grasp the flow of our system and not overwhelm the user.

One of the suggested methods is using Tkinter in Python to design the user interface.

2.2.3 Implementations

In this stage, the dataset for product image recognition has been set up. The user would also be able to log in as admin or another user if necessary. The system must be able to read barcode of a product. The system must also be able to identify when someone enters the shop and adding or subtracting the total people in the shop. In short, all modules can work independently and is now able to integrate into the system without compromising other modules. The user interface also serves as a base for all the modules created.

2.2.4 Testing

In this stage, it is crucial to ensure that the system runs smoothly and meets the expected requirements. The system needs to run product image recognition when selected, database connection is established and each of the menu is working as intended. The system is tested many times to ensure no errors. If the system cannot run, then the code in implementation phase may be the problem.

2.3 Summary

In conclusion, the project uses waterfall methodology as it allows the team to work in phases and in order. If any problem occurs, then the mistake can be traced back. Hence, this linear model, despite being inflexible, is suitable for our project since this project has a well-defined and unchanging requirement.

CHAPTER III: ANALYSIS

3.1 Analysis of Current Application

In this section, we selected the application "Fig: Food Scanner & Discovery" as our analysis of current applications, especially for the product healthiness classification module. Fig is a highly rated food scanner and discovery tool that assists users in determining what they can eat in restaurants and are looking for groceries in grocery stores. If the user is allergic to anything and is gluten-free, Fig will help users classify these ingredients.

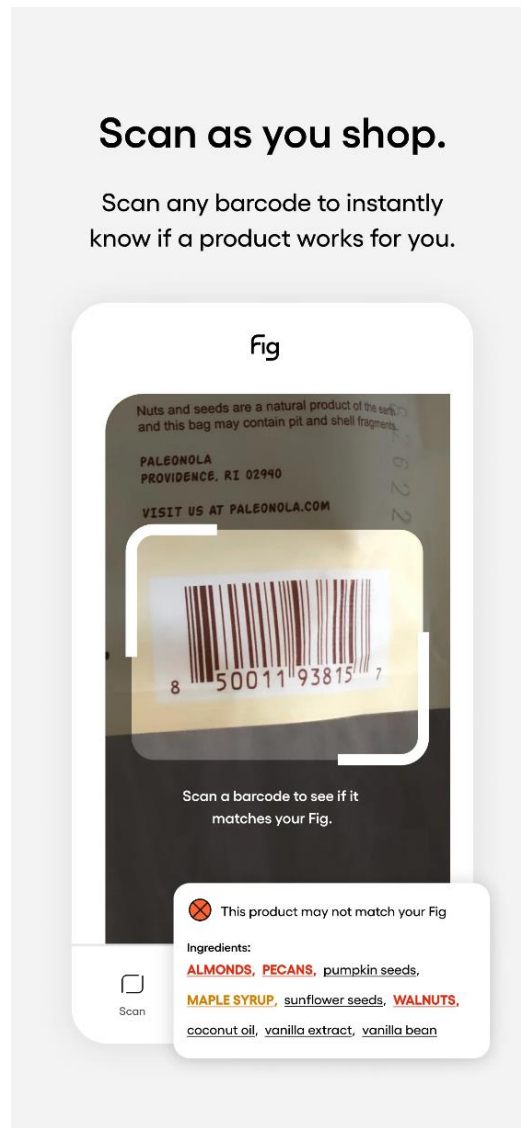


Figure 3: Fig: Food Scanner & Discovery

3.2 Analysis of Proposed Intelligent System

The desktop application that we will develop focuses on innovative convenience stores that can automatically detect products and calculate the total price that has been purchased. In our system, also there is a people counting for the admin to determine the number of visitors entering and leaving the store. There will also be a mobile application in the store that will make it easier for customers to view the ingredients and allergens in the product. So that before buying, the customers are sure that the product is safe to consume.

