Software Requirement Specification Document for Smart Suitcase

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Table 1: Document version history

Version	Date	Reason for Change
1.0	10-Nov-2022	SRS First version's specifications are defined.
1.1	25-Nov-2022	SRS sections completion.
1.2	15-Dec-2022	Further modifications Added.

GitHub: https://github.com/eyadamir19/Smart-bag.git

Contents

Abstract

This is the age of uprising technology where technology is used to facilitate people's lives and help those in need. Having a suitcase to store our items in is essential whether during shopping, Hanging out, or most importantly traveling. One of the most irritating experiences that travelers might have during traveling is the loss or mixing of their suitcase with other passengers. Another hard experience that is present during traveling is people with disabilities who are unable to carry or pull their suitcase. To help people and especially those with disabilities move and travel without any burdens we have developed smart suitcase. The bag will be intelligent enough to carry various everyday features. The suitcase works on AI technology that helps in detecting the owner and avoiding obstacles. The suitcase is connecting to a mobile application , raspberry pi that has the software which the camera need and prevents it from mixing with other's personal suitcase, the suitcase will has 2 Motors help move the bag along with its owner in a smooth way also we will use H bridge to control the inversion of DC motor and to control the speedway, strongly built chassis that helps to protect the contents inside the bag in case of collision.

1 Introduction

1.1 Purpose of this document

This SRS document's main goal is to describe and demonstrate the requirements for our graduation project, "Smart Suitcase". That is mainly helping people with disabilities to carry their possessions and move with them freely along with preventing the mixing of suitcase of traveling passengers. We aim to assist those in need and facilitate passengers' traveling experience.

1.2 Scope of this document

Our Project Smart Suitcase is aiming to help people move their possessions freely, especially those with disabilities with the least possible effort. The users will get the benefits of effortless traveling and shopping. This document helps in delivering the functions and instructions of the suitcase.

1.3 Business Context

Moving with possessions is extremely important to many people, but some face problems due to carrying lots of possession so they feel restricted others are having physical disabilities so they can't carry their items while moving. Another approach is for those who are required to travel and are facing the hardships of having their Suitcase mixed with other passengers. Such action may ruin the whole traveling experience. Thinking of those with who are required to travel have both the burden of their disabilities and the routine of carrying their possessions during traveling. This product will help all parties carry and enjoy their everyday activity and forget about the burden of saving and moving their possessions to a safe place.

2 Similar Systems

2.1 Academic

he objective of this research is to develop computer programs that can handle lists and counts as well as detect people and objects. [1] The targeting system can recognize objects by Pytorch's YOLOv5 (You Only Look Once) technology along with Deep Sort for tracking and counting. Additionally, this system only identifies the things needed by the user, which helps with system speed, as opposed to the well-known Yolo object recognition engine, which detects all items at once. Categorization, detection, and segmentation are the three processes that makeup object detection. Performance is evaluated using the following three criteria: mAP, Recall, and Precision.

This work focuses on developing object detection performance in these situations. Photography was done in a setting where it was difficult to identify objects.[2] The experimental data were based on images taken under various environmental situations, such as changing the drone's altitude, and capturing pictures in the dark. The experiment's final dataset contained 2080 images: clear, cloudy, rainy, snowy, evening, night, low altitude, and high altitude in training; 960 images for high altitude in validation. The mAP value of the YOLOv3 model is 93.9%, YOLOv4 model is 91.0%, and YOLOv5 model is 94.6%.

This work focuses on developing the connection between embedded systems and the communication network. The GPS can be used for outdoor positioning services. However, the indoor environment makes it impossible to pick up GPS signals. Many indoor touring applications require indoor position technology. Despite being used for indoor location applications, Wi-Fi position technologies' position accuracy is not widely accepted. This paper compares three different methods. The first method uses just the Wi-Fi positioning algorithm, the second way uses only the Wi-Fi and surrounding weighted position system, and the third method uses a combination of Bluetooth, Wi-Fi, and neighboring weighted positioning algorithm. Methods 1 and 2 are used. It is possible to see that the method I average error is 9.8675 meters. The method 2 average error is 7.191 meters. and methods 2 and 3. It can be shown that technique 2 has an average error of 7.191 meters. Method 3's average error is 4.87 meters. [3]

