IoT in Services for Communities in the Recognition of Plates with OpenCV-Python

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Abstract: The evolution of the technology day by day advances looking for greater comfort for the users, facilitating the daily living, allowing to reduce times, costs and resources, the advance of the technology allows greater learning. The application was designed with the objective of controlling vehicular access to the UTPL by recognizing the plaque, only the teachers and staff that have access can enter, in this way it will prevent people outside the university from entering. Periodic control of all income was taken to the university and that way a statistic can be drawn from the people who really belong to the university.

1 INTRODUCTION

The field of image processing is continuously evolving. During recent years there has been a significant increase in interest in fields such as image morphology, artificial neural networks, color and / or grayscale image processing, image data compression, image recognition and analysis systems. knowledge-based images. Recognition is a basic attribute of the human being, as well as of other living organisms. This recognition is usually generated by means of patterns (Peralta, 2009). With the advancement of artificial vision we could acquire, process, analyze and understand the images of the real world in order to produce numerical or symbolic information to be treated by the computer, just as humans do in order to understand the world we live in surrounds. We will describe the process of extraction of characteristic patterns of images, through the help of Artificial Neural Networks, for the treatment of the images libraries will be used OpenCV (P. García., 2013).

Computer systems that use computer vision make use of digital image processing techniques in order to emulate the vision system and algorithm (Enciso-Quispe et al., 2018). The research work developed has its origin in the need to develop a system that is capable of identifying images quickly and without excessive consumption of resources. Of all this the giants of the computer science (I. Ortiz, 2016) have realized and they have launched applications of recognition of images for mobile devices developing algorithms based on the content of the images recognizing forms and analyzing their resemblance. The idea of this project is born from the need to see an object that we do not recognize and we have not been able to look for it because we do not know under what name to look for it, or we have gone down the street and we have seen a monument and we did not know what it was, or we have been in a museum and we would have liked to have more information instantly about the work we contemplate.

2 RELATED WORKS

Computer vision aims to solve several of the problems that arise in the daily life of human beings. Everything that humans observe is through our vision, that is why we have investigated several projects to capture ideas of how computer vision works.

The recognition of images (P. García., 2013) using artificial neural networks describes the process of extracting characteristic patterns of images, with the help of Artificial Neural Networks. The information of the Neural Network together with additional data of the images, will be stored in a database and consumed by a web service. A mobile phone with an Android operating system will consume the informa-

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tion stored in the web service. After making an image capture with the phone camera, it processes the image and together with the data consumed by the web service will be able to identify which image it is. For the treatment of the images, OpenCV libraries will be used, both on the server and on the mobile phone.

The recognition of objects immersed in static images using the algorithm HOG and RNA-MLP is a research project approved by the Technological University of the Mixteca. It is based on presenting an object recognition system that it uses in the process of extracting characteristics from the HOG algorithm and an MLP type RNA in the classification process (García., 2015).
The practical application of artificial vision for the recognition of faces in an image, using neural networks and object recognition algorithms of the Opencv library is a project that focuses on studying the different methods and algorithms that allow detecting a face in an image , and develop an application that can be trained to perform the recognition of a specific person within the image (E. Caballero., 2017).

The application of neural networks (Lanzarini and Giusti., 2014) to the recognition of patterns in medical images is a project that presents the research in image analysis and recognition of patterns as a help to medical diagnosis is widely recognized for its complexity and importance, in this sense the neural networks result from It is extremely useful, since not only are they capable of learning with the help of the expert but they can themselves generalize the information contained in the input data, showing relationships that are a priori complex.

The development (Paucar and Tasiguano, 2016) of the algorithm for the recognition of vehicle license plates consists of a digital image algorithm. For this, a vehicle license plate recognition system has been developed using the LabView program and its artificial vision toolkit and a high resolution IP camera. The designed software locates the vehicle plate inside the captured image of the vehicle and recognizes the characters and numbers that are inside it. The location of the vehicle plate in the image is made by looking for patterns. For the recognition of the characters and numbers contained in the plate, optical character recognition, OCR is used. Once the text on the plate has been read, the characters and numbers are collated with thoseof a database that contains all the license plates of the vehicles that are authorized to enter the parking lot.

Plaque Recognition through OpenCv - Python: In our project we describe the development of a software system oriented to the Recognition of Vehicle Plates using both hardware and software tools. The system will locate the vehicle plate inside the image of the vehicle and will recognize the characters and numbers that are inside it and will be compared with those of the database that contain all the license plates of the vehicles that are authorized to access the vehicle. the University on Paris Street, seeking to optimize the access time.

3 TEORETHICAL FRAMEWORK

Computer vision aims to solve several of the problems that arise in the daily life of human beings. Everything that humans observe is through our vision, that is why we have investigated several projects to capture ideas of how computer vision works.

3.1 Arduino UNO

It is an electronic board based on the ATmega328P (technical sheet). It has 14 digital input pins, 6 analog inputs, a 16MHz quartz crystal, a USB connection, a power connector, an ICSP header and a reset button. The model of the Arduino with its different ports, circuits and components, can be programmed with the Arduino software (IDE). But this module is already pre-programmed with a boot loader that allows you to load a new code into the system without the use of an external hardware programmer (Badamasi, 2014),(Enciso-Quispe et al., 2017a).

Figure 1: Arduino UNO.