3.3 Structure Chart of Proposed Intelligent System

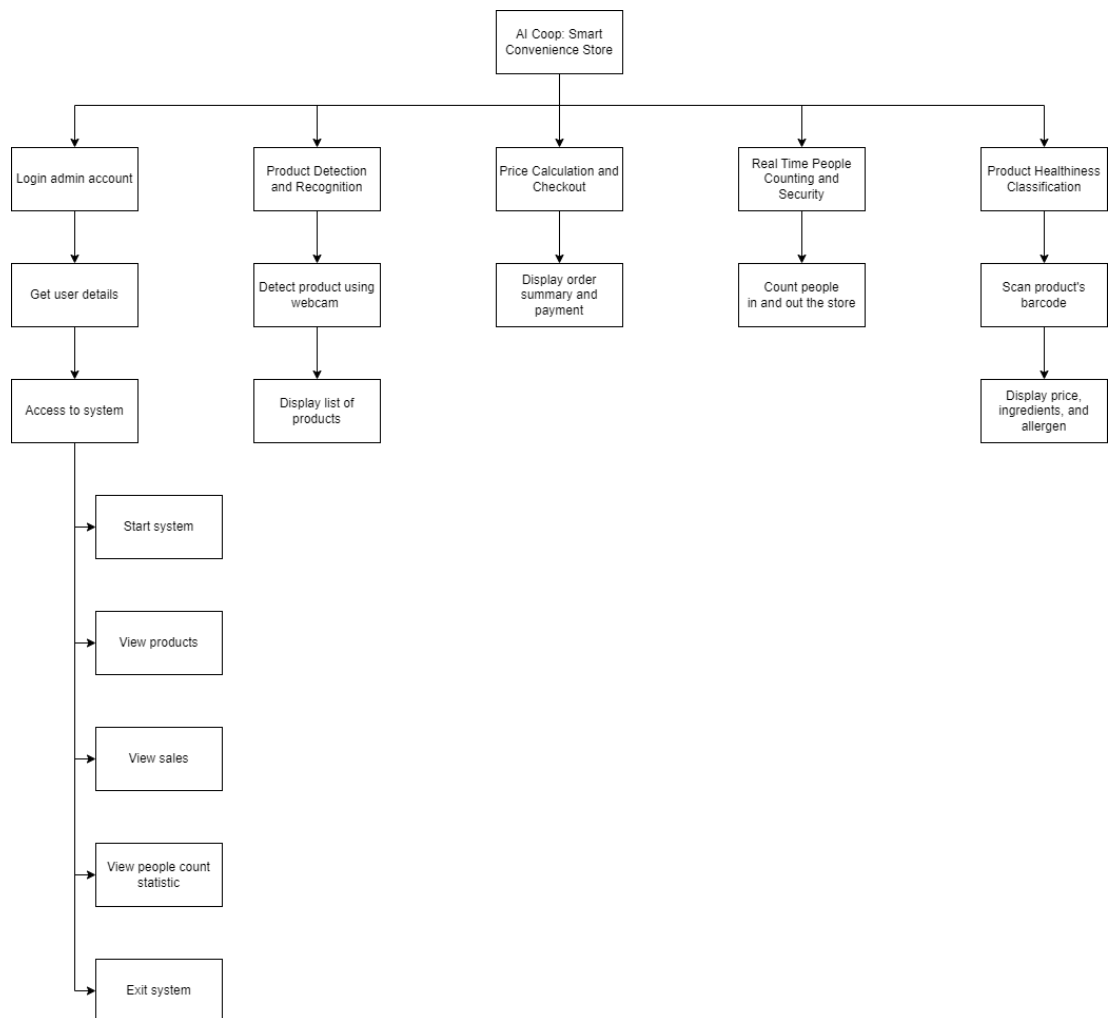


Figure 4: Structure Chart of Proposed Intelligent System

3.4 Work Breakdown

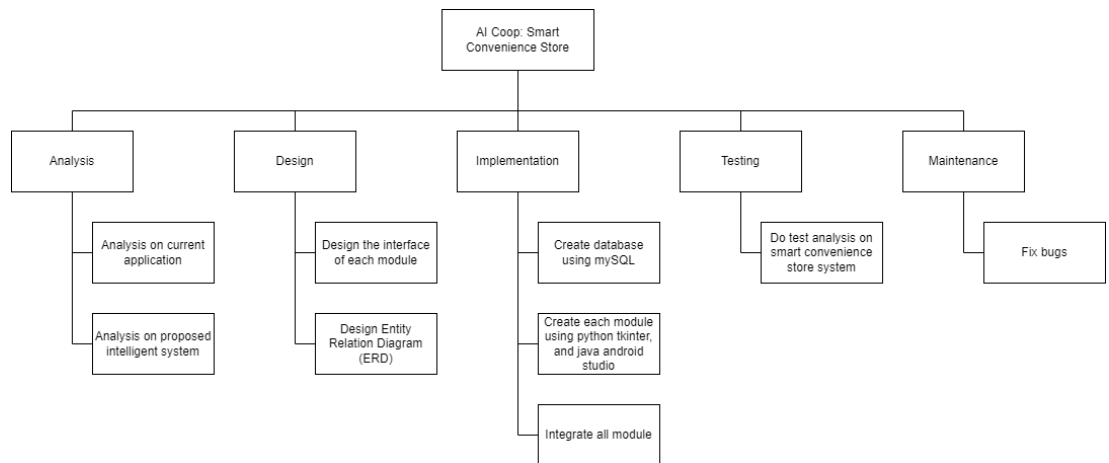


Figure 5: Work Breakdown Structure

3.5 Summary

In conclusion, to complete the project, the development and implementation of AI Coop: Smart Convenience Store must follow the structured chart and work breakdown structure. To summarize, this system will be build based on three AI modules which is Product Detection and Recognition, Real Time People Counting and Security, and Product Healthiness Classification.

CHAPTER IV: DESIGN

4.1 Introduction

The system is built with implementation of a convolutional neural network (CNN) transfer learning technique to train a model to recognise the type of product from the input image from the camera using PyTorch library and YOLOv5 model. The system also uses another deep neural network (DNN) model which can count the number of people going inside or going outside of the convenience store using MobileNet Single Shot Detector (SSD) model. Both the pre-trained object detection network model is loaded using OpenCV's dnn module. This will enable us to pass input images through the network and obtain the output bounding box (x,y) coordinates of each recognized object in the image.

4.2 Entity-Relation Diagram of Database

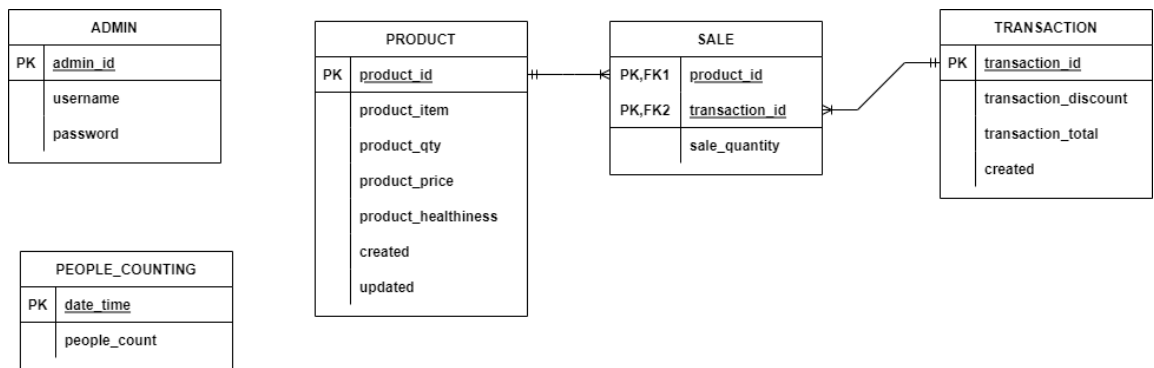


Figure 6: ERD Diagram of Smart Convenience Store

4.3 Intelligent System Architecture

Our system is well equipped with an intelligent product recognition module and people counting module. The tool used to develop the intelligent product recognition module is YOLOv5. YOLO is short for You Only Look Once, it is a family of single stage deep learning based object detectors. They are capable of more than real time object detection with state-of-the-art accuracy. It is a collection of object detection models. From tiny models capable of giving real-time FPS on edge devices to huge and accurate models meant for cloud GPU deployments. It has almost everything one might need. YOLOv5 contains 5 models in total. Starting from YOLOv5 nano (smallest and fastest) to YOLOv5 extra-large (the largest model). In this system, we decided to use YOLOv5s since it is fast and can provide good results using normal

CPU. We then train the YOLOv5s model using our own custom dataset of the products so that it can detect and recognise the products. The custom dataset consists of around 700 training images for each product taken from different angle. The products consist of 'Apollo Chocolate Cake', 'Apollo Chocolate Wafer Cream', 'Chips More Mini', 'Gardenia Cream Roll', 'Maggi Curry' and 'Oral B Toothbrush'. The total training images used is 4900 and the total testing images are 453. The neural network model is trained with 200 epochs.