2.2 Business Applications

The specifications of this bag are characterized by many features, the most important of which is Powered By Artificial Intelligence. The bag, designated R1, always collects data and transmits it to the CO-MOVE independent tracking system. The suitcase stays connected via Bluetooth by downloading the Rover Speed app and it's available on the play store and app store. The suitcase is Secured by One Of A Kind Smart Lock and is Ready To Go The Distance, The bag has a follow speed limit of 5.2 mph and a 12-mile range on a single charge. The salary of this bag is 1,499,99. [4]

COWAROBOT

Figure 1: cowarobot

For the simple reason that it can follow you around, it's one of the greatest smart suitcase goods. It can go up to 6.7 mph and has a 96Wh detachable battery that should last roughly 13 miles on a single charge. It can also charge your gadgets while you're on the road thanks to its two USB connections. There are also a lot of Features including a weight sensor, anti-lost alarm, GPS tracking, and AI vision through an embedded camera.[5]

Figure 2: Ovis Auto-follow Suitcase

3 System Description

3.1 Problem Statement

One of the most irritating experiences that travelers might have during traveling is the loss or mixing of their suitcases with other passengers. Another hard experience that is present during Everyday life including traveling is people with disabilities who are unable to carry or pull their luggage. Using one of the most efficient algorithms in deep learning (YOLOV5) for object detection, Image processing (for processing and understanding the objects that are detected and translating it to the bag to help in following the owner and evading the obstacles), Hardware components (Receive information from the software and translate it to movement) and Mobile Application.

