Chapter2: (Survey)

2.1 Overview:

In this chapter we are talking about the general idea of the project and show the related work researches which are divided into ML and DL, and a table for all researches to describe the important points.

2.2 General Background:

The highway fees are taken from cars at the gate which is on the way, that gates waste too much time of the car because every car have to stop at the front of the gate and pay the fee then go, that process make a traffic jam at the gate because of the cars row.

The system we build uses cameras to capture images of cars in the highway then extract the car license plate number and add the fee of the way to the car account on the application that provide the owner to pay from his credit card or any payment method, that will save time of cars on the highway and let them drive at usual speed without stopping.

2.3 Deep Learning and Traditional Machine Learning:

2.3.1 Traditional Machine Learning:

A Real-Time Car Towing Management System Using ML-Powered Automatic Number Plate Recognition

Ahmed Abdelmoamen Ahmed et al. in [p1] proposed Automatic Number Plate Recognition (ANPR) is a computer vision technology that automatically recognizes vehicle number plates using high-speed cameras. After capture the image convert it to grayscale, use Threshold function to be a binary image, use Connected Component Analysis (CCA) for image post processing then make image segmentation process to separates the relevant objects in the image, last step enters the feature vector to KNN classier to recognize the plate's actual characters. They used more than 160 car images and the model classification accuracy of 95% in testing dataset, the model requires around 10ms only to detect the actual characters in the number plate. The overall processing time 29 ms. the model fails to recognize some characters correctly and confuses characters with similar structures such as D with O, 6 with 8, K with I, etc.

Libyan Vehicle License Plate Recognition with Support Vector Machine

Aeyman M. Hassan, ET. in [p2] Proposed a Plate Recognition with Support Vector Machine for a vehicle building entrance. System starts with two gates (entrance - exit), An ultrasonic sensor detects the vehicle then send a command to a camera to capture vehicle, An Arduino board to control vehicle gates, then doing some Image Preprocessing to prepare the image (rgb2gray2binary), then use edge detection-vertical and horizontal edge histogram projection to detect car plate, then use connected-component labelling to separate each number, finally use histogram of oriented gradient and SVM to recognize the numbers. Amount of data used is 100 car images (70 training – 30 testing) and the model overall accuracy is 83.3% in testing dataset, the overall processing time is 5sec. sometimes the model fails to localize car plate or fails in one of the three stages in recognizing plate numbers because the digits were ambiguous.

Automatic Number Plate Recognition of Saudi License Car Plates

Manal Alghamdi et al. in [p3] Automatic Number Plate Recognition of Saudi License Car Plates proposed recognition of Saudi cars plates to Traffic regulation and traffic violations are major issues that Facing society. As a start we take the Image and convert it in a gray scale, images Resizing, scaling, and rotation Was performed on the images, Applying Gaussian blurring to remove high-frequency noise, image post processing then makes image segmentation process by two thresholds to separates the relevant objects in the image, to turn printed words of the preprocessed images into editable text, the OCR technology is used. The dataset contains 50 images of various parked cars, Results in an accuracy of 92.4% for Arabic and 96% for English texts. The car plate size and location may effect on the performance of the model.

License plate recognition for campus auto gate system

Nur Liyana Yaacob et al. in [p4] License plate recognition for campus auto gate system to the university gate. License plate localization: image enhancement, crop and convert it to gray scale, Sobel edge detection, erosion, image closing, image banalization, and locating license plate region. Character segmentation: morphological operations, skew correction, row detection and character segmentation. Character recognition: template matching method is utilized in the character

recognition stage. Data set is a total of 95 images were used as the input images, the success rate for the license plate localization, character segmentation and character recognition are 93.68%, 93.25% and 84.33% respectively. the license plate localization performance will be affected if the vehicle has text stickers on the vehicle body or vehicle model written on the front body and if the vehicle has a complex background, for the character segmentation stage, the performance will be affected if the characters are too close to each other, In the character recognition stage, there are some misclassification occurred. Because of the resemblances between the characters.