The following is a short description of each of the model of YOLOv5:

- YOLOv5n: It is a newly introduced nano model, which is the smallest in the family and meant for the edge, IoT devices, and with OpenCV DNN support as well. It is less than 2.5 MB in INT8 format and around 4 MB in FP32 format. It is ideal for mobile solutions.
- YOLOv5s: It is the small model in the family with around 7.2 million parameters and is ideal for running inference on the CPU.
- YOLOv5m: This is a medium-sized model with 21.2 million parameters. It is perhaps the best-suited model for many datasets and training as it provides a good balance between speed and accuracy.
- YOLOv5l: It is the large model of the YOLOv5 family with 46.5 million parameters. It is ideal for datasets where we need to detect smaller objects.
- YOLOv5x: It is the largest among the five models and has the highest mAP among the 5 as well. Although it is slower compared to the others and has 86.7 million parameters.

The YOLOv5 architecture is shown as below:

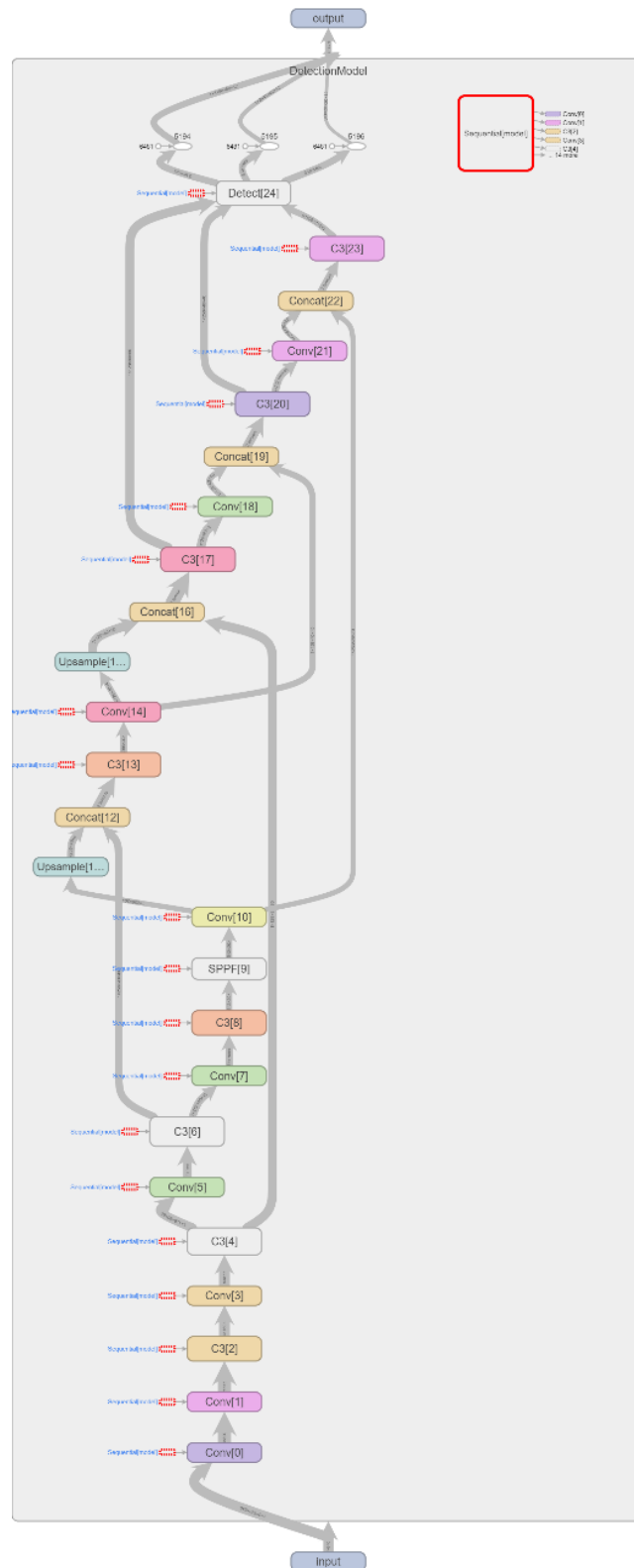


Figure 7: Architecture of YOLOv5 model

For the second intelligence module, the tool used to develop the intelligent people counting module is MobileNet Single Shot Detector (SSD) model. The MobileNet SSD was first trained on the COCO dataset (Common Objects In Context) and was then fine-tuned on PASCAL VOC reaching 72.7% mean average precision. The MobileNet SSD can therefore detect 20 objects in images including people. Therefore, in this system, we make use of the pretrained model of MobileNet SSD to detect people and then we do the counting people task using centroid tracking algorithm. The MobileNet SSD architecture is shown as below:

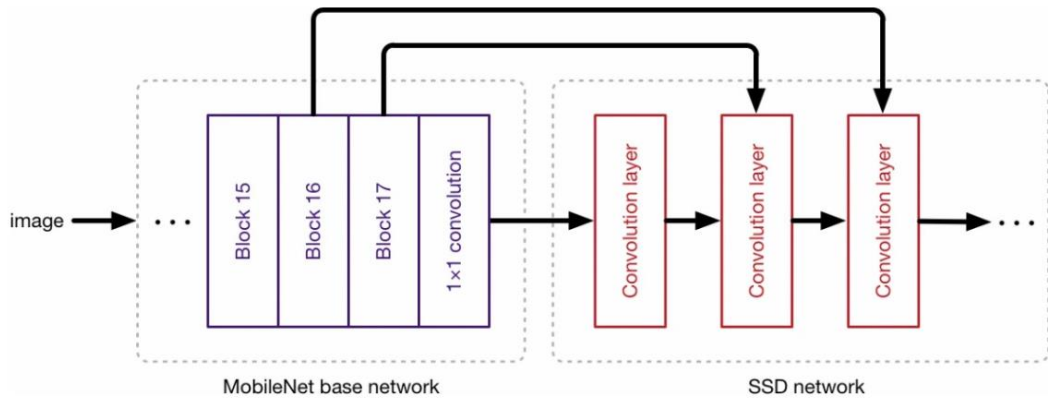


Figure 8: Architecture of MobileNet SSD model

4.4 Module 1: Product Detection and Recognition

In this system we implement the deep learning convolutional neural network (CNN) technique using YOLOv5 model to detect and recognise the product using a webcam. Firstly, the system will read in the frame from the webcam then it will be processed and analysed using the YOLOv5 model that train on our custom dataset. After that, we use OpenCV to annotate the frame for which the position of the products and return to the screen. The flow of module 1 is shown below:

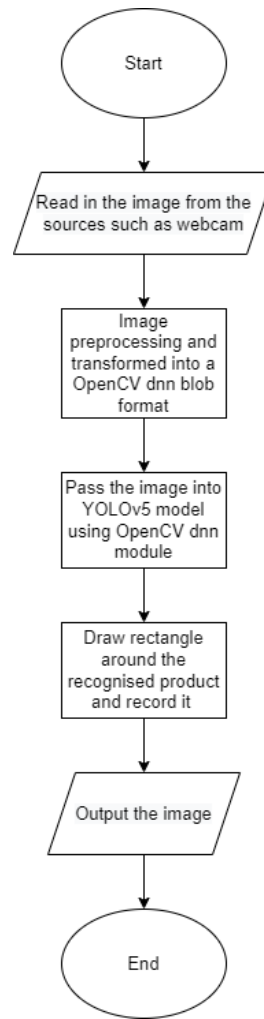


Figure 9: Flowchart of Module 1

4.5 Module 2: Real Time People Counting and Security

In this system we implement the deep learning convolutional neural network (CNN) technique using MobileNet SSD model to detect and count the people using a webcam. Firstly, the system will read in the frame from the webcam then it will be processed and analysed using the MobileNet SSD model. After that, we use OpenCV to annotate the frame for which the position of the people and return to the screen. The people count will also updated to the database. The flow of module 2 is shown below:

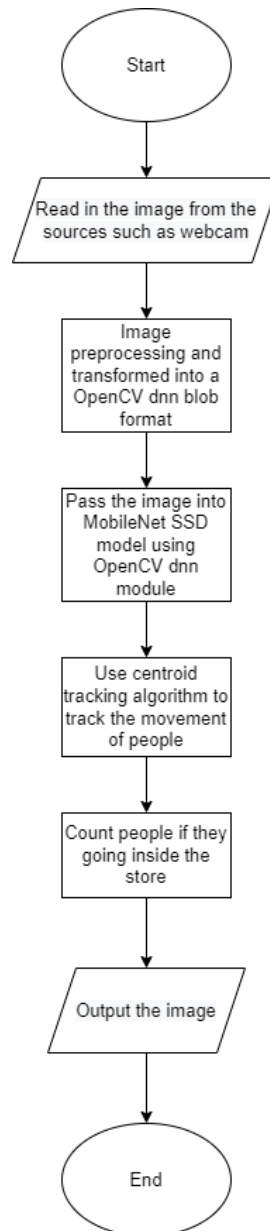


Figure 10: Flowchart of Module 2

4.6 Module 3: Price Calculation and Checkout

In this module, the detected product and their respective price will be list out and the total price will be calculated and displayed to the screen. This module will also display a Duitnow QR code for customers to do payment on the products they purchased. If the customer done the payment, the transaction will be recorded to the database.

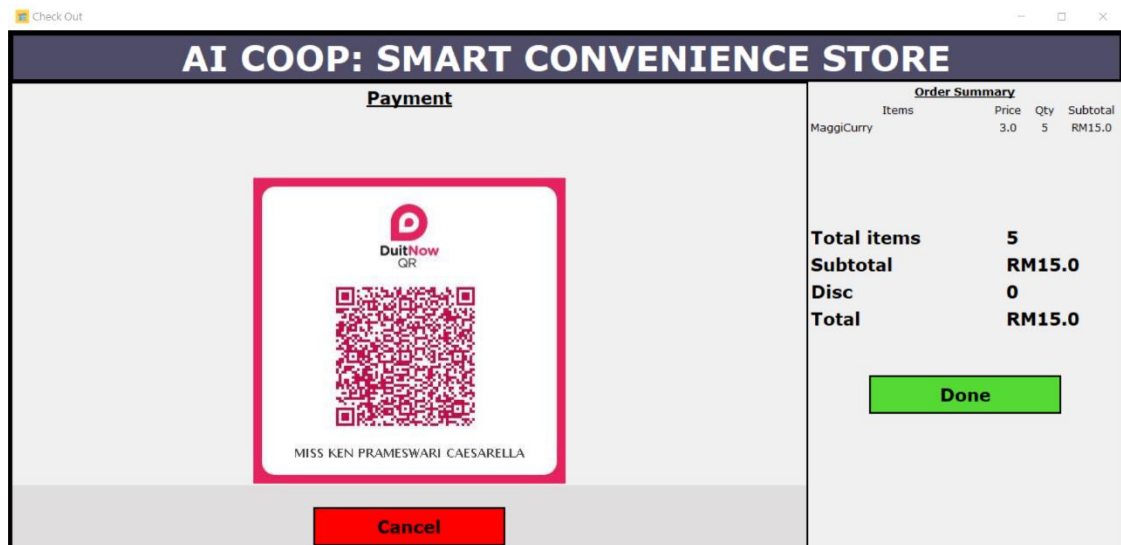


Figure 11: The Check Out Page

4.7 Module 4: Desktop Application

In this module, a desktop application with graphical user interface is developed to integrate with all the functionality provided by all the other modules. This module also provides the functionality to let the store owner view the analytic data of the sales, products and the people counting statistic. The desktop application is built with the python library Tkinter. The reason we choose Tkinter is that it is a standard library of python which it is built in with the python installer. This means that we do not have to install any third-party library in order to run this application if we already have python installed in our computer. The figure below shows some of the view of the application.