3.2 System Overview

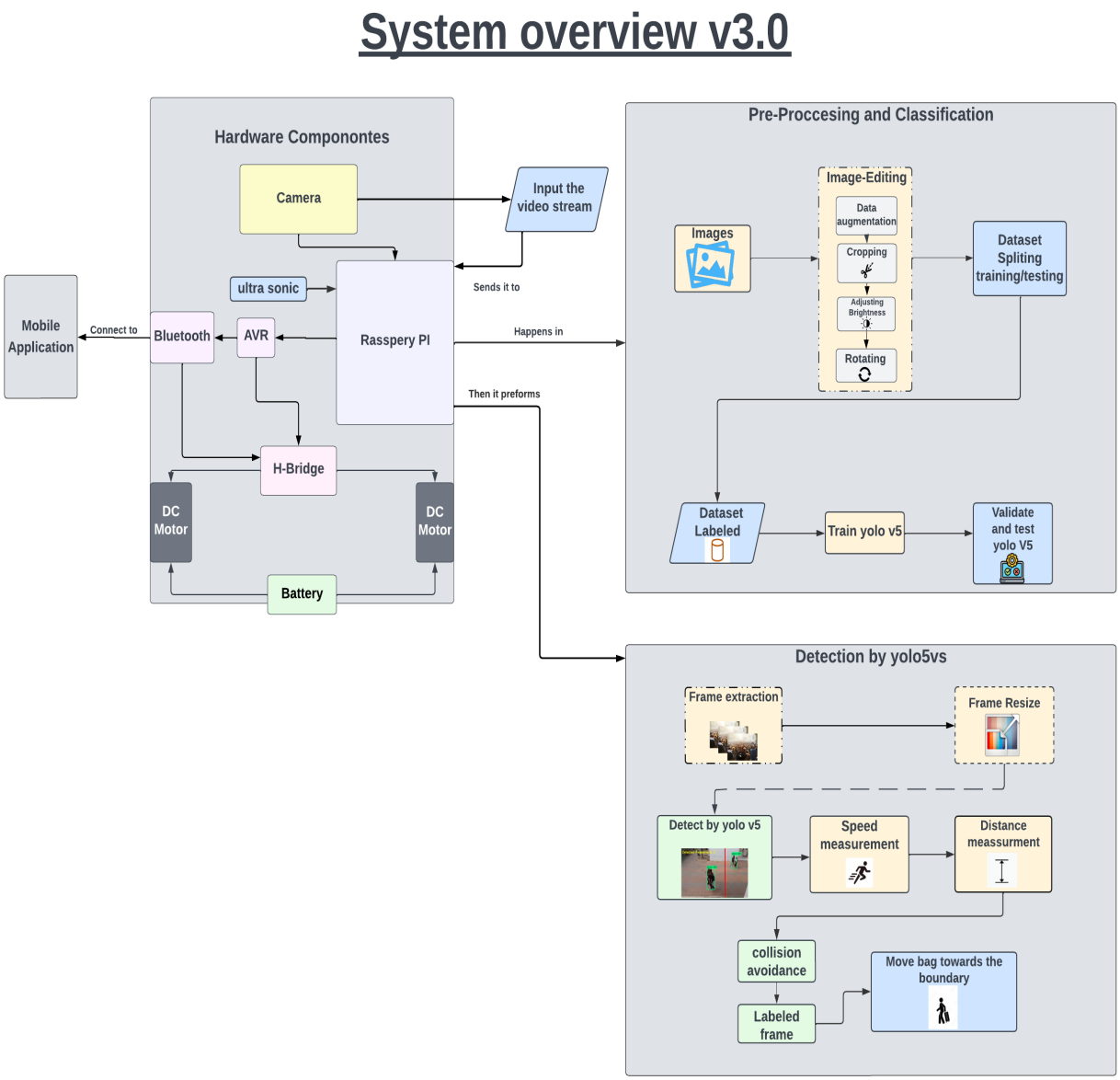

Figure 3: System overview

3.3 System Scope

The Suitcase shall:

- Track the owner of the bag.
- Detect objects and evade obstacles.

- Move on inclined surfaces.
- Produce alarm noise and send notification to the owner through the mobile application if the distance between the owner and the suitcase increased.

