

**PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC
RESEARCH
UNIVERSITY MOHAMED BOUDIAF - M'SILA**



**FACULTY: Mathematics and
Informatics**
DEPARTMENT: Computer Science
N°

**DOMAIN: Mathematics and
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BRANCH: Computer Science
OPTION: RTIC

Dissertation submitted to obtain Master degree

By: Chenene Soumia

SUBJECT

**Road Lane Line Detection Based on
ML and DL Techniques**

Publicly defended before the jury composed of:

M. Lamri Sayad	Lecturer A	In M'SILA President
M. Said Gadri	Lecturer A	In M'SILA Supervisor
M. Makhoulf Benazi	Lecturer A	Member

Academic Year 2022/2023

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Dedication

- *Finally, I arrived after hardship, fatigue, staying up late, and pain. I fell and went through problems and obstacles that almost made me fall... With my will and determination, I arrived and I am proud of that.*
- *As long as I tried and did not give up, I fell and got up. I consider it one of the biggest successes.*
- *I dedicate my graduation note to my mother, who encouraged me and was the source of my strength and my continuity to reach success, whether studying or other fields. She always wants me to reach the top and strives to be a successful woman in all fields, and to my father, the wonderful, caring father who worked hard for me to learn despite his circumstances, and supported me with everything he could do.*
- *I thank every person who gave me help or advice, even if it was something simple, and I say thank you to him*

Appreciation

- *We thank God Almighty who enabled us to complete this scientific research and who inspired us with health, wellness and determination..*
- *We extend our thanks and appreciation to the supervising professor (Said Gadri) for all the guidance and valuable information he provided us that contributed to the praise of the subject of our study in its various aspects. We also extend our thanks to the members of the discussion committee M. Lamri Sayad, M. Makhlouf Benazi*

I do not forget to present the great form to all the respected professors at the University of Mohamed Boudiaf in M'sila faculty Mathematics and computer Science, I say thank you very much for all your efforts.

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General introduction

GENERAL INTRODUCTION

Artificial intelligence is a set of programs that aim to design a machine capable to achieve a specific goal in a similar way to human. This includes the ability to learn from previous traders, understand science, understand sound, analyze image and video, and to think and discover meaning such as discovering mathematical theories and playing chess. It requires large amounts of training data to enable machine to predict the future based on the past such as identifying objects in the image.

Artificial intelligence plays important role in various fields and in the future. The concept of artificial intelligence has evolved significantly during the last decade. After it was just an idea, it shifted from thinking to implementation until it became an important part of our life today and its concept entered into many different fields and reduced the need for workers.

Deep learning is a branch of machine learning that relies on artificial neural networks that recognize complex patterns of images, text, and sound for accurate prediction. It is used in many fields of automotive, aerospace, manufacturing, electronics, medical research and other fields. For example, Self-driving cars use deep learning methods to detect road signs and road lane lines. DL is also used in: medical image analyze, computer vision, speech recognition, extract information and insights from images, videos, and facial recognition features.

Artificial Neural network is a method that makes the computer able to process data, solve problems in its own way, and help it make smart decisions. So, neural network is a type of deep learning that uses the idea that brain cells do to think and analyze data. There are many types of artificial neural networks including: Feed forward Neural Network, Radial Basis Function Neural Network, Multilayer Perceptron, Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), Modular Neural Network, and Sequence-To-Sequence Models.

Lane detection is an area of artificial intelligence, and it is intended to guide human drivers so that there are lanes, as well as to guide self-driving cars and avoid the dangers of entering another lane

Road detection is an important technology in the field of self-driving cars, and with the help of machine learning, we can detect road lines, and train them using images and videos, and with the increasing use of artificial intelligence and deep learning techniques, we expect its significant development in the future.

We have divided our manuscript into several chapters:

- on commence par la section
- In Chapter 1, we briefly described our project area, which is the road Lane Line detection
- In Chapter 2, we introduced some important concepts and definitions, including Artificial Intelligence, machine learning and deep learning.
- Chapter 3 describes the programming environment.
- In the last chapter, we presented the realized work
- Finally, we concluded our work by a general conclusion

Chapter 1
**Road Lane Line Detection and Self-
Driving Cars**

1. Introduction:

This chapter is an introduction to the project field, in this chapter we talk about definition of lane line detection, dangers encountered by the driver on the road, The goal of lane line detection and Lane line detection challenges, Definition of self-driving cars types of autonomous vehicles .

2. Definition of lane line detection:

Lane line detection is a computer vision task aimed at determining the boundaries of lane lines in images or videos of road scenes. Lane finding is an essential part of advanced driver assistance systems (ADAS) and self-driving applications.

Lane markings play an important role in improving road safety and security. It is based on the use of computers and algorithms to identify traffic lane lines. Algorithms used to determine the trajectory include computer vision techniques such as edge extraction, the Hough transform, and the application of machine learning techniques.[1]

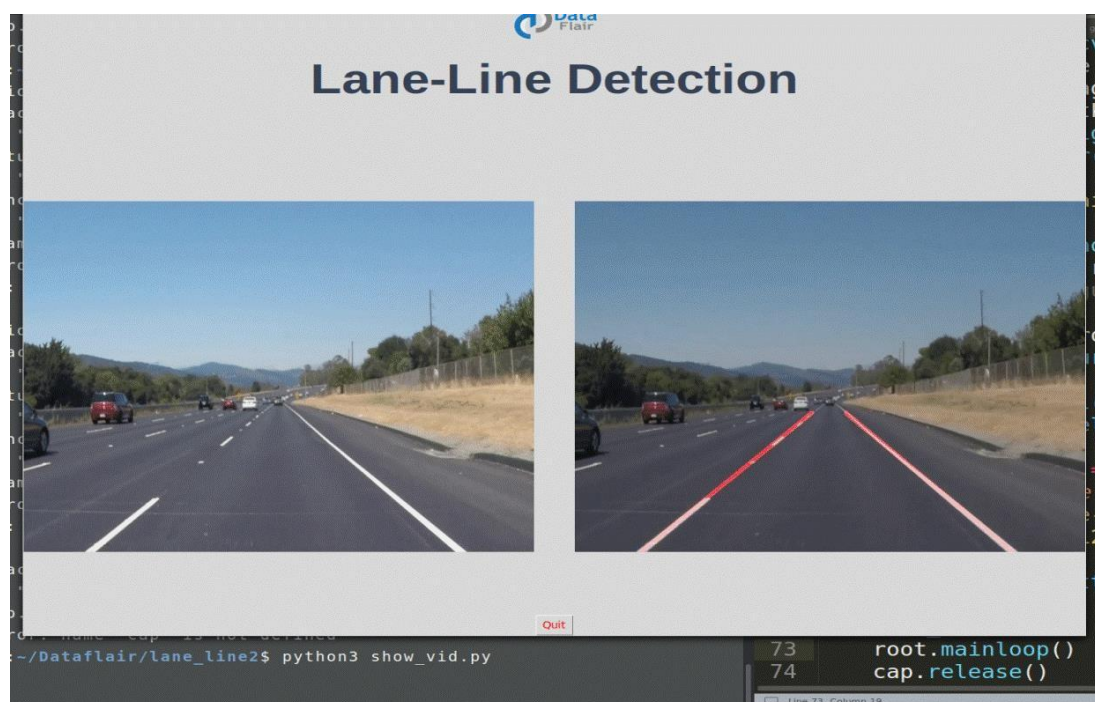


Fig 1.1:LaneLineDetection.

3.Dangers encountered by the driver on the road

Driver can meet many dangers when driving his car, notably:

- **Wrong road behavior:** Some people suffer from wrong road behavior, such as drifting between lanes or unsafe overtaking.



Fig 1.2:Unsafe overtaking

- **Fatigue and distraction:** Tired and distracted drivers can negatively affect



Fig 1.3:Drowsiness while driving

- **Driving in Low Light Conditions:** Drivers have difficulty seeing road lines in low light conditions such as at night or in heavy rain.



Fig 1.4:Driving at night

- Most of the roads in Algeria are one-way roads.
- Traffic congestion and speed



Fig 1.5:speed while driving.

- **Road condition:** the presence of wrinkles or cracks in the asphalt, on the clarity and smoothness of the drawn lines. Wrinkles and other factors can make lines look distorted and difficult to see clearly.
- **Obstacles:** Road lines may be overlapped or covered by other obstructions such as natural obstructions. This may hinder the driver from seeing and following the lines correctly.
- **Line Drawing Error:** Drivers may face a challenge when there is a line drawing error on the road. There may be lines that are not visible or improperly blurred

4.The goal of Lane Line Detection LLD:

These are some of the primary goals for lane spotting:

4.1. Improved traffic safety:

Lane line detection is an important part of advanced driving assistance systems ADAS and autonomous driving systems. Helps improve traffic safety by providing signals and alerts to drivers when they cross lane lines incorrectly or when they deviate from the designated lane.

4.2. Guiding Drivers:

Lane line detection can be used to help drivers steer in the correct lane and stay in the designated lane By accurately detecting and tracking lane markings, the system can provide real-time guidance to drivers, Gives assistance and details to pedestrians and drivers.[2]

4.3. Warning drivers of deviations:

Lane line detection can alert drivers when they unintentionally deviate from a designated lane. This helps avoid collisions caused by loss of vehicle control, and drivers can receive visual or auditory alerts if they unintentionally deviate or They approached the boundaries of the track..

4.4. Improved autonomous driving:

Lane detection is an essential part of autonomous driving technologies. Allows vehicles equipped with autonomous driving systems to steer to maintain a proper lane and maintain a safe distance from other vehicles.