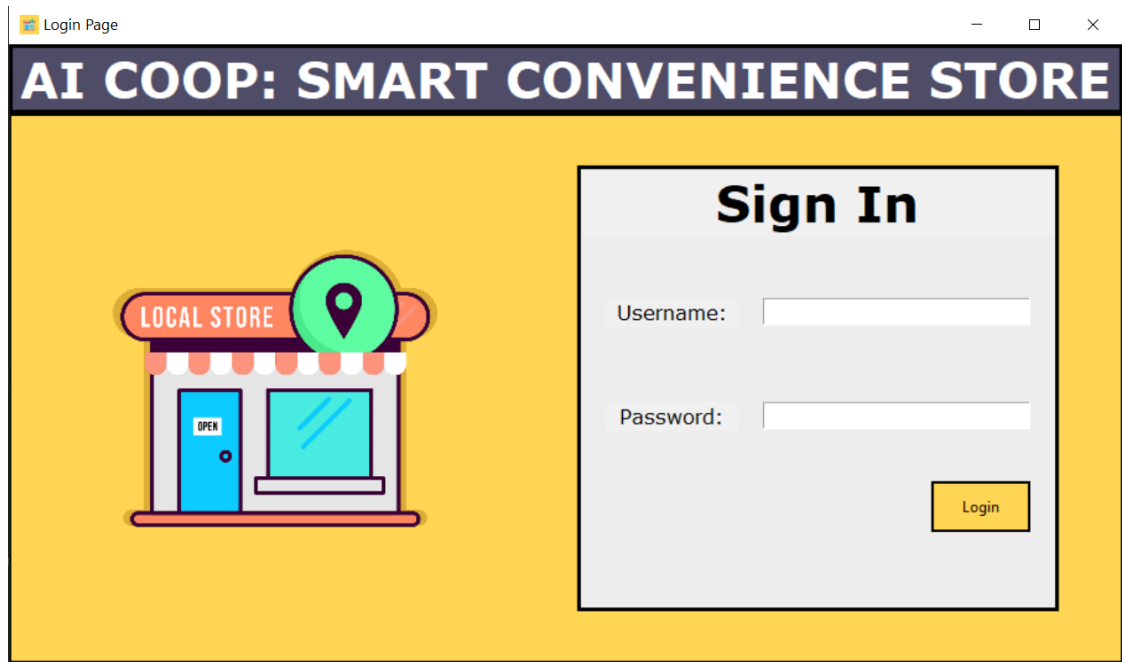


Figure 12: Login Page

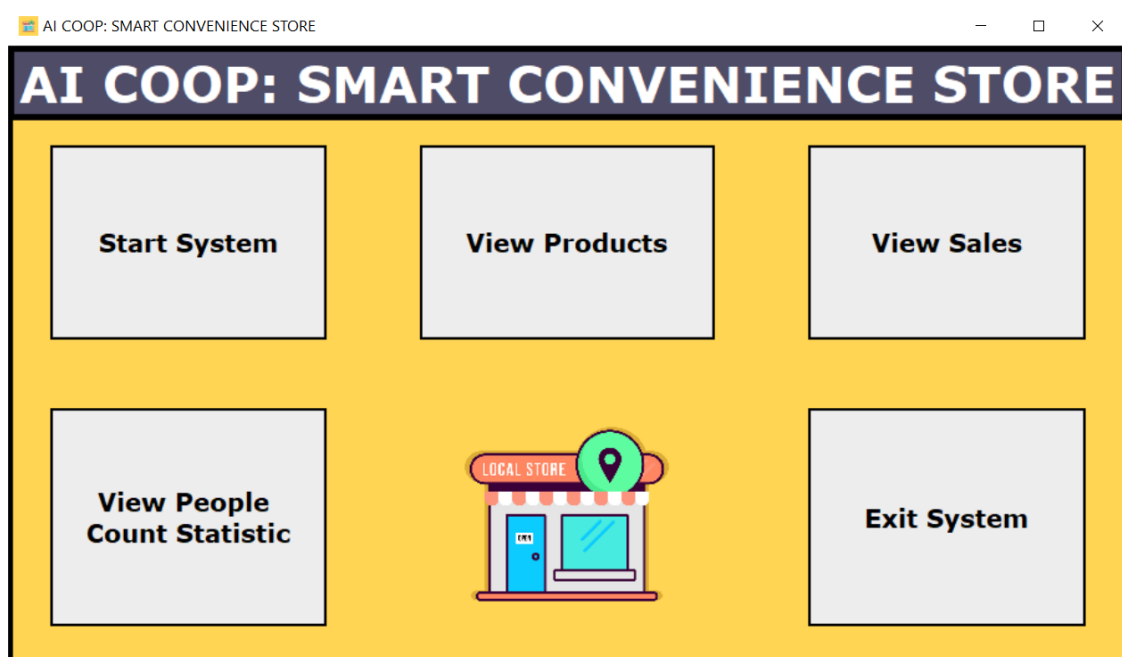


Figure 13: Home Page

4.8 Module 5: Product Healthiness Classification

In this module, a mobile application is developed using java on android studio. In this module, customer can easily identify allergens contain in their desired product or its price using the barcode scanner. When the customer scans the product's barcode using this application, the application will retrieve the information from a real time database, Firebase. If the barcode exists in the Firebase, the details of the products will be listed

out. The details include the price of the product, the ingredients of the product and the allergens of the product.

CHAPTER V: IMPLEMENTATION

5.1 Introduction

This system is made up of five major modules: product detection and recognition, calculation and checkout, product allergens, real-time people counts and security, and desktop. However, only modules that use artificial intelligence will be covered in this chapter, which is the product detection and recognition module, the product allergen module, and the real-time people counting and security module. The packages, libraries, API, and external resources required to build the artificial intelligence module will be detailed here.

Both the product detection and recognition module, as well as the real-time people counting and security module, are written in Python, whilst the product allergen module is written in Java. As indicated in the preceding chapter, all of the modules employ pre-trained models.

5.2 Intelligent System Development Environment

The artificial intelligence module is created using two separate software programs which are Visual Studio Code and Android Studio. Both the product detection and recognition module and the real-time people counting and security module were created using Visual Studio Code, which allows Python programming by simply adding an extension for that language, whereas the product allergen module was created using Android Studio because it is an app-based module. Android Studio is an integrated development environment (IDE) designed specifically for Android apps.

Module	Requirement
Product detection and recognition module	Python packages that need to be install: <ul style="list-style-type: none">• cv2• numpy• os• argparse• json• sys• re

	<ul style="list-style-type: none"> • pandas • torch.nn • torch.cuda • utils • val • tensorflow • yaml
Real-time people counting and security module	<p>Python packages that need to be install:</p> <ul style="list-style-type: none"> • numpy • imutils • dlib • cv2 • spacy.spatial
Product allergen module	<p>Additional android studio libraries:</p> <ul style="list-style-type: none"> • com.google.android.gms.vision.barcode.Barcode • com.google.android.gms.vision.barcode.BarcodeDetector <p>Additional dependencies:</p> <p>com.google.firebase:firebase-database:20.1.0</p> <p>Or</p> <p>add firebase assistant from android studio panel.</p>

5.3 Intelligent System Configuration Management

5.3.1 Identification

The system requires Windows 10 or later and an internet connection to connect to the database. The system's recommended RAM for the training phase is 8GB to guarantee smoother execution, and GPU may be required as the training set grows larger. Any version of Android Studio can be used for modules that require it, but the module is built with Android Studio Electric Eel. To execute all of the Python files, it is recommended that you utilise Visual Studio Code.

5.3.2 Baseline

Python version 3.7 or above is necessary for modules that utilise Python. The system's desktop application utilises a localhost database, hence Xampp with PHP is required to execute the desktop application. A new firebase account or database is not required for the product allergen module because it is a cloud server database that can be accessed from anywhere and is already connected to the module.

5.3.3 Version Control

Except for team members and the supervisor, Smart Convenience Store has not been shared or traded so there will be no other version of the system.

5.3.4 Auditing

There are no plans to upgrade the system after the workshop 2 period. If one of the team members wants to use the system for another project, they will consult with the others first.

5.4 Completing Task via Intelligence

Artificial Intelligence is employed as the key component of Smart Convenience Store to help ease the load of convenience store owners while also boosting customer shopping experiences from all ages, especially during peak hours. Instead of waiting for the cashier to scan all of their items, the system used artificial intelligence that can identify and recognise the customer's selected product all at once.

This will save them time in the checkout line and will come in handy when they are in a rush.