3.4 System Context

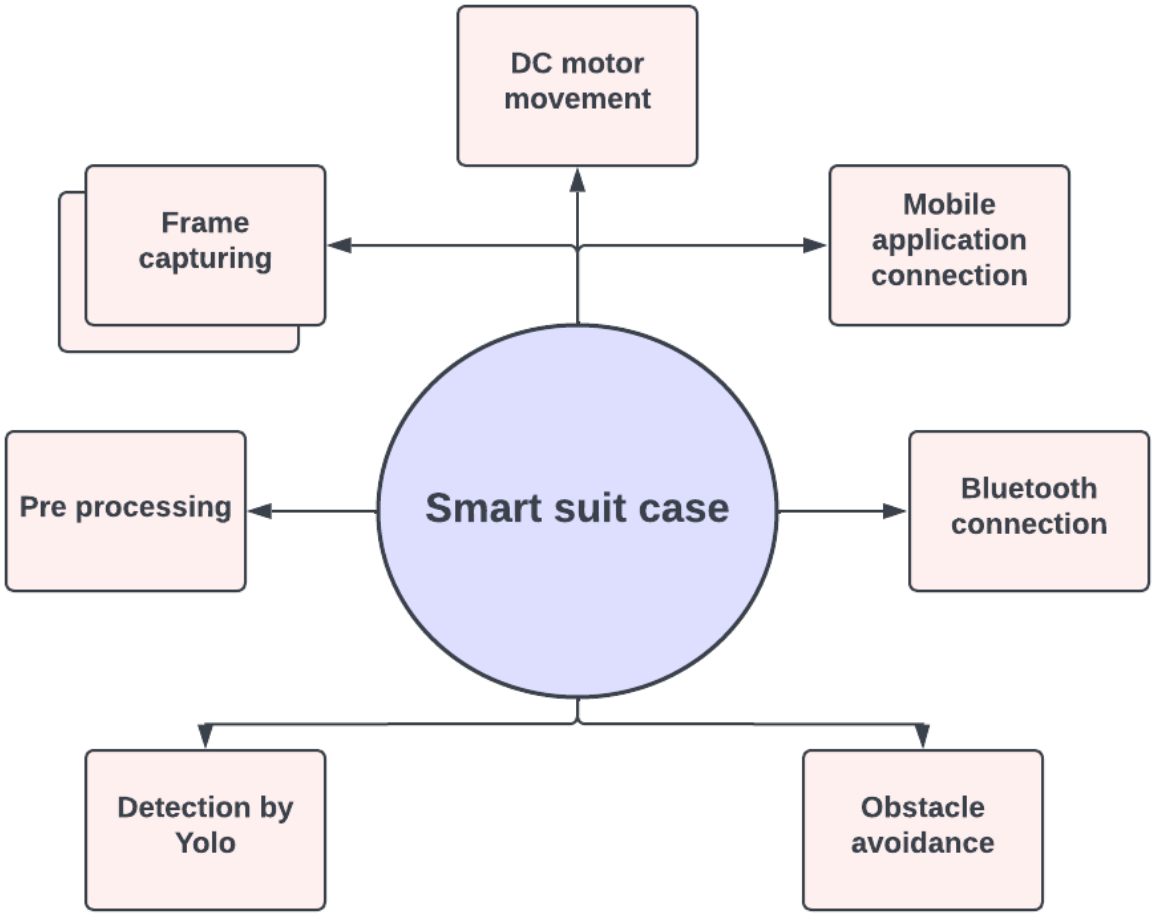

Figure 4: System context

3.5 Objectives

By using out Smart suit case:

- The suit case will move behind the user on it's own without any pulling needed.
- Obstacles will be avoided if it's blocking the path to the user.
- Notification will be sent if any security breach happens.
- The suit case will help people with disabilities and the powerless to pull their bag on their own.
- Notification will be sent if the obstacle on front of suit case is some how unavoidable.

3.6 User Characteristics

Our smart suit case is an embedded system that any type of users can use it and won't have as many interaction with it once the suit case app is downloaded,

4 Functional Requirements

- (F01): The smart suitcase shall capture the video from the camera
- (F02): The camera should send the video to Raspberry PI
- (F03): Raspberry PI should be able to pre-process the data
- (F04): The system shall use YOLO for the detection
- (F05): The smart suitcase shall use ultrasonic sensor for avoidance
- (F06): AVR should send signals that are understandable to the H-bridge
- (F07): The H-bridge shall steer the suitcase.
- (F08): The motors shall receive the signals from the H-bridge and start moving the smart suitcase accordingly.
- (F09): The smart suitcase shall use Bluetooth to track its owner
- (F010): The system should include a mobile application to connect between owner and his suitcase
- (F011): mobile application shall be able to receive notifications from the suitcase in case the suitcase is lost or stopped
- (F012): The suitcase shall contain an alarm in case of theft or the distance between the suitcase and its owner is exceeded

