CENG 407

Software Requirement Specification (SRS)

Licence Plate Recognition System

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1. Introduction

1.1. Purpose

In the License Plate Recognition System, we aim to determine the characteristics such as the type, color and size of the vehicles by using image processing, image detection and recognition methods. In addition to these methods, we aim to ensure that the Plate Recognition System gives accurate results by using the deep learning method with libraries such as TensorFlow and Keras.

1.2. Scope of Project

License Plate Identification System is a method that is frequently used in the identification of vehicles, in parking lots, in urban areas and in places where security is important such as road cameras. A license plate identification system is used to identify a vehicle.

The license plate recognition system is made by detecting the license plate region of the vehicles with the vehicle image and reading and separating the characters on the plate with image processing. By developing the license plate recognition system with deep learning and image processing, it will be tried to work towards detecting license plate recognition and the type of vehicle whose license plate is recognized.

With the License Plate Recognition System, our goal is to determine the license plates of vehicles using image processing methods such as character recognition and segmentation. We aim to determine the characteristics such as the type, size and color of the vehicles by using the determined plates. OCR (Optical Character Recognition) technology is used to recognize the characters of number plates. In addition, we aim to use the deep learning method using different vehicle images and datasets of some libraries in order to be accurate and realistic when defining the license plates in the License Plate Recognition System.

2. General Description

2.1 Glossary (Definitions, Acronyms, and Abbreviations)

Term	Definition
Camera	A device for recording visual images in the form of photographic, film or video signals.
Character Recognition	Character recognition is a process which allows computers to recognize written or printed characters such as numbers or letters and to change them into a form that the computer can use.
Character Segmentation	Character segmentation is an operation that seeks to decompose an image of a sequence of characters into sub images of individual symbols. It is one of the decision processes in a system for optical character recognition (OCR).
Deep Learning	Deep learning is a type of machine learning and artificial intelligence (AI) that imitates the way humans gain certain types of knowledge. While traditional machine learning algorithms are linear, deep learning algorithms are stacked in a hierarchy of increasing complexity and abstraction.
Keras	Keras is an open-source software library that provides a Python interface for artificial neural networks. Keras acts as an interface for the TensorFlow.
Licence Plate	A license plate is a sign on the front and back of a vehicle that shows its license number. A rectangular, usually metal plate that bears a sequence of numbers, letters, or both and is issued by a government to identify an officially registered vehicle. one of the signs with numbers on it at the front and back of a car.
Licence Plate Recognition System	License plate recognition system is a type of technology, mainly software, that enables computer systems to read automatically the registration number (license number) of vehicles from digital pictures.

Optical Character Recognition (OCR)	Optical character recognition or optical character reader is the electronic or mechanical conversion of images of typed, handwritten or printed text into machine-encoded text, whether from a scanned document, a photo of a document, a scene-photo or from subtitle text superimposed on an image.
OpenCV (Open Source Computer Vision Library)	OpenCV is a library of programming functions mainly aimed at real-time computer vision.
Python	Python has a standard library in development, and a few for AI. It has an intuitive syntax, basic control flow, and data structures. It also supports interpretive run-time, without standard compiler languages. This makes Python especially useful for prototyping algorithms for AI.
Software Requirements Specification	A document that completely describes all of the functions of a proposed system and the constraints under which it must operate. For example, this document.
Users	The person using the License Plate Recognition System.

2.2 User Characteristics

Users are which Persons or institutions that use, operate and observe the License Plate Recognition System.

Licence Plate Recognition System is a system that enables to read the license plates of the vehicles by detecting the vehicle according to the color and type of the vehicles. While doing license plate reading, it detects the vehicle, detects the location of the license plate and performs license plate recognition by reading the characters on the plate with OCR.

Support system manager is the person who helps the License Plate Recognition System when there is a problem with the system, camera or license plate reading.

2.3 Product Perspective

In the License Plate Recognition System, the system works by training the license plate position in the photos of the vehicles at different angles and in different frames, using the deep learning method, so that the license plates of the vehicles can be determined easily. For License Plate Recognition System, we prefer Python language to be used in the system due to its wide library possibilities such as TensorFlow, OpenCV and Keras. During the development of the project software, we aim to use Python supported compilers such as Visual Studio, PyCharm and Spyder.

In the License Plate Recognition System, besides the deep learning method, it is also aimed to use image processing and machine learning techniques. The system should be trained and tested using the sources in the license plate recognition system available on the internet, different vehicle images and the TensorFlow library dataset.