4.5. Improved driver comfort:

In short, the goal of lane line detection is to enhance driving safety and to guide drivers.

When lane lines are detected correctly and necessary information is given to drivers, their driving comfort is improved. This reduces stress and fatigue and increases focus on the road.

5. Lane line detection challenges:

There are many challenges to lane line detection, including:

5.1.Changes in Lighting Conditions:

Certain unfavorable lighting conditions, such as bright lighting or heavy shadows, can affect the system's ability to correctly detect the path.

5.2.Noise:

The presence of noise or visual noise in the images used in the path detection process can affect the accuracy and stability of the detection. Road signs, trees, or other obstructions can be confusing factors that can cause difficulty distinguishing lines clearly.

5.3.Changes in the weather:

Changes in the weather such as rain, snow and fog can affect the driver's vision and make it difficult to see the road lines clearly. These weather challenges make it difficult to accurately detect the path and take appropriate action.

5.4.Road condition:

Road conditions, such as wrinkles or other factors affecting the road surface, can make it difficult to distinguish and track lines correctly. Natural factors or public road erosion can cause lines to become distorted and difficult to distinguish.

5.4.Changes in road configuration:

Changes in road configuration, such as sharp turns, complex junctions, or changes in road width, can pose an additional challenge to correctly detecting and following a path.

6. Self-Driving Cars:

Lane line detection in a self-driving car plays a critical role in ensuring that the vehicle is steered safely and efficiently. It helps achieve a more precise and stable ride, and reduces the risk of drifting off course.

6.1. Definition of self-driving cars:

Autonomous cars or self-driving cars are those vehicles which are driven by digital technologies without any human intervention. They are capable of driving and navigating themselves on the roads by sensing the environmental impacts. With the help of the system built up by different sensors, hardware components and a complex software, the car can go from one place to another safely. Their appearance is designed to occupy less space on the road in order to avoid traffic jams and reduce the likelihood of accidents [3][4]

6.2.Types of autonomous vehicles:

The National Highway Traffic Safety Administration (NHTSA) relied on rating levels developed by the American Society of Automotive Engineering (SAE) to classify the level of autonomous vehicle control. According to SAE levels, autonomous vehicles are classified as follows:

6.2.1. Level 0 « No Automation »:

The vehicle is fully controlled by a human driver, and there is no automation involved. This includes most traditional vehicles.

6.2.2. Level 1« Driver Assistance »:

The vehicle has certain automated features, such as adaptive cruise control or lane-keeping assist, but the driver is responsible for most aspects of driving.

6.2.3. Level 2 « Partial Automation »:

The vehicle can simultaneously control multiple functions, such as acceleration, braking, and steering, but the driver must remain engaged and monitor the environment at all times. Examples include vehicles with advanced driver-assistance systems (ADAS) like Tesla Autopilot.

6.2.4. Level 3 « Conditional Automation »:

The vehicle can handle most driving tasks under specific conditions and environments. However, the driver must still be prepared to take control when prompted by the system. Level 3 autonomy is currently limited and not yet widely available.

6.2.5. Level 4 « High Automation »:

The vehicle is capable of fully autonomous driving under certain conditions and

environments without requiring driver intervention. However, there might be specific limitations on where and when it can operate autonomously.

6.2.6. Level 5 « Full Automation »:

The vehicle is capable of performing all driving tasks under any conditions and environments without any human input. Level 5 autonomous vehicles are designed to operate without a human driver and are not yet commercially available.[5][6].



Fig1.6: types of autonomous vehicles

7. Conclusion:

In this work, we presented the problems that the driver encounters on the road that hinder him while driving and the goal of detecting the lane line. We have also provided an overview of self-driving cars because lane line detection in a self-driving car plays a critical role in ensuring safe and efficient

Chapter 2

Artificial Intelligence, Machine Learning And Deep Learning

1. Introduction:

This chapter deals with machine learning and deep learning and their methods and algorithms and the increasing use of their methods in various fields, and the presentation of the supervised Unsupervised learning...etc.

Three definitions are the key words in this chapter; AI artificial intelligence, machine Learning ML, deep learning DL. Artificial intelligence is a field concerned with giving computers and computer systems the ability to simulate human intelligence. Artificial intelligence, machine learning is a branch of artificial intelligence that focuses on developing models and algorithms that enable systems to learn and adapt to data, deep learning is another branch of machine learning that focuses on using deep artificial neural networks to automatically process and analyze data.

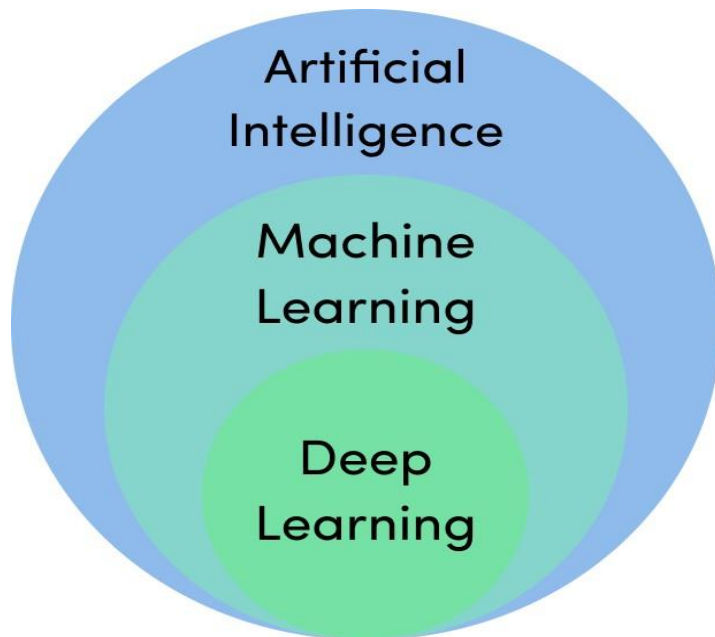


Fig 2.1: Artificial Intelligence, Machine Learning and Deep Learning and their relationship

2. Artificial intelligence:

Artificial intelligence (AI) refers to the development and implementation of computer systems that can perform tasks that normally require human intelligence. It involves creating intelligent machines that can perceive, reason, learn, and make decisions based on data and patterns.

Artificial intelligence aims to simulate and replicate human intelligence in machines, enabling them to understand, interpret and respond to complex information, solve problems, adapt to different situations, think logically, represent knowledge, learn from experience, plan and make decisions. Artificial intelligence has applications in many fields, including healthcare, finance, transportation, robotics, education, and more. It includes various technologies, such as machine learning, deep learning, computer vision, and robotics, among others.[5]

3. Machine learning:

Machine learning is a subfield of artificial intelligence (AI) that focuses on developing algorithms and statistical models that enable computers to learn and make predictions or decisions without explicit programming. It involves the construction of systems that can automatically learn and improve from experience, using data as the primary source of information.[7] [8][9]

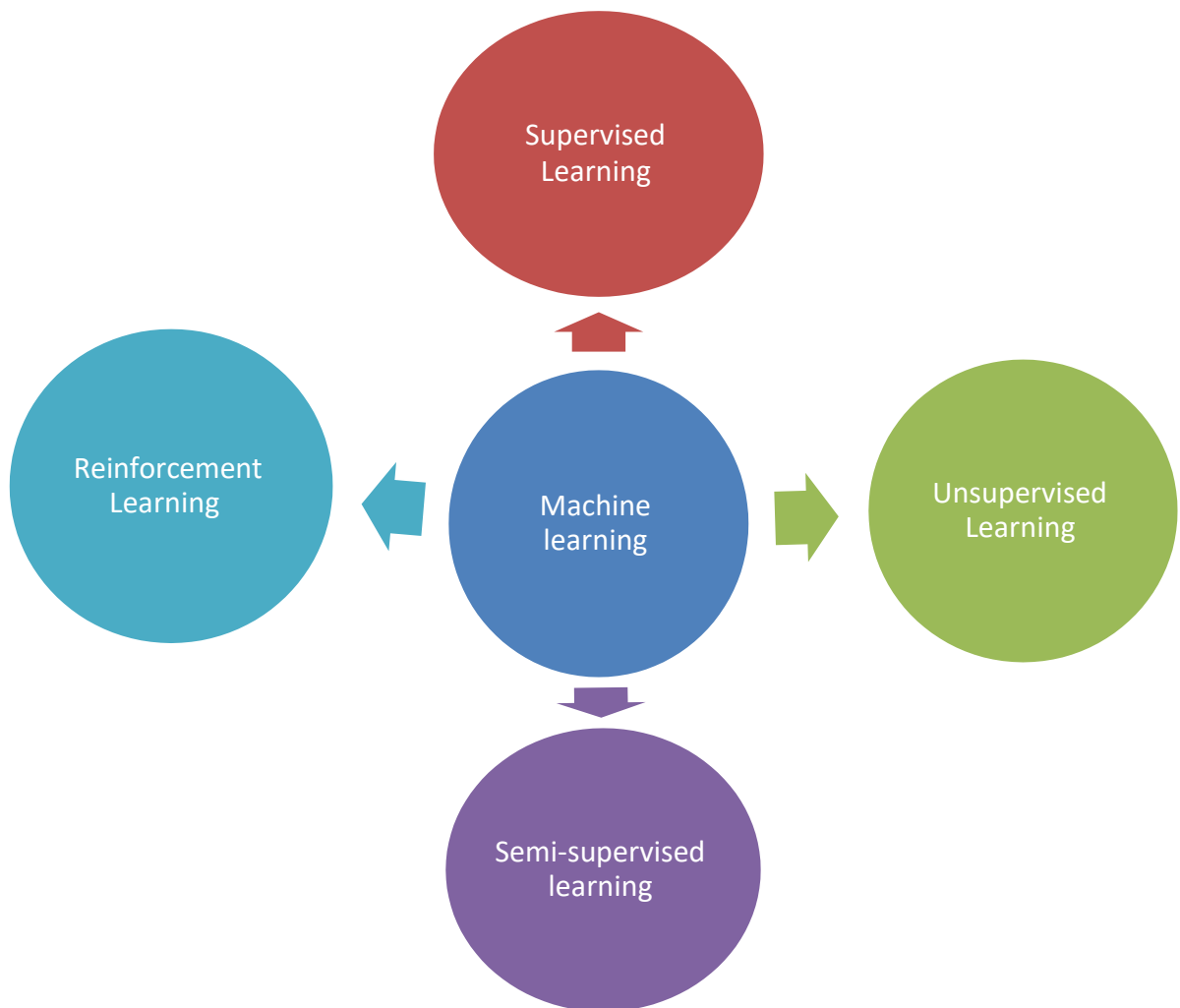


Fig 2.2:Types of Machine Learning.