4.1 System Functions

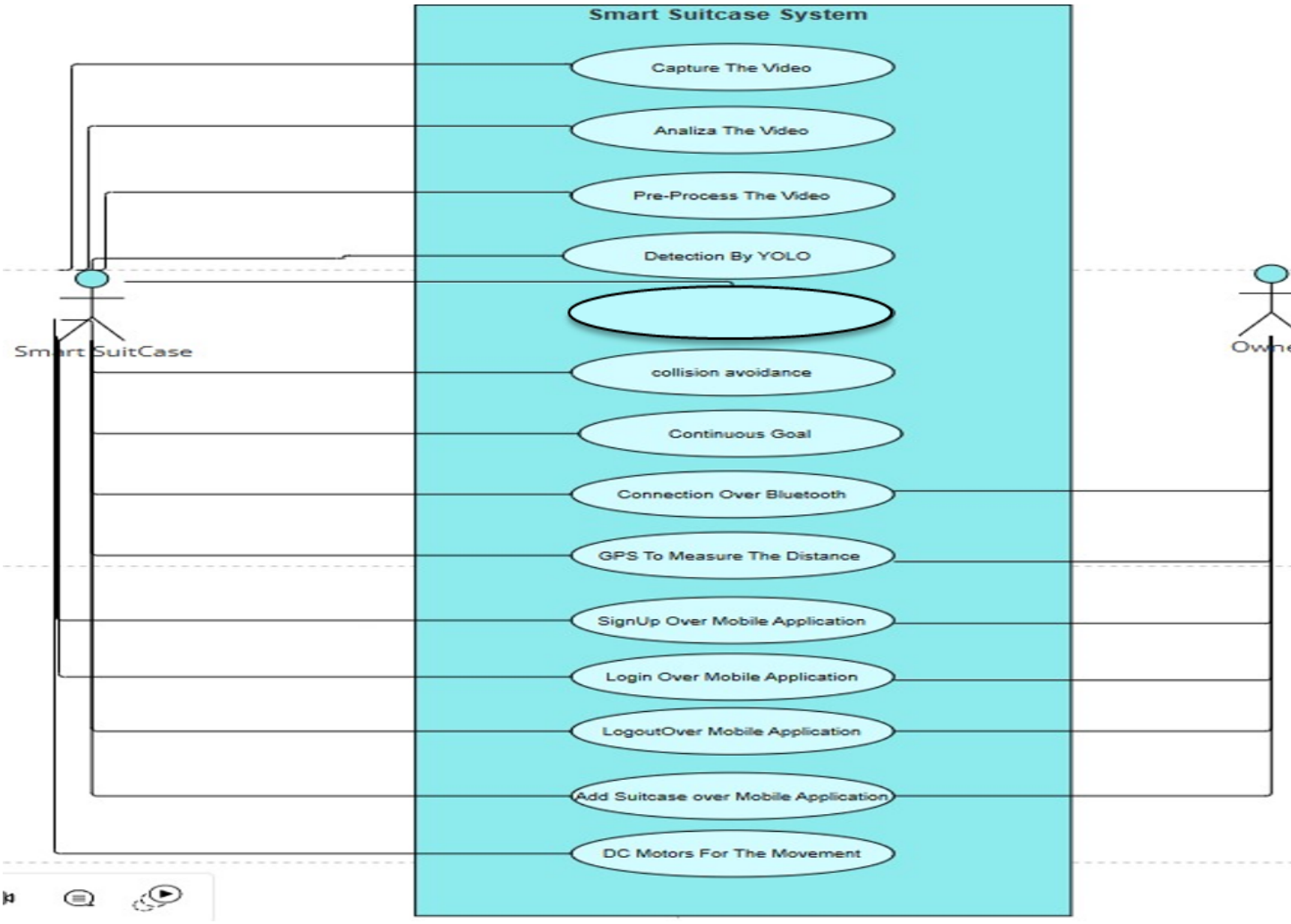

Figure 5: usecase

4.2 Detailed Functional Specification

Table1: capture the video Function Description

Function	capture the video
ID	f01
Priority	High
Critical	10/10
Description	capturing the video for processing
Input	the view that covered by the camera
Action	collect all the information about the owner
Output	Data the f02 will need
Risk	Standing directly in front of the camera and blocking the view, or falling anything on the camera and blocking the view of the camera

Table2: Analyzing and pre-processing Function Description

Function	Analyzing and pre-processing
ID	f03
Priority	High
Critical	10/10
Description	analysis and pre-processing of the video captured by f01
Input	video captured from f01
Action	edit images captured from the video by (data augmentation, cropping, rotating, and flipping)
Output	transmit the images after modification to f03

Table3: YOLO Function Description

Function	YOLO
ID	f04
Priority	High
Critical	10/10
Description	Detection, segmentation, and object location annotations of the scene
Input	received data from f02
Action	using yolo to detect the objects
Output	objects detected

Table4: Ultra sonic sensor Function Description

Function	Ultra sonic sensor
ID	f05
Priority	High
Critical	10/10
Description	ultra sonic sensor send waves to the owner to determine the distance between them and avoid obstacles
Input	from the waves.
Action	suitcase collision avoidance and measuring distance
Output	transmit data to the DC Motors

Table5: collision avoidance Function Description

Function	collision avoidance
ID	f08
Priority	High
Critical	10/10
Description	ultra sonic sensor send signals to the AVR and AVR transmit the data to DC motors
Input	Data received from F05
Action	evade the obstacles.
Output	transmit data to the DC Motors

Table6: Login over mobile application Function Description

Function	Login
ID	f013
Priority	High
Critical	8/10
Description	Allow user login to the system
Input	username and password
Action	Check whether user credentials are registered or not
Output	alert with login status
Risk	- Internet connection is required

5 Design Constraints

- The suitcase will not be able to climb the stairs, and if it faces the stairs, It will have to stop, And the alarm will be ready to alert the owner that the suitcase has stopped.

