

Vehicle access control using machine learning

Control de acceso vehicular mediante machine learning

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Abstract: Being able to apply machine learning techniques involves using technology that aims at innovation and that provides companies with certain strategic advantages over the competition they face. The purpose of this research is to develop a pattern recognition system to identify vehicle license plates that uses machine learning techniques to control the entry of vehicles into University facilities. The methodology used is Scrum, allowing cyclical incremental work "sprints", in which there were short times where a number of tasks were carried out, achieving planning and control of the development of the project, fulfilling scheduled tasks, intervening three roles the scrum master, the product owner and the team. The solution is built by a set of small services, to guarantee reusability, scalability, flexibility and all the advantages that a microservices architecture offers us. The results of the technological development in the research made it possible to demonstrate that it is possible to identify and recognize license plates accurately and quickly using machine learning models and algorithms, managing to overcome difficulties that include various image conditions, accurate detection and segmentation of license plates, as well as the system adaptability to various fonts, sizes and styles of license plates.

Keywords: Artificial Intelligence, Machine Learning, Scrum, Segmentation.

Resumen: El lograr aplicar técnicas de machine learning implica usar tecnología que apunte a la innovación y que brinden a las empresas ciertas ventajas estratégicas frente a la competencia que enfrentan. El propósito de esta investigación es desarrollar un sistema de reconocimiento de patrones para identificar placas vehiculares que utilice técnicas de aprendizaje automático para controlar el ingreso de vehículos a las instalaciones de la Universidad. La metodología utilizada es Scrum, permitiendo un trabajo cíclico incremental "sprints", en la que se contó con tiempos cortos en donde se realizó un número de tareas, logrando una planificación y control del desarrollo del proyecto, cumpliendo con tareas programadas, interviniendo tres roles el scrum master, el producto owner y el team. La solución está construida por un conjunto de pequeños servicios, para garantizar la reusabilidad, escalabilidad, flexibilidad y todas las ventajas que nos brinda una arquitectura por microservicios. Los resultados del desarrollo tecnológico en la investigación

permitieron demostrar que es posible identificar y reconocer las placas con precisión y rapidez utilizando modelos y algoritmos de aprendizaje automático, logrando superar dificultades que incluyen diversas condiciones de imagen, detección y segmentación precisas de matrículas, así como la adaptabilidad del sistema a diversas fuentes, tamaños y estilos de matrículas.

Palabras clave: Inteligencia Artificial, Machine Learning, Scrum, Segmentación.

1. INTRODUCTION

Worldwide, in 2020 more than 248,976 stolen vehicles were registered, where this causes and brings serious problems, where the organized theft of vehicles, apart from giving owners a concern, also brings with it financial implications for the companies that insure said vehicles. [1] In this way, [2] they express that the use of information technologies has supported this practice in which the resale of parts of stolen vehicles is reflected, becoming a cause for great concern.

On the other hand, the increase in vehicle theft in Colombia has become a great difficulty since it has been increasing, as stated in Valora Analitik, which carries out an investigation that results in vehicle theft only in the period between January and June, vehicle theft increased by 12% over the same period in 2020, which went from 4,318 stolen vehicles to 4,836 stolen vehicles among the same periods. [3]

Due to the existing insecurity in the city of Aguachica, vehicle theft is a highly trained crime that presents opportunities due to the profitability it offers in the auto parts trade at increasingly lower prices and informally, it is not the same as what Criminals gain more than what is used in practices related to technology for the care, search, and whereabouts of vehicles. [4] Currently, the procedure to enter the university is unsafe since entry is done manually and the only rule to allow or not allow entry to vehicles is through the university credential, which does not It has an authentication module to verify its legitimacy.

Likewise, Rincón et al. [5] explain that controlling access to a large number of users is a tiring, complex and cumbersome task, however, there are other systems designed for this purpose, they do not meet the necessary requirements to give users adequate attention and that access a specific location and verify if they access a certain location.

From this point of view, using the license plate recognition system to verify and identify vehicles that enter and leave represents significant support

for the Universidad Popular del Cesar, however there is a great diversity of software options in commerce, the price of This is very high, which is a great impediment to achieving it and establishing it in the institution, this is one of the reasons why there was an urgent need to develop a prototype to recognize patterns on vehicle license plates and whose use of licenses does not exceed research development costs.

The development of vehicle license plate recognition systems in the city of Aguachica is practically non-existent despite the needs to increase security, adding to this the high costs of the equipment and software that exist on the market. For this reason, Trejo explains that there are several reasons why vehicles are identified by license plates “Traffic control, search for stolen and/or suspicious vehicles, statistical registration of vehicle behavior, among others” [6, p. 14]. Given that the number of vehicles entering the Popular University of Cesar is increasing, as it has a student population of around 2,768 active students, 168 teachers and administrators, without counting the personnel who enter, whether third parties or graduates of the institution.

