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Chapter 1:   Project Overview

Chapter 1: Project Overview

In this chapter, the general context and the problem investigated of the project is presented, divided into several parts: the first part consists in presenting a description of the problem under study, in the second part, presenting the motivation that results from this work, in the third part, the definition of the research questions. and concluding with a presentation of the objectives and the justification of the project.

Content

1.1   Introduction

In today's difficult mobility environment, especially with the current demographic development, the transport sector in Algeria has undergone enormous development in the recent few year from cars and buses to trams and metros, where buses continue to be the preferred mean of transport for Algerians because of its advantage and low cost, seeing an increase in the number of buses to meet the huge demand. However, transport companies have been growing while Maintaining an obsolete management system; as a result, companies Are facing risks of embezzlement. Bus monitoring agents have been used while it leaves a gap due to the inability of covering the whole trip. The urgent need for a global monitoring system became inevitable, and public transport companies should offer safer and more economical solutions and this requires effective transport system management and planning. This chapter helps to understand the public transport types and its management systems and, furthermore, the assets embezzlement risks faced by the bus transport companies in Algeria.

1.2   Case study and motivation

Since the decision to study at the University of Tlemcen, the bus trip was the most convenient means of transport for us. It has been noticed that sometimes, while booking the trip (other than in the booking office), the conductor of the bus has not given us a ticket, not paying attention to it the first time, but this action is often repeated. After explaining this problem to the ELIP startup jurors and coaches —Entrepreneurship, Leadership, and Innovation Program, they have asked for more information about this problem, where they have motivated us to investigate and to apply our knowledge to study such problems. In order to identify and understand the source

of the problem, a meeting with the director of the transport company was necessary, he expressed several problems encountered in his company, he said: "you came at the right time, today a receiver stole 13 000 DA from me in one trip and fortunately I was able to catch up with him". A second manager of the wilaya of Mostaganem, when he explained same problems within his company, he told us: "when a bus goes out for a daily trip, the driver does not respect his route, he makes extra trips without telling me", thus stealing the money of this trip. Those are some witness and victim of this case of study.

1.3   Research questions

In this perspective, and as part of our Graduation Project, work has started towards finding the actual needs of these companies and defining the concept of this project—in method chapter, together with the validation of this concept with the managers who have expressed their patience with the concept of this project. An opportunity to put into practice all the knowledge acquired in industrial engineering studies.

The relevant questions of this research are:
- what methods will we use to help this company to recover these losses?
- How can this problem be a cost-effective solution to business?

- How could our project be integrated into the logic of Algerian transport companies?

Other less general but equally important questions seem to be of interest to us: questions relating to the functional as well as structural requirements of the equipment:
- What technology will allow us to count passengers and to locate the buses?
- and how will this equipment be integrated into the buses?
- How will the information from the equipment be displayed to the end-user (the company owners)?

These questions will be the basis of any reflection that will allow us to define the different concepts for the formulation of this project.

1.4   Objective and justification of this research

While the business income of the company is concentrated on the payment of travel expenses for the passengers and transport costs for the goods—thus the income from the trip for the company is calculated in relation to the number of passengers traveling and their itineraries, a part of this money are collected by conductors from the passengers directly—as a cash on hands, some companies maintain obsolete management system, where owners does not have full information about the journey, in which some conductors take advantage of that to embezzled company revenue or to misappropriate the company fleets. However, a more challenging tasks for managers to keep their business afloat, and to try to draw up an exit plan from problems, particularly on the basis of academic research, in which we are also engaged to improve our community. Noted also that the problem of mismanagement has a greater loss, where it has not yet been measured in Algeria.

Therefore, the approximate calculation of the number of passengers on the bus and their itinerary gives us an overview of the profit that results from the trip, or at least it can be used to check the number of passengers and create more credibility between drivers and managers. Knowing the number of passengers on the bus was a challenging task because of the different scenarios in which the passenger got on and off the bus, as well as the technology to be used together with its expense. Therefore, creating a cost-effective system was the main challenge of this project in order to provide a solution to the problems faced by transport companies. This work is done at different stages, a first step towards using different sensors for passenger counting technology, followed by including tracking tools and geolocation using Android phones, and then collecting and storing this information so that it can be sent to the central database of our platform.

1.5   Paper structure

The search contains the following section: introduction to the problem statement, description of related work of previous research; with the method used in this work as well as the tests result, and finally conclusion with further recommendations.

1.6   Conclusion

In this chapter an overview of current problems, our motivations, and the objectives to be expected is given. Then, in the following chapter, we introduce the transport system, especially in Algeria, the techniques of system engineering, and artificial intelligence.

Chapter 2:   Background of the Study

Chapter 2: Background of the Study

In this chapter, the general background of the relevant area of this study is introduced. And in the other side it gives an historical view of transportation means, in addition the actual situation of it in Algeria.

Content

2.1   Introduction

A long time ago, many people needed to travel, whether for work, immigration, or sightseeing. So, people exchanged their thoughts skills and knowledge as they traveled from one place to another as well, creating new means of transportation day after day.

2.2   Definition of transport

Transport is a fundamental element in the sustainable development of a country. One of the means to achieve economic development is to provide modern transport systems and networks to ensure social welfare and environmental protection. And could be defined as: "The movement of goods and persons from place to place and the various means by which such movement is accomplished" (The Editors of Encyclopaedia Britannica, 2019).

Transport also is known as a commercial activity. It involves transporting both people and goods over specified distances by various means such as vehicles, buses, subways, trains, etc. These companies are considered as profit-making enterprises and are subject to the National Transportation Low.

2.3   The development of transportation

Historically, animals was used as a "means of transport", and this method has been widespread for thousands of years, where They have used the animal either by mounting it or driving it to a cart-carriage. Another mean is the mobility by natural factors as Maritime transport, where it is also used to transport goods and people; after the creation of sailing ships, it became an important means of trade. This means of transport uses the force of the wind and, in some cases, rowing was used. Later, another invention was the first steam engine (Denis Papin) which used steam to move the vehicle; and since then, the invention continues to gain access to various technologies. To reduce travel time and create powerful machines using gas, gasoline, electricity, and the nuclear cell of submarines, the latest invention in this field is the use of hydrogen energy. The invention in this field will never stop.

2.4   Means of transport

The modes of transport are various but with the same purpose, to move from one place to another. These means are mentioned as follows:

2.4.1   Air Transportation

Air transportation is the activity of moving passengers or cargo by air. Air transportation is managed by airline companies using airplanes. Most aircraft are equipped for the transport of goods and passengers. Most airlines jointly run two activities: commercial flights (for passenger transport) and cargo flights (for the transport of goods). The most important technical characteristics of the airplanes mean are the capacity (weight or volume), the range, and the speed. As a result of research in this field, airlines were obliged to adjust their network according to the capacity of their planes, which made it necessary to make technical stopovers on certain routes.

The increase in performance has gradually removed these constraints and airlines now have a decisive say in the drafting of plane specifications (Organisation de aviation civile internationale, 2004, pp. 1–3).

2.4.2 Maritime transport

The maritime transport depends on an infrastructure composed of seaports and canals. However, there are two modes of this type of transport: the maritime transport of people, and the maritime transport of goods, using a combination of ships, ferries, and mega-ships. Where the maritime transport is in development since the invention of the steam engine in the 19th century. Overcome natural constraints such as wind and sea currents with various ships and technical vessels, and to cover large distances while having a high load capacity.

2.4.3 Road transportation

The road transport system is one of the best, most flexible and efficient methods. This means carrying people (or goods) through different types of vehicles, trains, subways, and buses. There are five modes of road transport:

2.4.3.1 Tramway

The tramway is a means of public transport with electric traction running on rails. this means of transport has the capacity to carry a substantial number of passengers (up to 10,000). and it has many advantages such as the insignificant nuisances, and known by its benefit to reduce the heavy traffic in big cities; on the other hand, this means of transportation has an important cost of investments, and difficult implantation.

2.4.3.2 Subway

The subway depends on urban traction railways on an underground site or a bridge. The metro is considered an excellent means of urban transport in the major capitals of the world where the Paris metro is a good example.

2.4.3.3 The bus

The bus is the most used mean due to its great flexibility, and low-cost—in term of energy consumption and journey trip, but he is the most polluting and the least efficient due to its limited capacity in terms of the number of passengers, often be one of the main reasons for traffic jams on the roads, unless it runs in dedicated lanes. As an alternative, the minibuses are the most comfortable and the fastest on road.

2.4.3.4 The car (Taxi)

Although the car (taxi) offers the same advantages and disadvantages as the bus, it also supplies more personal service and comfort, speed, and flexibility.

2.4.4   Rail transport

At the beginning of the birth of railway transport, the use of it was only to transport coal, in horse-drawn trains on wooden rails; and rather in 1832, this means of transport began to transport passengers, where England was the first place that knew it, using steam locomotives, running on metal rails.

The focus of the development within the means of transport is to find the best way to get from one point to another. Indeed, a key factor in this development is to put proper fleet management, and the management of the different cities in networks, to satisfy people's need for transport.

2.5   Transport in Algeria

The transport situation in Algeria is not so far from the other situations that exist almost everywhere in developing countries—as there is unbridled urbanization, increase in the number of private cars, the unattractiveness of public transport, traffic congestion, non-formal transport, etc. however, everyone agrees that the transport sector is essential for economic and social development. There is also a very broadly shared desire around the world for facilitated and increased mobility. As a result of the huge benefits brought by the transport sector, the need for a fleet management system for these vehicles continues to grow, notably for large-scale companies. As a result of this perception, the functioning of Algerian transport management systems has some particularities compared to other countries. However, the transport sector in Algeria has undergone a real transformation in recent years. Numerous projects in the sector have been implemented and have been carried out to make them more efficient and effective.

2.6   Transport Management System

The Transport Management System (TMS) is a family of information systems, for organizing and managing data to produce, query, and make decisions in order to operate or improve regulations and to provide efficient and functional management of public transport.

2.6.1   Definition

TMS is a digital information system that allows, from various sources, to gather and organize, manage, analyze, and combine, elaborate, and present information relating to transport equipment, contributing in particular to travel management (Rouse, 2019).

2.6.2   Properties

An TMS makes it possible—through the manipulation of the database formed, to query any useful information by simple and rapid methods, as well as to perform mixed applications. An TMS can manipulates and provides several types of data to the transport companies (such as vehicle geolocation information: average speed, the route taken, and more other information). Thus, work performance will enhance, and bad habits of employees will be eliminated or reduced.

2.6.3   Transport Information Systems in Algeria

The SOGRAL company—Booking and Management System of Algerian bus transport, has indicated in its latest statistics that about 900 daily trips have been registered in the capital Algiers, all lines combined, and that statistics on trips across the country have also been published (Slimani, 2018). From the same source, the director of the booking company SAGRAL indicated that it was difficult to organize this huge number of trips, and also stated that there were some irregularities as well, and according to the managers of companies we listened to, the amount of the embezzlement can be up to Millions of Algerian Dinars due to the last statistics from EPE SOGRAL spa, (2019) the number of trips and passengers between 2015-2018 in Figure 1 and 2.
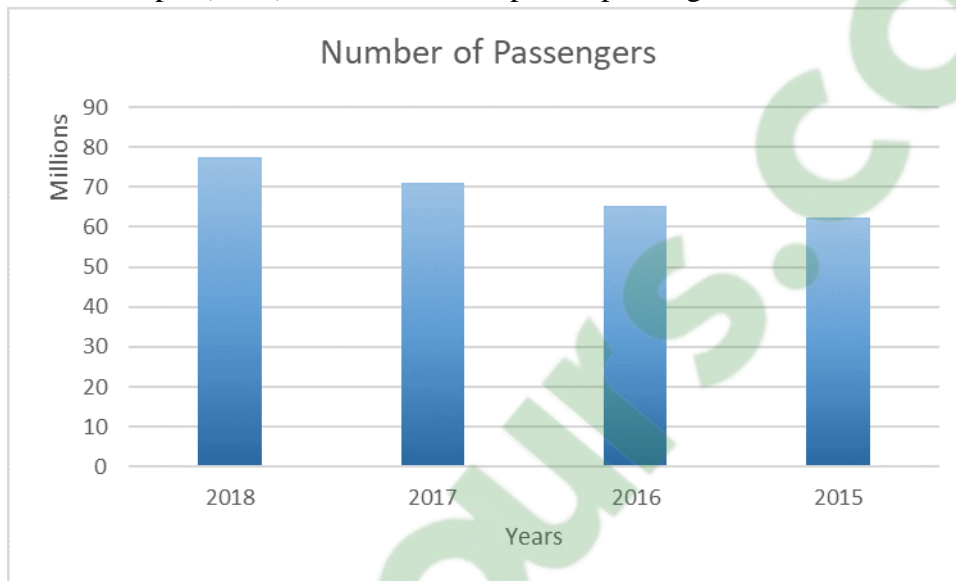
Figure 1. Number of passengers between 2015-2018.
Source. (EPE SOGRAL spa, 2019).
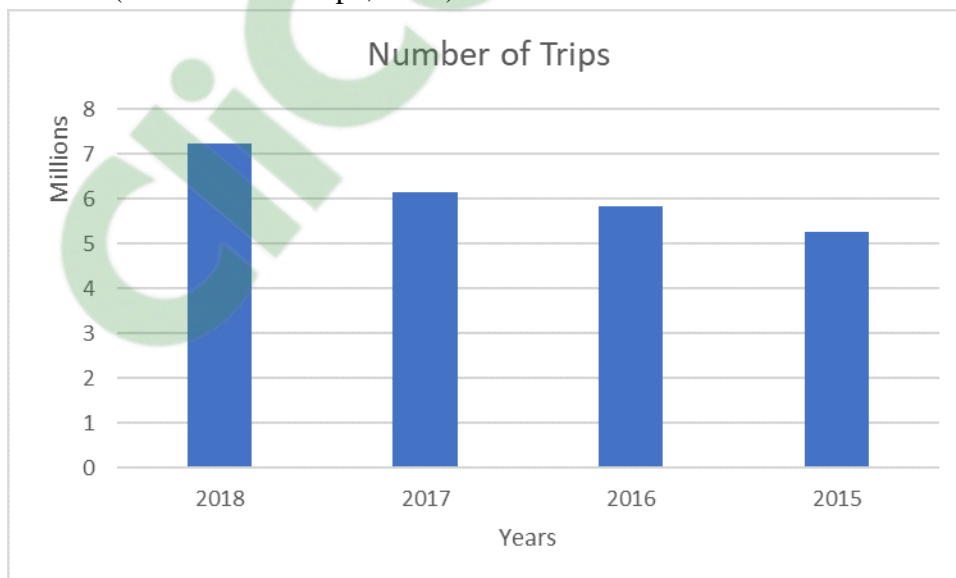
Figure 2. Number of trips between 2015-2018.
Source. (EPE SOGRAL spa, 2019).

2.7   System engineering

In the 1940s, the term "systems engineering" was coined at Bell Labs, and since the 1950s, systems engineering has developed best practices and formal methods, which have been codified in several standards and manuals. These standards are extremely useful in providing structure and consistency to the systems engineering process.

2.7.1   Definition

2.7.1.1   The system

A system is defined as an integrated set of people, products, and processes that meet a specific need or goal (Holstein et al., 2015).

2.7.1.2   Systems engineering

Holstein et al. (2015) define the "Systems engineering" as the technique of using knowledge from various branches of engineering and science to introduce technological innovations into the planning and development stages of a system. In another term: Systems engineering is a multidisciplinary management procedure aimed at designing, developing, and verifying an integrated and balanced overall life cycle of systems. It aims to solve systems development problems and to define a strategic line of the project in which the clients' needs and goals will be satisfied (Defense Acquisition University, 2001, pp. 1–3). However, the systems engineering could be summarized in the *Figure 3*.
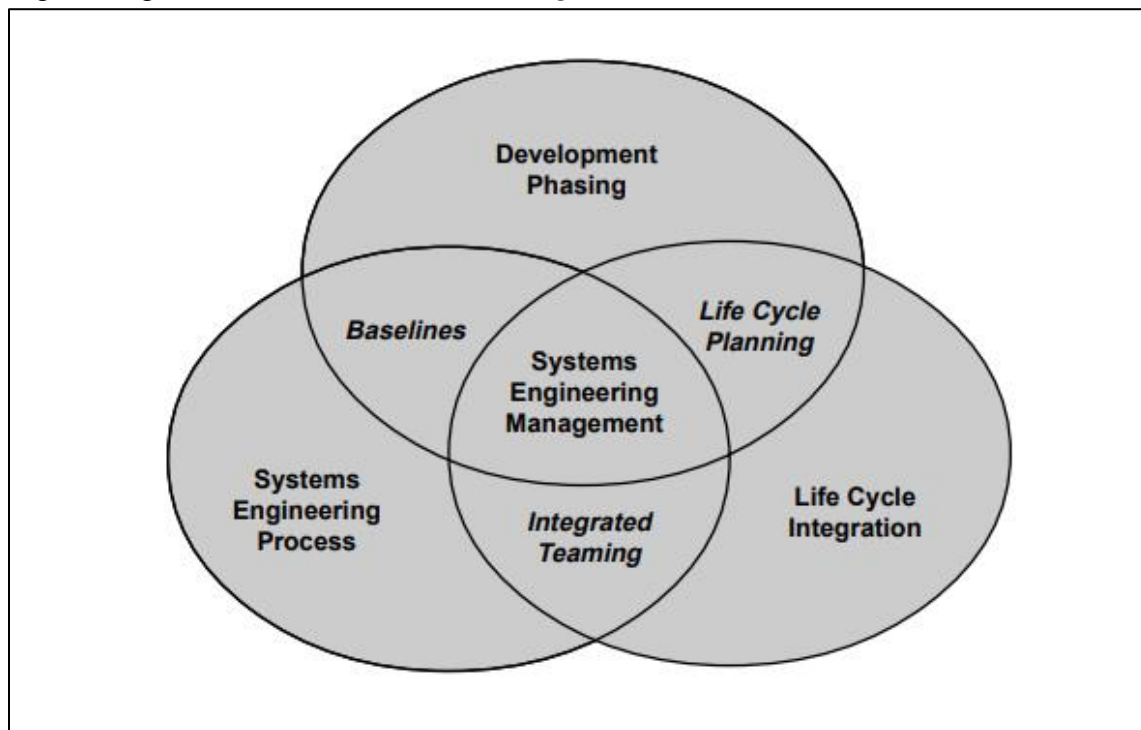
Figure 3. Activities of Systems Engineering Management.
Source. (Defense Acquisition University, 2005, pp. 1–3).

2.7.2   Systems Engineering approach

For easier understanding, the idea of the concept of systems engineering can be presented in a single graphical view in Figure 4. Systems thinking is well integrated into the concept. An essential element of the concept is the process model, which is divided into four modules, that can be combined according to the characteristics and needs of a particular project (Haberfellner et al., 2019, pp. 1–3).
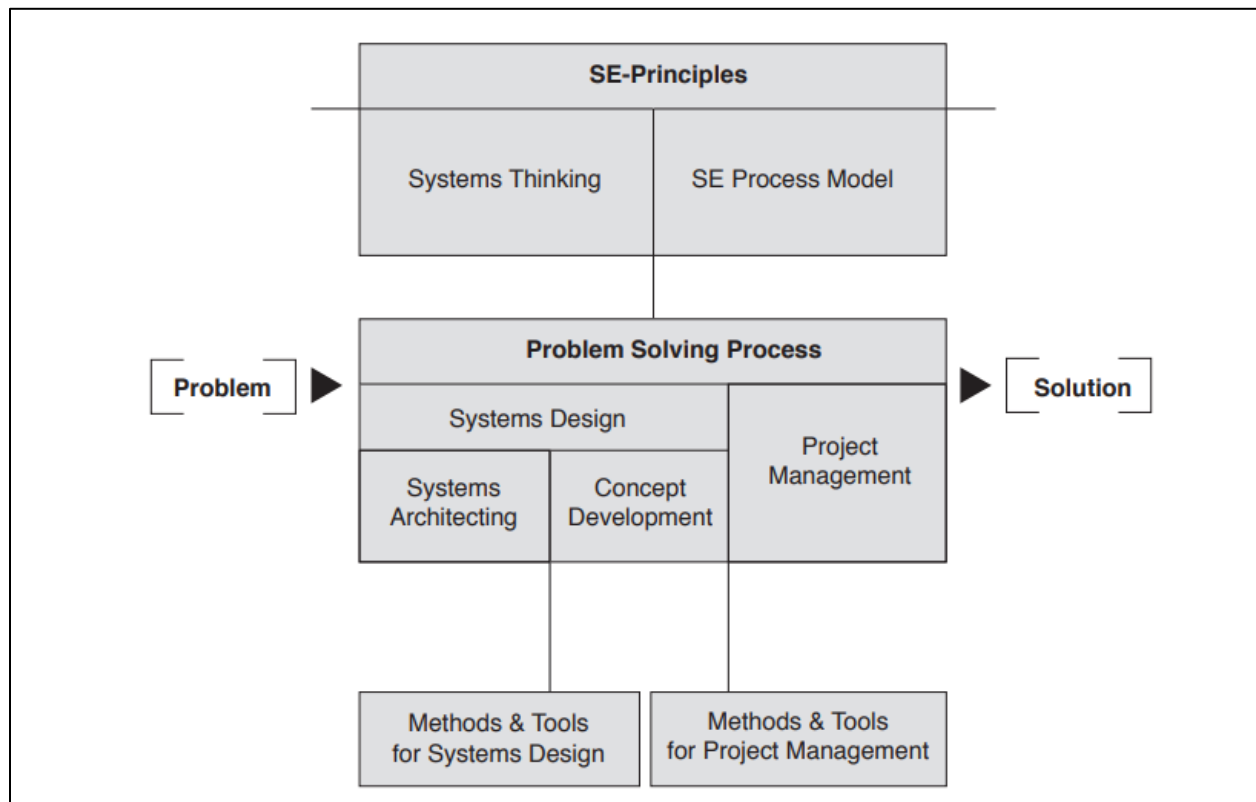
Figure 4. The systems engineering concept.
Source. (Haberfellner et al., 2019, pp. 1–3).