5.1 Hardware Limitations

- Raspberry pi 3 b+ technical specifications is internal RAM 1 GB so raspberry pi maybe have technical problems with algorithms that need high processor.
- Camera maximum resolution is 640x480 and frame rate is 30 fps.
- DC motors used in the project can handle by maximum 15 kg include the weight of the bag and Speed at maximum efficiency is 21000 rpm.

6 Non-functional Requirements

6.1 Performance and Speed

The smart suit case must be fast in everything such as: constantly getting and saving coordinates about the user the bag in real time, Speed of processing it's surroundings and moving accordingly, Speed of maneuvering around obstacles on it's path, speed of alerting the user about any security issues, Speed of read and processing sensors and camera data from hardware. Our system must have little to no delays to keep the bag constantly behind the user.

6.2 Reliability

Any user of different ages can rely on our smart suit case on everyday use as the sensors and camera reading will be very accurate so everything about decision making will be fairly simple with the help of artificial intelligence and deep learning, So that the user can enjoy free weight luggage moving, But otherwise if the bag and user phone aren't connected to the internet it won't be able to retrieve or save the user location.

6.3 Safety

Making moving suitcase less of a headache and safe Due it's compatible with elderly people, disabled users and children who can't carry their suitcase so our smart suit case will help them move wherever they want care free. If the system readings detected an unavoidable obstacle it will alert the user and Detecting if the distance between the user and bag got out of range. Also if the system detected an inclined ground our safety brakes won't let the suit case fall.

6.4 Security

Our smart suit case comes with Security features such as: Detecting unauthorized opening of the suit case so it will give an alert, face detecting to make sure that this is the owner of the suit case.

6.5 Usa bility

The smart suit case will be fairly easy to use just giving it few information and turning on Bluetooth and making sure the wifi connection is strong and working fine that's it.

6.6 Portability

Our smart suit case will able to carry up to 7 killo of weight fine with 12 is the maximum number it can carry, it would be fairly small so it can increase it's maneuverability around obstacles and to be easy to handle.

7 Data Design

Our Dataset (Open Images) Dataset [6] It is the largest available dataset containing object location annotations, with a total of 16M bounding boxes for 600 objects on 1.9M images. To guarantee accuracy and consistency. It also includes 2.8M instance masks over 350 classes, 3.3M annotations on 1.5k relationships, 675k localized narratives annotations (caption, audio, mouse trace), and 66M point annotations over 5.8k classes.