On the other hand, [7] explains that other advantages offered by these technologies are the low prices of various devices for wired and wireless cameras, which have significant savings in infrastructure and technology. Similarly, [8] express that taking full advantage of different open source and publicly licensed software alternatives, such as libraries, database managers, MySQL, etc., that are freely accessible are crucial for software development.

Having a system that recognizes patterns on vehicle license plates helps companies and organizations to command, protect, capture and identify vehicles, or as a tool for vehicles to automatically enter the company. [9] On the other hand, Zambrana states that “artificial vision and image processing have become very useful tools for the examination and study of objects or movements based on knowledge-based systems, involving different methods of image processing”. [10, p. 2]

Currently, technological advances have been increasing at a dizzying rate, increasing the quality of technological competence and the quality of protection within the university facilities. This proposal is proposed with the aim of offering better security and greater flow. vehicle of the academic and administrative society upon entering the institution. The development of this proposed vehicle license plate recognition system contributes to the improvement of quality in the provision of services provided by the university to the entire academic group, both technologically and at the protection level, since it contributes to recording the flow of vehicles that enter the institution, preventing the entry of third parties or ill-intentioned people.

2. METHODOLOGY

In order to describe the type and design of research and also the description of the methodology for the development of the system in which the research is focused from a qualitative paradigm with a descriptive approach due to what was stated by, Mousalli-Kayat, points out that this “procedure is responsible for achieving a better result, verifying the methods to formulate and verify assumptions based on verification, which forms the hypothetical-deductive representation, that is, based on data collection” [11 , p. 8]

Likewise, the research adopted a documentary approach, since it has a descriptive domain scope and is based on the information collected through the bibliographic review to propose the best solution for the research, Hernández et al. [12]

The investigation is carried out on absolute endings or on how an individual, group or thing currently behaves or works. As a method for carrying out the project we rely on direct observation, it is a method that only measures the characteristics of the element to be studied. The researcher observes the subject from a distance and the type observed is natural and positive considering that he is in a satisfactory environment, Guevara et al. [13, p. 5].

Regarding the descriptive level, the approach made by Rojas will be considered, being: “Observational, exploratory approach, in which knowledge of reality is exhibited as it is presented in a given space and time situation, which is observes and registers, or asks and registers” [14, p. 8]. On the other hand, Mousalli-Kayat explains that descriptive studies serve to: “Specify the skills, abilities and compliance of each professional, person or any

other person interested in undergoing an exam, aiming exclusively at evaluating or accumulating results of an investigation” [11, p. 14]

3. RESULTS

Taking into account that different phases intervene in the software product development process where steps are required to provide solutions to the client's requirements, so it is necessary to opt for a software development methodology, since it is necessary to have a framework of work to follow up to achieve compliance with the initial requirements.

The methodology used is “agile/scrum”, since this is a methodology oriented towards incremental cyclical work called sprints, in which there are short times in which a number of tasks are carried out, in this way achieves planning and control of the development of a software project, fulfilling scheduled tasks. Within this methodology, the agents involved work under a focus on improvements or changes to the project requirements, being self-organized and focused on the final product and the client. According to the criteria of [15] it is very important to define the roles that intervene in the iterations, so in the development of this project we will talk about three:

- Scrum master: Responsible for guiding in compliance with the methodology processes.
- Product owner: Responsible for representing the client and their responsibility to ensure that a quality product is delivered and that it meets the client's requirements.
- Team: they are the group of professionals in charge of developing the product, being self-organized to achieve a final product that meets the client's requirements.

Capítulo	Fase	Procesos fundamentales de Scrum
8	Inicio	1. Crear la visión del proyecto 2. Identificar al Scrum Master y Stakeholder(s) 3. Formar Equipos Scrum 4. Desarrollar épica(s) 5. Crear el Backlog Priorizado del Producto 6. Realizar la planificación de lanzamiento
9	Planificación y estimación	7. Crear historias de usuario 8. Estimar historias de usuario 9. Comprometer historias de usuario 10. Identificar tareas 11. Estimar tareas 12. Crear el Sprint Backlog
10	Implementación	13. Crear entregables 14. Realizar Daily Standup 15. Refinar el Backlog Priorizado del Producto
11	Revisión y retrospectiva	16. Demostrar y validar el sprint 17. Retrospectiva del sprint
12	Lanzamiento	18. Enviar entregables 19. Retrospectiva del proyecto

Fig. 1. Conceptual Model Design – System

This concept diagram allows you to have a clearer vision of the system to be developed, the important entities to take into account, the relationships they have and the attributes that in one way or another are essential to meet the main objectives of any application or software. Caballero et al. [16] talk about the importance of using machine learning to recognize patterns on vehicle license plates, where the design of a logical model is crucial, since these systems are based on algorithms and models that have been taught to detect and recognize patterns. individuals in images of vehicle license plates. The effectiveness, accuracy and reliability of the system are ensured by a well-designed logic model as shown in Figure 2.