3.2.1. Supervised learning:

Supervised learning is a machine learning technique in which a model is trained using labeled examples or input-output pairs. It involves learning a mapping or function that can predict the output or label for new, unseen input data based on the provided training data.

A good example of label data set and supervised learning process is shown in fig 2.3 .the collection of data sets are fruits take an input data the name of input data name is called label data so the name of labeled data is apple. The model is processing of supervised learning algorithms .the prediction of model is apple so the output is correct[11][12]

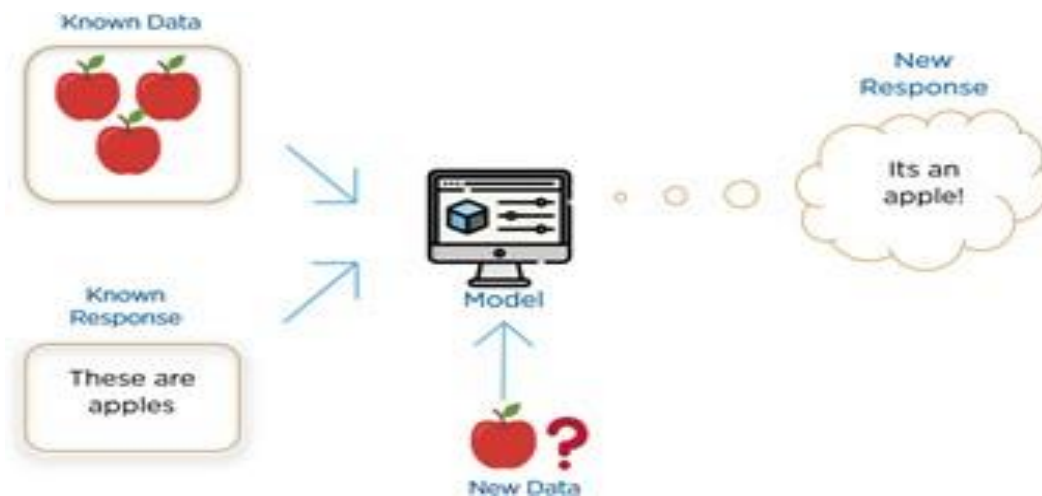


Fig2.3: supervised learning model.

3.2.1.1 Types of supervised learning:

There are two main types of supervised :

- **Classification:** Supervised learning problem that involves predicting a class label.
- **Regression:** Supervised learning problem that involves predicting a numerical label.

Both classification and regression problems may have one or more input variables and input variables may be any data type, such as numerical or categorical.[11][12].

3.2.1.2 Supervised learning algorithms:

- **Decision tree :**

It is one of the algorithms in automated trading, classification and prediction machine. A tree is a multi-branch control structure that consists of a series of successive series to reach a final result. Decision tree construction consists of dividing the data set into subsets It can be used simply by path from the root to the leaf appropriate to the common conditions Decision tree can be used with numerical, categorical and multi-categorical independent variables[13][14]

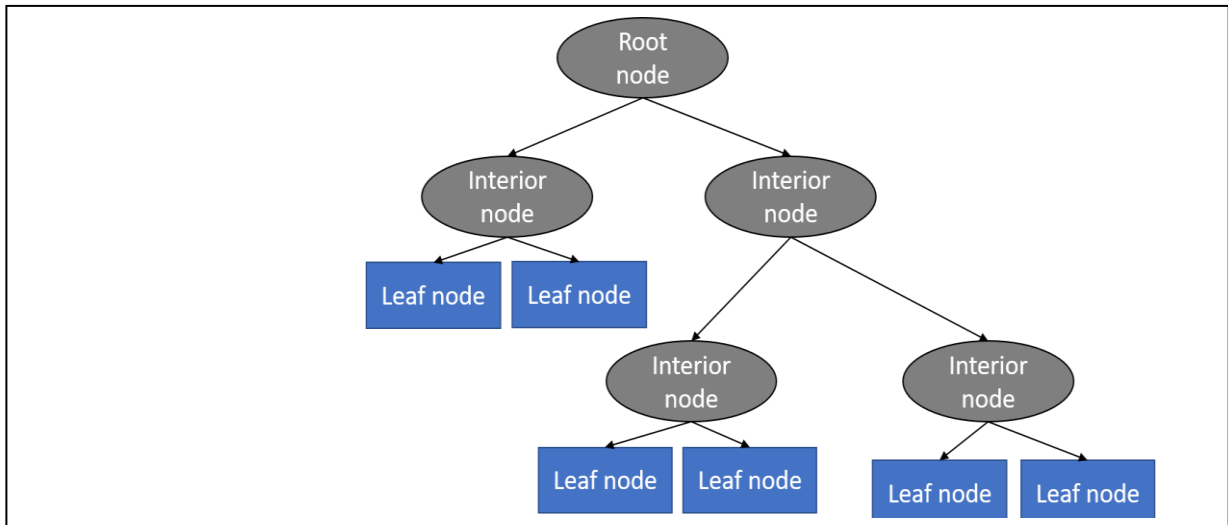


Fig 2.4:Decision tree example.

- **Support Vector Machine (SVM) :**

Support Vector Machine (SVM) is a popular supervised learning algorithm used for classification and regression tasks. It is particularly effective in solving binary classification problems, where the goal is to separate data points into two classes.

The main idea behind SVM is to find an optimal hyperplane that maximally separates data points of different classes. The hyperplane is chosen to have the largest margin, which is the vertical distance between the hyperplane and the nearest data points for each class, also known as support vectors.

The basic idea behind a support vector machine is illustrated by the example shown in Figure 2.5. In this example, the data is linearly separable.

So, There is a linear hyperplane that separates points into two different classes. In the two-dimensional case, Figure 2.5 shows two such hyperplane, B1 and B2. Both hyperplane can split the training examples into their respective classes without making any classification errors.[15] [16].

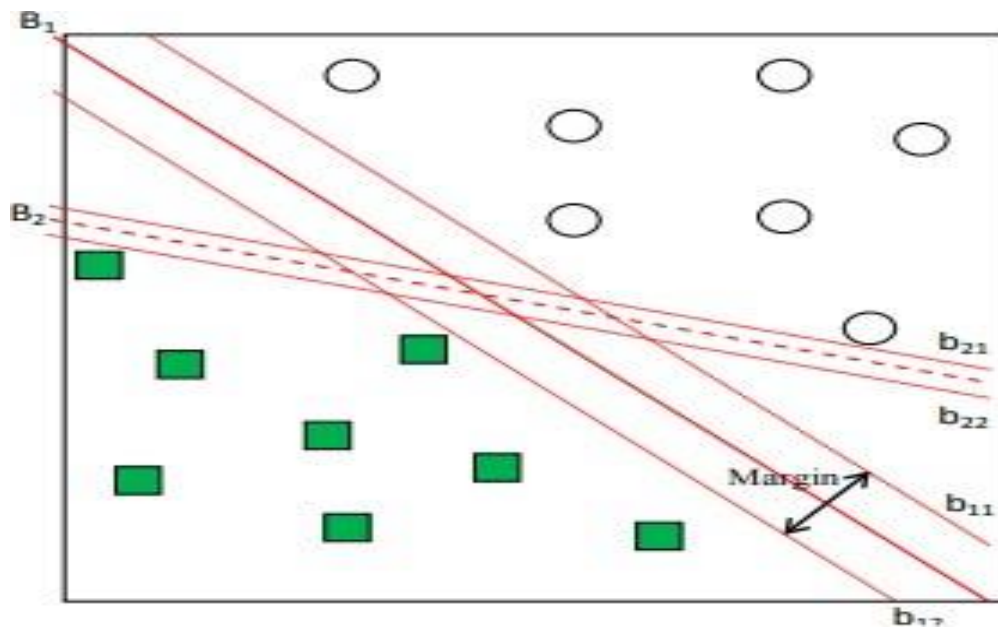


Fig 2.5: An example of a two-class problem with two separating hyperplanes, B1 and B2

3.2.2. Unsupervised Learning:

Unsupervised machine learning is a type of machine learning where the algorithm learns patterns and structures in data without being explicitly provided with labeled examples or a predefined output. Unlike supervised learning, there are no target labels or specific outcomes that the algorithm is trying to predict..