Aside from that, the system may aid to alleviate the strain on the owner by including an intelligence surveillance camera that can count and track the movement of customers entering and exiting the store. It will notify the owner if there are still customers in the store when it closes. This might provide an additional degree of protection for the shop.

Finally, the system has a feature for detecting allergens in all items, which is useful because not all manufacturers display allergy information on their packaging. The feature also displays all product information in a larger perspective for customers who, like the elderly, are unable to read the little information on the packaging.

CHAPTER VI: TESTING

6.1 Testing Method

Software testing is one of the important steps when developing a software as it will ensure the reliability of every function of the software. Upon developing this project, there are a few testing methods that has been used. Those methods are as followings:

a) Unit Testing

Unit testing refers to a process of assessing a small part of a system. The purpose of this testing is to ensure that each unit (small part of the system) is individually operatable. As this project consist of multiple modules, each module is tested for proper operation individually.

b) Integration/System Testing

Integration testing focuses on examine the system as a whole, in which each software modules are combined and tested together instead of separately like in unit testing.

6.2 Test Result Analysis

Followings are the software testing methodology in order to see whether this system is working well or not.

Module 1: Product Detection and Recognition

Scenario	Test step	Expected result	Test result
Customer place a product on the counter	Place one (1) Gardenia Cream Roll (or any other in-database product) in front of the camera	System will recognise the product and it will label and identify the probability of the product	Passed
Customer place multiple same	Place three (3) Gardenia Cream Roll (or any other in-database	System will recognise each the product and it will label and identify	Passed

products on the counter	product) in front of the camera	the probability of each product	
Customer place different product on the counter.	Place three (3) types of product - Gardenia Cream Roll, Chips More Mini, and Maggi Curry, one (1) for each of the product in front of the camera	System will recognise each the product and it will label and identify the probability of each product	Passed
Customer place multiple different products on the counter.	Place three (3) types of product - Gardenia Cream Roll, Chips More Mini, and Maggi Curry, two (2) for each of the product in front of the camera	System will recognise each the product and it will label and identify the probability of each product	Passed

Figure below shows the accuracy that we get for each of the 200 epochs of the training of the CNN neural network model. The highest accuracy we get is 0.995 which is obtained from 132 epoch.

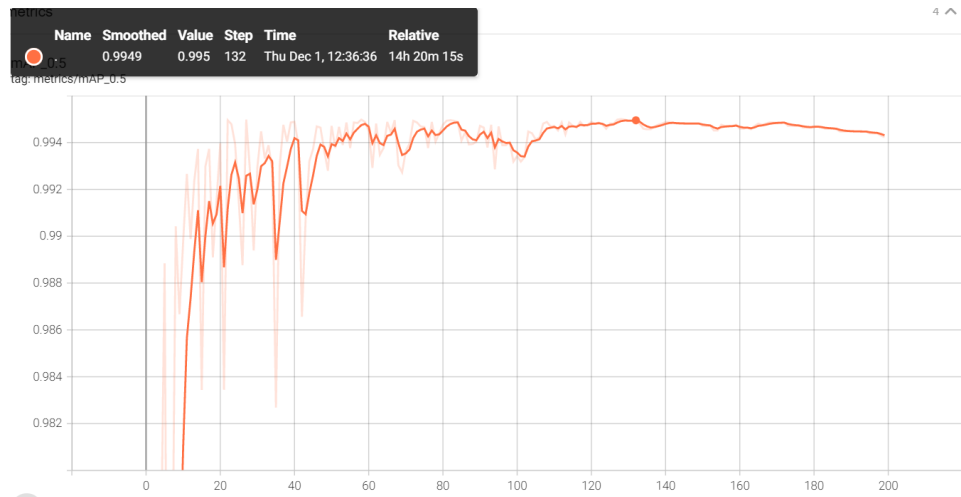


Figure 14: YOLOv5 accuracy

Module 2: Real Time People Counting and Security

Scenario	Test step	Expected result	Test result
A customer going into the store	Number of people count in store is 0. A person walks under the camera, the movement must be from top to bottom part of the camera display.	System will assign number on the person as he/she walked by and increment the number of people in store by 1.	Passed
A customer going out of the store	Number of people count in store is one (1). A person walks under the camera, the movement must be from bottom to top	System will assign number on the person as he/she walked by and decrement the number of people in store by 1.	Passed

	part of the camera display.		
Multiple customers going into the store	Number of people count in store is 0. Three (3) different persons walk under the camera, the movement must be from top to bottom part of the camera display.	System will assign number on every person as they walked by and increment the number of people in store by 3 as soon as all of them passed the camera.	Passed
Multiple customers going out of the store	Number of people count in store is three (3). Three (3) different persons walk under the camera, the movement must be from bottom to top part of the camera display.	System will assign number on every person as they walked by and decrement the number of people in store by 3 as soon as all of them passed the camera.	Passed

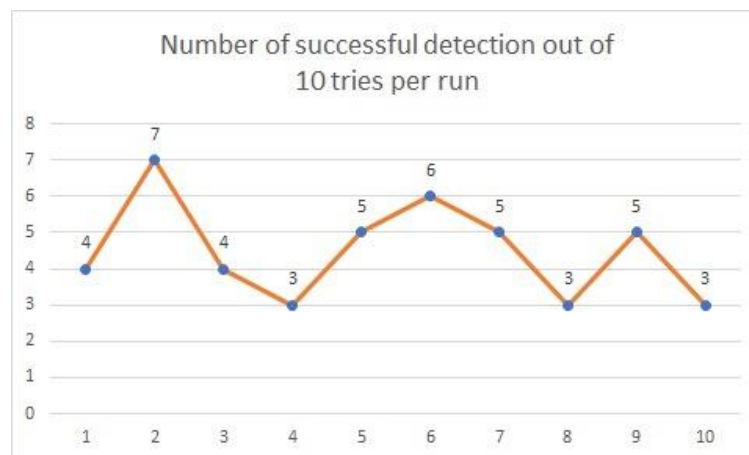


Figure 15: MobileNet SSD accuracy

To get the accuracy of this pretrained model, we test it by walking in front of the camera 10 times for every run, checking whether the model is able to tag or label people accurately, and we did it for 10 runs. Therefore, the average accuracy obtained for this model is 0.45.