Furthermore, Systems Engineering consists of two important areas: the area of technical knowledge in which the systems engineer works and the systems engineering management department. This approach involves important steps in the implementation of the project. As shown in *Figure 5*, (Defense Acquisition University, 2001, pp. 1–3).
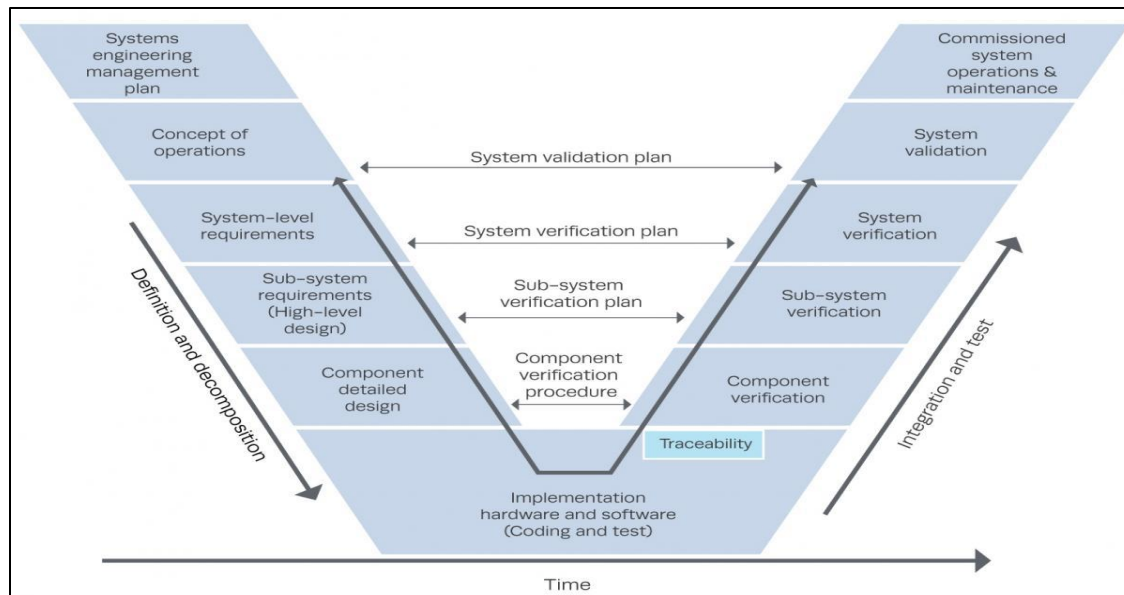
*Figure 5.*The Systems Engineering Cycle.
Source. (Defense Acquisition University, 2001, pp. 1–3).

2.8   Machine learning

As said: "Data is the new Asphalt" and "AI (Artificial Intelligence) is the new Electricity," as the Electricity had once transformed countless industries: transportation, manufacturing, healthcare, communications, and more. Artificial Intelligence (AI) promises to bring an equally big transformation, and the part of AI that is driving these developments is Deep Learning (Andrew, 2019).
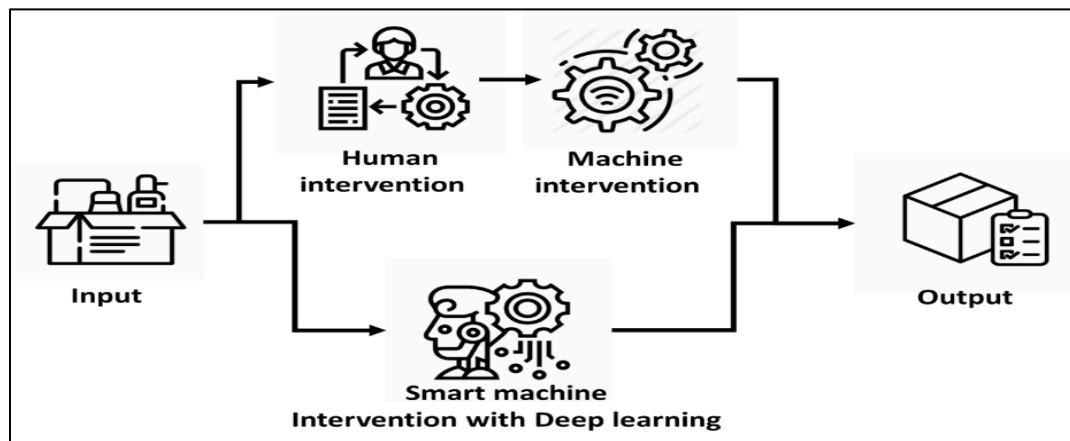
Figure 6. Traditional workflow vs Artificial intelligence workflow.
Source. Andrew (2019).

2.9   Conclusion

This chapter provides an overview of transportation systems worldwide and in Algeria, the different approaches to systems engineering, machine learning, and artificial intelligence. Then, in the next chapter, we will highlight recent work and research related to this project.

Chapter 3:   Literature review

Chapter 3:Literature review

While in literature chapter, a reviews and discussions of the recent research of: computer vision and transport system management is done, through a theorical review, method review, and scope review.

Content

3.1   Introduction

The literature review chapter presents a clear statement of the relevant studies in this area of research. It indicates the importance, interest, and challenges behind machine learning, the relevant model of computer vision, it also presents a review of existing transportation management systems, and concludes with a summary of the research.

3.2   Theoretical review

This section explains the existing theories and their relationships, as well as the degree of development of existing theories.

3.2.1   Deep learning

Deep learning has been around for decades starting appearing in the work of MucCluche in 1940 with their work on the electronic brain, research has started after that period arriving at the work of Hiton hierarchical feature learning (Deep neural network pre-training) in 2006; the reason behind the evolution of deep learning is the availability of both: large datasets and the computational power. However Deep learning is seen as a well-structured automatic algorithm that tries to emulate human learning to obtain different knowledge. It is distinguished by the fact that it does not require pre-programmed rules, but the system itself can "learn" by itself to perform a task through a pre-training phase. (SmartPanel, 2019).

Deep learning is based on neural networks (NN); which is composed of three different neural layers:

- Input Layer: It is composed of the neurons that make up the input data which can be images or videos.
- Hidden layer: it is in charge of processing and calculations. In this layer, the more neurons there are, the more complex and expensive the calculations are.
- Result: the last network decides on the object to be recognized according to the percentage of probability obtained
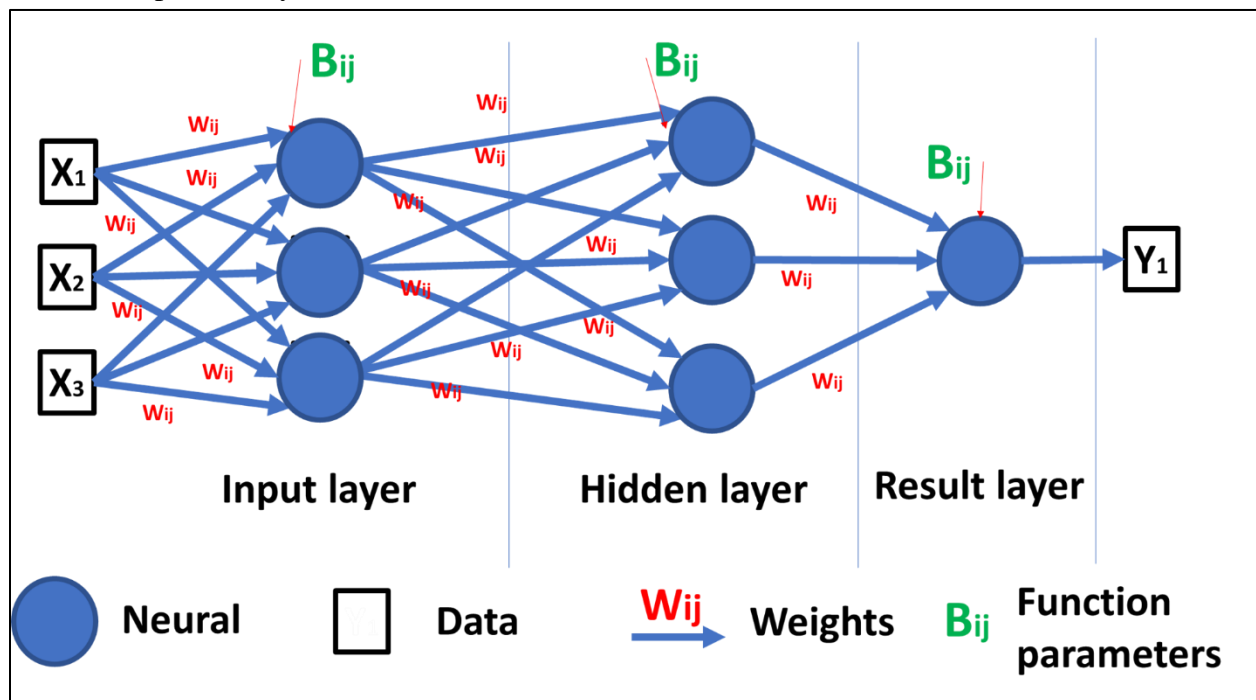
Figure 7. Deep learning composition and workflow.
Source. XuShuai, (2018).
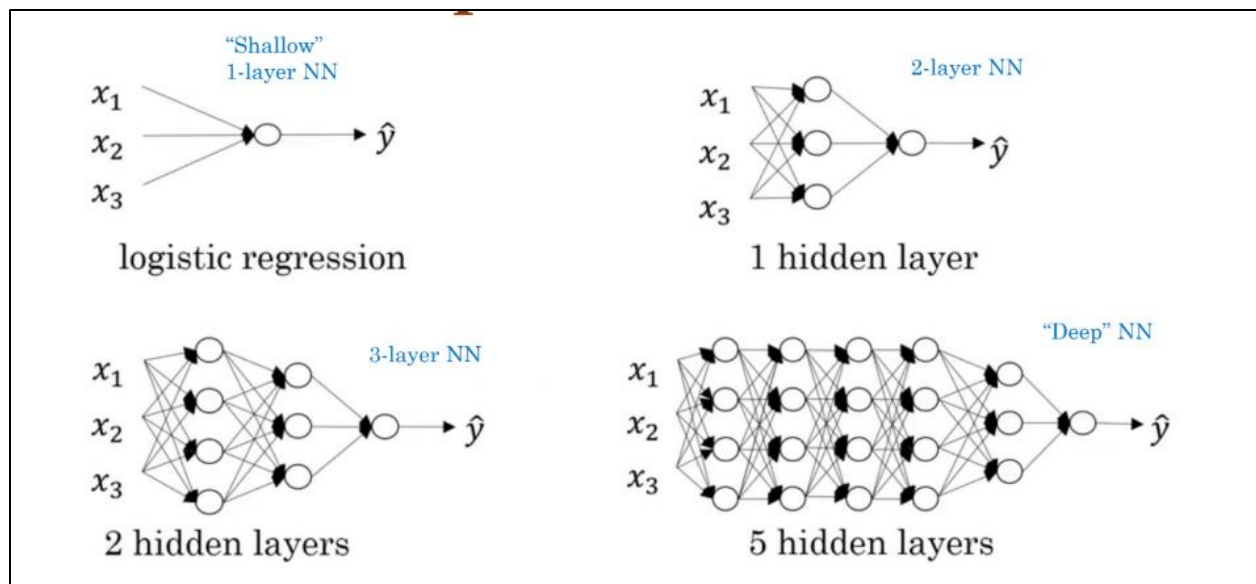
Figure 8. Different type of neural network.
Source. XuShuai, (2018).

The Deep Learning is a very empirical process because it contains both of parameter—a value which we can be estimated from data, like the weights (Wij) and function parameters (Bij); and hyperparameter—a value which cannot be estimated from data but only through experiments, like the Learning rate; Number of iterations of gradient descent; Number of hidden layers L…Etc.

One of the aims of the machine learning is to emerge applications in deferent human life, like the Computer Vision, the Natural Language Processing the Medical Diagnostics, Object Recognition, Emotion Prediction, Voice-enabled assistant, etc.

3.2.2   Computer Vision

Computer vision Field is part of robotics aims to identify objects from given image or video, thus robots can "see." lot of work are one in this field, from image classification to objects segmentation, pathing the way to stereo vision within a three-dimensional field of view. As complex is the computer vision, the computing power beyond the capabilities of present-day technology become grater. The computer vision deals with how machines can learn high-level understanding from digital media (e.g., images and videos) to automate the robustness tasks and that the human visual system performs.
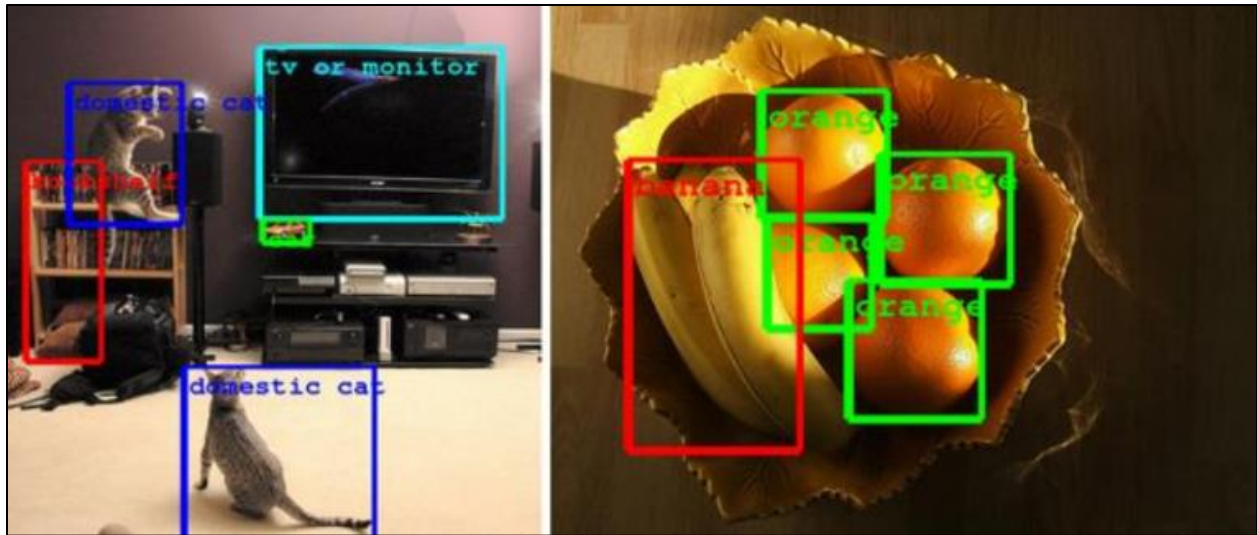
Figure 9. Object detection with computer vision.
Source. Building a Deeper Understanding of Images, (2014).

Furthermore, computer vision can perform for us Different tasks as the figure below shows, where it has a lot of applications on interdisciplinary fields, and even more it can combine more than different fields together, like: medicine, computer science, robotic and more.
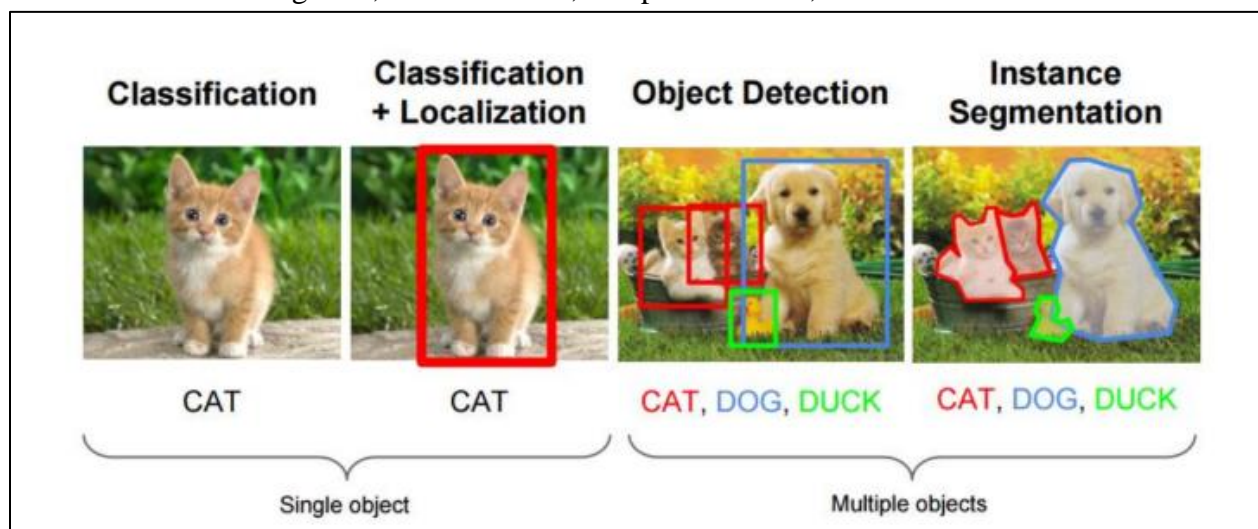
Figure 10. Type of object detection.
Source. Chaosmail, (2016).

3.3   Methodological review

In this section, a review of the framework of understanding at different levels of recent research approaches, data collection and techniques], it presents the practical level of computer vision for use in fieldwork. This approach highlights the ethical aspects that are important for this research project to be aware of and to consider in this case study.

3.3.1   Object detection algorithms

Currently "detection algorithms" has distinctive characteristics that are used in a variety of applications, this section reviews the best-known ones and those that have been improved for better performance in the computer vision algorithms

3.3.1.1   Region feature with Convolutional Neural Network model (R-CNN)

In the work of Girshick et al. (2014, p. 5), they have proposed a method where it was used in the selective search to extract the quantity of 2000 regions from the input image and name them Region feature with Convolutional neural network (R-CNN). Consequently, instead of trying to classify a large number of regions, it now limits itself to working with 2000 regions. The algorithm improves the disadvantage that existed at the beginning with the first deep learning programs, for the reason of taking a large number of regions of interest in the image and with this to take at a great cost in term of computation power, so the R-CNN, focus in the selection of a large number of regions.
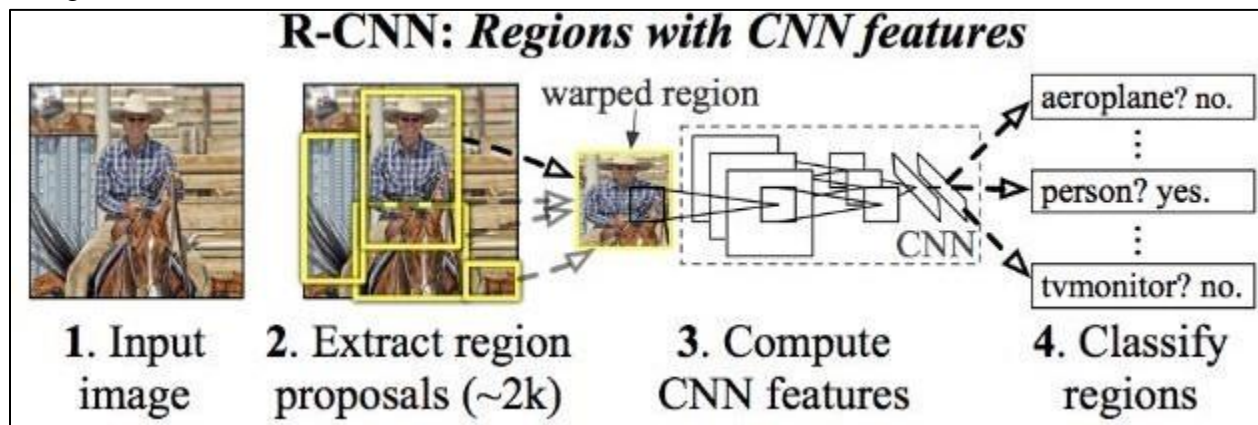
Figure 11. Region feature with convolution neural network algorithm R-CNN.
Source. Khandelwal, (2019).

This solution of the 2000 extracted regions is combined into a square and then introduced into a convolutional neural network that generates a feature vector of 4096 result dimensions. The CNN functions as a featured collector and the dense output layer already hold the features extracted from the input image, which are then fed into a Video Coding for Machines (VCM) to identify the object in the selected proposition. It is important to mention that the problem with this algorithm is the time it takes to perform the entire process, although it has solved a problem away. Still, the program cannot be running in real-time application because it takes about 47 seconds to process a single image.

3.3.1.2   Fast R-CNN algorithm

Moreover, Girshick et al. (2014, p. 5) had also developed another solution to some of the problems of R-CNN, by building an improved algorithm called "Fast R-CNN". Similar to R-CNN, but instead of generating the region's R-CNN, it feeds the input image to the CNN to generate a

map of convolutional features. From this map, it can recognize the region of the propositions and deform them into squares, and, using the Region Of Interest (ROI)—proposed regions of the different sizes (e.g. 3x5, 4x3 ...etc.) from the original image, then ROI pooling is applied to lets the ROIs have same sizes to pass to the Fully Connected layer with fixed size (Erdem, 2020). From the vector of ROI characteristics, the softmax and bounding box regressor layers are used to identify the class of the proposed region and additional displacement values for the bounding box. (Gandhi, 2018)
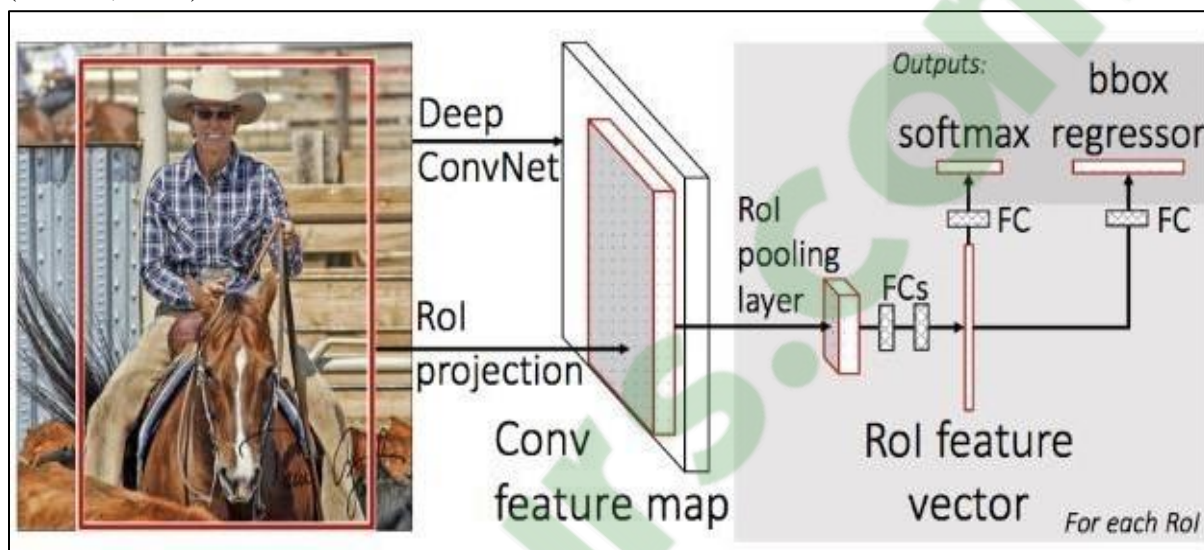
Figure 12. Algorithm for early detection R-CNN.
Source. Khandelwal, (2019).