A Novel Approach for Automatic Car Plate Detection and Recognition

Fattah Alizadeh et SazanLuqman. in [p5] proposed Automatic Car Plate Recognition (ACPR) system that automatically recognizes vehicle number plates using high-speed cameras. After capturing the image, the image was resized to 200*200 pixels, converting the color image into a grey scale and binary one, and then the de-noising process. The proposed system utilized Speeded up Robust Features (SURF) descriptor for separating the car plate region from the whole image. Then, an image segmentation process was applied to separate the relevant objects in the image, and then the underlying descriptors of the digits later will be compared to those which have already been saved in the dataset. The minimum distance between the target image and the saved ones indicates the digit. Dataset of 200 images which was categorized into 5 groups, in terms of distance from the camera, view angle, alignment, plate color, and weather condition was used to evaluate the proposed system. The images were taken in different locations of the region, and the model accuracy of 94% in testing dataset, when the car plate is 1 Meter far from the camera, the highest accuracy will be achieved which is 94%, but for the 4-meter distance, the localizing and recognition is not satisfactory at all (27%), so the model accuracy depends on the distance between the car and camera in addition to the weather.

2.3.2 Deep Learning:

Malaysian Vehicle License Plate Recognition Using Deep Learning and Computer Vision

Kuken Raj Pugalenthy et al. in [p6] proposed using computer vision to recognize the car plate registration number in order to monitor the vehicle movement. When capture the car image they use NumPy slicing to get right region of interest and make Image Warping, they use YOLOv3 to detect the position of car registration plate and resize images by OpenCV, NMS technique solve the problem on multiple detection and make image thresholding for color inversion, after that use PyTesseract to read the characters from the image and Regular Expression to eliminate the weak predictions from the PyTesseract results. They didn't mention the dataset, the model achieved 100% accuracy in recognizing. The car registration number makes harder to look in moving motion. So here, fast operation is needed to capture the picture or also make a video out of the captures. the main scope of this paper is to identify and recognize the vehicle registration license plate under normal weather daylight condition.

IoT Based License Plate Recognition System Using Deep Learning and Open VINO

 Mau-Luen Tham et al. In [p7] IoT Based License Plate Recognition System Using Deep Learning and Open VINO to recognize Malaysian car plate is attained via transfer learning. the YOLOv4 trained model's weights file is inputted into the Open VINO toolkit, Node-RED is chosen as it is a lightweight and convenient flow based editor that uses a web browser to build workflows and MQTT as a cloud, before passing the cropped car plate frame to the Tesseract OCR, convert it to gray scale, blurring, thresholding and dilation to Last, character segmentation is enabled by contour function, we adopt the Tesseract OCR for image to-text conversion. The dataset consists of a total of 500 Malaysian car images, which are divided into 80% for training and 20% for validation of the detection model. YOLOv4, together with Tesseract OCR recognize accuracy with 100% detection accuracy and 89.22% OCR accuracy, but High similarity in numbers and shapes may effect on the performance.

A vehicle plate recognition system based on deep learning algorithms

TaoufikSaidani et al. in [p8] proposed an automatic license plate recognition system, which is an intelligent system based on analyzing visual data to detect and recognize characters in license plates. The proposed system based on the Faster R-CNN improved by adding an adaptive attention network for the segmentation of the license plate to retrieve the numbers and the letters of identification. Moreover, a deconvolution layer at the top of the features extraction network was added to detect the small size of the target license plate. The anchor sizes, scales, and aspect ratios were modified to fit the license plate, speed up the processing speed to achieve real-time conditions by using the Inception v3 model. These plates are from Egypt, KSA, and UAE, because they are similar in their Arabic numbers. The model fails to recognize the plates in difficult weather times of rain and sandy winds, as well as in low light. The model has been developed to be able to process images at speeds up to 23 FPS. the model achieves a recall of 98.65 % and a precision of 97.46 %. We couldn't get dataset public on the internet and I collected it from the streets and python script then it was manually filtered and labeled and it has a size of 6000 images.

A Flexible Approach for Automatic License Plate Recognition in Unconstrained Scenarios

Sergio M. Silva and CláudioRosito Jung .in [p9] proposed an Automatic License Plate Recognition (ALPR) that automatically recognizes vehicle number plates using high-speed cameras. After capture the image resizing it to 320×320 pixels, converting the color image into a grey scale and binary one, and then the de-noising process, use Improved Warped Planar Object Detection Network (IWPOD-NET) that is able to detect the four corners of an LP in a variety of condition from the whole image. They trained two distinct networks, one to detect cars and LPs jointly, and another to perform Optical Character Recognition OCR, for classification they use two distinct CNNs then using YOLOv3 for recognition the car plate. This network was trained with a small amount of annotated data (only 693 images), and showed remarkable generalization to handle both car and motorcycle LPs capture data variety of illumination conditions and viewpoints. tolerances in the string edit distance. For some datasets, the system was not trained to capture strong geometric distortions. The system achieves 100% accuracy, which is also an indirect clue that the LPD module can correctly locate the LP.