Module 3: Price Calculation and Checkout

Scenario	Test step	Expected result	Test result
Customer wants to calculate a product	Place one (1) Gardenia Cream Roll (or any other in-database product) in front of the camera. As everything is labelled, click calculate button.	System will list the type of product, the price, the quantity, and the subtotal (In this case it will be: Gardenia Cream Roll, 1.10, 1 and RM1.10)	Passed
Customer wants to checkout a product	Repeat test step in customer wants to calculate a product. Then, click check out button.	System will redirect to payment page using QR. There will be a QR displayed along with the buying list and the details of the payment.	Passed
Customer wants to calculate multiple same product	Place three (3) Gardenia Cream Roll (or any other in-database product) in front of the camera. As	System will list the type of product, the price, the quantity, and the subtotal (In this case it will be:	Passed

	everything is labelled, click calculate button.	Gardenia Cream Roll, 1.10, 3 and RM3.30)	
Customer wants to checkout multiple same product	Repeat test step in customer wants to calculate multiple product. Then, click check out button.	System will redirect to payment page using QR. There will be a QR displayed along with the buying list and the details of the payment.	Passed
Customer wants to calculate different product	Place three (3) types of product - Gardenia Cream Roll, Chips More Mini, and Maggi Curry, one (1) for each of the product in front of the camera. As everything is labelled, click calculate button.	System will list the type of product, the price, the quantity, and the subtotal.	Passed
Customer wants to checkout different product	Repeat test step in customer wants to calculate different product. Then, click check out button.	System will redirect to payment page using QR. There will be a QR displayed along with the buying	Passed

		list and the details of the payment.	
Customer wants to calculate multiple different products	Place three (3) types of products - Gardenia Cream Roll, Chips More Mini, and Maggi Curry, two (2) for each of the product in front of the camera. As everything is labelled, click calculate button. Then, click check out button	System will list the type of product, the price, the quantity, and the subtotal.	Passed
Customer wants to checkout multiple different products	Repeat test step in customer wants to calculate multiple different products. Then, click check out button.	System will redirect to payment page using QR. There will be a QR displayed along with the buying list and the details of the payment.	Passed

Module 4: Desktop Application

Scenario	Test step	Expected result	Test result
Login			

Admin wants to sign in with registered username and valid password	Enter username and password as in the database then click login button.	The system will be redirected to home page.	Passed
Admin wants to sign in with registered username and invalid password	Enter username as in the database but with invalid password then click login button.	The system will pop up a notification telling password entered is invalid.	Passed
Admin wants to sign in with unregistered username and password	Enter username and password that is not in the database then click login button.	The system will pop up a notification telling username entered is invalid.	Passed
Start system			
Admin wants to start store operation	Desktop app is successfully logged in. Click on start system button.	The system will start all cameras need to be used for the store.	Passed
View sales			
Admin wants to check sale in a month	Repeat any test step from price calculation and checkout module. From desktop app home page, click view sales button.	The system will redirect to sales page, showing all sales made, as well as the one keyed-in to the system.	Passed
View people count statistic			

Admin wants to know number of customers coming into the store.	Repeat any test step from people counting and security module. From desktop app home page, click view people count statistic button.	The system will redirect to people counting statistic page, showing total number of visitors every day, as well as the one keyed-in to the system.	Passed
Exit system			
Admin wants to close the system with no people inside the store.	Desktop app is successfully logged in. Click on exit system button with no one inside the store.	System closed successfully.	Passed
Admin wants to close the system with people inside the store.	Desktop app is successfully logged in. Click on exit system button with someone inside the store.	System will pop out a notification that tells someone is in the store.	Passed

Module 5: Product Healthiness Classification

Scenario	Test step	Expected result	Test result
Scanning in-database product barcode	Scan the barcode of in-database product (Gardenia Cream Roll)	System will scan the barcode and redirect to another activity that list	Passed

		out all product details	
Scanning not-in-database product barcode	Scan the barcode of not-in-database product	System will scan the barcode and remain on the scanning page	Passed

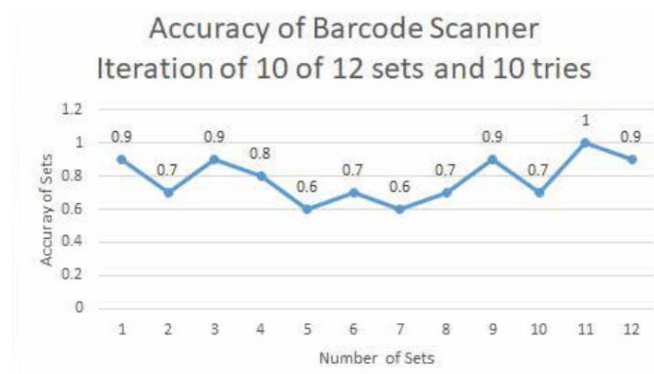


Figure 16: Android packages accuracy

As product healthiness uses android packages to scan barcode, above is the accuracy graph given by the model. The test is held by presenting the barcode in front of the camera and checking whether the model is able to read the barcode accurately. This model managed to get 0.78 as for the accuracy.

6.3 System Constraints

Limitations for this project covers on the security issue as there is no guarantee that the number of products being checkout on the cashier by the customer is the same as the number of products bring out from the store.

On the other hand, our current system has no way to verify whether the customer has successfully made payment or not as we only ask the user to click on done button in the interface provided before generating the receipt for the customer.

CHAPTER VII: CONCLUSION

7.1 Intelligent System Advantages and Commercial Values

The main advantages of this system are it can facilitate convenience store owner managing style as well as improve customer shopping experience. This system helps convenience store owner by providing multiple functionalities in one same system.

Using this AICoop: Smart Convenience Store system, store owner (or admin) can get a short report on number of visitors or customers based on the real time people counting and security module. From this module, store owner also does not have to hire a worker for surveilling the camera or closed-circuit television (CCTV) during operation hour anymore as the system is able to track number of people going in and out as well as notify number people in store during closing. The report generated also can be used to help with decision making in order to attract more customer etc.

Moreover, store owner also can track product sold every month and view a report on it. The data on product sold is from the self-checkout functionality. This self-service mechanism from product detection and recognition module will enhance customer shopping experience as this generation prefer self-checkout as well as it will reduce long queue during peak hour. This mechanism also requires no cashier in which automate the conventional way of checking out products from the store.

Based on price calculation and checkout module, AICoop implements cashless payment method via QR payment. Nonetheless, customers with allergy can check for allergen that may appear in every product they want to buy and be aware of the allergen before consuming any of the product. This facility accommodates people with specific requirements in which will improve customer shopping experience and will help with the store's monthly sale.

7.2 Intelligent System Weaknesses

As this system consist of multiple AI (Artificial Intelligence) implementation, let us dig into product detection and recognition module first. The weakness of this module implementation is it can only detect product that are separated from each other, and two products cannot be in stack in any ways as the system would not recognise it as two distinguished products.

Other than that, people counting and security module requires a specific camera positioning to be able to count people accurately and precisely. If the position of the camera is tilted or in different angle and in different scale, it will mistakenly count or miscount people. This circumstance will produce a large number of false positive and false negative error.