Fast R-CNN is faster than the R-CNN algorithm since the 2000 regions that used to feed the layers no longer exist, as an alternative the feature map is generated once by reducing the execution time per image as shown in *Figure 13*.
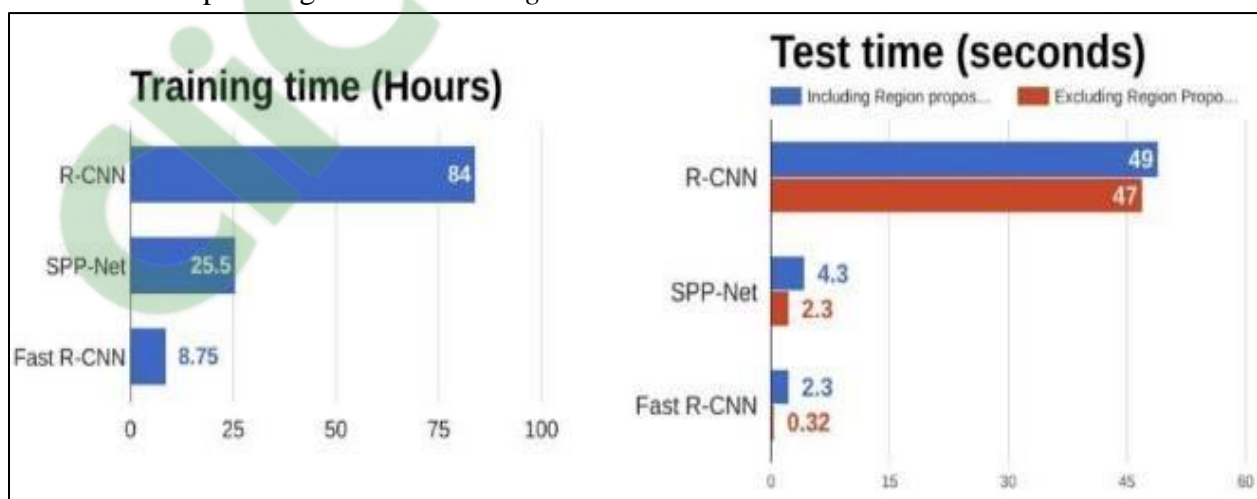
Figure 13. Comparison over time of the execution of the detection algorithms.
Source. Khandelwal, (2019).

3.3.1.3 Faster R-CNN

In case of Ren et al. (2017, p. 1145) they have improved the algorithm to make it much faster than the earlier programs (R-CNN and Fast R-CNN), where both region proposal generation and objection detection tasks are all done by the same convolutional networks (Tsang, 2019). With such design, object detection is much faster. Obtaining a frame time of 10 (ms) which, compared to Fast R-CNN, it takes 2 seconds. This algorithm changes the region proposals of the selective search (SS) to the idea of using another independent convolutional network as Region Proposal Network (RPN) that takes care of predicting the proposals of regions or objects in the image, the selected delimiting boxes are reshaped using the ROI Pooling layer, finally, it is classified and the result of the formed object is obtained (Tsang, 2019 & Ren et al., 2017, p. 1147).
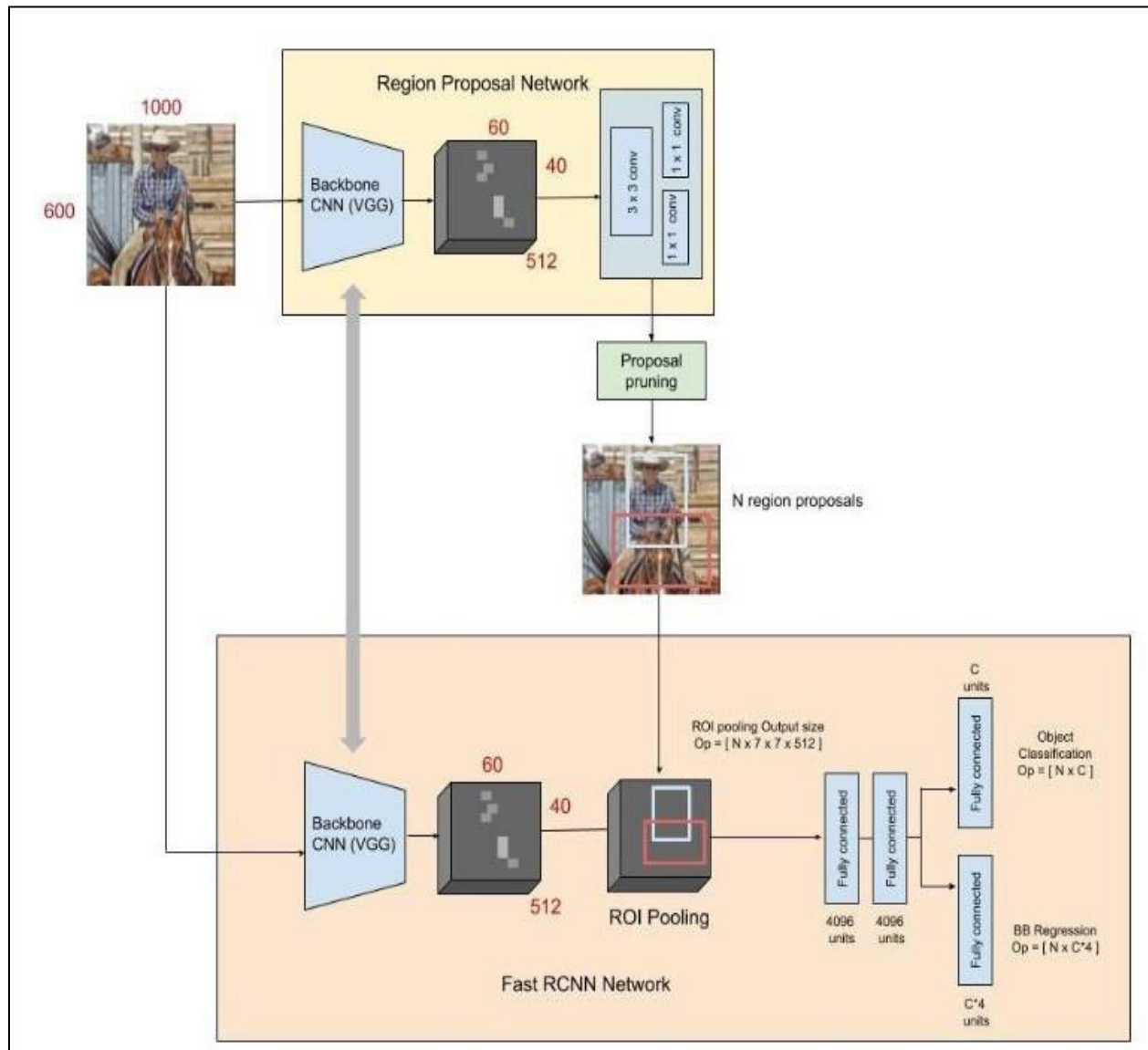
Figure 14. Fastest R-CNN Algorithme architecture.
Source. Ren et al. (2017, p. 1147)

Response time compared to other algorithms.
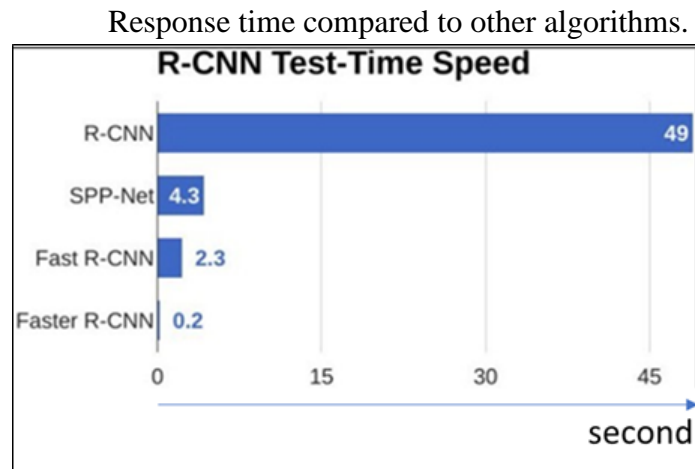
Figure 15. Comparison of the speed of the detection algorithms
Source. Gandhi (2018)

3.3.1.4 *YOLO detection algorithm*

The previous mentioned detection algorithms are based on the use of regions to detect the object in the input image, the problem is that the array used does not observe the entire image, the YOLO algorithm is very different since it uses a single convolutional array which is responsible for predicting the boundary frames and the probabilities of the object for each frame.

The operation of YOLO is based on taking the input image and dividing it completely into the same size of pixels (square matrix), in each of the grids N boundary boxes are taken. For each selected frame, the grid performs a value probability, if the frames pass above a defined threshold value, it is selected and used to locate the object in the image.
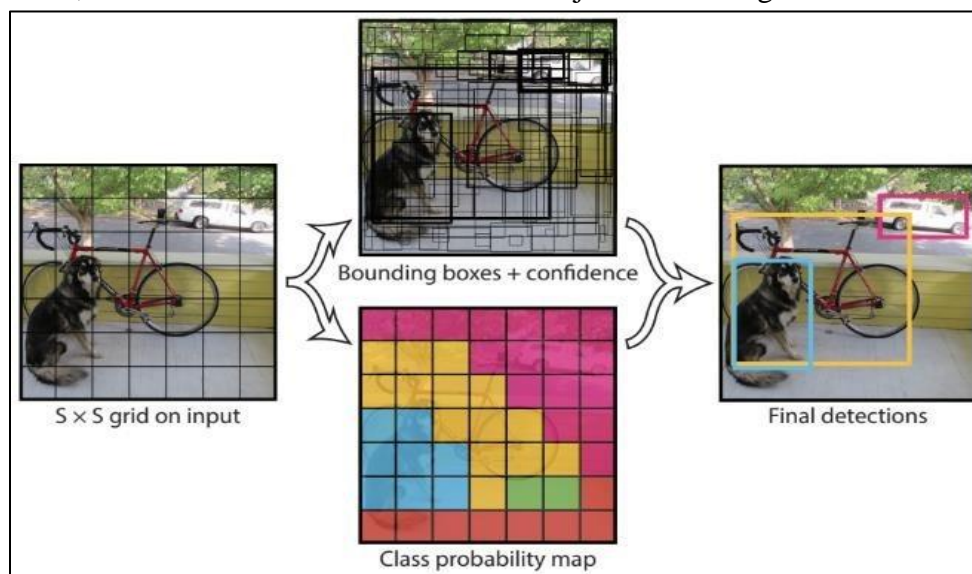
Figure 16. The architecture of the YOLO detection algorithm.
Source. Gandhi (2018)

With this method, YOLO obtained a super-fast result but with a slightly low accuracy as you can see in *Figure 17*. With the speed, the contraction that occurs in an input image is exceedingly small objects and cannot be detected.

Figure 17. accuracy and speed Comparison between detection algorithms.
Source. Jayalath, (2019).

3.3.1.5   *Single-shot detector (SSD)*

The main feature of this detector is its good balance between speed and accuracy. The SSD works by running a convolutional array on the input image once, in which it calculates the feature map, and then it runs a small 3x3 convolutional kernel on this map to obtain the boundary box prediction and classification probability. The SSD obtains Prediction after several convolutive layers with each of them has the advantage of being able to detect objects at different scales. For the development of this work, we use the SSD algorithm for its advantages and the application in which it works, allows us to join another algorithm which is the tracking of the object, as well as it allows us to work in real-time through a video stream at an acceptable calculation cost.

3.3.2   Object tracking algorithms

Tracking is mainly based on the location of a specific object in a sequence of images. The different algorithms that cover this objective will be detailed below:

- Optical flux density: These algorithms determine the direction vector of a selected pixel in the input image.
- Optical flow: these algorithms help to track the characteristic points of an image.
- Kalman filters: this is a common vision algorithm that allows us to determine the position of an object by collecting information on previous movements.
- Single Object Locator: These algorithms lock the object of interest into a frame to follow it later in the sequence images that appear.
- Multi-object locators: this algorithm works in sequence with the object detector, which has to be fast, because when an object is recognized, the algorithm encloses each of

them in a box, identifying them with different variables and then generates the tracking in the sequence of images.

3.3.2.1 TLD Algorithm

The work of Kalal et al. (2012, p. 1419) in attempt to solve the tracking and detection of unknown object in given input video, as a result, they have created a novel approach named: Tracking, learning, and detection (TLD) algorithm, which is a considered as a semi-unsupervised learning, using the following strategy: (i) evaluate the detector, (ii) estimate its errors by a pair of experts, and (iii) update the classifier.

Its block diagram is shown in figure 18. Where the Tracker estimates the object's motion in given frames noted that the motion is limited and the object is visible. The tracker is likely to fail and never recover if the object moves out of the camera view. Detector treats every frame as independent and performs full scanning of the image to localize all appearances that have been observed and learned in the past, in the semi-unsupervised detector there is two types of errors: false positives and false negative. Learning observes performance of both, tracker and detector, estimates detector's errors and generates training examples to avoid these errors in the future. The learning component assumes that both the tracker and the detector can fail. By the virtue of the learning, the detector generalizes to more object appearances and discriminates against background.
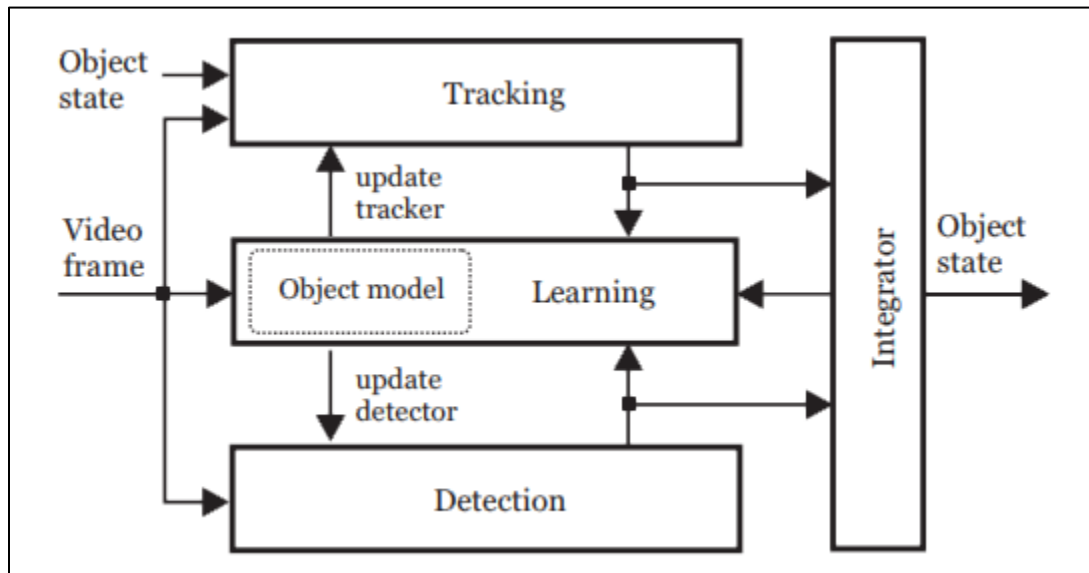
Figure 18. Source TLD Operating Diagram
Source. Kalal et al. (2012, p. 1419)

3.3.2.2 Centroid tracking algorithm

This algorithm works in conjunction with object detection by taking into account one or more inputs from the detected objects. When an object appears in the image, a unique "identification" is created that will later help us track it as it moves through the images of a video.

This tracking algorithm is based on the centroid because it encloses the detected object in a box and defines its centroid, then it is helped by the calculation of the Euclidean distance between the detected objects to recognize and differentiate whether it is the same object or a new one, and finally, it starts with the tracking within the video.

Figure 19. Algorithm for tracking functioning centroids.
Source. (Rosebrock, 2020b).

3.4   Scoping review

Recent development has brought advanced technology to the world, including the vehicle management system, one of the most commonly used solutions in the Internet of Things (IoT). It is used worldwide and, in many applications, including the vehicle location system, anti-theft and tracking system, the company's fleet management system, and its intelligent transport system, as well as for air and marine navigation. These systems organize the data of assets (or fleets) with various information and intelligence such as vehicle locations, speed, fuel consumption, etc.

On the other hand, the need for timely and accurate data is essential for the efficient operation and functioning of fleets and efficient business economics, and this need is mandatory for large enterprises. Ramadan et al. (2012, p. 86) suggested the design and development of a system for this purpose: A vehicle tracking system, which also functions as a theft prevention system, has been established to protect the vehicle from being stolen by strangers. The researchers used the Global Positioning System (GPS), and Global Standard for Mobile telecommunication (GSM) sensors for this system. and to improve the accuracy of position finding and reduce geolocation errors, they integrated the use of KALMAN filters. Their work provides important information. For example, when the engine is started, an alarm is sent to the owner indicating that the engine is started, and also a feature for the owner to switch off the engine immediately in case of unauthorized use.

ElShafee et al. (2013, p. 23) introduced another vehicle tracking system with a new feature, where the owner can view the location of his vehicles across the social media network (of that region) as a value-added service to the traditional tracking system. The proposed system is based on Google tracking maps. Built using the Arduino micro-controller with GPS sensors, GSM (Internet).

Jose et al. (2015, p. 444) suggested a real-time GPS-based vehicle monitoring system with Google Maps and cloud computing technology to collect important information about vehicle movements such as location, speed, and so on, and analyze it on the cloud. That information is sent in near-real-time through the Internet to a central database server located in the cloud. This information will be displayed to the manager and certain authorized persons in real-time after connection to the web platform, anytime and anywhere, as long as the connection to the Internet is available.

The above systems contain a set of devices and services provided for the user through a Web platform and/or software. Supported technology for extracting location data uses the GPS device installed in the vehicle with a GSM device to connect to the Internet. Besides, the services include the current location of the vehicle to visualize it on the map, with detailed reports and alerts, as well as tracking. the system provides to the user the summary of the journey of the vehicle (Chi & Lau, 2013, p. 67). Researchers like Lee et al. (2014, p. 354) created a GPS and GSM tracking device. This device is placed inside the vehicle for real-time tracking. GPS coordinates are obtained regularly and periodically. The GSM module is used to transmit data (the location of the vehicle) and then store it in the cloud database.

Our work shares the same concept with the work mentioned above, with additional features as an added value. The features include the ability of counting passengers on the bus, as well as a solution to the interruption of the Internet during the trip. and more additional features. This work is based on the Traccar platform—an open-source tracking server with a graphical user interface, that allows the system to increase the awareness and flexibility for the users.

While estimating the number of people in a given place is crucial information and has many applications. Especially in the field of security and administration, such as the management of shops, buildings, and transport, or the estimation of an influx in public places. Over the last few years, Camera has been integrated into Artificial Intelligence programs under the name of computer/machine vision, resulted from the evolution of image processing algorithms and the increase in computing power. Various techniques have been developed using the camera as well as resumed within:

- Background subtraction and object tracking approach for people counting system;
- Image classification and recognition by computer vision to identify and track the human body;
- Stereo camera approach to recognize the human body in the 3D model.

The second and third technique is more accurate than the first because they can differentiate between humans and other objects, but the problem is the complexity and it needs high-performance computing where the first approach is lowest in term of computational power than the others. However, due to limitations of the machine used, it was not possible to operate in real-time, because the machine used could not calculate the mathematical capacity of these algorithms, and that is why the first technique is used in most systems.

3.4.1.1   *Computer Vision algorithms for counting objects*

Most algorithms for object counting are based on background subtraction, due to the advantage to work in near-real-time, but it has limitation when it comes to lighting conditions, the use of this procedure implies the establishment of standardization of images in the operational environment—like light, noise, size of the object, etc., (Jovann, 2019).

Figure 20. Background subtraction while the execution of the object (cars) counting process. Source. Li et al., (2014, p. 1).

3.4.1.2   *People counting algorithm based on face recognition.*

People counting algorithms can also be based on face recognition in conjunction with tracking, the goal is to recognize and count people entering a place in certain controlled scenario. The most widely used method for face recognition is the Holistic Matching Methods—it takes the complete face region as input data into face catching system. One of the best examples of holistic methods is Eigenfaces (Divyarajsinh & Brijesh, 2014, p. 84).

3.4.1.3   *Cost-effective people counting system*

Whereas of the high computational power, a low-cost technology is introduced to count people that enter a door, the challenge of these technology is the accuracy of counting, where only one person should pass through the door to have good counting, this technology is intelligent enough as the previous ones, this approach may use two sensors (two of the ultrasonic sensors, or laser beam sensors, or active/passive infrared sensors) which they are placed in the front of the door. This approach can find the direction and the number of people passing through a door, although it is the best choice in some situation.

3.5   Conclusion

Computer vision applications incorporate two different systems: the image processing software, and the visualization hardware that most of the time is a camera or a combination of different cameras. Consequently, there are vision approaches and methods that are made as a part of software development, there are different approaches for hardware choices to such applications. in the other hand, the transportation management systems is in another level of development and it is more and more connected to the company's assets This literature review discusses these two aspects of the system, and introduces the recent research associated to both of them.

Chapter 4: Methodology

Chapter 4:Methodology

This chapter present the methodology that this project had followed up in order to arrive at the actual level. The main work in this project is that it uses system engineering plan. The used approach outperforms state of the art considering the next following points in this chapter.

Content

4.1   Introduction

The success of a TMS project depends, to a large extent, on non-technical factors such as the analysis of needs, the implementation method, the economic conditions related embezzlement estimation, effect on investments and operations costs. Its sustainability requires trained and permanent staff, daily operation, adaptation to the organization of services, and the development of future development plans. To release this project—fleet tracking with people counting feature for the control and supervision of the company's buses, the following points was mandatory.

4.2   Setting the conditions for the success of the project

Create an information and monitoring system that must assign several services and tasks and requires verification of the distinct phases of the project. It should be noted that this type of project must be piloted by people convinced of the value and information of the project. It is a matter of communication and awareness among the members of the project. The implementation of an TMS can be a difficult factor for companies because it can redefine new jobs, functions, tasks, and processes. One does not forget that the software used has a cost, where is a big investment for them. And before its implementation, simulation must be done several times to: estimate the embezzlement cost and lose for the company, and to do the cost-analysis of this project. In same time this project passed through following points.

4.3   Preliminary study

4.3.1   Analysis of the needs

The desired uses, the expected results, the territory covered, the deadlines for the implementation of TMS are all important information where it helps to identify such needs, by setting up interviews with different business managers, either by construct a simulation model of the company works. Where this will guide us to draw up the TMS needs and operating path.

Table 1

Business needs analysis.

Intuitive Research	Research-based on the need expressed by the manager	The environment study, the study of the context - Analysis of the existing
What are the main aspects of the useful information (in relationship with the TIS)?	Who are the end-users from the TIS?	What are the conditions use of TIS? How does the TIS interact with data and/or software pre-existing? (internal)
Are there any constraints (confidentiality? Reliability? …)	What are the data?	What are the TIS and data sources already existing? (external and internal)
What will be the added value in the service?	What problems will the TIS solve?	What are the existing source data (statistical data), bibliographical data, repositories, and software packages in the service? (internal)
	How long will this need exist?	How will the TIS be accepted? What changes in the organization will it involve? (internal)
	How will the business need change?	