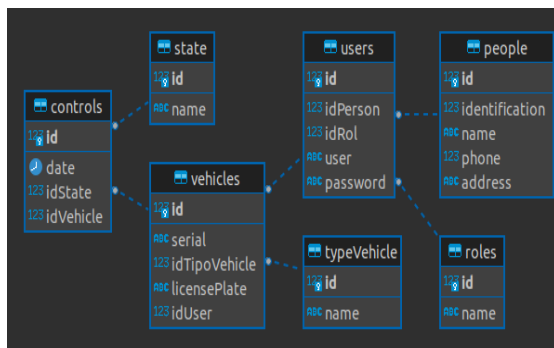


Fig. 2. Logical model design

Processing a large number of images in real time and recognizing vehicle license plates can be resource-intensive tasks. [17] explains that a carefully considered logic design allows optimization of the model architecture and algorithms to ensure efficient and scalable performance, while avoiding unnecessary delays or performance issues that could jeopardize the system's operability.

```

# Import modules and libraries
import cv2 # OpenCV v2
import pytesseract
import modules.draw as draw # module to draw
import modules.processFindContours as processFindContours # module to find contours
import modules.filterContours as filterContours # module to filter contours

# ----- global variables -----
camera_device = 0 # default
window_name = 'Camera Preview'
# aspecto de tablas de la placa 235 mm. de largo, por 105 mm. de ancho: 235/105 = 2.238095238
placa_ratio = 2.238095238
placa_width_max = 640
placa_width_min = 40
placa_height_max = 285
placa_height_min = 11
placa_text = ''
    
```

Fig. 3. Import Modules and libraries

Each of these libraries and modules plays an important role in the image recognition process, OpenCV is used for image manipulation and analysis and Tesseract is used to extract text from the whiteboard. With the above, [18] talk about taking into account custom modules that perform special functions, such as drawing bounding boxes or searching for contours to define the plates, is a task that minimizes execution times in image

capture. [19] maintains that all these tools can automate license plate recognition based on image capture, which can be useful in applications such as security systems, vehicle tracking or parking management.

```

alphanumeric = "ABCDEFGHJKLMNPQRSTUVWXYZ0123456789"
options = "-c tesseract_char_whitelist={}".format(alphanumeric)
options += " --psm {}".format(7)

# ----- video capture -----

source = cv2.VideoCapture(camera_device) # open a capture device
if not source.isOpened():
    print("Cannot open camera")
    exit()

# allows you to resize the window
cv2.namedWindow(window_name, cv2.WINDOW_NORMAL)

# ----- start the program -----
    
```

Fig. 4. Video capture image

[18] explains that license plate recognition involves training a machine learning model to detect and read license plates in images. For this reason, as shown in Figure 4, by capturing images of individual license plates, you can create custom data sets that reflect the types of license plates and the conditions in your environment. According to [19], establishing a model is essential to be effective in real situations.

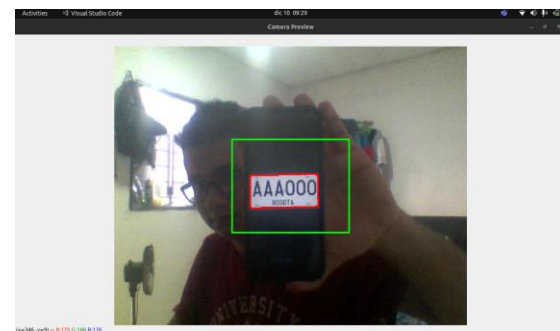


Fig. 5. Vehicle license plate recognition

In this stage as shown in Figure 5, the characters are extracted from the plate and saved in a vector for analysis. [21] maintains that in the verification stage, it is necessary to apply a mask through the use of regular expressions, because the algorithm can give us different lines of texts. Likewise, [22] explains that "the results that are obtained in the development and application of autonomous learning algorithms show that they depend directly on the quality of the image", (p. 43)

4. RECOGNITION

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has talented experts in the field of intelligence. . Artificial.

5. CONCLUSIONS

Recent developments have shown that it is possible to identify and recognize license plates accurately and quickly using machine learning models and algorithms. In addition to improving traffic management and facilitating law enforcement, however, to address the major problems, a rigorous research approach is necessary. These difficulties include various image conditions, accurate license plate detection and segmentation, as well as the adaptability of the system to various fonts, sizes and styles of license plates, in addition, privacy and data protection are important factors to consider to ensure that they are met. privacy standards and that the user's confidential information is protected.

It is crucial to consider the ethical and social implications of these systems as research develops, it is important to address concerns about algorithmic bias, fairness in license plate identification and recognition, and openness in selection criteria. To ensure responsible system development and implementation, maximize benefits and minimize potential risks, it is also essential to promote collaboration between researchers, government organizations and industry.

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