An example of unlabeled data sets is shown in Fig2.6. Input data is defined in the form of patterns and images but it does not show the name of the pattern and images . In an unsupervised algorithm, we have the input data but no output data. It helps to discover hidden patterns and insights in the provided data. [17][12]

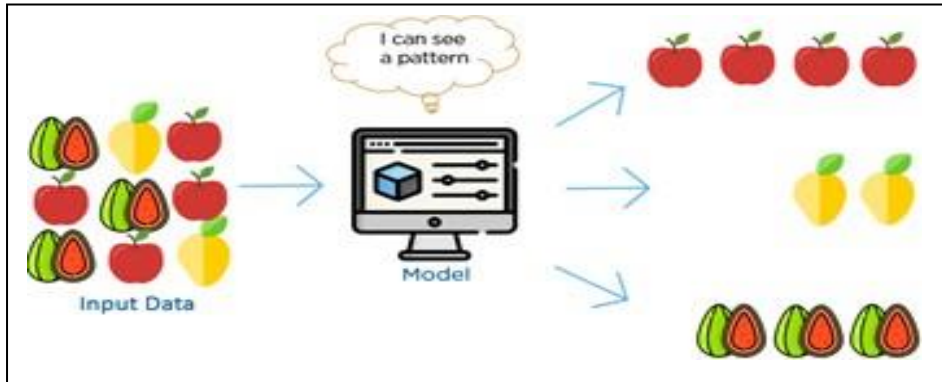


Fig 2.6: Unsupervised Learning model.

3.2.3. Reinforcement Learning(RL):

Reinforcement Learning is a branch of machine learning that focuses on how an agent can learn to make sequential decisions in an environment to maximize a notion of cumulative reward. Unlike supervised and unsupervised learning, reinforcement learning involves an agent interacting with an environment, learning from the consequences of its actions, and receiving feedback in the form of rewards or punishments.

3.2.4. Semi-supervised learning:

Semi-supervised learning is a type of machine learning that combines elements of both supervised and unsupervised learning. In semi-supervised learning, the algorithm learns from a dataset that contains both labeled and unlabeled examples. It leverages the available labeled data to guide the learning process while also utilizing the unlabeled data to extract additional information and improve the model's performance.[18]

4. Deep Learning:

4.1. Definition:

Deep learning is a subfield of machine learning that focuses on developing and training artificial neural networks to learn and make predictions or decisions on their own. It is inspired by the structure and function of the human brain, Deep learning algorithms are designed to learn from large amounts of labeled or unlabeled data and automatically extract meaningful features from the data, without the need for explicit programming. These algorithms are typically implemented using artificial neural networks, which are composed of multiple layers of interconnected nodes, or "neurons." [5]

4.2. Deep Neural Network:

4.2.1. Definition:

Deep Neural Network (DNN) is a network of multiple layers of interconnected neurons. Each neuron takes input from the previous layer, performs a weighted computation, applies an activation function, and passes the output to the next layer. The layers in a DNN are typically arranged in a feed forward manner, where information flows from the input layer through the hidden layers to the output layer. [19][20]

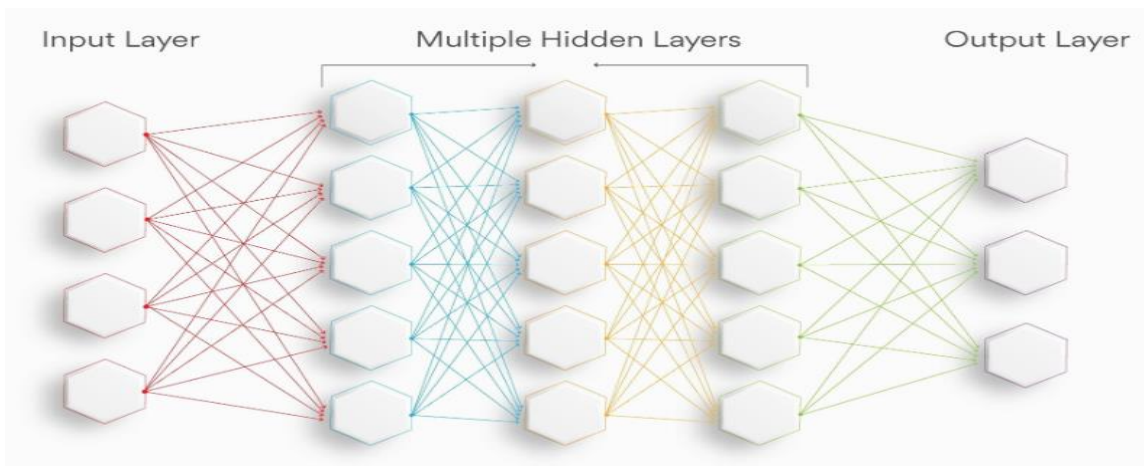


Fig2.7: Deep Neural Network

4.3.2. Activation Function:

- **Sigmoid**: is a mathematical function that maps its input to a smooth, "S"-shaped curve it produces values between 0 and 1. If the instance value's weight is min threshold, the class is

negative and so on.

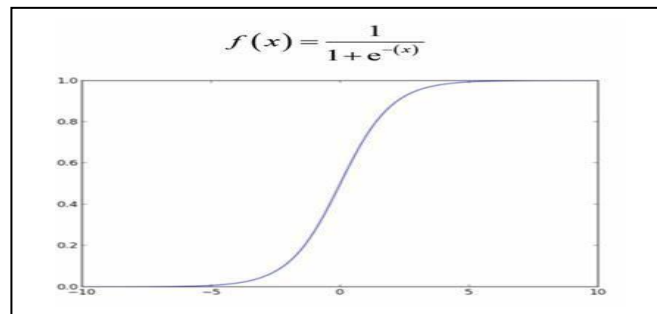


Fig.2.8: Sigmoid function curve.

- **ReLU:** Stands for Rectified Linear Unit, which is a common activation function ,ReLU does not activate all neurons at the same time, which means that if the input is negative it will turn it into zero (in other words, it returns value between 0 and the weight bias), resulting in only a few neurons to be activated at one time.

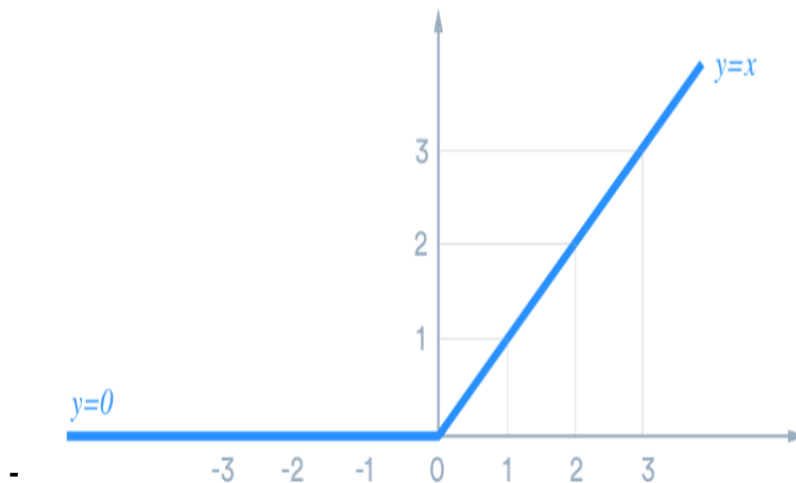


Fig 2.9:ReLU function curve.

-**Step function:** The step function, is a mathematical function that has a constant value for a given range of input values and abruptly changes its value at a specific point. The step function is defined as follows:

Where the output is 1 if the value of x is greater than equal to zero and 0 if the value of x is

less than zero. Where the neural network uses back propagation method to calculate weights of different layers. Since the step function is non-differentiable at zero. This is what fails the weights update task.

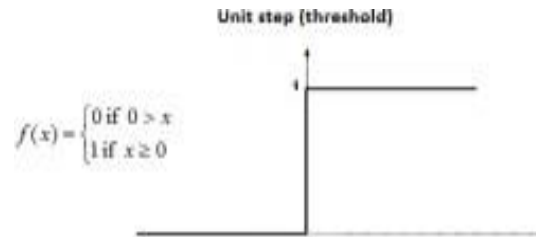


Fig 2. 8: Step function.

TanH: The $\tanh(z)$ function is a version of the sigmoid, and its output range is $[-1, 1]$ instead of $[0, 1]$..[20]

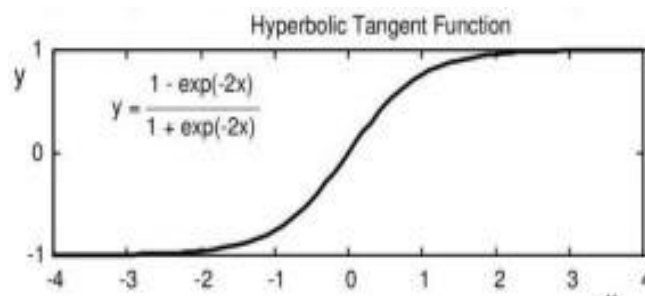


Fig 2.10: TanH function curve.

4.3.3 Deep Neural Network types :

1. Deep Feed-Forward Neural Network:

A deep feed-forward neural network, is a type of artificial neural network where the information flows in a single direction, from the input layer to the output layer. It is called "feed-forward" because there are no feedback connections or loops in the network

In a deep feed-forward neural network, the first layer is the input layer, which receives the raw input data. The subsequent layers, known as hidden layers, perform intermediate computations by applying linear transformations and activation functions to the inputs. The output layer produces the final predictions or classifications based on the transformed input.

Deep Feed-Forward Neural Network layers is composed of many layers: [21].