Note. Internal means pre-existed in the company; External means does not exist in the company.

This step must accompany different actors, to bypass the different difficulties, from the design of this system, to its implementation. The questions asked in the table 1 have been reviewed with coaches/teachers and company managers. However, some questions asked have not yet been answered. But there is existing tribal information on some similar systems. In this phase, the system requirements have been discussed, and consider the following point:

4.3.2 Pre-requirement of the system

- The system must consider human resources, either by re-allocating the current position or by creating a new one.

- Also, it defines two levels of skills (the supervision on the platform, the operator in charge of one or more buses).

- Training of staff to be skilled in the use of the platform

- Consider whether the driver revenue data and the platform data that will be obtained are the correct types.

- Provide optimal solutions in terms of hardware and software solutions.

4.4   Realization phase

Once the possible scenarios have been studied, the project will be formulated with a more precise description. The formulation of the technical specifications and conditions should enable the company to have proper work in the future.

4.4.1   Acquisition phase

It includes the selection of the supplier and/or service provider capable of guaranteeing the supply of the equipment used. Installation of the basic software. Installation of the end-user platform/software; Provision of specific developments: training; And installation; And support. The collection or acquisition of bus data can be managed. Establish the schedule of the works, as we are the type of medium- and long-term projects.

4.4.2   Execution phase

Assign supervisory staff to monitor the progress of the different bus routes and the compliance of their activities. Undertake professional training and work assignments to ensure the continuity of the project. Advising and engaging the future end-users on the system.

Chapter 5: System design and conception

Chapter 5:System design and conception

For the Chapter 5, the general workflow and architecture of the system and simulation model are presented. Including the detailed explanation of each part of this system and its workflow. Software and hardware are also presented. However, the operation of the bus in the line Souk-ahras to Tlemcen is done with Arena Rockwell.

Content

5.1   Introduction

In order to answer the questions and objectives of this research, this section present the requirements of the system needed to realize this project, as follows:

1. the passengers counter is able of providing an accurate count of passengers on the bus with cost-effective equipment.

2. the location system is capable of recording all the routes the bus passes through, including speed and stop location.

3. the e-platform is capable of showing all the information that managers want, such as live location tracking, history of the locations with the number of people on the bus, at anytime and anywhere.

5.2   Architecture

The choice of main control unit in the bus was the Raspberrypi device due to its advantages and multitasking units. Therefore, it is connected to the passenger counting device—the camera due to it can work in complex scenarios. As well as it is also connected to an Android device that provides GPS data and Internet access—android GPS is chosen because it does not need to permit/license. All these elements are combined to be installed in the target vehicle. The internet platform (cloud-based) is also an important part of the system where the information sent by the bus is received by this platform to monitor/track the bus—Traccar platform is chosen to be the host due to its scalability. The bus information can be displayed via the platform's dashboard with access via computer/smartphone. In addition to these hardware components, both the user interface and the server module provided by "Traccar" are used as part of the software. The illustration below summarize the components of this project, Figure 21.
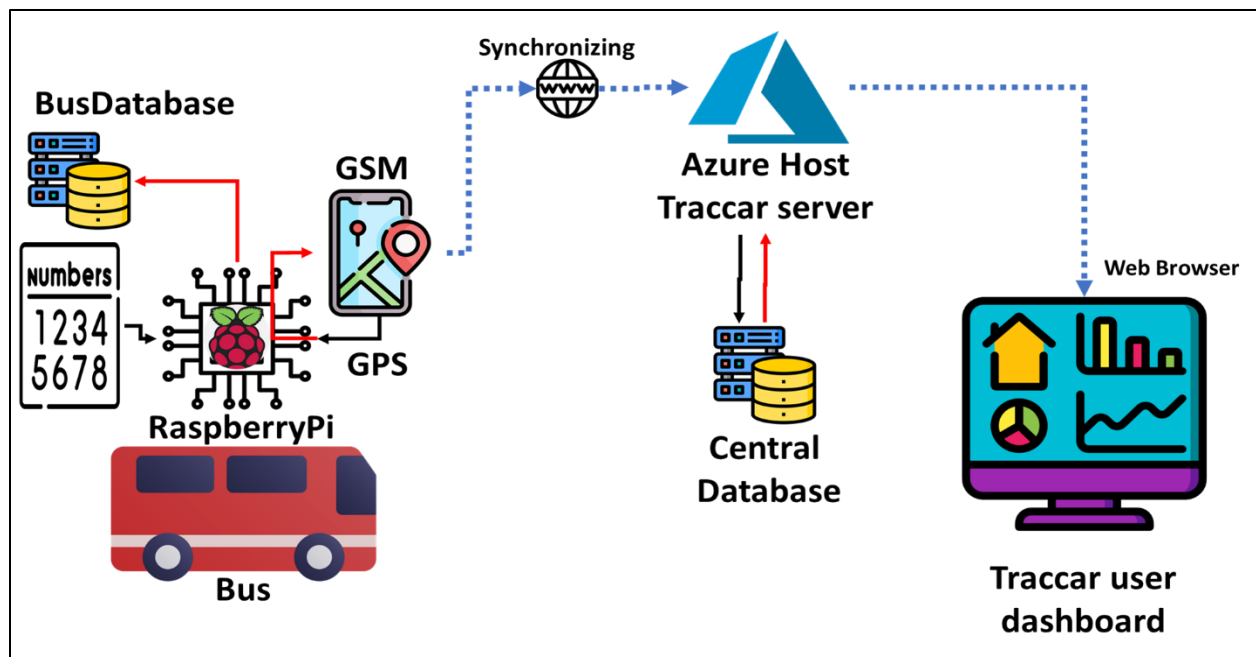
Figure 21. Illustration of the proposed system layout.

The operation of this public transport management systems, and the description of the work of each component in this system, including: the different passenger counting techniques have been used, and the acquisition of the various data required by the system. This chapter deals with the design and introduction of the application that will be useful for analyzing the existing system and for managing certain entities. To implement our information system that consists of managing and monitoring public transport in Algeria, we went through the following steps.

5.3   People counting system

The used devices in this project to count passengers is based on ultrasonic or camera, for the ultrasonic people Counter, we have used two of ultrasonic module sensor, when someone passes through them they will detect the person and his Direction in or out, we have used this type of device in the old turnstile Gateway, as an additional feature to be able to count people pass through turnstiles in each station of the subway as the Figure below shows.
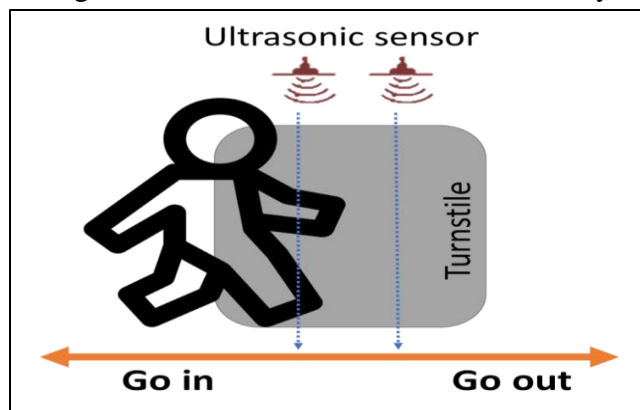
Figure 22. design of People counter by ultrasonic sensors.

Figure 23. Ultrasonic people counter algorithm.

      The figure below illustrates the algorithm of the people counter using ultrasonic sensors, where it waits for some object to cross the line as the figure 22 shows, if one of the sensors detect the presence of the object, it will wait the second sensor to detect the object also to be able to: increment the number of people or decrement this one. Which gives as a result the total number inside. In case the other sensor did not detect the object, this will return to the initial state "waiting and object".

      In the other hand, the use of cameras in passengers counter device by the detection And tracking of the Passenger algorithm, this algorithm uses the background subtraction method where it removes the background from the input image then detect if an object—in this case person, is present in the image, then tracking this person from the initial frame (first appear) to the end frame, where tracking ID is given to each object, analyzing the line made by this person will be

used to determine if the person is going in or going out this process is summarized in Figure *24*below.
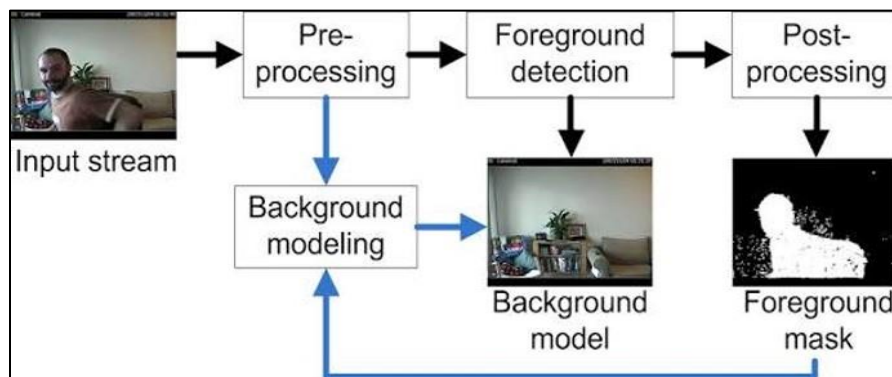
Figure 24. Background subtraction process.
Source. Parks & Fels, (2008, p. 1).
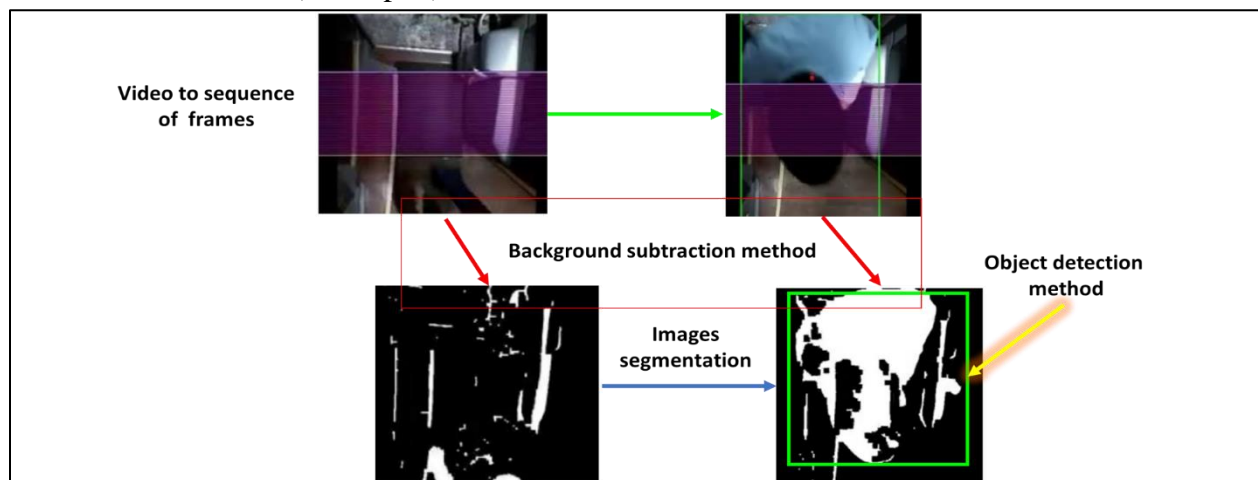
Figure 25. people detection and object counting by the camera (with background subtraction method).
Source. VION VISION, (2016).

Furthermore, an advance algorithm using computer Vision and human detection is used to provide high accuracy to count people this algorithm is using an open-source pre-trained model for object detection (YOLOv3) —in our case human detection, which is a deep learning-based object detector with the ability to recognize objects in the current frame/image, An object tracker is an algorithm used to follow the (x, y)-coordinates of the detected object, where each detected will have an assigned ID. Tracking this object as it moves during a video stream input —as the algorithm converts the input video to successive frame/image. this method combines the concept of object detection and object tracker in one algorithm, resumed as follow:

Phase 1 video preparation: in this step, the input video will be divided into consecutive image/frame, then resizing these frames in as low as possible to reduce calculation, the last step will convert these frames to RBG format.
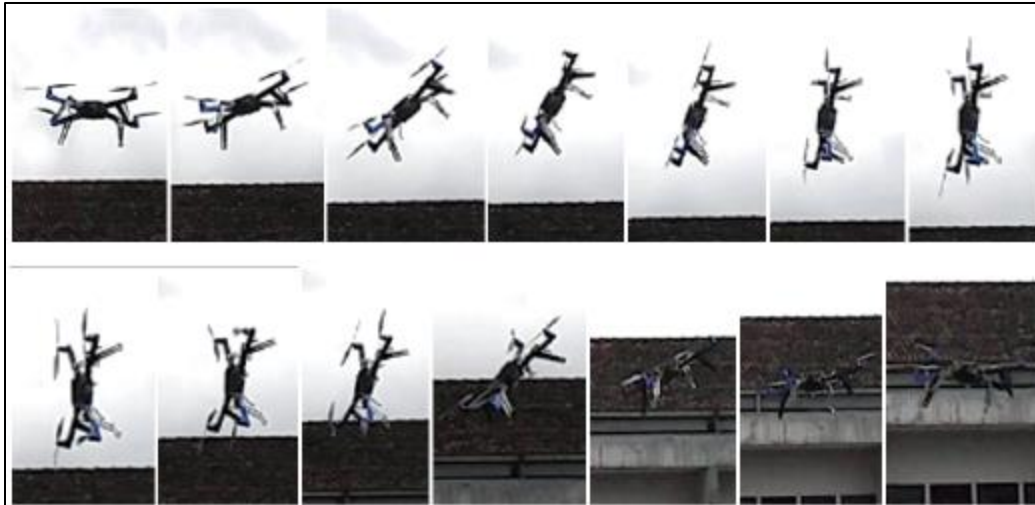
Figure 26. successive frames output from the input video.

Phase 2 detection: the object detection system requires a combination of two steps: (1) detection if there is a new object and (2) determination if that object has disappeared "lost". For each detected object, a tracer is created or updated with the new coordinates of the boundary box. The human detection is provided by the YOLOv3 object detector. This process works every N frame to save time (computing time) to be able to work in near really time because it is a complex and expensive calculation.
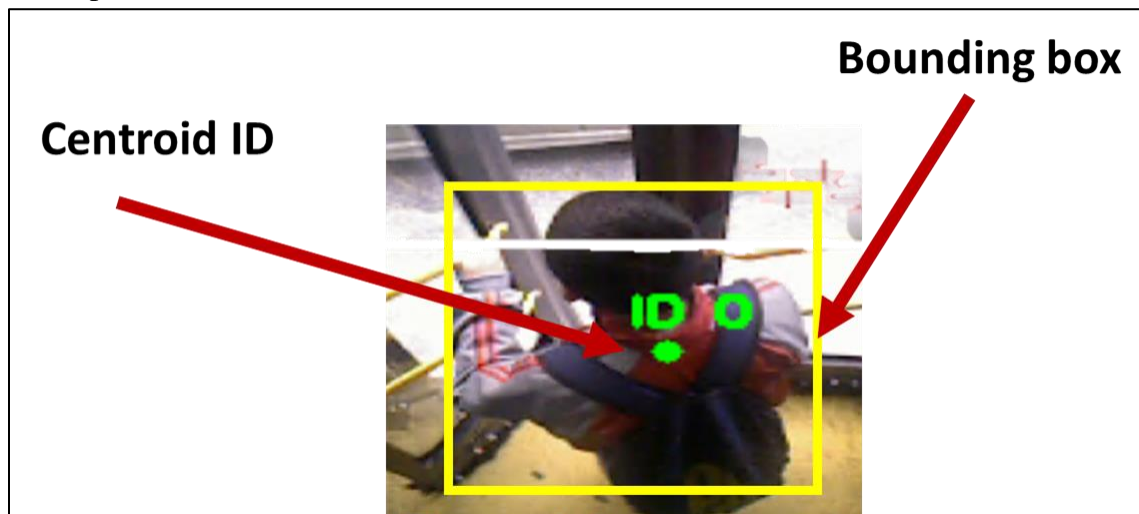
Figure 27. Assigning an ID to the detected object.

Phase 3 tracking: while the object is detected in the frames, the creation of an object tracking system to follow that object as it moves across the next frames. This process loops until the object are detected as "lost". And will result in the history of coordinates from "detected" to "lost". The tracking line is the result when joining all of the previous centroid coordinates [(X0,Y0), (X1,Y1), (X2,Y2)… (Xn,Yn)] from the first frame when is detected to the last one, as a result, it will draw a line in the output video.
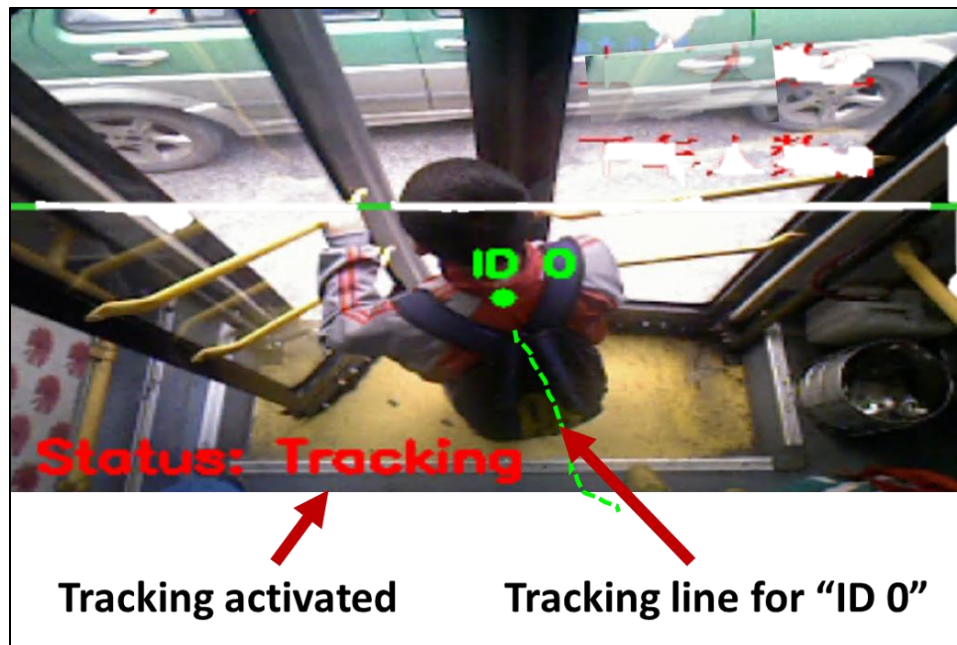
Figure 28. tracking function activated with the tracking line of the detected object.

5.4   the workflow of the model

The operation mode of the last technic of passengers counter is shown in Figure below, which involves the video input that is the camera, the interlacing between the detection and monitoring algorithms, as an output to the operator the result on a monitor that shows the results.
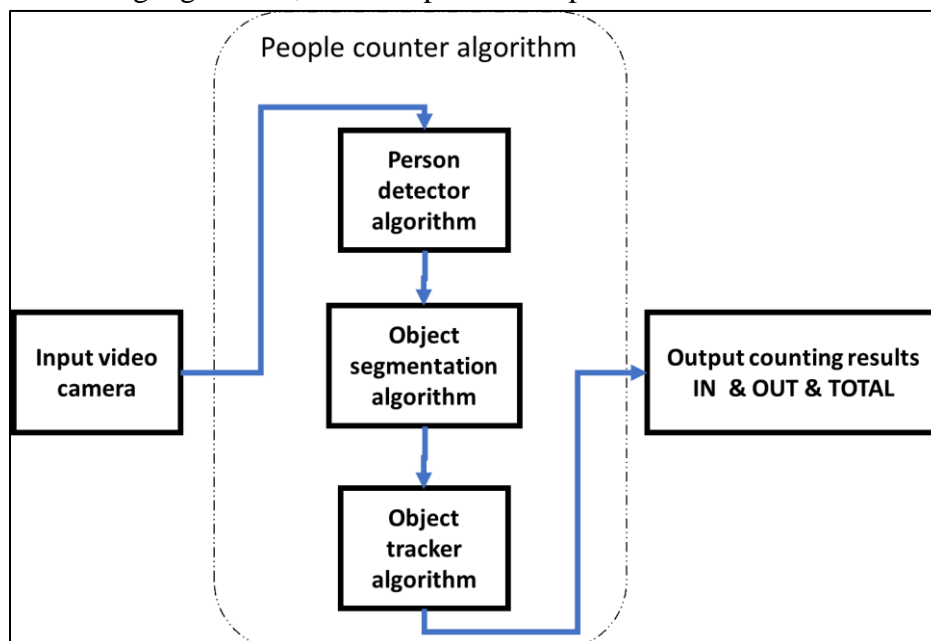
Figure 29. the workflow of the people counting prototype

5.5   Localization device

To determine the geographical position, the GPS sensor within Android Smartphones is used which is just for prototyping because of the unavailability of the GPS module and the restriction of the use by local government on the use of the GPS module only with a license. GPS data is collected by an Android application connected to the Raspberry Pi via Bluetooth for data storage with the initial database and then synchronize it with the database platform to be able to display the path of each bus.
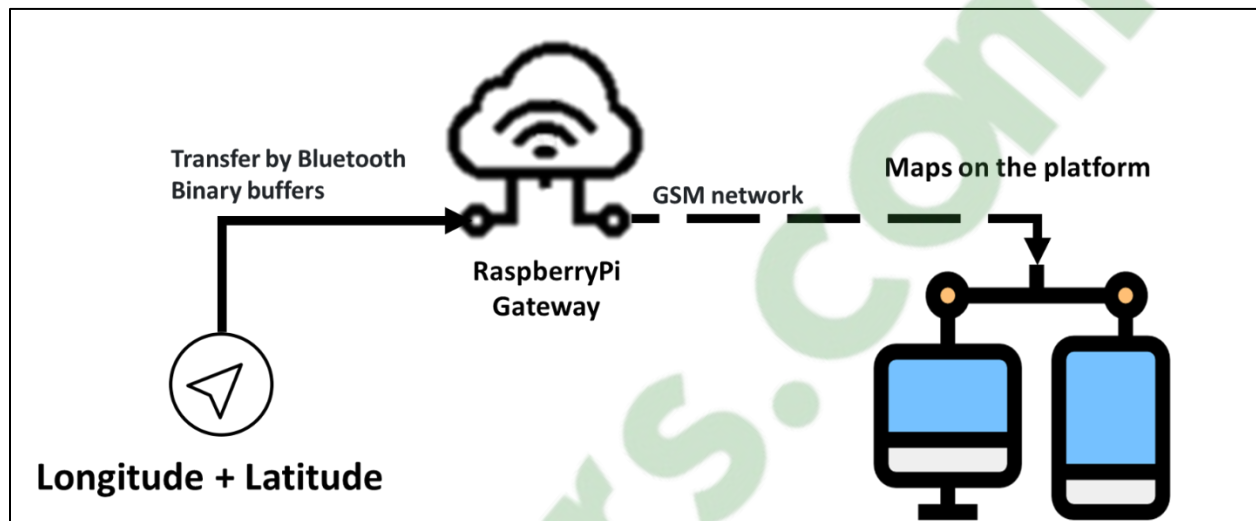
Figure 30. GPS architecture

5.6   Web Platform

Initially, a digital platform to visualize the results of passenger counting in tram stations was built in collaboration with Brinco (consulting company). The platform first requires the user's authorization, then to station visualization, in the form of a dashboard where each station has sensors with "ultrasonic passage counter" installed at the turnstile, then the user will be provided with graphic visualization of the counting history (see Figures 60-63 in appendix).