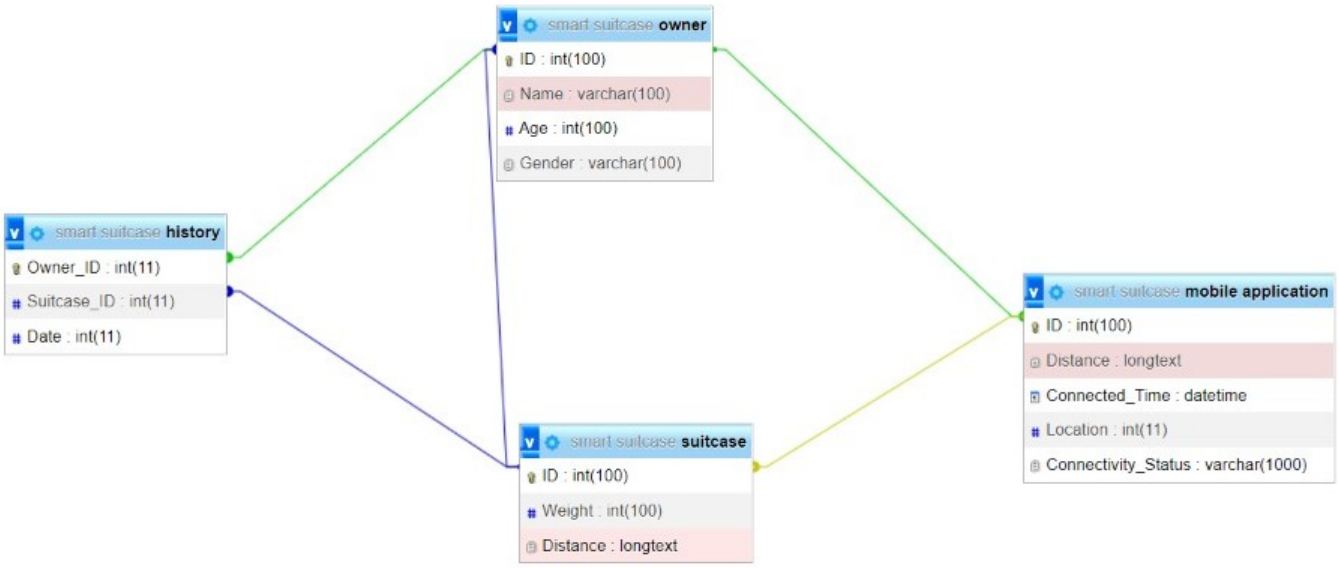

Figure 6: ER-Schema

8 Preliminary Object-Oriented Domain Analysis

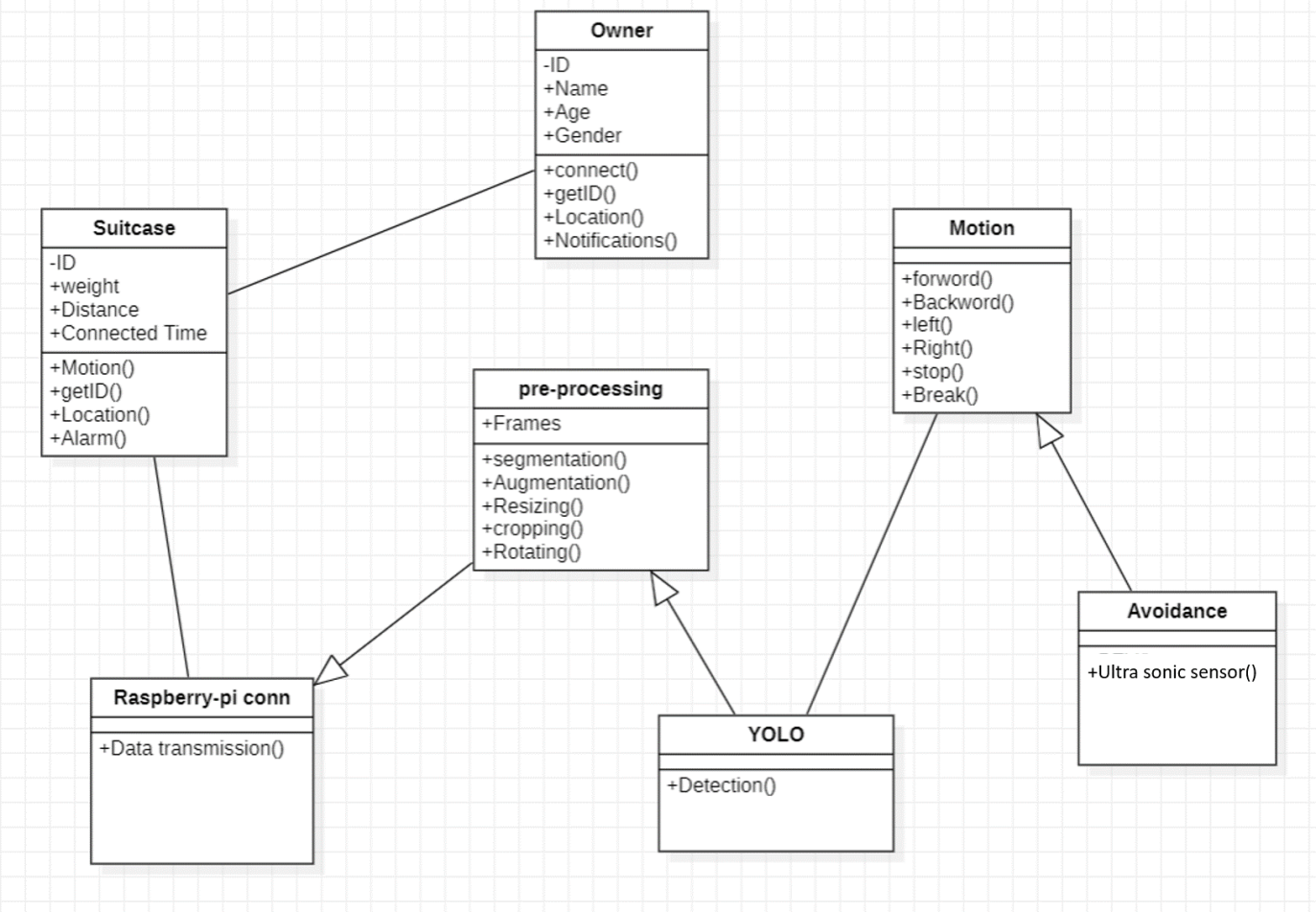

Figure 7: UMLDiagram

9 Operational Scenarios

9.1 Scenario 1

The user starts by signing up via the mobile application and then signing in with his email and password. The application will request the user to open the Bluetooth on his device. After pairing is successful the user will be able to use the product

9.2 Scenario 2

The user is walking on an inclined surface. The user will sign in normally and activate the Bluetooth on his phone then he will start walking and the suitcase will be able to detect and follow him

9.3 scenario 3

The user is walking normally and then he faces the stairs. The suitcase will not be able to climb the stairs so it will notify the user by a message sent to his phone and an additional feature will be added which is an alarm for extra warning.

9.4 Scenario 4

The user starts to increase his walking speed and the distance between the user increases. When this happens the user will be notified via the mobile app and the alarm also will start to operate to give the user extra attention that something is not working properly.

9.5 Scenario 5

The user puts too much weight on the suitcase. whenever this happens the motors will not be able to operate therefore the distance between the user and the suitcase will increase so the user will be notified through the mobile app and the alarm.