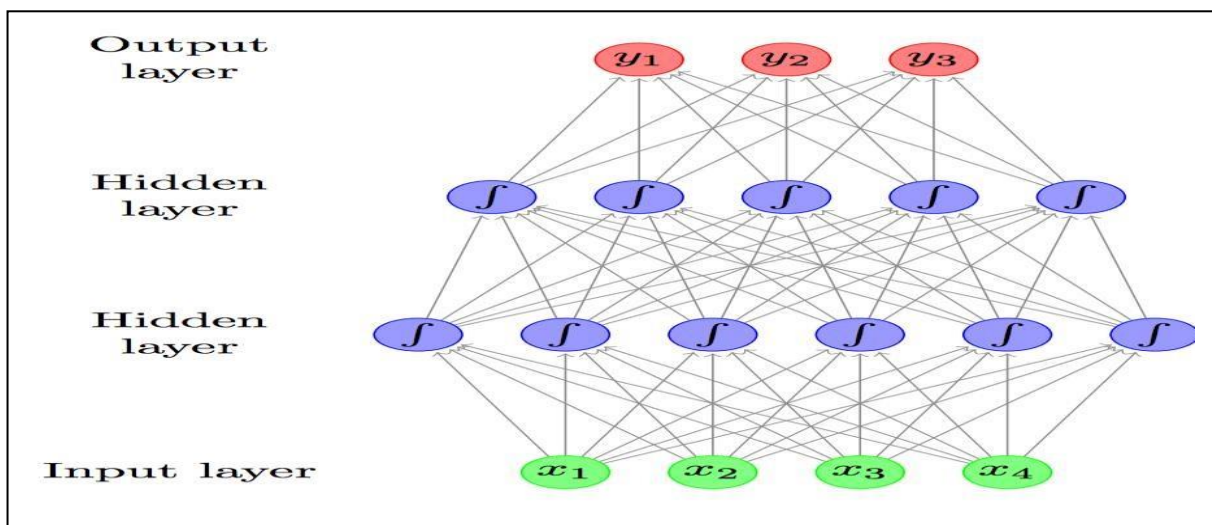


Fig 2.11: Deep Feed-Forward Network architecture

2. Recurrent Neural Network (RNN) :

Recurrent neural network (RNN) the order of the data points is important in a recurrent neural network. Unlike feed-forward neural networks, RNNs have feedback connections, allowing information to flow in loops within the network. This enables RNNs to maintain a form of memory, making them well suited for tasks involving sequential or temporal data.

At each time step, RNN takes an input and combines it with the hidden state from the previous step to produce an output and update its hidden state. The updated hidden state is then used in the next step.[21]

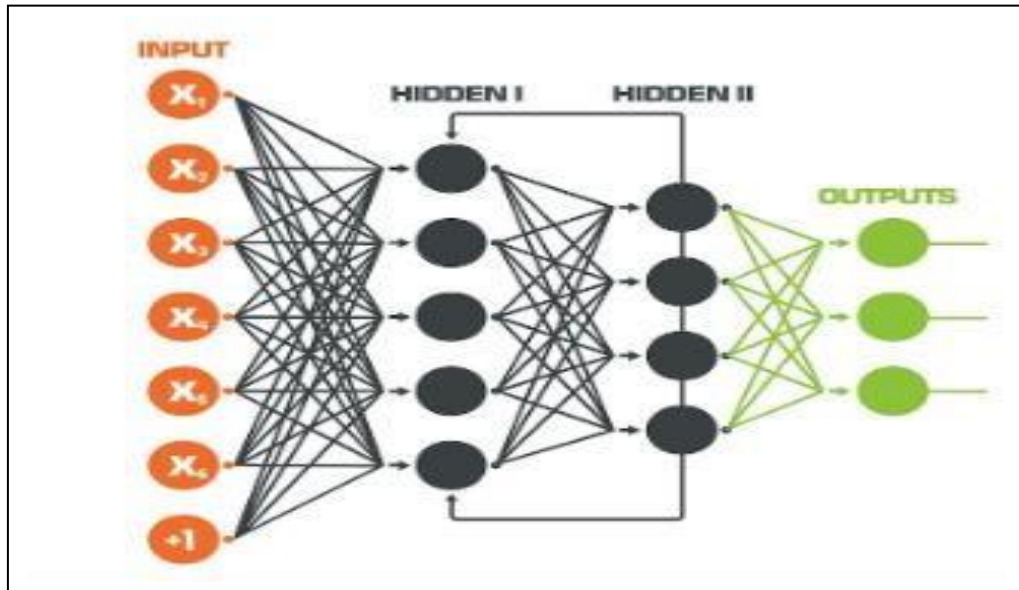


Fig 2. 12: A Typical Architecture of Recurrent Neural Network.

3. Convolution Neural Network (CNN) :

Convolutional Neural Network processes image through several layers:

- **Convolutional Layer:** Convolutional Layer is the main building block of Convolutional Neural Networks. that performs most of the computationally heavy work. Most generally, we can think of a CNN as an artificial neural network that has some type of specialization for being able to pick out or detect patterns. This pattern detection is what makes CNNs so useful for image analysis.

The convolutional layer receives the input, performs convolution operations, and then outputs the converted input to the next layer. The convolution operation is performed by moving the filter over the image. At each location, we multiply the matrix by the elements and add up the result.

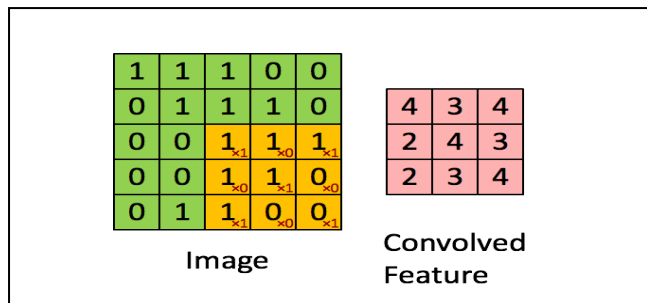


Fig 2. 13: Convolution process

- **Pooling Layer:** Its function is to progressively reduce the spatial size of the representation in order to reduce the number of parameters and computation in the network, . In image classifications task, pooling reduces the dimension of the image by the reducing the number of pixels in the output from the previous convolutional layer.

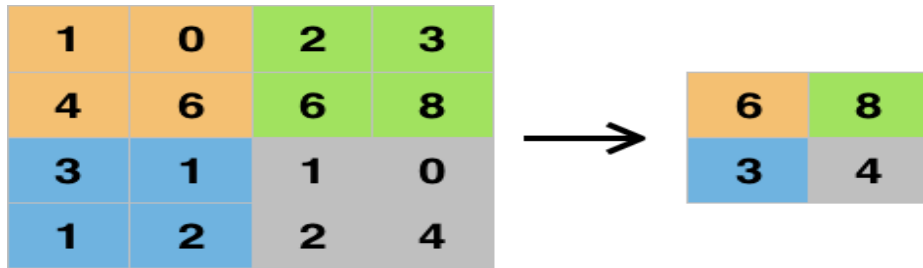


Fig 2.14 :Maxpooling process.

-**Flattening Layer:** layer that is used to prepare data to be the input of the final and most important layer . Since in general, neural networks receive data in one dimension in a form of an array of values, this layer uses data passed from pooling layer or convolutional layer and squashed the matrixes into arrays. Then, these values are used as an input to the neural network.

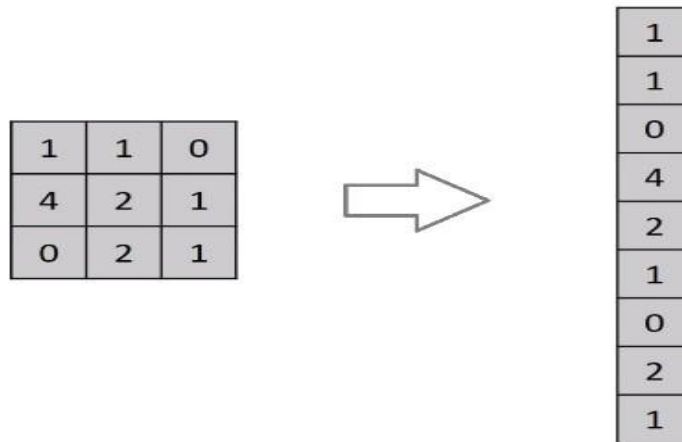


Fig 2. 15 : Flattening data

- **Fully-Connected Layer:** The final layer and the layer that does the actual classification is the so-called Fully-Connected layer. This layer takes input from the flattening process and feeds and forwards it through the Neural Network.[22][23]

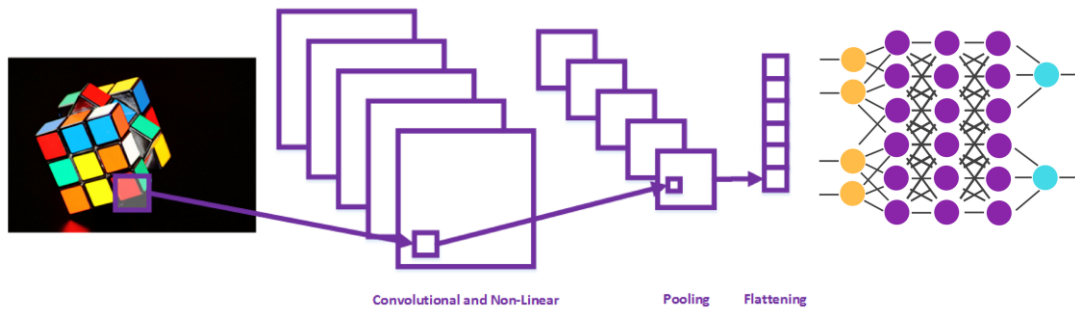


Fig 2.16: A Typical Architecture of Convolution Neural Network .