The second platform built, is based on the Traccar platform, which allows multitasking of multiple devices thanks to the Netty Java framework and its scalability. To track the GPS devices installed in the buses, several functionalities are provided to the users, such as the history of the journey, including speed, the current position in real-time if the bus is connected to the Internet, if not, the device installed in the bus allows the GPS coordinates to be recorded to synchronize them later with the platform, which means that there is no loss of data, the platform also can define the zones for which the managers want (or don't want) their bus to be in that zone, they can also communicate with the driver as well as receive the desired notifications (see Figures 64 in appendix).
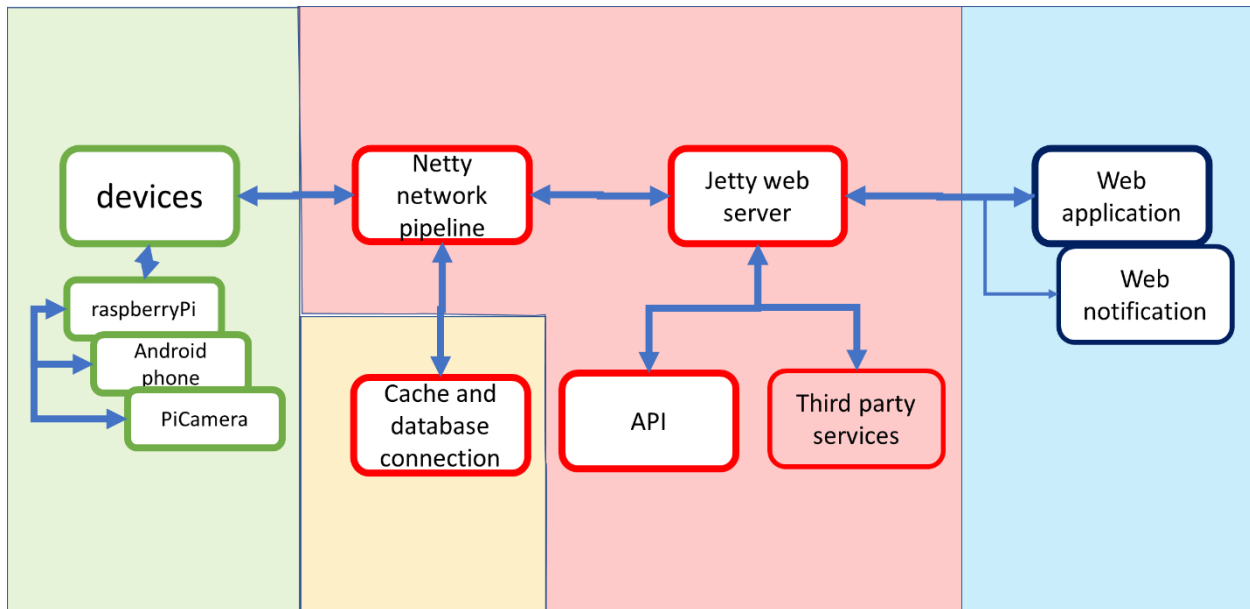
Figure 31. architecture implemented in this work

5.7   Work process

The operating cycle of the proposed system is 4 main operations will be carried out simultaneously:

5.7.1   The first process: "Geolocation"

1. the android smartphone collects data from its GPS sensor where the location coordinates are obtained from satellites.

2. Once the data are received, they are converted to NMEA format[1].

3. Then it must be saved locally afterward.

4. Android application will also extract the necessary information (latitude, longitude, speed, etc.) from the NMEA string.

5.7.2   The second process: "door status detection"

1. The GPIO[2] pins of the raspberry pi are connected with a sensor that will get the status of the doors of the bus, and returns if the door is closed or open;

2. If the door is closed, nothing happens.

3. If the door is open, the raspberry pi considers this location as stop position; and starts the people counting process and ends it when the door closes to reduce the use of its processor.

---

[1] The National Marine Electronics Association (NMEA) is a standard data format supported by all GPS manufacturers, much like ASCII

[2] general-purpose input/output digital signal pin (circuit or electronic circuit board)

5.7.3   The third process: "people counting"

1. Obtaining the input video stream from the camera in the top corner of the bus door.

2. Then convert the input video into concessive images.

3. Followed by the detection process of the human presence (object detector) in the image; if so, a specific ID must be given; if not, this image is ignored and skipped to the next image.

4. Locate the human detected in the following images and record its coordinates (x,y) on the image.

5. Compare the line obtained by the tracking process to be able to determine whether this person will get on or off the bus.

6. Save the number of people on the bus.

5.7.4   The fourth process: "Transfer the data"

1. Now, the application receives the data from the Raspberry Pi (number of people in the bus, door statue, etc.).

2. Then, transfer this data with the necessary information via the GSM/3G network to the cloud database.

3. To carry out this process, the android application has been programmed accordingly. To do this, the data is sent to the server by HTTP request using a script while receiving an HTTP OK (a confirmation of reception) response.

4. On the server-side, data processing is done by scripts.

5. Data is regularly transmitted, received, and recorded at specified time intervals.

Firstly, the smartphone's GPS sensor needs a few seconds to get the geographical position from the satellites. Once it receives the signal, it starts recording the data into a local database. During this time, the bus door status sensor determines whether the door is open; if so, the RaspberryPi launches the passenger counting application; then, as soon as the door is closed, this application closes automatically and gives the current number of passengers on the bus; this is recorded together with the time value. Then, the values will be stored in the same database where the geolocation coordinates are located, where this data will be sent to the Traccar server. In this case, the GSM sensor implemented on the smartphone will be used, which can also function as a data receiver and transmitter (if necessary). In case of difficulty to send these data to the server (due to a connection problem or a problem with the server), the application will continue to save the data to the local database, where it will be synchronized as soon as the problem is solved. The Traccar server will receive these data in its database to be analyzed and displayed to the user. By

default, the H2 database[3] is used by the Traccar server, and the processing of the data is done at the server level, such as the calculation of the speed and other parameters. This allows the system to have lower latency and better performance. These data are easily displayed on the interface of any browser. The user accesses the platform through an HTTPS link. After logging in, a dashboard is made available, with very flexible functionalities for a better graphical interface.

5.8   People Detection Algorithm

In this work, MobilNet SSD (Single Shot) Detection Algorithm were used to be able to detect a human in-stream video. This detection method uses a single neural network and is similar to the YOLO algorithm because, as the name suggests, it takes only one shot to detect different objects in the input image. Because of this feature, the method is fast and has a balance with the accuracy of detection, so the speed and accuracy of the most commonly used algorithms will be shown.

- SSD 300: results in 59 FPS[4] with 74.3 mAP[5]
- SSD 500: results in 22 FPS with 76.9% mAP.
- Faster R-CNN: results in 7 FPS with 73.2% mAP
- YOLO: results with 45 FPS with 63.4% mAP

These results obtained with this method are mainly due to the elimination of the "region proposals" as used by R-CNN. In addition, it has a progressively decreasing convolutional filter applied to several feature maps to predict object categories and compensations in the locations of the bounding boxes, i.e. at multiple scales.

5.8.1   SSD detection method architecture

This algorithm has its core network, the VGG-16, as well as multi-box convolution layers. The main network is in charge of extracting the characteristics of the input image; the other layers that follow are in charge of detection and perform recognition at different scales.

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[3] H2 is free SQL database written in Java (www.h2database.com).
[4] frame rate (frames per second or FPS).
[5] mean Average Precision: used to measure the performance of models doing document/information retrival and object detection tasks (Tan, 2020)
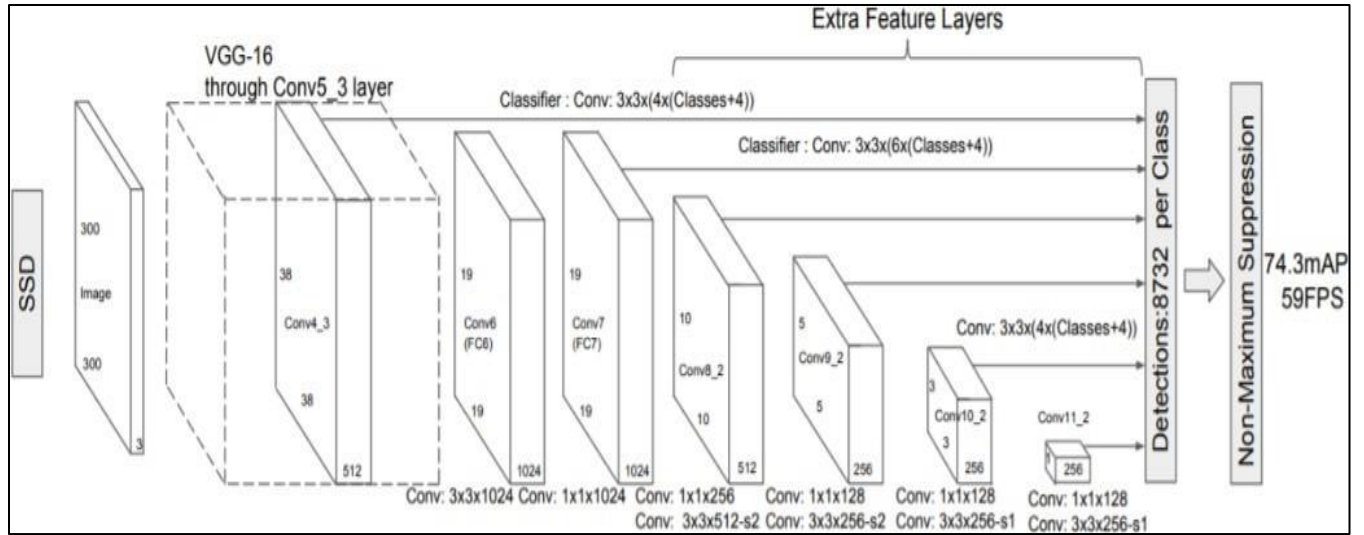
Figure 32. The architecture of the SSD detection algorithm.
Source. Forson, (2019).

The progressive reduction of convolutional layers allows you to benefit from the depth of image analysis by covering objects of varied sizes.

5.8.2 MultiBox detector

During the training process, several predetermined boxes are defined and compared with each other to match the location, scale, and aspect values. The boxes with the greatest overlap are selected because they indicate that the detected object is within this frame.

(a) Image with GT boxes   (b) 8×8 feature map   (c) 4×4 feature map
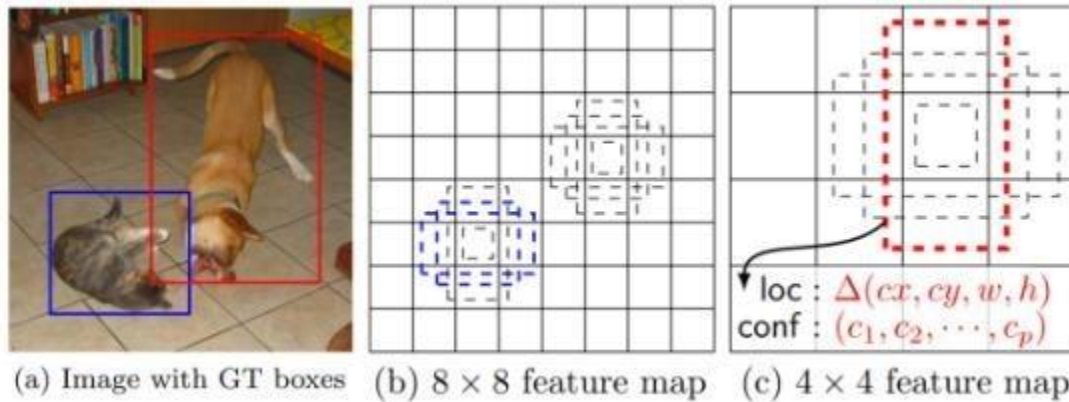
Figure 33. Selection of tables at different scales, locations on various feature maps.
Source. (Liu et al., 2016, p. 30).

Figure 33 shows two limit boxes at different scales. The box on the left indicates the recognition of a cat while the box on the right indicates a dog. After defining the different boundary boxes, the box with the highest definition of the object's characteristics is called the positive boundary box and the others are treated as negative. The predictions for the bounding boxes consist of:

- The confidence value for all detected object types or classes. Class 0 is reserved to indicate the absence of the object.
- Each bounding box contains the displacements from the center of the default box, the height and width (Figure 34).
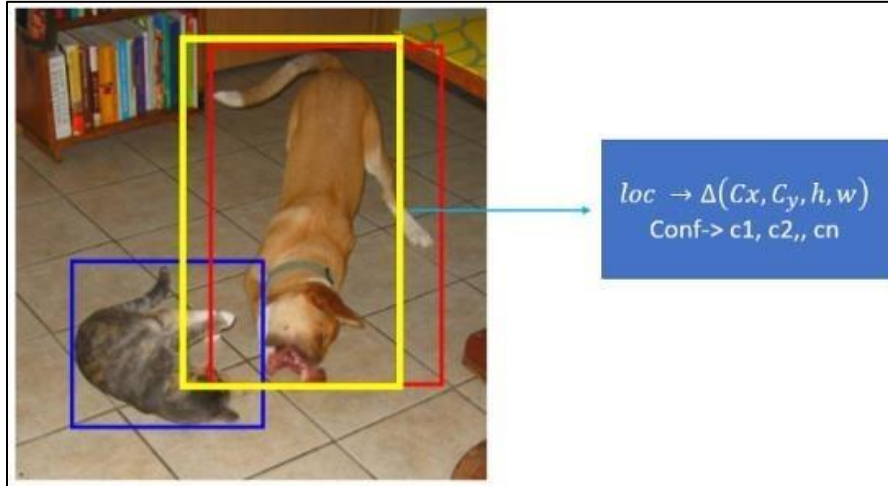
Figure 34. Boundary and confidence box containing each detected object.
Source. Khandelwal, (2019).

5.8.3 Training in the SSD detection method.

The main layer of the VGG-16[6] is the base network that performs feature extraction. The following layers evaluate boxes of different aspect ratios at each location on various feature maps at different scales. The multi boxes are like anchors similar to the Fast R-CNN algorithm. Where several default boxes of varied sizes are generated, with an aspect ratio over the entire image as shown in Figure 35. The SSD uses 8732 boxes, which makes it possible to find the default box that most overlaps the bounding box containing the object. (Khandelwal, 2019).
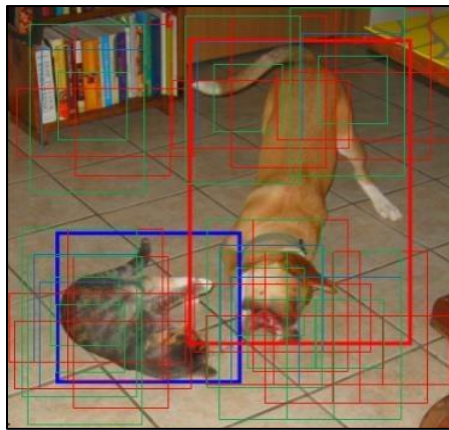
Figure 35. The SSD formation process.
Source. Khandelwal, (2019).

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[6] Visual Geometry Group from Oxford: pre-trained networks and good architecture for benchmarking on a particular task

5.8.4 Centroid's tracking algorithm

This algorithm must work in conjunction with detection. For each detected object, the tracker is generated and the action it performs can be identified as it moves around the video image. The first step that this algorithm performs after the detection of an object is to receive a set of enclosing boxes (detected objects), and then in each of them, its center or centroid is calculated, as shown in Figure 36, which shows that there are two objects with their enclosing boxes (Rosebrock, 2020a).
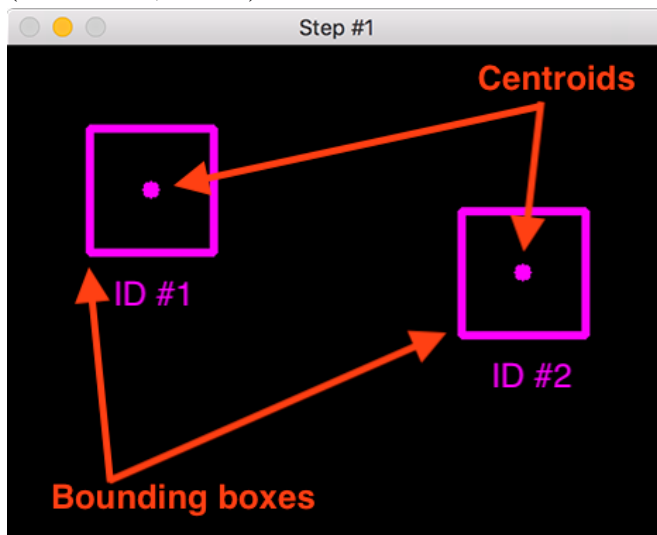
Figure 36. Calculation of the centroid in each boundary box of the detected object.
Source. Rosebrock, (2020a).

The second step is to calculate the Euclidean distance between the new centroids (yellow) and the existing centroid (violet), as shown in Figure 37. This calculation makes it possible to identify when there is a new object or, on the contrary, when it is not the same, as long as it does not exceed a set distance it is recognized as the same object, thanks to this false positives are avoided and the error that can be generated in the counting of people is reduced (Rosebrock, 2020a).
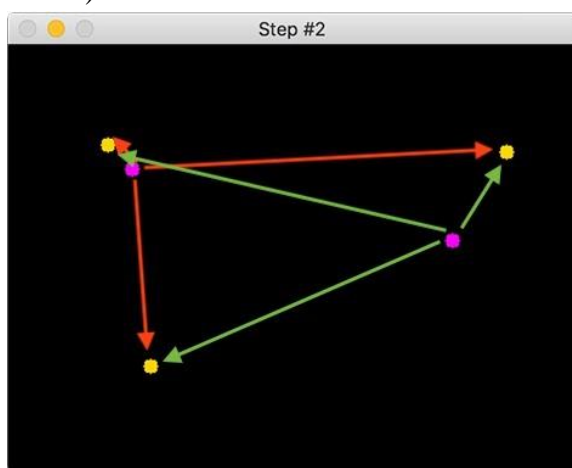
Figure 37. Calculation of the Euclidean distance between new and existing centroids.
Source. Rosebrock, (2020a).

Once the calculation of the distance is done, we proceed to the association of the IDs of each object, as shown in Figure 38. Its shows that the yellow dot that is unknown refers to a new object, while the other two, since they do not exceed the established distance, are the same existing objects that have moved a little in the frame.
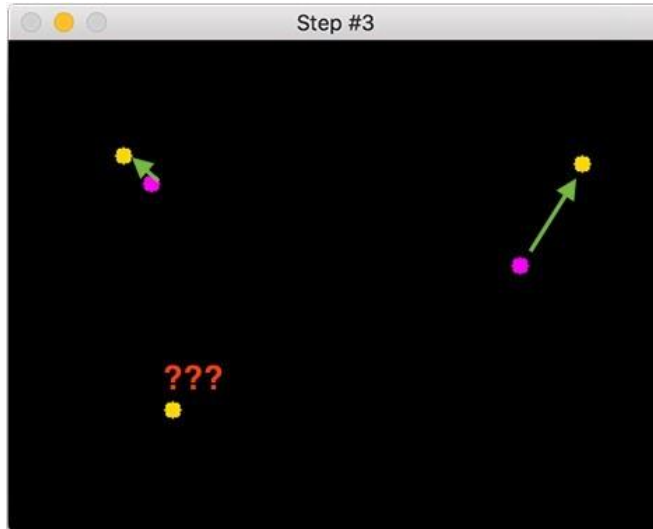
Figure 38. Association of identifiers to new or existing objects.
Source. Rosebrock, (2020a).

Figure 39 shows the assignment of IDs to each object, with two existing objects and one new object appearing in the frame.
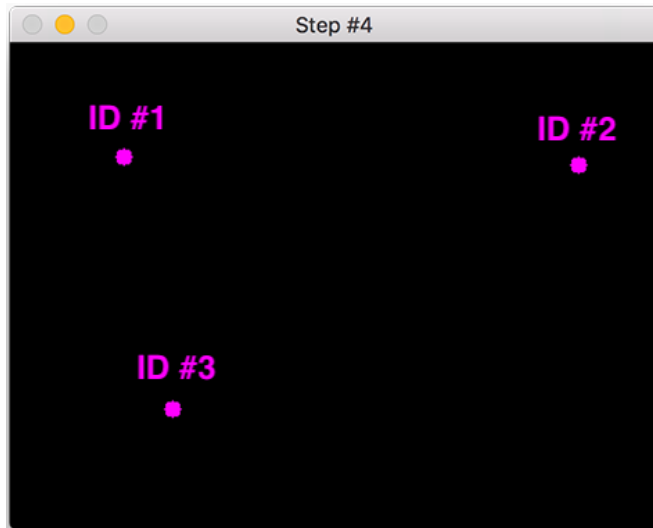
Figure 39. Assigning an identification to each object.
Source. Rosebrock, (2020a).

5.9   Software and hardware development

This part will introduce the different hardware and software used in the work

5.9.1   Hardware

5.9.1.1   *Micro-controller*

raspberry pi

Raspberry Pi is an inexpensive (credit card-sized) nano-computer that plugs into a computer or TV screen and uses a standard keyboard and mouse. It allows to explore computers, electronics, and learn to program in languages such as Scratch and Python. It is capable of doing everything expected of a desktop computer and can also do more depending on what is needed. The Raspberry Pi was launched in 2012, and several versions and changes have been released since then. From the original Pi with a 700 MHz single-core processor and only 256 MB of RAM to the recent Pi with a 4*1.5 GHz processor and 4 GB of RAM at an average price of $40.