In case an external camera such as ESP32 is used as an external camera, images are taken via the ESP32 camera and transferred over Wi-Fi to a sufficiently equipped computer to operate the system. Thus, in the images transferred to the computer, first the location of the plate is determined, then the character cementation is done. Finally, character recognition is done and license plate recognition is done.

2.4 Overview of Functional Requirements

In the Plate Recognition System, the recognition process of the plates first takes place by finding all the contours in the picture. It happens that each stroke has its bounding rectangle. Then it has to compare and verify the side ratio and area of each bounding rectangle with an average plate. Image segmentation is then applied to the image within the verified contour to find the characters inside the plate. As the last step, the characters on the plate are recognized by using OCR (Optical Character Recognition). In the license plate recognition system, there is also a training phase by using the deep learning method for more recognition of the license plate in the images. Thus, different directions of vehicles and license plate positions can be better detected using multiple images or different sections of a video. In this way, it also provides convenience in terms of accuracy and speed in plate recognition.

2.5 General Constraints and Assumptions

Software Conditions: Since the images and times to be used for teaching using deep learning in the license plate recognition system can vary, it can be seen as the challenging part. Since the type of car will be determined with different vehicle images, the teaching time may vary. Every user shall need a computer and compiler that can run the codes in the software part of the license plate recognition system well.

Ambient Conditions: In order for the License Plate Recognition System to work properly, the camera must be in sufficient light and in suitable weather conditions, day or night.

Hardware Conditions: In case of using an external camera such as ESP32 other than the normal camera, the video must be at a suitable distance to be sent. Also the videos need to be sent via the Wi-Fi module over the network.

Security Conditions: In case of using an external camera such as ESP32, since the camera will be connected via Wi-Fi when connecting to the system, other devices using the same Wi-Fi must not block or access the camera. For this, the security of the camera is provided via Wi-Fi.

It is assumed that the system should be trained and tested using the sources in the license plate recognition system available on the internet, different vehicle images and the libraries such as TensorFlow library dataset.

3. Specific Requirements

3.1 Interface Requirements

3.1.1 User Interface

Since the users will use more compilers in the License Plate Recognition System, the recognized license plates on the vehicles and their outputs will be displayed here.

Requirement 1: Running the Compiler
In this interface, the user can operate the system with the buttons on the compiler and observe the outputs.

3.1.2 Hardware Interface

Requirement 1: For the License Plate Recognition System, a computer that can train the data in deep learning and that has good enough hardware should be used.

Requirement 2: Thanks to the ESP32 camera module as an external camera, video transfer is carried out over Wi-Fi. The video taken from the camera reaches the computer and plate recognition is performed.

3.1.3 Software Interfaces

Requirement 1: As operating systems, any Windows, Linux and MacOS operating systems with the latest version are chosen as much as possible for the best support and ease of use.

Requirement 2: Libraries such as TensorFlow and OpenCV are planned to be used for the license plate recognition system. Therefore, compilers such as Visual Studio, PyCharm and Spyder are used that support these libraries and Python language.

3.1.4 Communication Interfaces

Requirement 1: In case of using the external camera, the network connection is required to be stable in order to establish the connection properly.

3.2 Detailed Description of Functional Requirements

By using the deep learning method in the License Plate Recognition System, it provides license plate recognition by training the pictures of the vehicles with their license plates from different angles and frames. Thus, high accuracy results are obtained by minimizing the error rate and false results. In the License Plate Recognition System, a picture is taken first, and the location of the plate is determined in the picture taken. Then, character segmentation is done and finally the process is completed by character recognition.

Requirement 1: The user operates and uses the License Plate Recognition System.

Requirement 2: Pictures or videos are uploaded to the License Plate Recognition System.

Requirement 3: For the License Plate Recognition System, firstly, the defined pictures or videos are trained to detect different angles and frames by deep learning method.

Requirement 4: Vehicle image defined in License Plate Recognition System is converted to grayscale format.

Requirement 5: The image is binarized to reveal the plate.

Requirement 6: In the License Plate Recognition System, all the contours of the vehicle picture are found.

Requirement 7: The bounding rectangle of each contour in the vehicle image is found.

Requirement 8: In the License Plate Recognition System, a comparison and verification of the

side ratio and area of each bounding rectangle with an average plate in the vehicle image is made.

Requirement 9: Image segmentation is applied to the image within the verified contour to find the characters in the license plate found in the system.

Requirement 10: In the Plate Recognition System, the characters are recognized separately by using OCR (Optic Character Recognition) as the last process.

Requirement 11: Users can see the license plates of the defined vehicles as a result of the operations in the License Plate Recognition System.

Requirement 12: Support System Manager assists the user and fixes any problem that occurs during the operation of the License Plate Recognition System.