5. Machine Learning Vs Deep learning:

Properties	ML	DL
Amount of data	Small	Big
Features	Need to be created Manually	Learn automatically
Time	Short	Long
Accuracy	Good	The best
Debugging	Easy (know of information)	Very difficult(black Box)
Expensive	Less	More

Table2. 1: Machine Learning Vs Deep learning

6. Conclusion:

This chapter presents the essential of deep learning concepts, including: definitions of AI, ML and DL models, their respective technologies, their types, and concepts related to each.

Chapter 3

Environment Tools

1. Introduction:

In this chapter, we will first learn what Anaconda we use in our work and how to download it, learn about Spyder as well as Python and its libraries such as:OpenCv, .Pandas, NumPy, Keras and how to install Python packages using conda.

2. Anaconda:

2.1. Definition:

Anaconda is free software that provides a toolkit designed for research and science. Installing Anaconda gives you access to different environments that allow you to write code in Python or R. These environments, also known as Integrated Development Environments (IDEs), are platforms or applications that greatly facilitate code development. It performs a similar role to word processors like Microsoft Word, Google Doc, and Pages for writing text, but it's really much more than that. [24]

3.Spyder:

3.1. Definition:

Spyder is a highly functional IDE specifically designed for data analysis. It can be seen as an all-in-one IDE, containing an editor to write code scripts, a variable explorer to easily inspect data, and python console and much more. It also includes powerful tools for code inspection and debugging, allowing the user to analyze code either entirely or line-by-line to detect and fix errors.[25]

3.Python:

3.1. Definition:

Python is one of the most popular programming languages in research. The structure of the language and its object-oriented approach help programmers to write logical and clear code for small and large projects. Python libraries (packages) effectively simplify many important processes such as analyzing and visualizing data, retrieving unstructured data from the web, image processing, building machine learning models, and textual information [26].

3.2.Python libraries:

3.2.1. OpenCv :

OpenCV is an open source Python library that focuses primarily on real-time computer vision. OpenCV has a modular structure, meaning that the package consists of several shared or static libraries. The following modules are available: Core functionality (core) , Image Processing (imgproc) , Video Analysis (video), Camera Calibration .



Fig3.1:OpenCV logo

3.2.2. Pandas:

Pandas is a fast, powerful, flexible, and easy-to-use open source data analysis and manipulation tool built on the Python programming language. Pandas is being used for data wrangling and analysis and provides simple ways for cleaning, manipulating, and transforming data.

3.2.3. NumPy:

NumPy is an open source library that contains multidimensional arrays. The NumPyndarraycan be used to store data in a homogeneous “n” dimensional array object .NumPyis used in industry to compute arrays,. To manipulate those images, we need to operate on those pixels. NumPy is very useful in this scenario. NumPyis also used by advanced Python libraries like Pandas and SciPy. NumPy is more efficient than Python’s List in terms of:



Fig3.2 :NumPy logo.

3.2.4. Scikit-learn :

Scikit-learn is a machine learning library for the python programming language. After cleaning and manipulating your data with Panda or NumPy, Scikit-learn is used to build machine learning models, as it has thousands of tools used for modeling and predictive analysis . There are several types of machine learning models that can be built using scikit-learn, namely; supervised and unsupervised learning, cross-validate the accuracy of models, and conduct feature importance. It has various classification, regression and clustering algorithms including support vector machines, random forests, gradient boosting.

3.2.5. TensorFlow :

Tensor Flow is a free, open source library for machine learning in Python. It can be used in a wide range of tasks, but has a special focus on training and inferring deep neural networks. It uses multidimensional arrays, also known as tensors, which allow it to perform multiple operations on a particular input.



Fig3.3 :TensorFlow logo.

3.2.6. Keras:

Keras is a deep learning API written in Python and runs on top of the Tensor Flow machine learning platform. It was developed with a focus on the possibility of rapid experiments.

3.2.7. Plotly :

The Python Plotly package is an open source library built on Plotly JavaScript (plotly.js). Plotly is definitely an essential tool for creating visualization because it is a powerful and easy-to-use library that is able to interact with visualizations [20].

3.2.8. Matplotlib :

Matplotlib is the most popular library to explore and visualize data. You can use it to create basic charts such as line charts, scatter plots, histograms, bar charts and pie charts. It particularly comes in handy when a programmer wants to visualize the patterns in the data. It is a 2D plotting library used for creating 2D graphs and plots. [8][20]



Fig3.4 :Matplotlib logo.

4. Conclusion:

In this chapter, we have introduced all the environment tools that we used in our work and talked about Anaconda and the Python language the most popular language in data science for deep learning, we chose the open CV library for video playback.

Chapter 4

Realized system and obtained results

1. Introduction:

This chapter presents the experimental part as it contains the following:

- Deep Learning, Lane Line Detection background.
- Line discovery methodology.
- The road lane line detection steps.
- Hough transform.

2. Deep Learning, Lane Line Background:

Deep Learning DL becomes one of the most popular sub-field of IA and ML, especially in speech recognition, computer vision, and some other interesting topics. Its success is motivated by three factors: the increased amount of available data, the improvement and the lowest cost of hardware and software, the increased chip processing abilities (e.g., GPU units).

The application of deep learning approach proposed by researchers has yielded surprising results in many fields of research, including: computer vision [17-18], image processing [19-22], object detection [23, 24], network optimization [24], handwritten digits and character recognition [25-27], sensor networks [28-30], sentiment analysis [31], system security [32], Diabetes Detection [33-34]. The DL approach gives better results in terms of accuracy but needs massive data.

There are several algorithms in the literature for road segmentation and detection of the road lanes. Most classical algorithms are composed of several phases, such as pre-processing, feature extraction and model fitting [34], [35], [33]. Some of these classical algorithms even perform both tasks with the same pipeline [37], [38], [39]. Recently, Deep Learning has proven to be effective in training neural networks in a end-to-end fashion. That is, all the steps mentioned are performed by the neural.

3. Line discovery methodology:

Road lane line detection is an important task in computer vision, especially in applications like autonomous driving and advanced driver assistance systems. Here is a general methodology for road lane line detection:

1. Input Acquisition:

Capture or obtain the input image or video frame from a camera or other sensors.

2. Preprocessing:

Convert the image to grayscale, Apply Gaussian blur to reduce image noise.

Perform any necessary image enhancement techniques.

3. Extract the edge features:

Extracting edge features from an image is a critical step in many computer vision and image processing tasks. Edge detector is one of the most popular algorithms for edge detection using Canny edge detection algorithm

4. Region of interest selection(ROI) :

Region of Interest selection is a technique used in computer vision and image processing to focus on a specific area or region within an image for further analysis or processing. By selecting a ROI, you can ignore irrelevant parts of the image and concentrate only on the area of interest.

5. Determine target edge points:

To determine target edge points within a region of interest (ROI) in an image

6. Lane detection: is the identification and tracking of lanes on a road from photos or video frames.[24]

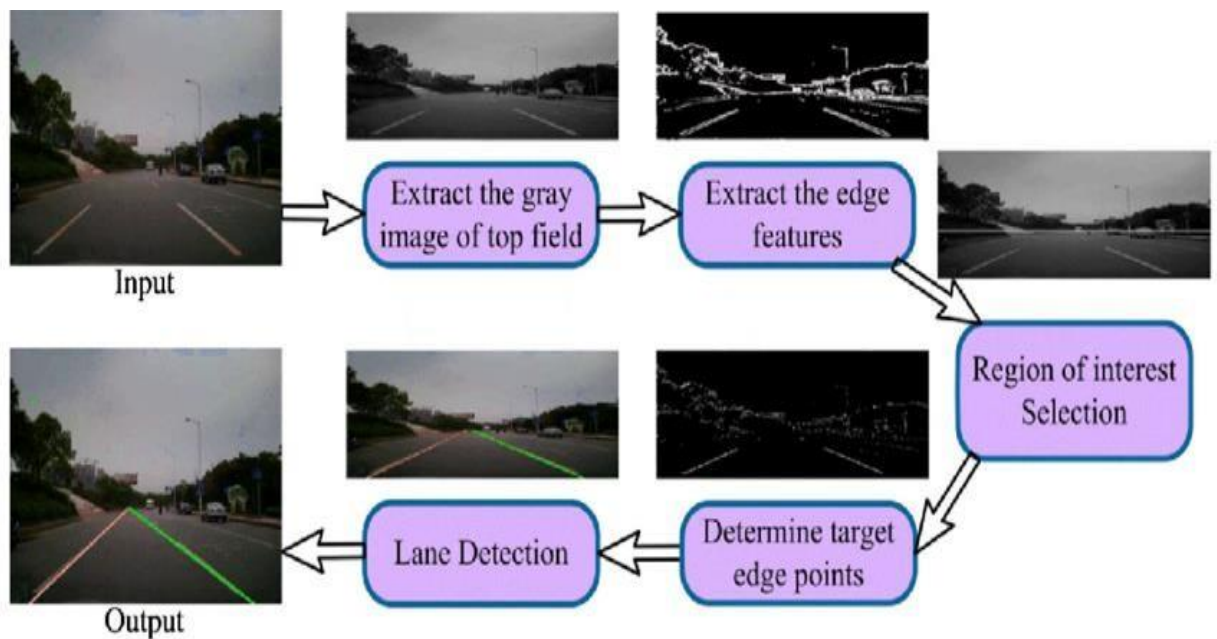


Fig4.1:LLD methodology

4. The road LLD steps:

1. Read frames from the video file:

Read frames from a video file by initializing the Video Capture object in OpenCV. The video file specified in the argument ("original.mp4") will be used as input for further processing.

2. Convert the frames to grayscale:

Using the OpenCV function `cv2.cvtColor()`, it converts the image from the RGB (Red-Green-Blue) color space to grayscale.