The Raspberry Pi operates in the open-source ecosystem. It supports several operating systems, where Raspbian OS, is the official one. It is open source and runs a suite of open-source software, but The Raspberry Pi is not open hardware (Opensource.com, 2020).
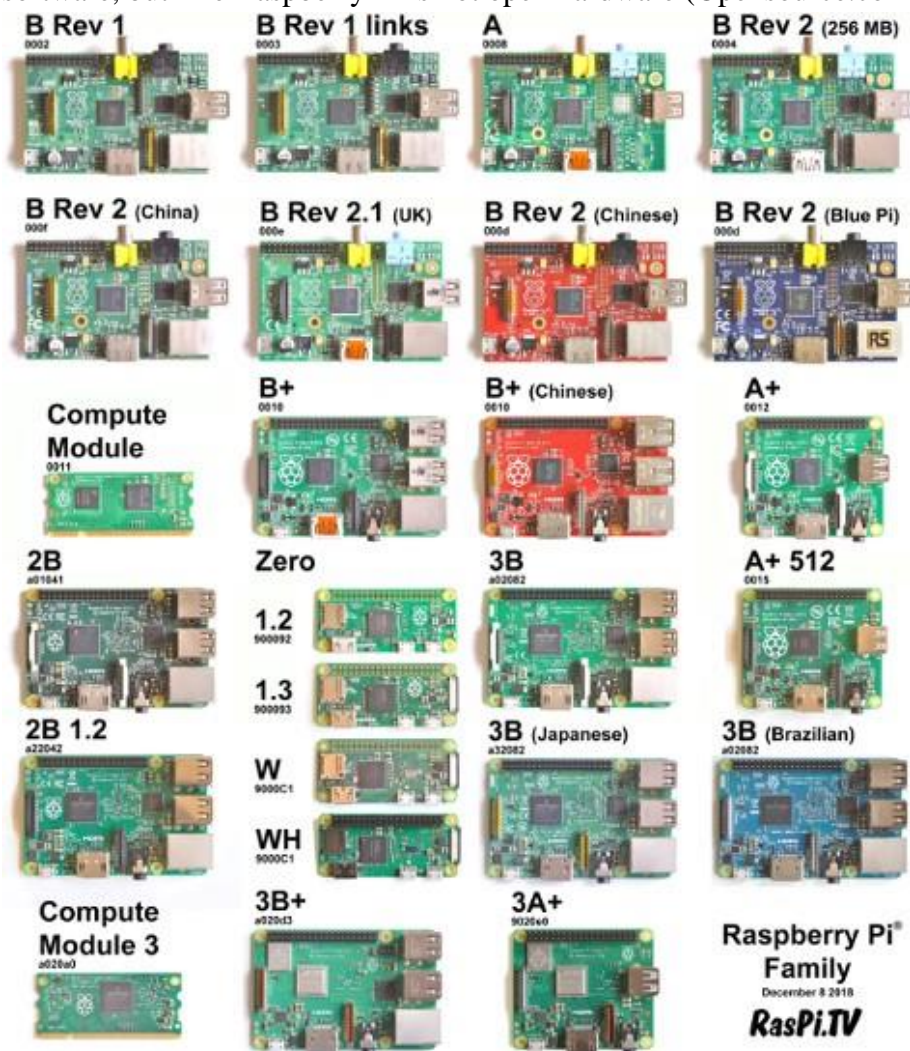
Figure 40. Raspberry pi models.
Source. Upton, (2017)

Arduino

An Arduino card is a small electronic card of dimension (5.33 x 6.85 cm) with an integrated micro-controller. The microcontroller manages the commands of the actuators from events detected by sensors and from a program defined by the user.

There are several types of Arduino board. The most used is the Arduino Uno board. Arduino is open-source either by the hardware design. The electronic schematics are distributed under "Creative Commons Attribution Share-Alike 2.5 license[7]" and by the source code of the programming environment and embedded libraries (are available under LGPL[8] license). Besides, a large community of amateurs and enthusiasts contribute to develop applications and share them (Fréou & Grimault, 2016).
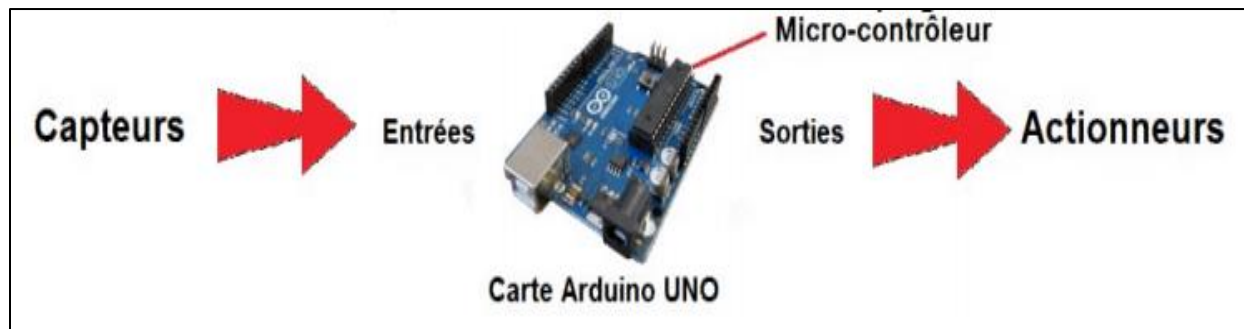
Figure 41. The wordflow of Arduino.
Source. Fréou & Grimault, 2016).

5.9.1.2 Sensors

Ultrasonic

The HC-SR04 ultrasonic sensors use high frequency sound waves, and calculate the time interval between generating and receiving the echo, to determine the distance to an object like bats do. It provides excellent detection with non-contact distance accuracy (from 2 cm to 400 cm). Besides that, sunlight or black materials do not affect it. Although acoustically, there are materials that are difficult to detect such as textiles (soft fabrics materials). The ultrasonic transmitter and receiver are integrated with this module (tutorialspoint, 2020).

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[7] one of several public copyright licenses that enable the free distribution of an otherwise copyrighted "work"
[8] The GNU Lesser General Public License: free-software license published by the Free Software Foundation

Figure 42. HC-SR04 Ultrasonic sensor.
Source. tutorialspoint, (2020).

PiCamera

The PiCamera is a portable and lightweight camera that supports the Raspberry Pi. It communicates directly with the RaspberryPi using the MIPI camera serial interface protocol. The module is used for image processing, machine learning, and computer vision projects. It is commonly used in surveillance drones because the camera payload is very small. Apart from these modules, Pi can also use normal USB webcams, which are used with the computer but not as the PiCamera (components 101, 2018).

Figure 43. PiCamera module.
Source. Components 101, (2018).

Proximity sensor

Today, proximity sensors are commonly used with Arduino for many applications, ranging from distance measurement (from 10 cm to 40 cm) to object detection and heat emission measurement. It is therefore very important to choose one that is easily connectable, accurate, and

reliable to meet your needs. Indeed, it is designed small in size to allow flexible applications (Shawn, 2019).

Figure 44. Proximity sensor.
Source. Shawn, (2019).

ESP8266-01

The ESP8266 ESP-01 has been designed as a Wi-Fi module to allow microcontrollers to access a Wi-Fi network. This module is a stand-alone system-on-a-chip (SOC) that does not necessarily need a microcontroller to process inputs and outputs as one would normally do with an Arduino (Jaycon Systems, LLC, 2017).
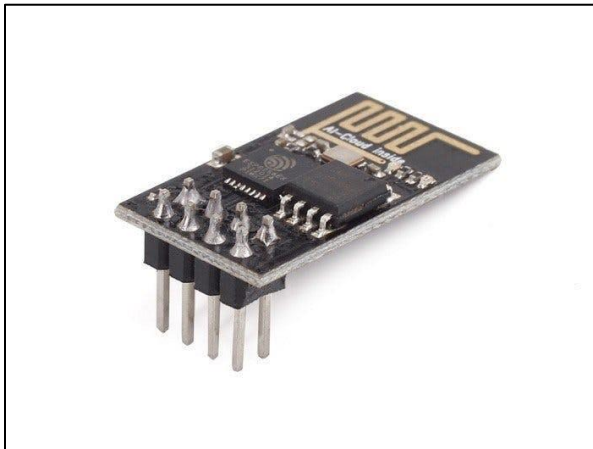
Figure 45. ESP8622 WiFi module.
Source. Jaycon Systems, LLC, (2017).

5.9.2   Software

5.9.2.1   *Programming language*

Arduino IDE

The Arduino Integrated Development Environment (IDE) is an open-source cross-platform application (for Windows, MacOS, Linux operating systems) built in C and C++ functions [2]. It is used to write and download programs to Arduino-compatible boards, as well as other development boards from other vendors (Arduino, 2018).

Python

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. Its high-level integrated data structures, combined with dynamic typing and dynamic binding, make it extremely attractive for rapid application development, as well as for use as a scripting or glue language for linking existing components together. Python's simple and easy to learn syntax. The Python interpreter and the extensive standard library are available in source or binary form free of charge for all major platforms and can be freely distributed. Python because of the increased productivity it provides has become remarkably successful and popular. Since there is no compilation step, the edit-test-debug cycle is incredibly fast. Debugging Python programs is easy with their debugger, which is written in Python itself (Python Software Foundation, 2020).

Dlib library

This library is versatile and can be used in C++ or Python. Being open source, it has several algorithms for machine learning, image analysis, interval methods for classification and regression, multiclass SVM, etc. In this work, this library is used for the implementation of correlation filters in object tracking.

OpenCV libraries

OpenCV is a multi-platform library. It belongs to the open-source mainly used in machine vision. This library has been used in various applications such as object recognition, motion detection, security, process control, etc. A wide range of functions that precisely support and benefit detection and recognition applications. In this work, this library is responsible for image processing[9].

Android Studio

Android Studio is the official Integrated Development Environment (IDE) for Android application development, which is based on IntelliJ IDEA[10]. Besides IntelliJ's powerful code editor and development tools, it offers even more features that enhance the productivity of Android application development (Android Developers, 2020).

Web development tools

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[9] Available on: https://opencv.org/
[10] IntelliJ IDEA is an integrated development environment written in Java for developing computer software.

Web development tools help developers work with various technologies and create websites. They help developers create a custom design, a responsive website design that improves online navigation and facilitates the user experience. In addition, web development requires both front and backend development tools. The backend defines how the website works and do the Data processing in the back server, while the frontend is used to visualize things on browsers to make the website more user-friendly and easier to use (Top 13 BEST Front End Web Development Tools to Consider In 2020, 2020).

Softwares

Traccar open source GPS tracking

Traccar is a free and open-source GPS tracking server, claims to support more than 1,500 different models of GPS tracking devices. Traccar is owned by Traccar Limited. Founded in 2009 by Anton Tananaev, it became open source in early 2010. According to a 2019 Windows Report, Traccar was ranked among the top seven free software solutions for fleet management and GPS tracking (Tananaev & Zalysin, 2016).
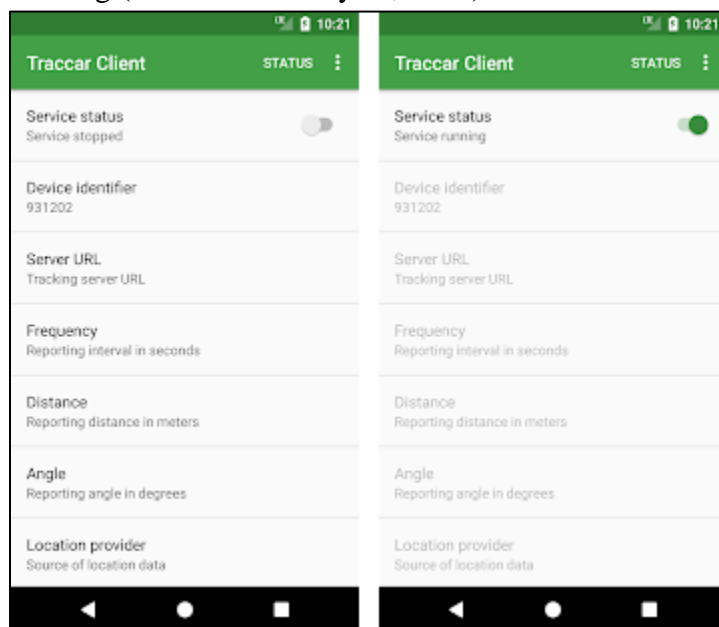
Figure 46. Traccar Android application.
Source. Tananaev & Zalysin, (2016).

Traccar mobile application is also open source and has many configurations depends on how will be used; it provides the frequency of sending the data to the server, precision of coordinates, etc.

Arena Rockwell Automation

Arena is a discrete event simulation and automation software developed by Systems Modeling and acquired by Rockwell Automation in 2000 [1]. It uses the SIMAN processor and simulation language. The main objective of this software is Business Process Simulation (BPS) to

help make business decisions in the enterprise, where it is an efficient way to evaluate all the implications of business decisions before they are implemented. Arena works by simulating discrete events to describe a process involving a set of unique and specific events over time. These flexible activity-based models can be used effectively to simulate almost any process. In Arena, the user builds a model of experience by placing modules (boxes of different shapes) that represent processes or logic. Connecting lines are used to link these modules together and to specify the flow of entities. While the modules have specific actions with respect to entities, flow, and time, the precise representation of each module and entity with respect to real-life objects is subject to the modeler. Statistical data, such as cycle time and work in process (WIP) levels, can be recorded and produced in the form of reports. For 30 years, Arena has been the world's leading discrete event simulation software (Rockwell Automation, 2020).

Data sources

The data used in this project was provided by the work of Sun et al. (2019, p. 3605), where they have recorded several videos of people who board and alight bus, in both color and depth videos. These videos are divided into several categories: "noisy" and "normal" senses with two subcategories: "crowd" and "uncrowded" senses. In this project, we have used this data to do the test and evaluation of the people counting system using the camera.

In the "Normal" senses, videos are in clear image quality, while the "noise" senses have some low quality compared to the normal one. The "uncrowded" senses show only one or two people who boarded or alighted the bus, while the "crowd" senses more than four people enter or leave the bus at the same moment.

5.10 Simulation model

5.10.1 Material

This section presents a simulation model developed using Arena Rockwell Automation, where the model simulates the work of 24 hours for 30 day, according to the schedule of the company. Where only the operations of one bus was simulated in this work due to COVID-19 pandemic, the bus makes the round trip between "Souk Ahrass" city and "Tlemcen" city (Algeria). The line has six pick-up and drop-off stations "East to West": Souk Ahrass, Oum El Bouaghi, Chlef, Relizane, Sidi Bel abbès and Tlemcen

5.10.2 Data

Datasets (Stations and prices) in this model were collected from the bus transport company "BEN MABROUK Eurl" and from the official website of "SOGRAL Sarl." (Table in appendix). This dataset includes trip information (price of the journey, statistics of number of trips, and finance related information of this company from the bus of this study).

5.10.3 Developed simulation Model

The model has three parts: the first one aims to create passengers randomly with assignment of their departure station, destination station, where they are queued in their departure station pending for the bus at the station (Figure 47). The second part simulates the bus functionality, including picking-up and dropping-off passengers from/to their stations, considering the travel time and bus capacity (45 passengers) as seen in Figure 48. The third part is dedicated to estimation of the accounting calculations of the trip (real incomes, known incomes, net incomes, number of employee theft, theft worth, and theft as a percentage from the net incomes) (Figure 49).
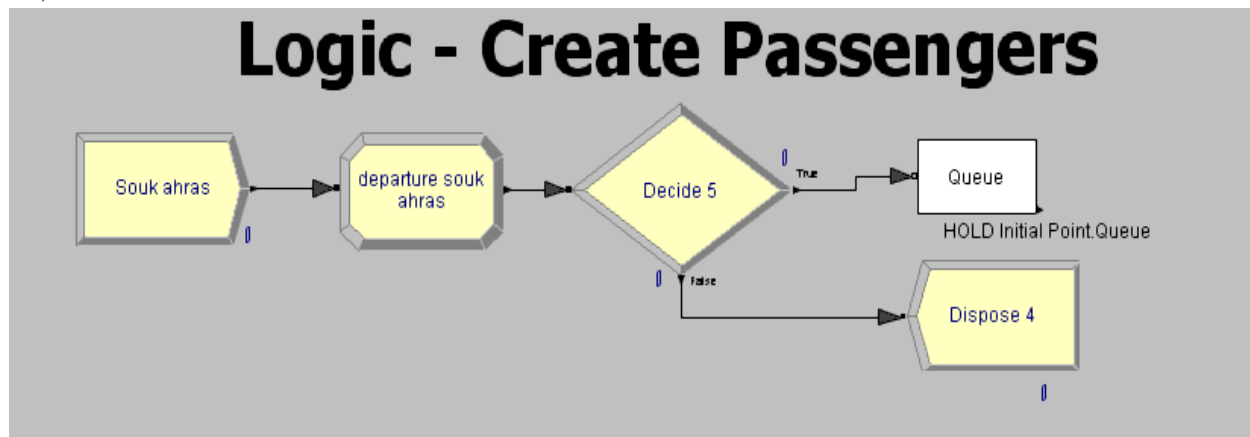
Figure 47. Model responsible over passenger's creation.
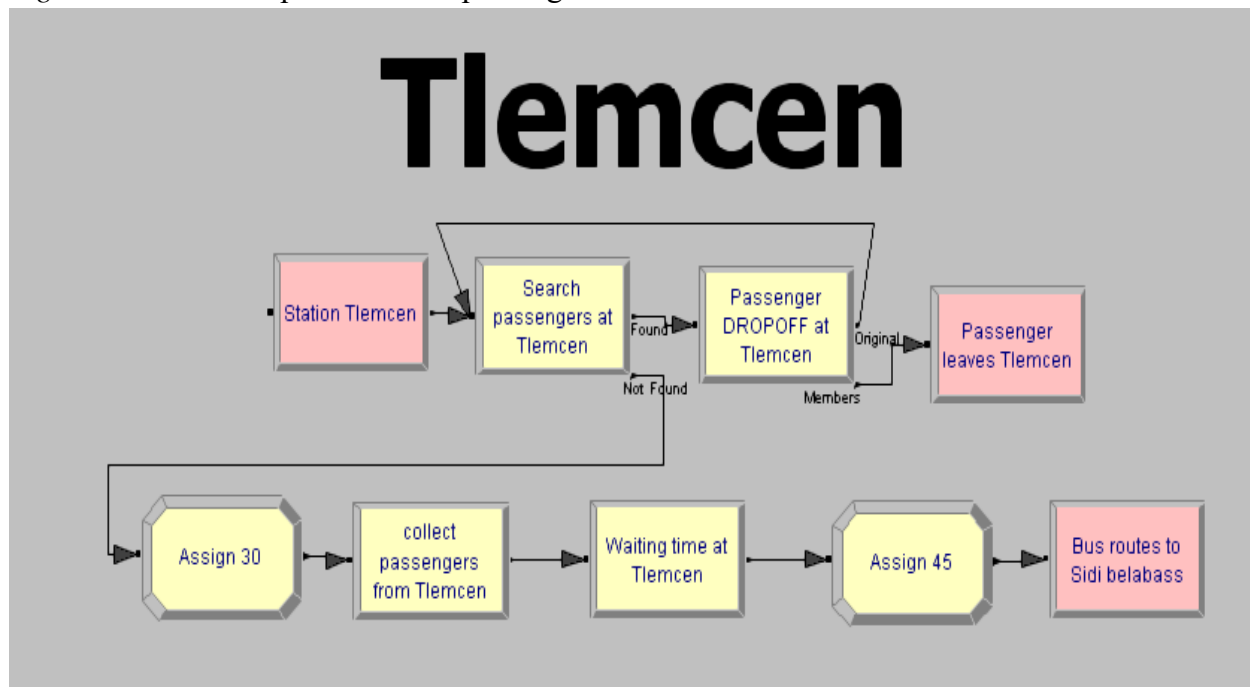
Figure 48. Model represents the work at the station Tlemcen.
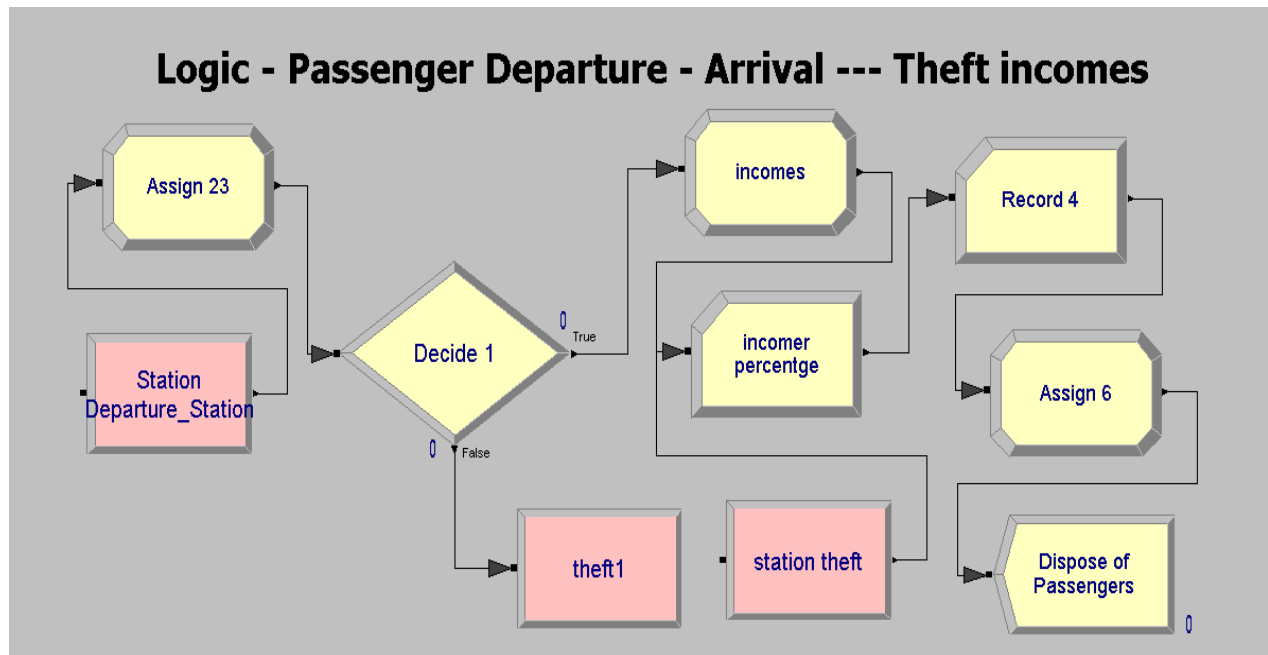
Figure 49. Model responsible over accounting calculations.

5.11 Cost benefits analysis

The project cost and related information will be discussed for further understanding of the final choice related to the type of technology that will be used in the final product. Accounting calculations are made with customer interviews to give them the perfect option to buy our product.

Chapter 6: Results

Chapter 6: Results

In this Chapter, the results of tests and simulation in this study is presented. This chapter contain also the explanation of the object detection and tracking algorithm, as well the result of the test of this algorithm. In addition of the simulation results including estimation of the theft of employees, monthly revenue estimation for the study case, lastly as a conclusion, the cost and benefits analysis is also presented.