7.3 Suggestions for System Improvement

For further improvement, there are a few things that can be worked on. For product detection and recognition module, we need to consider various ways of product placing on the counter and train them so that the model can identify each product accurately with their respective exact amount. We also need to consider using camera from various side of the counter so there will be no hidden product on cashier's counter before customer checkout.

As for people counting, we may use different approach other than using MobileNet SSD pretrained model, for example is to train our own model using supervised learning and feed all the data into a neural network to identify people going in and out of the store. The data used must be from multiple angle and position so that the model will have the ability to label the target more precisely.

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APPENDICES

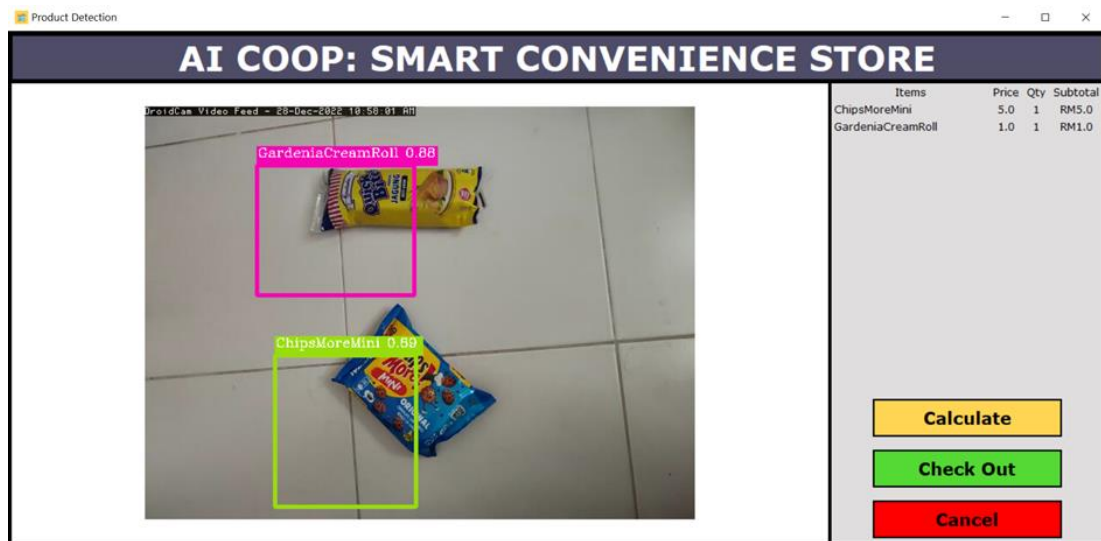


Figure 17: Product Detection and Recognition Page

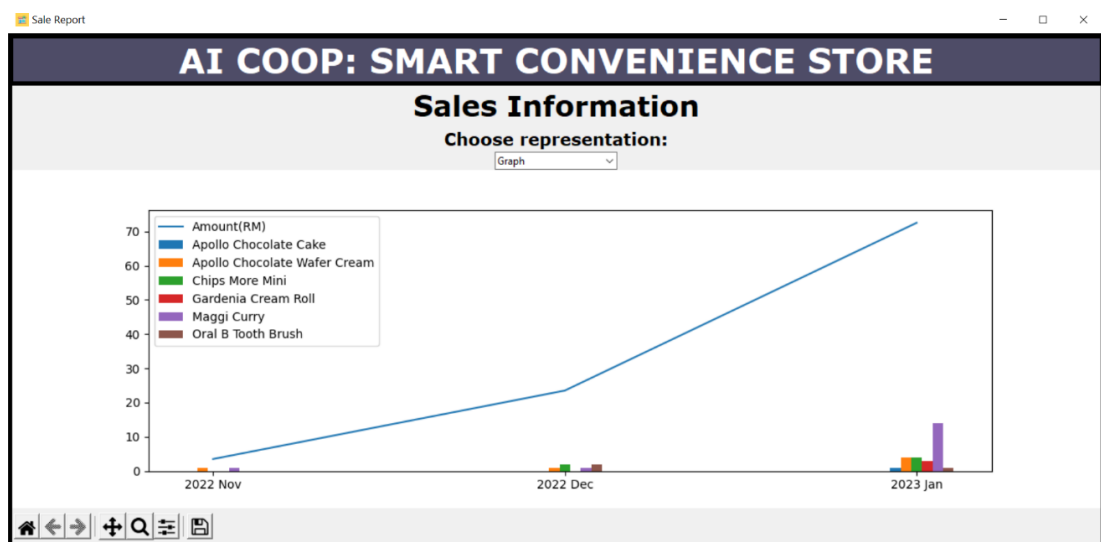


Figure 18: Monthly Sale Report

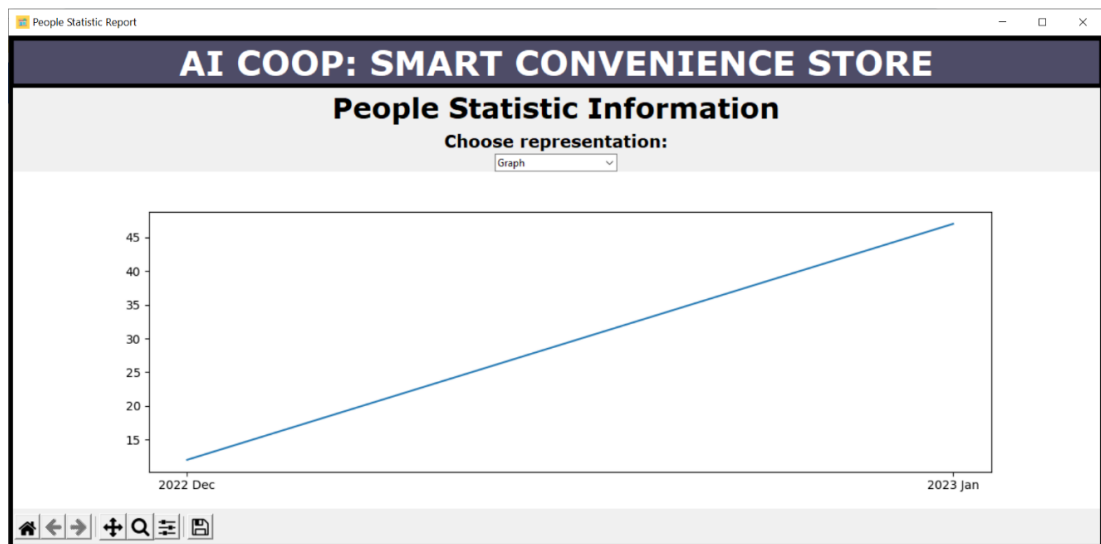


Figure 19: People Count Statistic Report