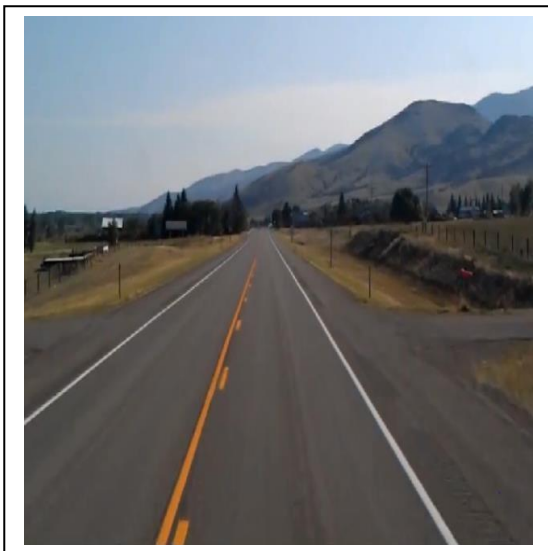


Fig4.2: The original image.

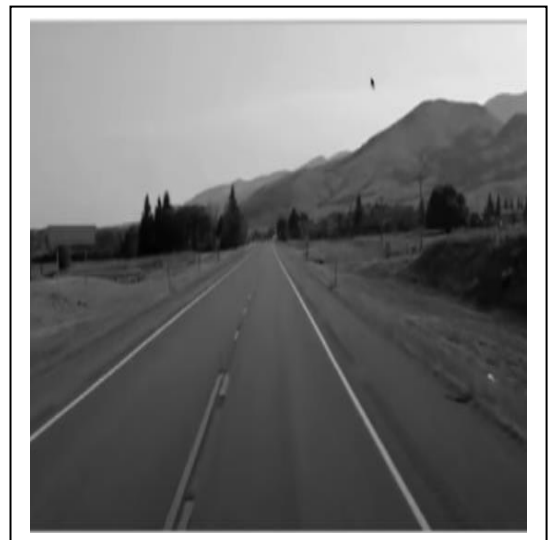


Fig4.3 : The original image in grey scale

3. Filtering the noise: this is done using the OpenCV function "GaussianBlur" which

executes the Gaussian filter algorithm. A kernel size of 5 has been selected.



Fig4.4:The image in grey after the Gaussian Blur Filter is applied.

4. Edges Detection and Extraction:

this is done using the OpenCV function “Canny” which executes the well-known Canny algorithm. Fig. 4.8. The following table (Table 4.1) lists the several parameters for the algorithm operation that have been selected after careful tuning and many trial and errors sessions

The cv2.Canny() function is used for edge detection in an image. It takes three arguments:

- gray: The input grayscale image on which the Canny edge detection will be performed.
- The lower threshold value .
- The upper threshold value.

Parameter	Value
Low threshold	50
High threshold	150

Table 4.1: Canny algorithm parameters.

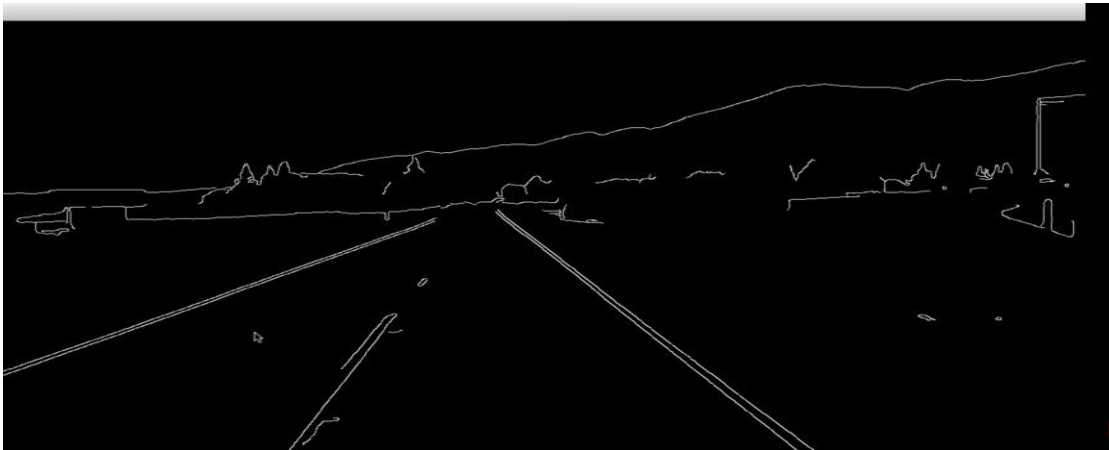


Fig4.5: The image after the Canny algorithm is applied.

5. The Identification of the region of interest:

This is implemented by masking a trapezoidal area in an image with edges detected. The `region_of_interest()` function is used to define a region of interest (ROI) within the Canny edge image. The function creates a mask with the same shape as the input canny image. Fig4.9: the region of interest.

The area inside this red triangle is the region of our interest. We need the coordinates of these points to define our region of interest. To find the coordinates,

we can use matplotlib. Fig4.10:the coordinates by use matplotlib.The defined region of interest is a triangular shape with vertices at $(200, \text{height})$, $(550, 250)$, and $(1100, \text{height})$, where height represents the height of the canny image. Fig4.11.

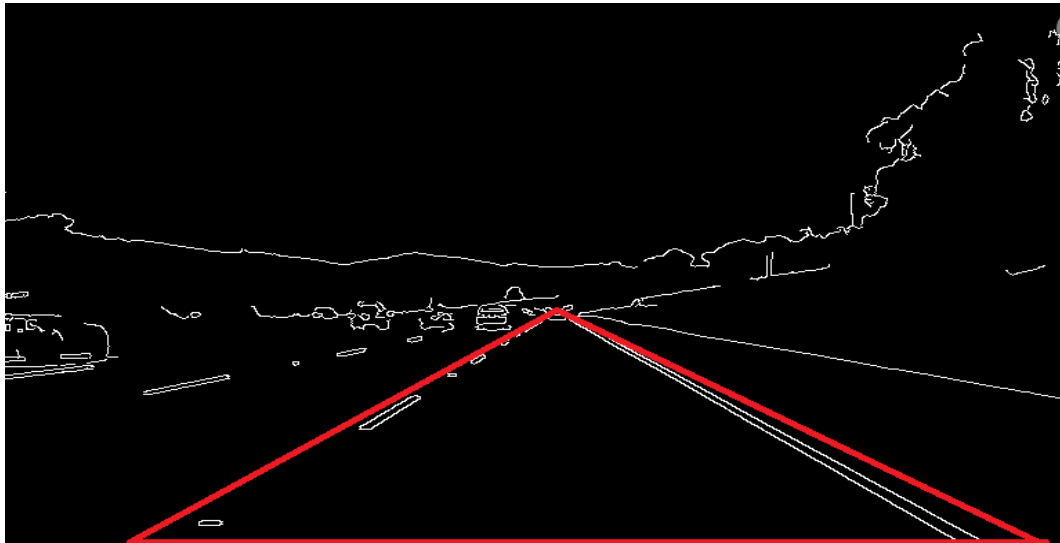


Fig4.6:the region of interest

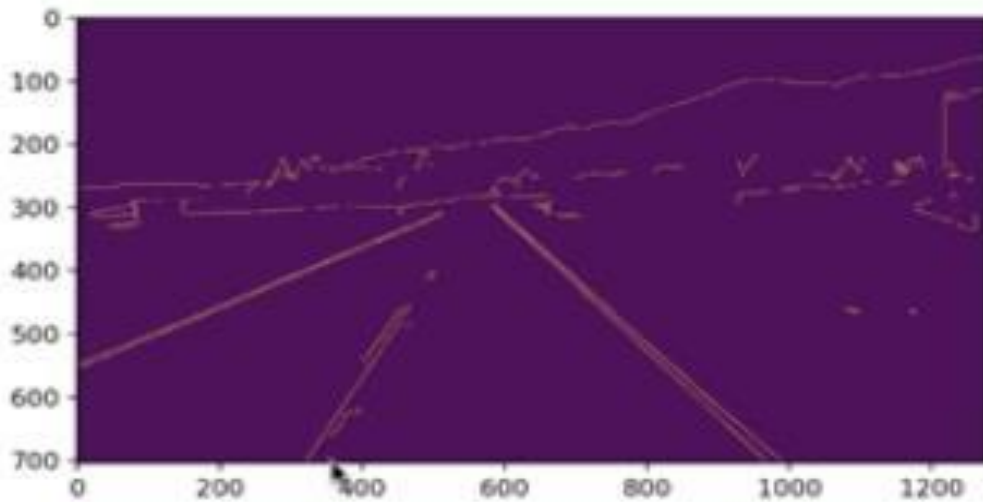


Fig4.7:the coordinates by use matplotlib



Fig4.8:triangular.