Content

6.1   Introduction

In this chapter, an algorithm is implemented using OpenCV and Python tools under the windows system using the recorded videos to count people entering or leaving the bus, generate a GPS coordinates with the Traccar mobile application, then the visualization of this data of the Traccar web dashboard. This chapter details how the algorithm works, both for people counting and bus tracking. Also, it presents the result of simulation model of the bus trip operation between Souk-ahras and Tlemcen.

6.2   Explanation of object detection and tracking of people (video processing).

The Detection: The algorithm that we are going to use is already preformed. It is the MobilNet SSD. During this phase the detector is executed every N frames. It consists in updating every new object that appears in the frame of the image by generating new coordinates in every delimiting frame.

Tracking: the algorithm to be used is based on centroid tracking, which consists of receiving all the delimitation frames provided in the detection phase, calculating its center or centroid. The tracking is carried out within the video frame. The movement generated in each centroid will be discriminated against to know in which direction it is moving, i.e. whether it is entering or leaving the bus.

Sending: the algorithm then sends result value-form, counting people get in or get out a bus with the total people inside it, to the main server where it will be visualized with other bus data.

6.3   Test of the algorithm

To prove the efficiency of the built system, a prototype was developed and tested using simulation because it was impossible to test on a real case (on the bus). In this section, the results of the experimental run are displayed. A simulation program was created using Python language to simulate the functioning of the bus. It works like the prototype that will be installed on the bus. Where GPS coordinates are pre-filled into the simulation script. Also, other sensors, such as door status and passenger counts are pre-filled too. The vehicle is constantly monitored. The required information is collected and successfully displayed via the user interface. The following figure illustrates the results (Sun et al., 2019, p. 3606).
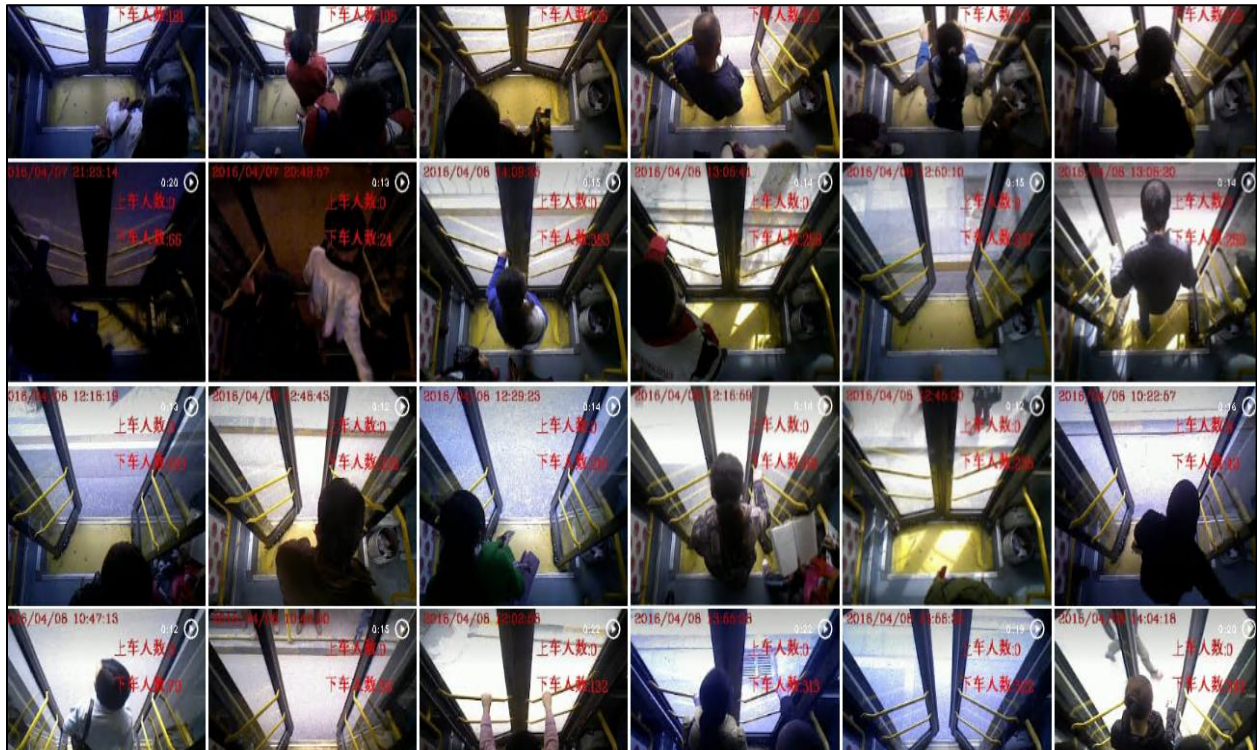
Figure 50. Some recorded videos used for our simulation.
Source. Sun et al., (2019, p. 3606).

Figure 50 illustrates several recorded videos used to run our algorithm. Each video has a predetermined location (GPS coordinates). These videos have been recorded with Xbox Kinect where both color and depth videos are available. The position of the camera is showed as the figure below shows.
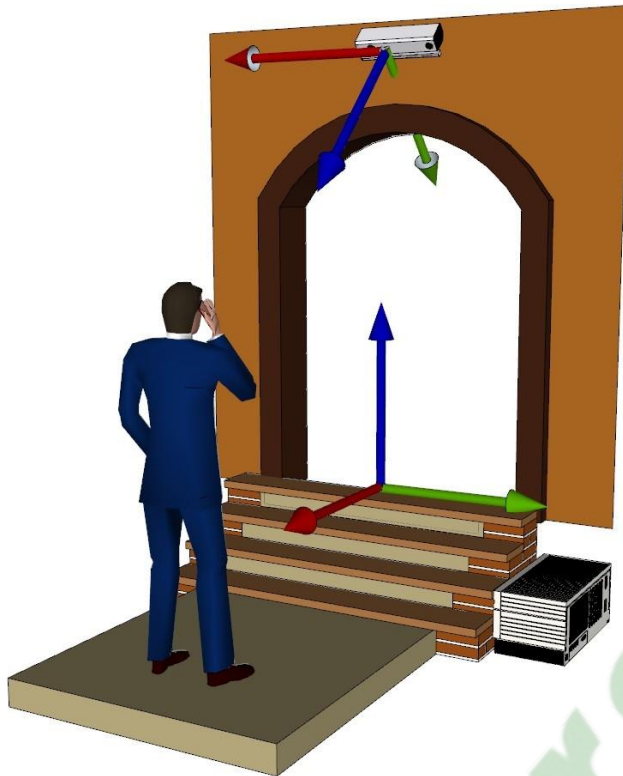
Figure 51. Camera location.
Source. Sun et al., (2019, p. 3606).

The tests to be carried out establish the different configuration of parameters in the algorithm. Several tests will be carried out in two different controlled environments, on the one hand, normal senses which shows up to two persons get in or get out the bus during the day and on the other hand, crowded senses where many people get in or out in the same time (minimum of 4 person). It should be noted that this evaluation is carried out due to the change of confidence parameter in the algorithm —the probability of minimum value to be able to detect human, which we can control the error of the detection process.

6.4   Configuration in the input video

Different tests were carried out in which the following parameters were defined:

- Video resolution: this parameter is important because it defines the quality with which it is going to be possible to visualize. The algorithmic counter of the people does not accept high values like the example 1024x768 pixels. This is mainly due to the cost of calculation that would take these input values, said that the value that better results I provide is the resolution of 640x480.
- Confidence value: this parameter refers to the minimum value that human will be detected from the input video. This value should not be extremely high or exceptionally low (between 0.25 to 0.85), because in both cases the objects in the image cannot be well distinguished or, on the contrary, it overloads the information, slowing down the input video. The most used value is between [0.65-0.82].

- Frames per second (FPS): this parameter is similar to the confidence value concept mentioned previously; also, it cannot be an extremely high or exceptionally low value. It mainly influences the calculation cost of the card used. Moreover, both of the value confidence and the FPS work together to get the best accuracy. The most used value is 29 and 15 FPS.

- GPS data: this value represents the coordinates longitude and latitude, where they are pre-defeminated values in the simulation test. This value is been recorded from the Android device previously. Also, with other data like the speed.

- State of the door: a Boolean value (opened/closed) provides the state for the door of the bus, where if he is open or close. If is open it will execute the people counter from the input video.

- Time value: this value is mandatory because it links data together and ensures the correct visualization in the user dashboard.

6.5   Settings the emulation

In the present work, for the TMS with people counting, a pre-trained algorithm is used for the human detection process, which is the MobileNet SSD. Basically, this method recognizes objects every N – images. This value by default is 30 (means it treats one second of video and skips one second). In addition, another value is the "maxDisappeared" when generating the "CT" instance that refers to the use of "Centroid Tracker". The compliant values have a relation to the maximum number of consecutive frames that remains the ID of the object tracked in the video and the value of the Euclidean distance to discriminate new or existing objects.

The intervening value that the tracked object remains on the screen cannot have a high value. This is due to the reason that the ID of the counted object would remain too many frames generating the loss of new detections and counts that may appear in the video sequence. The value also cannot be low by the fast loss of the ID in the frame of the video coming to fail to count it and generate consecutive errors. After the previous tests, it was defined as the best (maxDisappeared=30). When running tests, if the value of Confidence is in [0.4-0.8], it gave us an accurate recognition of the human in the counting area, whereas changing these values out of this interval gives error in the detection process, thus counting error. Notice that the trip of the bus (generating of GPS coordinates) starts when the door status is false (closed door) and starts reporting its speed and information to the user dashboard.

6.6   Tests

The tests of the accuracy of the people counter with the configurations are mentioned with the settings made during this test and his results are detailed in table 2:

Table 2
result of the test

Video name	People board		People alight		parameters	
	Real	Test	Real	Test	Confidence	FPS
crowdup 1	6	6	0	0	0.8	24
crowdup 2	14	14	0	0	0.4	29
crowdup 3	8	8	0	0	0.7	29
crowdup 4	7	7	0	0	0.505	29
crowdup 5	6	6	0	0	0.4	29
crowdup 6	2	2	0	0	0.4	29
crowdup 7	1	1	0	0	0.4	29
crowdup 8	17	17	0	0	0.63	2
crowdup 9*	2	2	1	0	0.63	19
crowdup 10	2	2	0	0	0.63	29
crowdup 11	6	6	1	1	0.65	26
crowdup 12	5	5	0	0	0.7	31
crowdup 13	9	9	0	0	0.78	29
crowdup 14	8	8	0	0	0.7	29
crowdup 15	15	15	0	0	0.82	31
crowdup 16	3	3	0	0	0.82	31
crowdup 17	2	2	0	0	0.82	30
crowdup 18	3	3	0	0	0.82	30
crowdup 19	1	1	0	0	0.82	30
crowdup 20	2	2	0	0	0.82	29
crowddown 11	0	0	7	7	0.35	6
crowddown 12	0	0	5	5	0.8	15
crowddown 13	0	0	3	3	0.7	25
crowddown 14	0	0	5	5	0.4	16
crowddown 15	0	0	6	6	0.5	20
crowddown 16	0	0	3	3	0.5	20
crowddown 17	0	0	3	3	0.4	25
crowddown 18	0	0	3	3	0.65	1
crowddown 19	0	0	2	2	0.4	25
crowddown 20	0	0	2	2	0.7	2
crowddown 21	0	0	2	2	0.35	15
crowddown 22	0	0	1	1	0.4	25
crowddown 23	0	0	3	3	0.4	29
crowddown 24	0	0	1	1	0.6	29
crowddown 25	0	0	1	1	0.6	29
crowddown 26	0	0	3	3	0.8	18
crowddown 27	0	0	8	8	0.67	7
crowddown 28	0	0	2	2	0.9	15
crowddown 29	0	0	2	2	0.9	15
crowddown 30	0	0	9	9	0.8	18
crowddown 31	0	0	9	9	0.7	16
crowddown 32	0	0	7	7	0.8	16
crowddown 33	0	0	9	9	0.8	16
crowddown 34	0	0	3	3	0.8	17
Total count	119	119	101	100		
Accuracy		100%		99%		

Note. Same Video source as previous.

This configuration was done with the proposed parameters and other parameter values could be correct. As one can see in this case, the configurations of parameters to the input video of the people counting algorithm give a quite acceptable percentage of success, and accuracy is achieved. The analysis of the counting result will be detailed while the bus is returned to the company park. Comparison between the number of people travel (as the drive detailed in his report) with our system report, showing the stopover location, how many people had entered the bus in that location. This information helps the manager to supervise their bus.
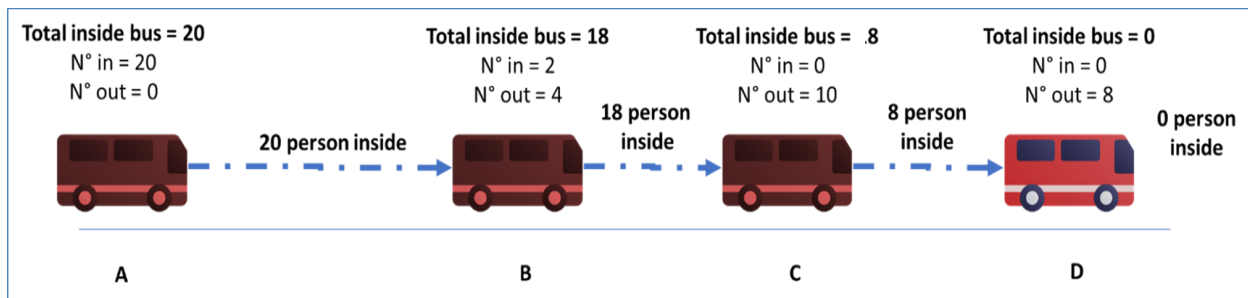

Figure 52. scenario and emulation of the system.

This figure 52 illustrates how the system works and how the manager or user will use this system. The manager will control the driver's report with tickets showing the departure and destination place of each passenger, which means that from this report the information such how many people were inside the bus from locations A to B, B to C, C to D is known. Our system also will provide this information to compare it with the driver's report. This means it should give more transparency within the work. In case that reports have different trips and passenger statistics, an investigation will start with the driver to clarify the reported gap.

Managers and users get system information from the web dashboard as the figure shows the monitoring result and the current location. It displays the bus locations with its stopovers on the map. Figure 65 (in appendix) shows a different set of parameters collected during the experiment, such as speed calculation and the number of people. The list presented here is customized according to the user's needs.

6.7   Simulation model results

To examine the worth value that the company gets from bus trips along the line East- west, various scenarios were used, with mild changes according to the company trust level in the employee, and to the accuracy of accounting calculation. The process analyzer aims to process these scenarios, where the trust level is between 100-93%, while accuracy of accounting is 98-93-80% of each trust level. The model was running under 10 replications. The result is showed in the figure below (Figures 53 and 54).
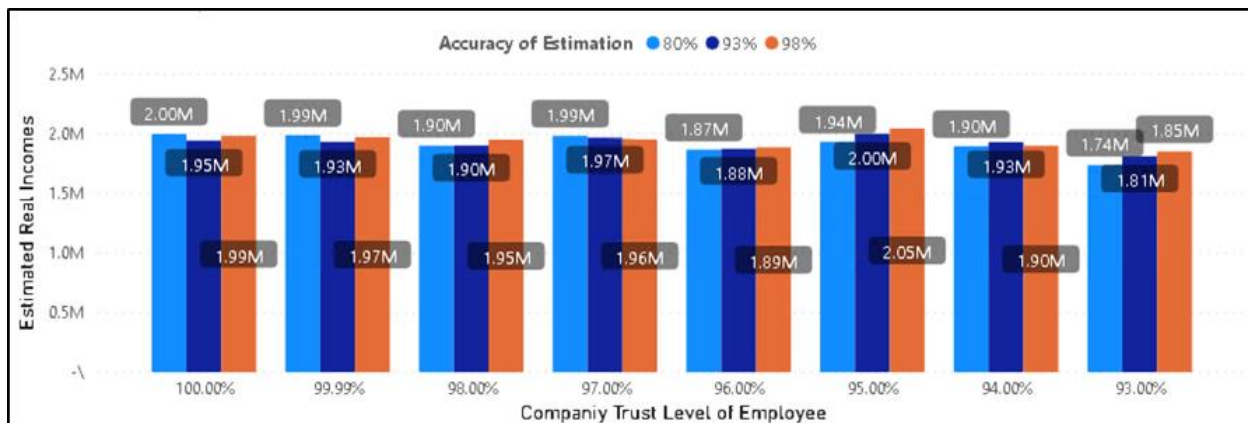
Figure 53. Estimation of Real incomes in Algerian Dinar.
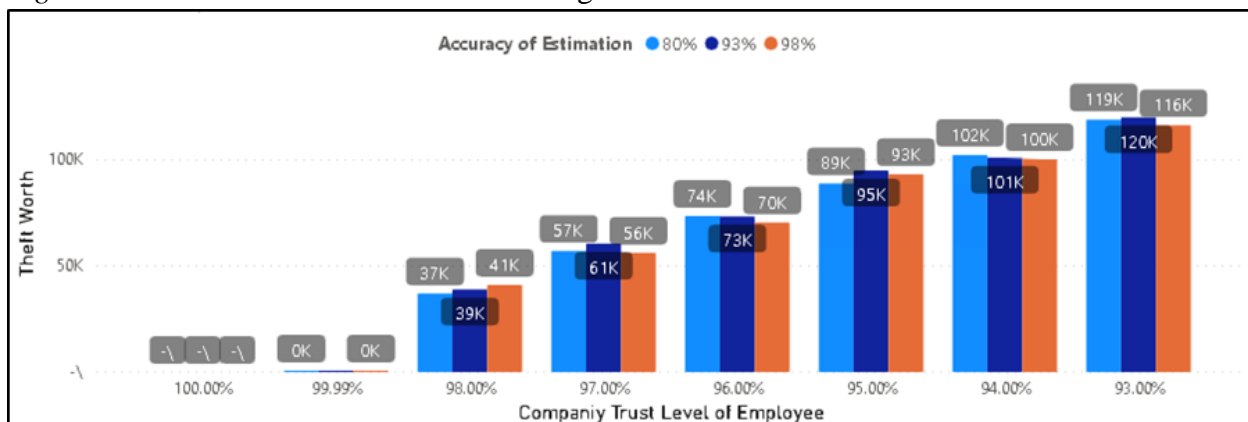
Figure 54. Estimation of theft worth value in Algerian Dinar.

The figure 54 shows that during the simulation, theft value increase whenever the trust level decrease, where this company may trust a specific driver up to 99.99% but it is exceedingly rare this case where company trust level is between 99-95%. The theft worth value presented in the figure 54 is a monthly estimated where it represents important percentage of the net incomes of the company. It goes up to 6% of the net incomes, thus value of 100 thousand Algerian Dinar (Figures 55 and 56).
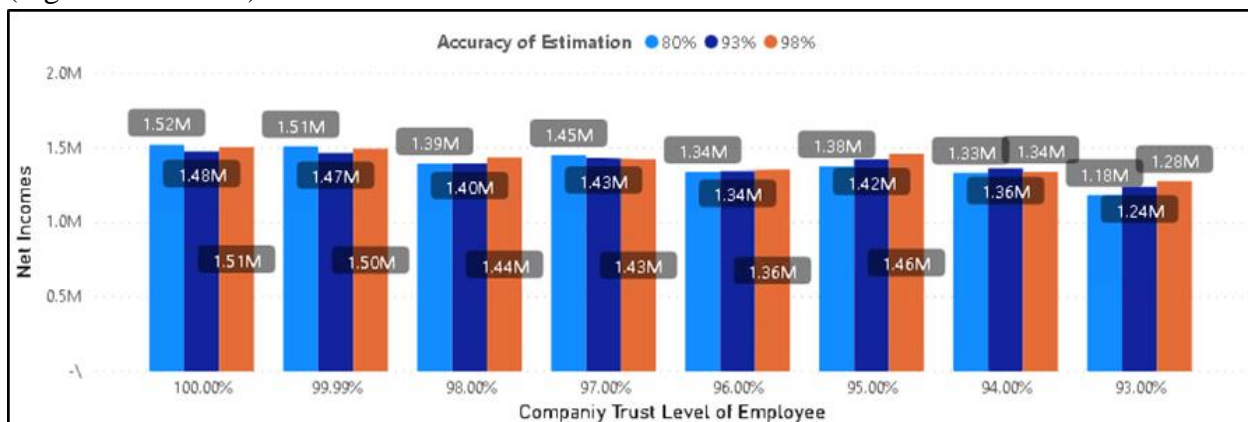
Figure 55. Estimated Net Incomes in Algerian Dinar.
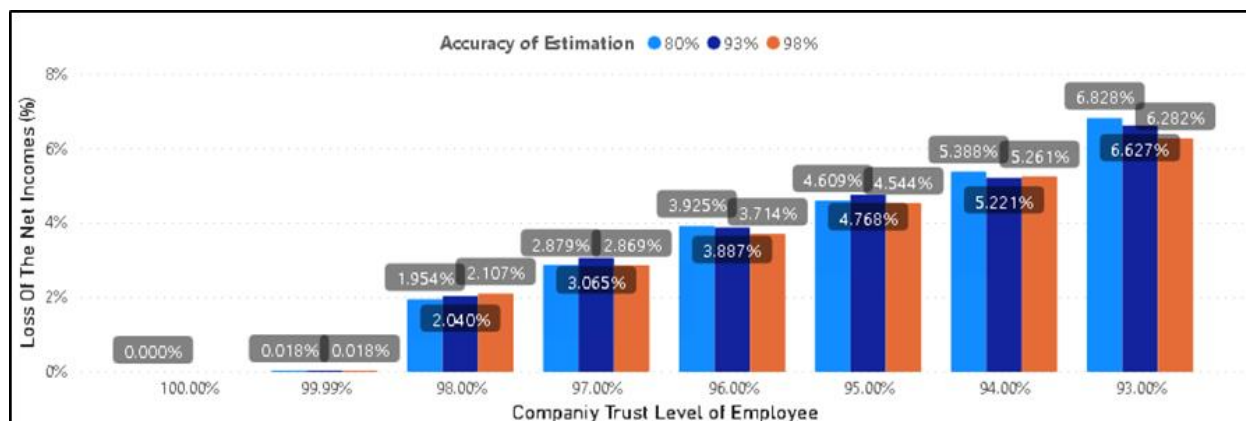
Figure 56. Estimated theft worth as a percentage of the estimated net incomes.