3.3 Non-Functional Requirements

Requirement 1: Speed

In the License Plate Recognition System, it is important that there is a minimum delay in the image source.

Requirement 2: Size

According to the size of the images in the Plate Recognition System and the size of the libraries used, it will occupy a certain space on the computer.

Requirement 3: Performance

In the License Plate Recognition System, the performance of the recognition process of the license plates may vary depending on the camera or the current operating speed of the computer.

Requirement 4: Usability

In order to use the deep learning method in the License Plate Recognition System, certain

libraries must be on the computer and the images must be transferred to the computer to be run.

Requirement 5: Reliability

If an external camera such as ESP332 is used in the License Plate Recognition System, since the connection of this camera with the computer is done via Wi-Fi, necessary protection measures must be taken over Wi-Fi.

Requirement 6: Robustness

License plate recognition shall be done according to changing ambient conditions and ambient light.

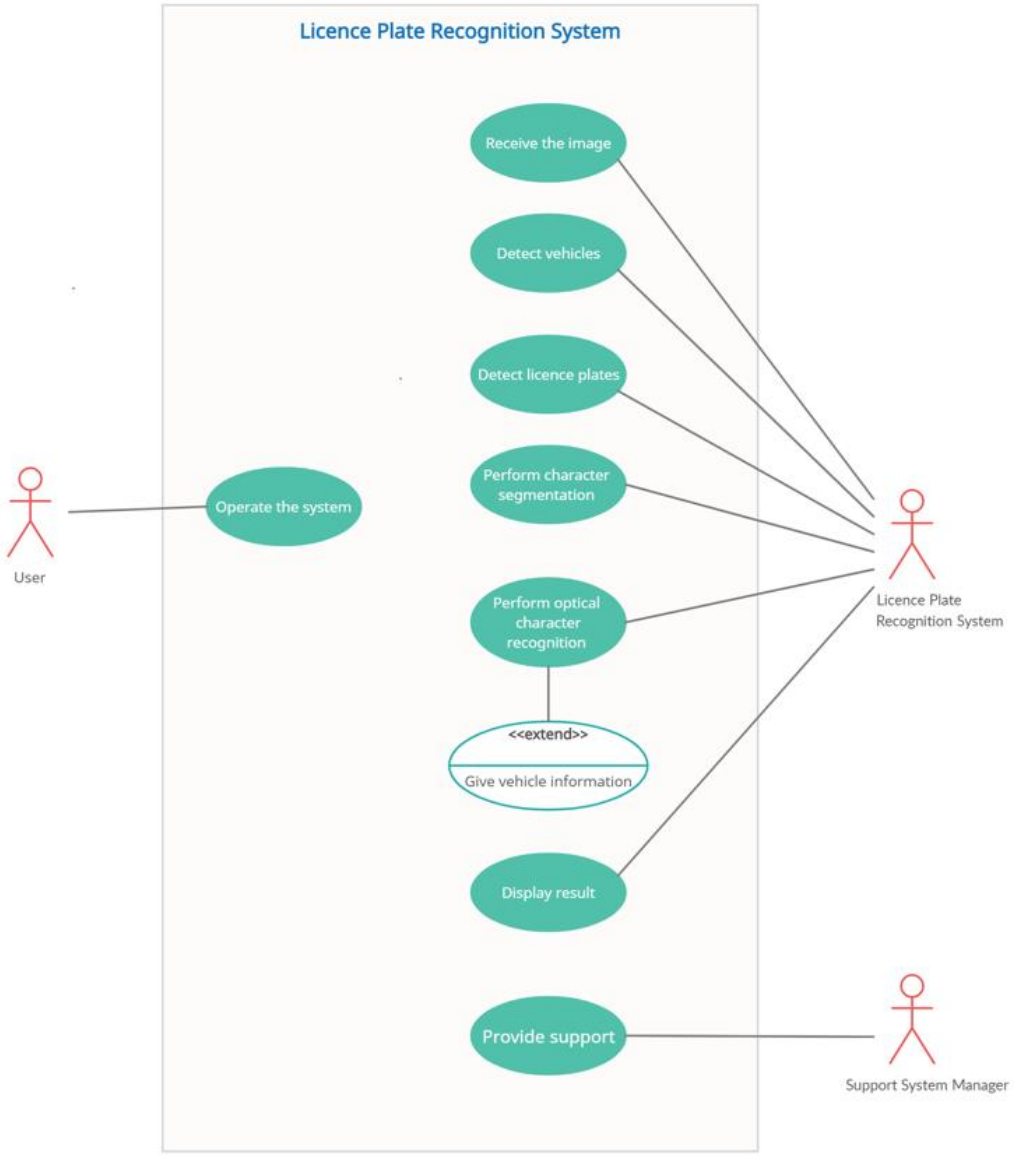
Requirement 7: Portability

License Plate Recognition System can be used in any computer environment.