6. bitwise_and:

performs a bitwise AND operation between the canny image and the mask. It combines the two images based on their pixel values using the bitwise AND operation

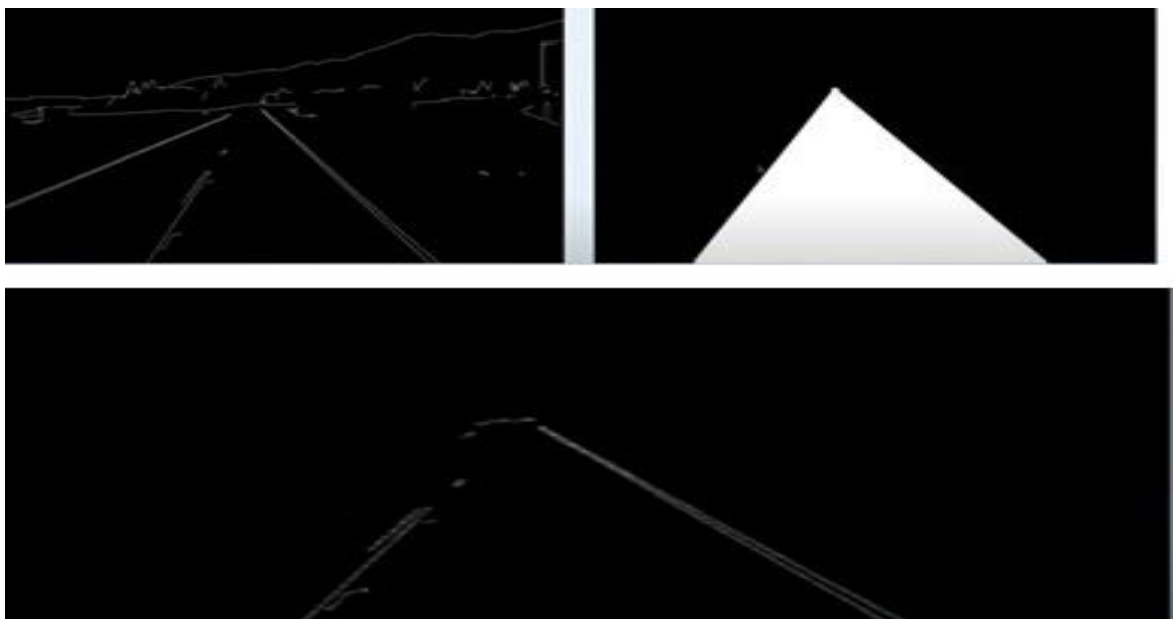


Fig4.9:then applies the mask to the canny image using the cv2.bitwise_and() function

7. Detecting Straight Lines:

straight lines are identified using the Hough algorithm [10] in polar coordinates using the `OpenCVHoughLinesP()` function.

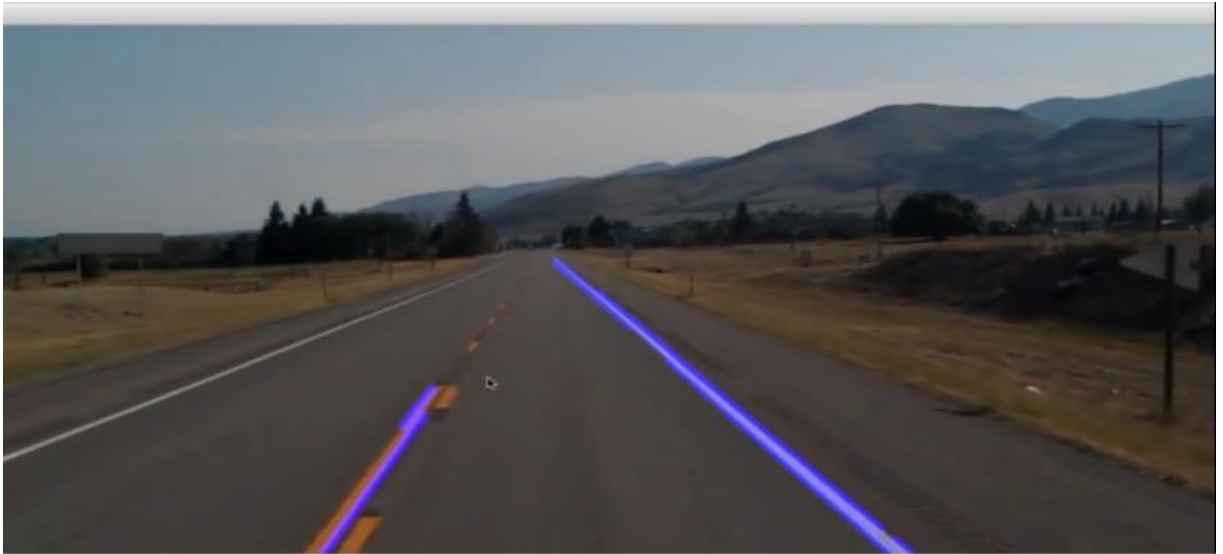


Fig4.10:The image after drawing lane lines by Hough transform.

5. Hough transform:

The Hough transform is a computer vision technique used to detect shapes in digital images, particularly for line and circle detection, used in various applications, including object recognition, image analysis, and computer graphics.

the basic idea behind the Hough transform is to represent shapes in an image as parameterized mathematical equations. For example, in the case of line detection, a line can be represented by the equation

$$y = mx + b \dots \dots \dots (1)$$

where m is the slope of the line and b is the y -intercept. The Hough transform converts the (x, y) coordinates of image points into a parameter space, known as the Hough space, where each point corresponds to a possible line in the image.

which are polar coordinates, are proposed in light of this aspect: [47]

$$\rho = x \cos \theta + y \sin \theta \dots \dots \dots (2)$$

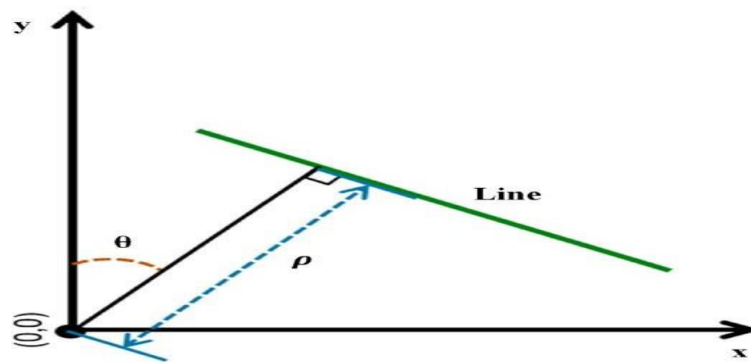


Fig 4. 11: Schematic representation of ρ and θ .

6. Conclusion:

This last chapter in which we presented the realized work, we got to know how the path is detected and the algorithm used Hough transform.

General Conclusion

GENERAL CONCLUSION

The Lane Line Detection project can help to develop a better understanding of lane detection capabilities and test and compare several image processing methods and lane detection algorithms. Through continuous experimentation and analysis, the performance of the path finding system can be improved and the most effective methods can be determined.

Lane Detection is a key component of Intelligent Autonomous Vehicle and Advanced Driving Assistance technology. Lane detection technologies have, many important and useful applications which can be realized, including the lane departure warning system to warn the driver when he unintentionally crosses the lane limits, thus contributing to the maintenance of road safety. We were interested in the lane detection problem in this project. This is why we have introduced the latest detection algorithms, which have enabled us to develop our own pathfinder. Detecting lanes in unstructured or out-of-control contexts is a major challenge in the field of smart cars. Although a large number of research and solutions are available, progress is still continuing and continuing in this field. Unregulated and changing road contexts may require the development of more advanced solutions and artificial intelligence to achieve effective lane detection. This requires the use of technologies such as machine learning and deep learning to improve the system's ability to recognize pathways and interpret the surrounding environment. In addition, the scope of the research can be extended to include the integration of various data sources such as cameras and other sensors to obtain multidimensional information and improve detection and classification accuracy. In general, progress in lane detection is expected to continue with the development of technology and additional research, contributing to improving the performance and safety of autonomous driving systems and providing a better and more efficient driving experience

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الملخص: يعد اكتشاف خط المسار تقنية مهمة في أنظمة مساعدة السائقين والسيارات الذكية ، وتهدف إلى تحديد خطوط الممرات وتتبعها على الطرق السريعة والشوارع العامة. يعد اكتشاف الخط أمرًا ضروريًا للحفاظ على السلامة المرورية وتحقيق قيادة آمنة وفعالة. تم تطوير العديد من الخوارزميات في مجال التعلم الآلي على مدار السنوات الماضية ، خاصة في مجال التعلم العميق ، وهو فرع مهم من التعلم الآلي. كأدوات برمجة ، استخدمنا Python ، Open CV ، وهو الأكثر استخدامًا في هذا المجال. لقد أنشأت تطبيقًا يحذر السائق إذا تم عبور الخط على الطريق .

الكلمات المفتاحية: التعلم الآلي ، التعلم العميق ، اكتشاف خط الحارة ، الشبكات العصبية ، السيارات ذاتية القيادة

Summary: Lane detection is an important technology in driving assistance systems and smart cars, intended to identify and track lane lines on highways and public streets. Line detection is crucial to maintaining traffic safety and achieving safe and efficient driving. Many algorithms have developed in the field of machine learning over the past years, especially in the field of deep learning, which is an important branch of machine learning. As programming tools, we used Python, Open CV, which is the most widely used in this field. I created an application that warns the driver if the line is crossed on the road, intentionally or unintentionally.

Keywords: machine learning, deep learning, lane line detection, neural networks, self-driving cars.

Résumé : La détection de voie est une technologie importante dans les systèmes d'aide à la conduite et les voitures intelligentes, destinée à identifier et à suivre les lignes de voie sur les autoroutes et les voies publiques. La détection de ligne est cruciale pour maintenir la sécurité routière et assurer une conduite sûre et efficace. De nombreux algorithmes se sont développés dans le domaine du machine learning ces dernières années, notamment dans le domaine du deep learning, qui est une branche importante du machine learning. Comme outils de programmation, nous avons utilisé Python, Open CV, qui est le plus utilisé dans ce domaine. J'ai créé une application qui avertit le conducteur si la ligne est franchie sur la route, intentionnellement ou non.

Mots-clés : apprentissage automatique, apprentissage en profondeur, détection de lignes de voie, réseaux de neurones, voitures autonomes