6.8   Cost benefit analysis

The project cost is estimated to $187 by bus plus the subscription to the cloud services as the figure 57 shows as well as other costs in table 3 below. While the revenue is calculated by the rent of these devices to the companies—due to the continue need of it. The rent was estimated to be as the figure 58 shows, while the forecast of the approximate benefit and costs is shown in the figures 59 and 60, as a result of starting with 30 bus and an annual increment factor of the demand (*1,5 evolution).
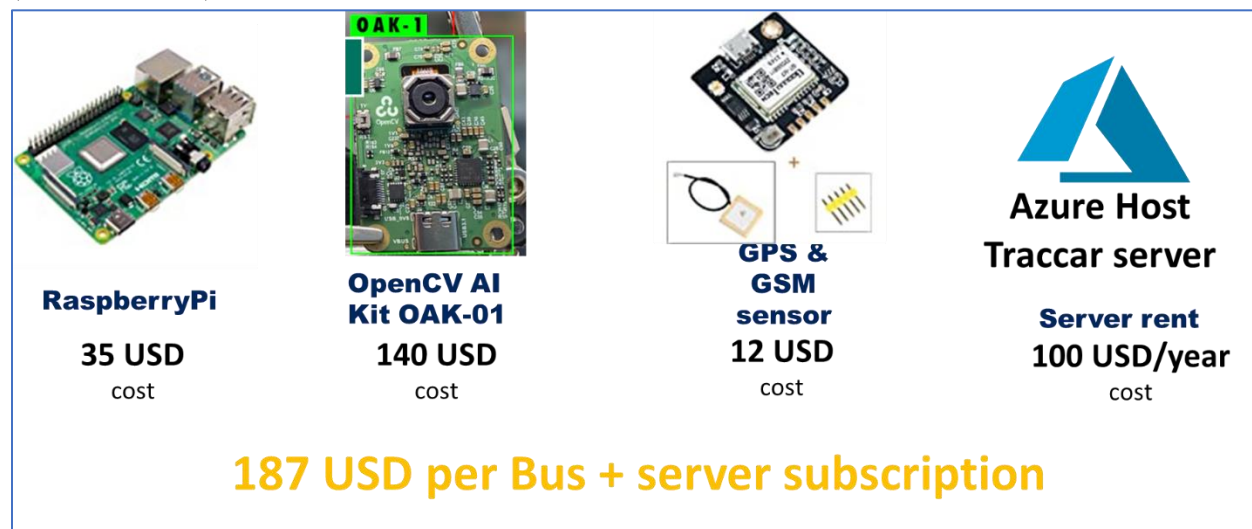
Figure 57. The estimated cost of one device.

Table 3

Investments costs

Investment type	Cost in USD	Monthly
Investment	10000	
Rent per bus	100	×
Licenses and permits	200	
Operating costs	1500	×
Repair and maintenance	80	×
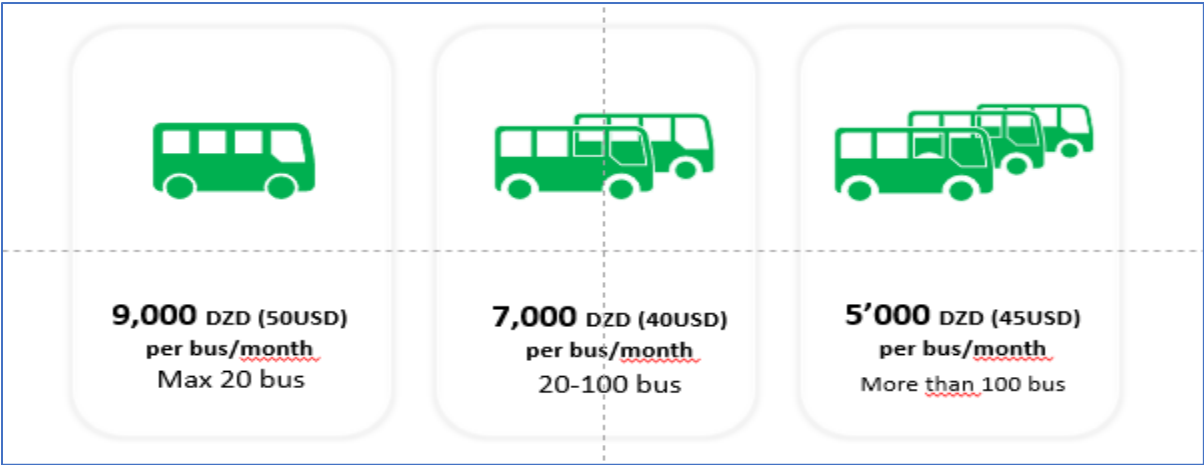
Figure 58. Proposed rent price for the companies.
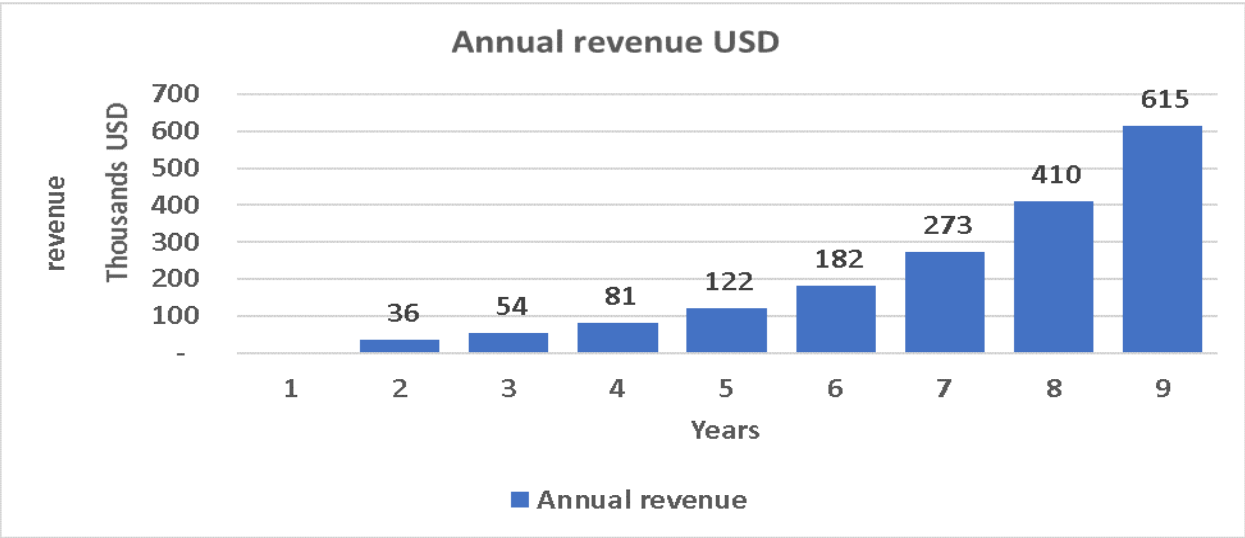
Figure 59. Estimation of revenue in the next 9 years.
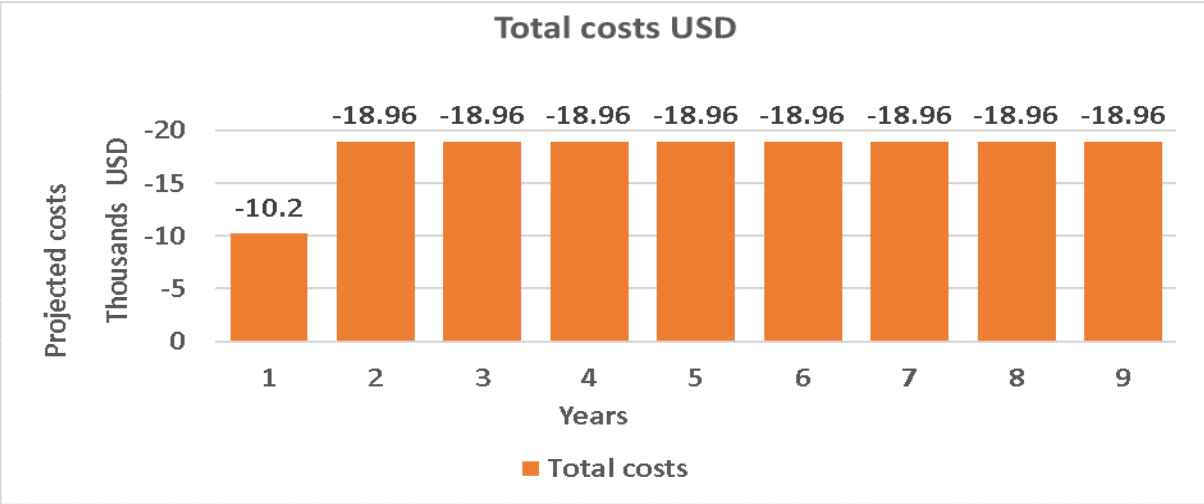
Figure 60. Estimation of costs in the next 9 years.

Chapter 7:   General Conclusion

This study presents a major problem faced by transportation companies causing loss that differs from small to large depending on the trust level of employee. Through the simulation modeling approach (East-west bus journey case), the current trust level is not well-known in the companies, and varies from one employee to another. As a result, the loss worth differs as well and may cost a lot for these companies where this theft is deducted from the net incomes of the company. Moreover, this paper presents the simulation modeling framework of theft of cash by employee (drivers) and this is just an example of theft in organization, where the point of this study highlights the gap that causes undetected loss in most cases. However, more intensive investigation is needed to estimate this theft in its different way, and continue to develop efficient management system that may prevent these thefts.

As technology develops rapidly and the Internet of Things grows, a variety of needs has emerged to provide fleet information, including tracking. This information technology has provided important tools for fleets management. Today's conditions increase the demand for effective vehicle management to manage and improve transport traffic. Financial losses are among the difficult challenges facing these companies. This has cost them a lot of money both in their ability to estimate these losses, such as losses resulting from road accidents and other information, they did not estimate at all, such as misappropriation of company funds or improper use of their equipment; as well, making a bad decision despite having the chance to make a good one. These factors increase the demand for proper vehicle management. The proposed system offers dynamic vehicle management with continuous monitoring to ensure safety and security, as well as to reduce operational costs and avoid illegal bus use, fuel consumption, and reduce misuse. In addition, this system can be used to study and analyze new methods, to satisfy passengers and to reduce traffic mess. This can be implemented through an in-depth statistical analysis of the number of passengers and the best route to reach such a destination. To pave the way for this, the proposed system can see many improvements such as the use of a trip cost calculation system through simulations to optimize this cost and obtain more profit. Furthermore, the GSM/GPRS module can also be replaced by its best alternatives such as 3G, 4G, etc., to make the proposed system faster and more powerful.

 The simulation used has proven to be an appropriate choice as it is very efficient and cost-effective. In this work, a flexible and robust real-time vehicle tracking system is required. The used devices are implemented as components of the inboard unit that will be placed in the target vehicle. A web server has also been used to coordinate with the base station and the inbound unit. The hope is to experiment with this prototype in a real-life case to show consistent and accurate results to the business. The simulation of the system was evaluated in different videos and scenarios, i.e. normal and crowded, testing the effectiveness of the parameters established in the algorithm for 40 videos, maintaining the success rate.

During the tests carried out on the prototype, it was decided to use an emulation of the bus-device. In this case, configuring the resolution of the video input was set, as well as the GPS coordinates and other data. For detection, the frame rate of the video input was between 1-31 FPS, due to insufficiency in computational power, thus avoiding an imbalance in the recognition and

counting functions. The percentage of success obtained in each environment evaluated is quite good, but it should be mentioned that the prototype has an error value of less than 1%, which is usually due to the accumulation of people. This is due to the number of N-frames that the detection algorithm has waited to start the whole counting procedure. The previous analysis was made in which it was determined the use of the SSD (Single Shot Detection) object detection algorithm. The main character it provides is related to the speed and accuracy generating a balance between the two parameters, this benefit in the interlacing that must exist with the detection algorithm.

7.1   Future research area and recommendations

For future work, the present work shows a gap in transportation companies, which encourage more investigation in the field and in other sectors as well. The developed application in this work can be extended to other fields such as security, virtual fences and smart farming. As well as, it can give useful statistics of the number of people in given area, rather than other objects (cars, animals, products, etc.).
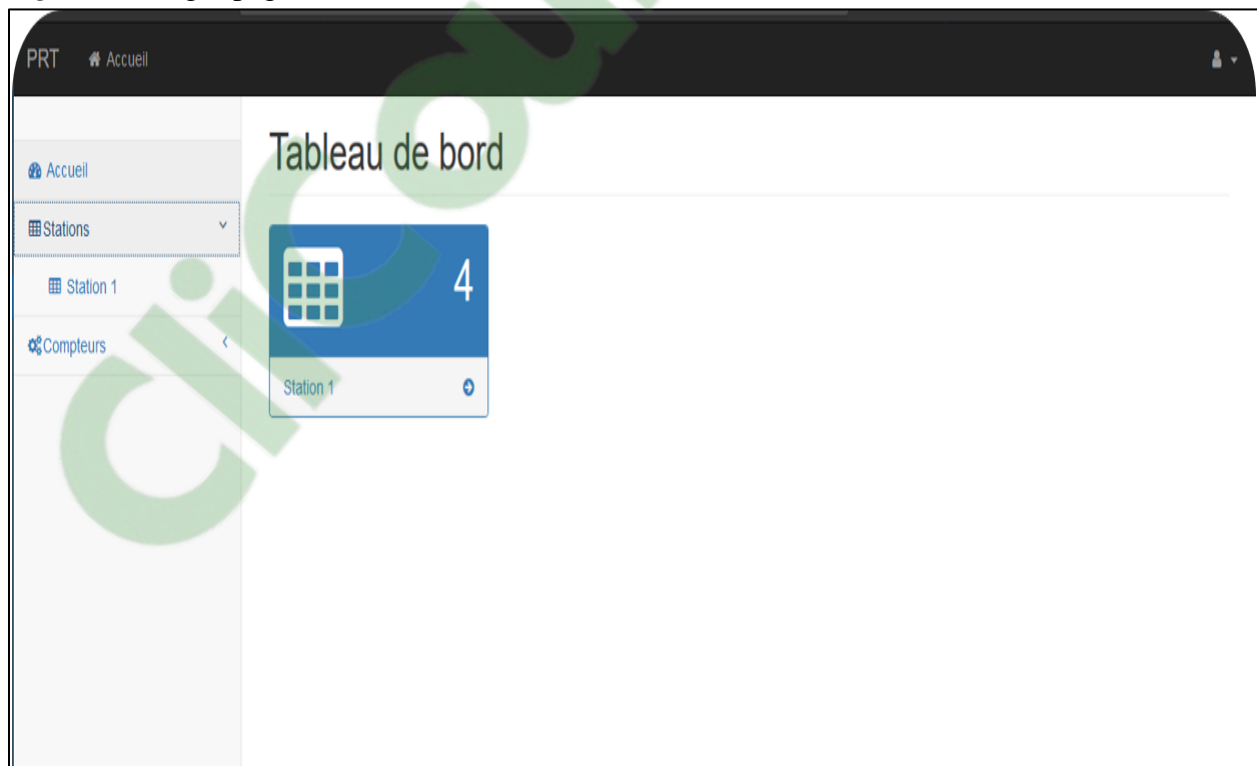
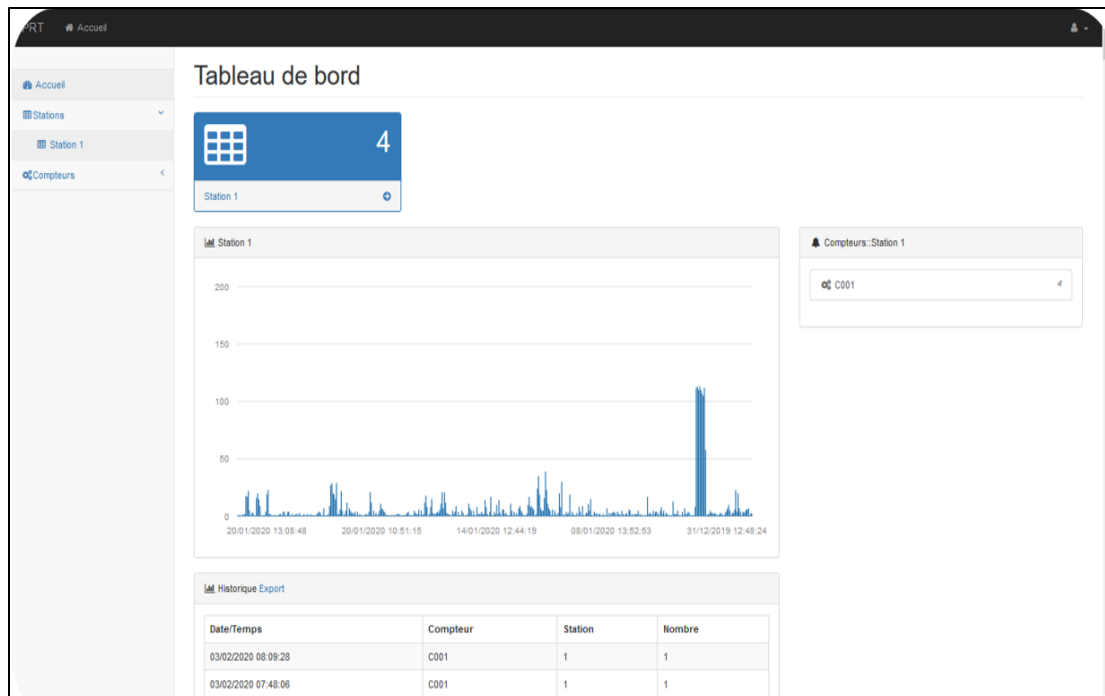# Appendix

Figure 61. Login page

Figure 62. Station page

Figure 63. Dashboard of station
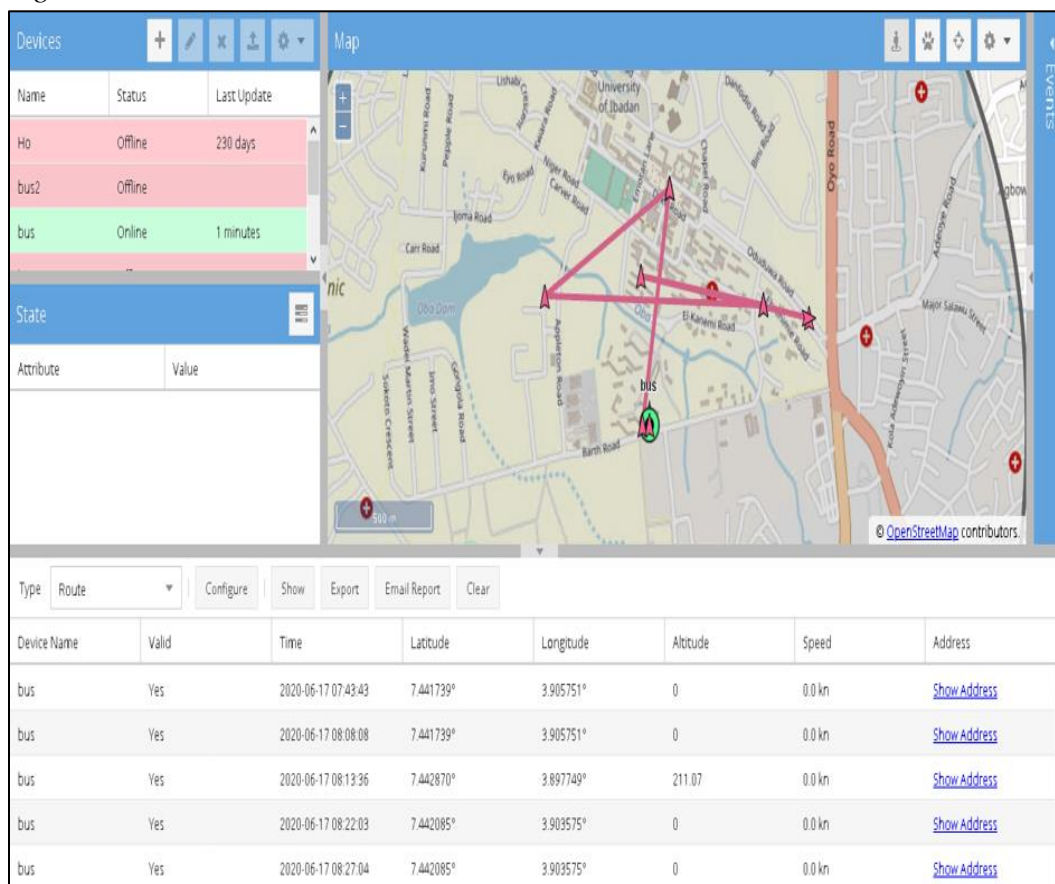
Figure 64. Traccar GPS platform.

Figure 65. Bus data

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Abstract

The Developpement of the transport sector in Algeria has allowed an increase in the number of buses to meet demand while maintaining an obsolete management system of buses, and therefore companies are confronted to risks of embezzlement and theft by their employees. This research aims to estimate the misappropriated revenues and thus determine the loss of bus companies also to suggest solution for it. Within this study, the bus journey from the east to the west of Algeria was simulated over a period of one month. As a result, employee theft was estimated (based on the level of trust placed in the employee) to be up to 6% of the company's net revenue on this route. Finally, further exploration is done to build management system including GPS tracking and passenger counting, while the need of such solution to recover is unavoidable.

Keywords: theft of employee, simulation, transport management, modeling, people count.

Résumé

Le développement du secteur des transports en Algérie a permis d'augmenter le nombre de bus pour répondre à la demande tout en maintenant un système de gestion obsolète de ces derniers, et les entreprises sont donc confrontées à des risques de détournement de fond et de vol par leurs employés. Cette recherche vise à estimer les revenus détournés et ainsi proposer une solution. Dans le cadre de cette étude, le travail d'exploitation d'un bus de l'est à l'ouest de l'Algérie a été simulé sur une période d'un mois. En conséquence, le vol des employés a été estimé (sur la base du niveau de confiance accordé à l'employé) à 6% des revenus nets de la compagnie sur cette ligne. Enfin, une étude plus approfondie est menée pour mettre en place un système de gestion comprenant le suivi par GPS et le comptage des passagers, alors que la nécessité d'une telle solution est inévitable.

Mots clés : confiance, vol d'employé, simulation, gestion du transport, modélisation, comptage de personnes

نبذة مختصرة

أدى تطور قطاع النقل في الجزائر إلى زيادة عدد الحافلات لتلبية طلب المواطنين لكن مع الحفاظ على نظام تسير الحافلات القديم، تواجه شركات النقل مخاطر الاستغلال السيء لحافلاتها وسرقتهم. ويهدف هذا البحث إلى تقدير العائدات المسروقة واقتراح حل للمشكلة. وكجزء من هذه الدراسة، تمت محاكاة رحلة حافلة من شرق إلى غرب الجزائر على مدى شهر واحد. ونتيجة لهذا، قُدِّر قيمة الخسارة (استناداً إلى مستوى الثقة الممنوحة للموظف) إلى 6% من صافي إيرادات الشركة. وأخيراً، تم إجراء دراسة أكثر عمقاً لإنشاء نظام إداري يشتمل على تتبع نظام تحديد المواقع العالمي وفرز الركاب، في حين لا مفر من الحاجة إلى مثل هذا الحل.

الكلمات المفتاحية: الثقة، سرقة الموظف، المحاكاة، إدارة النقل، النمذجة، عد الأشخاص