10 Project Plan

- Done by All

Time	October, November	December, January 2023	February, March 2023	April, May 2023	July 2023
Training Yolo with the dataset possessed	From 26/10 To 10/11				
Setup raspbbery pi and AVR	From 15/11	To 10/12			
Setup ultra sonic sensor and Bluetooth to work with AVR		From 14/12 To 4/1			
Setup communication between Camera and raspberry pi		From 10/1	To 5/2		
Building mobile application to handle security notifications and location of bag			From 10/2 To 13/3		
Setting up H-Bridge, AVR			From 18/3	To 5/4	
Adding security features				From 10/4 To 7/5	
Testing Bag on varies condition and fixing issues				From 15/5	To 28/6

Figure 8: Time plan

References

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[2] Hyun-Ki Jung and Gi-Sang Choi. "Improved YOLOv5: Efficient Object Detection Using Drone Images under Various Conditions". In: *Applied Sciences* 12.14 (2022). ISSN: 2076-3417. DOI: 10.3390/app12147255. URL: https://www.mdpi.com/2076-3417/12/14/7255.

[3] Hui-Kai Su, Zi-Xiang Lıao, Chıh-Hsueh Lin, et al. "A hybrid indoor-position mechanism based on bluetooth and WiFi communications for smart mobile devices". In: *2015 International Symposium on Bioelectronics and Bioinformatics (ISBB)*. 2015, pp. 188–191. DOI: 10.1109/ISBB.2015.7344955.

[4] *The Biggest Issues Faced by Elderly Travelers at American Airports*. https://cowarobotusa.com/. Accessed: 2022-09-30.

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