4. Analysis –UML

4.1 Use cases

4.1.1 Drawing Use Case Diagram



4.1.2 Describing Most Use Cases

4.1.2.1 Operate The System

Use Case Name	Operate The System
Actor	Users, Licence Plate Recognition System
Description	1. It is necessary to start the software from the compiler.
Trigger	Compile the program
Preconditions	Users starts the Licence Plate Recognition System project source code.
Postconditions	After users start the system, they can observe the results.

4.1.2.2 Receive The Image

Use Case Name	Receive The Image
Actor	Licence Plate Recognition System
Description	1. The system compiles images from vehicle images and video frames in the IDE.
Trigger	Receiving the image.
Preconditions	Licence Plate Recognition system gets the image.
Postconditions	Pictures are made ready to apply the operations by the License Plate Recognition System.

4.1.2.3 Detect Vehicles

Use Case Name	Detect Vehicles
Actor	Licence Plate Recognition System
Description	1. The processed image is converted to grayscale format and the image is blurred. 2. The blurred image has vertical edges. 3. The image is binarized to reveal the plate. 4. All contours in the picture are found.
Trigger	Process the image.
Preconditions	The system detects the vehicle by using software.
Postconditions	After the vehicle is detected, the license plate recognition phase starts in the License Plate Recognition System.

4.1.2.4 Detect Licence Plates

Use Case Name	Detect Licence Plates
Actor	Licence Plate Recognition System
Description	1. The transformation is applied to the thresholded image. 2. The rectangular white box of the plate is revealed. 3. Contours are drawn in the binary and transformed image. 4. By drawing all the extracted contours to the original image, the boundaries of the license plate and vehicle are determined. 5. For the plates, the minimum area rectangle enclosed by each contour is found and the side proportions and area are

	verified. 6. The minimum and maximum area of the plate is defined according to the plate to be used. 7. The plate has contours in the verified region, and the lateral proportions and area of the bounding rectangle of the largest contour in that region are verified. 8. The found contour is subtracted from the original image and the view of the plate is obtained.
Trigger	Detection of vehicles
Preconditions	Determination of the contours of vehicles.
Postconditions	Character segmentation process is started.

4.1.2.5 Perform Character Segmentation

Use Case Name	Perform Character Segmentation
Actor	Licence Plate Recognition System
Description	1. To fully recognize the characters on the plate, image segmentation needs to be applied and the value channel is extracted from the HSV format of the plate image. 2. Adaptive thresholding is applied to the value channel image of the plate to binarize and reveal characters. 3. In order to find the connected components in the image, not bitwise processing is applied on the image. 4. A mask is created to display all character components and their contours in the mask. By subtracting the contours, the largest is

	taken, the bounding rectangle is found, and the side ratios are verified. 5. By verifying the lateral proportions, the convex shell of the contour is found and drawn on the character candidate mask. 6. All contours in the character candidate mask are found and these contour areas are extracted from the threshold value image of the plate, all characters are taken separately.
Trigger	Detect Licence Plates
Preconditions	Defining the plate perimeter and contour.
Postconditions	The optical character recognition stage is applied.

4.1.2.6 Perform Optical Character Recognition

Use Case Name	Perform Optical Character Recognition
Actor	Licence Plate Recognition System
Description	1. Plate texts are obtained from the picture with character segmentation.
Trigger	Completion of character segmentation.
Preconditions	Obtaining the characters on the plate separately as a picture.
Postconditions	Determination of vehicle type and features and recognition of license plate.

4.1.2.7 Give Vehicle Information

Use Case Name	Give Vehicle Information
Actor	Licence Plate Recognition System
Description	1. Providing vehicle type and features by using plates.
Trigger	End of Optical Character Recogniton.
Preconditions	Completion of license plate recognition processes.
Postconditions	Proceeding to the display stage.

4.1.2.8 Display Result

Use Case Name	Display Result
Actor	Licence Plate Recognition System
Description	1. After the license plate recognition process is completed, the plate is printed in text format.
Trigger	End of Optical Character Recognition processes.
Preconditions	Vehicle information is defined.
Postconditions	Printing the License Plate Recognition System.

4.1.2.9 Provide Support

Use Case Name	Provide Support
Actor	Support System Manager, Licence Plate Recognition System
Description	1. System problems are addressed and necessary solutions are realized.
Trigger	Error message.
Preconditions	Error occurred in the system.
Postconditions	Support system manager solves the problem.

5. References

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