2.3.3 Deep Learning and Machine Learning (Table [T1]) :

Study	Objectives	Methodology	Classifier	Dataset	Performance Measures
P1	enhance the accuracy of recognizing number plates in real time & time of processing	1) Using high-speed cameras to capture the car. 2) Convert the image into grayscale one. 3) Use Threshold function to be a binary image. 4) Use (CCA) for image post processing. 5) Image segmentation process to separate the relevant objects in the image. 6) Enters the feature vector to (KNN) classier to recognize the plate's actual characters.	KNN	Kaggle & Google Web Scraper (160 Image)	The model classification accuracy is 95%
P2	Design a model for a vehicle building entrance using a license plate recognition algorithm	1) An ultrasonic sensor detects the vehicle then send a command to a camera to capture vehicle. 2) An Arduino board to control vehicle gates. 3) Image Preprocessing to prepare the image (rgb2gray2binary). 4) Use edge detection-vertical and horizontal edge histogram projection to detect car plate. 5) Use connected-component labelling to separate each number. 6) Use (HOG) and SVM to recognize the numbers.	SVM	–	The model overall accuracy is 83.3% with 30 testing images and 70 training images.
P3	Recognition of Saudi car plates with the use of edge detection, segmentation, and contouring techniques	**CNN** to detect the language and the country of the LP	Binary K-means	50 images of various parked cars.	Results in an accuracy of 92.4% for Arabic and 96% for English texts
P4	Designed to work in an IR sensor is used to detect the motion of the car and the camera will be triggered to capture the vehicle image	License plate detection (LPD) method	Template matching	95 images with an 8MP iPhone camera	License plate localization, character segmentation and character recognition are 93.68%, 93.25% and 84.33% respectively

P5	Create an automatic system to detect, extract, segment, and recognize the car plate numbers in the Kurdistan Region of Iraq (KRI)	Speeded Up Robust Features SURF descriptor	_	200 images.	accuracy up to 94%
P6	Identify and recognize the vehicle registration license plate under normal weather daylight condition to monitor the vehicle movement	1) Capture the car image. 2) Use 'NumPy' slicing to get right region of interest. 3) Image Warping. 4) Use (YOLOv3) to detect the position of car registration plate. 5) Resize images by OpenCV. 6) Use (NMS) technique for multiple detection. 7) Image thresholding for color inversion. 8) Use (PyTesseract) to read the characters. 9) Use (RGX function) to eliminate the weak predictions.	_	_	The model achieved 100% accuracy in recognizing.
P7	Identify and Recognition of License Plate Recognition System Using Deep Learning	**CNN-** learned features. **HOG** feature for detection.	KNN	102 images	accuracy with 100% detection accuracy and 89.22% OCR accuracy
P8	Detect and recognize characters in license plate	- Developing an automatic license plate detection system (ALPD) based on the Faster R-CNN model. - Improving the performance of the Faster R-CNN model by adding the adaptive attention network and the deconvolution layer. - Modifying the anchor sizes, scales, and aspect ratios to fit the license plate. - Speed up the processing speed to achieve real-time conditions by using the Inception v3 model.	_	6000 images Collected by python script and manually filtered	Recall of 98.65 % and a precision of 97.46 %
P9	an automatic system to detect, extract, segment, and recognize the car plate numbers	-Improved Warped Planar Object Detection Network (IWPOD-NET) that is able to detect the four corners of an LP in a variety of condition from the whole image. -YOLOv3 for recognition the car plate. - CNN	CNN	693 images	Accuracy 100%

Research number	Research Name
1	A Real-Time Car Towing Management System Using ML-Powered Automatic Number Plate Recognition
2	Libyan Vehicle License Plate Recognition with Support Vector Machine
3	Automatic Number Plate Recognition of Saudi License Car Plates
4	License plate recognition for campus auto-gate system
5	A Novel Approach for Automatic Car Plate Detection and Recognition
6	Malaysian Vehicle License Plate Recognition Using Deep Learning and Computer Vision
7	IoT Based License Plate Recognition System Using Deep Learning and OpenVINO
8	A vehicle plate recognition system based on deep learning algorithms
9	A Flexible Approach for Automatic License Plate Recognition in Unconstrained Scenarios