3.2 Artificial Vision

Artificial computer vision is the ability of the machine to see the world around it, more precisely to deduce the structure and properties of the three- dimensional world from one or more two- dimensional images

(Pajares and de la Cruz, 2008). It is defined as a field of "Artificial Intelligence", allows the use of appropriate techniques, allow the collection and analysis of any spatial information obtained through digital images. It is composed of a set of processes designed to perform image analysis. These processes are: capturing images, memorizing information, processing and interpreting results. With artificial vision you can:

- Automate repetitive inspection tasks performed by operators.
- Conduct quality control of products that could not be verified by traditional methods.
- Perform inspections of objects without physical contact.
- Reduce cycle time in automated processes.

3.3 Artificial Intelligence

Artificial intelligence (AI) or also known as computational intelligence is the intelligence shown by machines, in a broad and somewhat circular definition, aims at the study of intelligent behavior in machines. In turn, intelligent behavior involves perceiving, reasoning, learning, communicating and acting in complex environments(Nilsson, 2001).
The machine has to be able to recognize the natural language in which humans speak. Speech is associated with a superior intelligence, and for a machine to be able to recognize it and also to build sentences it must be able to perform complex morphological analyzes , syntactic, semantic and contextual of the information it receives and the phrases it generates. In order for an artificial entity to be considered intelligent, the following is considered (Serrano, 2013):

- Natural Language Processing or NLP.
- Automatic reasoning and Machine learning.

3.4 Neuronal Networks

Neural networks are schemes that aim to mimic the architecture of the brain. It serves to effectively represent any function that is very complex in algebraic terms, as well as pattern classification tasks (C. Sanchez, V. Sandonis., 2017). Artificial neural networks (ANNs) arelearning systems inspired by the functioning of the human brain. They are mathematical models constructed based on the functioning of biological neural networks (H. Vega, A. Cortez, A. M. Huayna, L. Alarcón, P. Romero., 2017).

3.5 Detection of Vehicle Plates

The techniques must be chosen according to the needs of the particular environment in which the system will operate, so that the methods with the highest performance in general will be exposed. In the same way factors such as performance, execution time and platform should be taken into account, since they will directly affect the performance of the system.

3.5.1 Processing of Binary Images

This technique is based on combinations of statistical methods of analysis and mathematical morphology. (Used to extract useful components of images, for the representation and description of the shape of regions)(R.Radha, 2012). The method, is based on the principle that the change of brightness in the region of the plate, is more remarkable and stronger than in any other place of the image.

3.5.2 Grays Level Processing

1. Global Image Processing. For the location of the plate, several systems use an approach as presented in (Draghici, 1997), which consists of scanning the image horizontally, looking for repeated changes of contrast on a scale of 15 pixels or more. The assumptions that the contrast between the characters the bottom of the plate is su ciently good and that there are at least three to four characters in a plate whose minimum vertical size is 15 pixels(Draghici, 1997).

2. Partial Analysis of the Image. This method scans the image of the vehicle partially, making several repetitions of the analysis in different sections of the image taking into account some distance N- the. as a limit of the section, to then count the existing borders in said section. If the number of edges is greater than an average, it can be assumed that the plate was located in that area. The execution time of this method is very fast since it only scans certain images of the image (J. Cano, 2003).

3.6 Python

Python is a programming language whose philosophy emphasizes a syntax that favors a readable code, it is a programming language multiparadigma, since it supports object orientation, imperative programming and, to a lesser extent, functional programming. It has an interpreter by command line in which you can enter sentences. Each sentence is executed and produces a visible result, which can help us understand

Figure 2: Successfull detection of the vehicle plate.

better the language and test the results of the execution of code proportions quickly (Python Software Foundation, 2017).

3.7 OpenCV

OpenCV (Open Source Computer Vision Library) is released under BSD license and, therefore, is free for both academic and commercial use. It has C ++, C, Python and Java interfaces and is compatible with Windows, Linux, Mac OS, iOS and Android. OpenCV was designed for computational efficiency and with a Strong focus on real-time applications. Written in optimized C / C ++, the library can take advantage of the processing of multiple cores. Enabled with OpenCL, you can take advantage of the hardware acceleration of the underlying heterogeneous information platform (OpenCv Team, 2017), (Enciso-Quispe et al., 2017b).

4 METHODOLOGY

4.1 Analysis

Currently there are different types of problems with respect to control vehicular in parking areas or areas of restricted access, added to these problems does not take a statistical control of the different parameters that are generated when entering or leaving a vehicle from the parking lot, that is, vehicles entered, parking availability, parking demands over time, or for prevention of future problems. This project focuses on the development of a detection system and extraction of vehicle plates in the area of access to a parking lot based on artificial vision. The system will allow access to be automated, if the vehicle is in the database and if it is verified that the vehicle belongs to someone belonging to the university, it will be given access, otherwise it will be denied.

4.2 Diagram of the Application

In the Figure 1 and 2, details all the components involved in the use of the application, it shows that the user approaches the control and is when the IP camera communicates through the WI-FI with the router the LPR System complements the next:

- Identification of a user using his vehicle license plate.
- Presentation of information related to a plate.
- User administration that will be identified later through vehicular plate.
- Guarantee access to the parking lot.
- It will control a prototype of a front entrance to a parking lot.

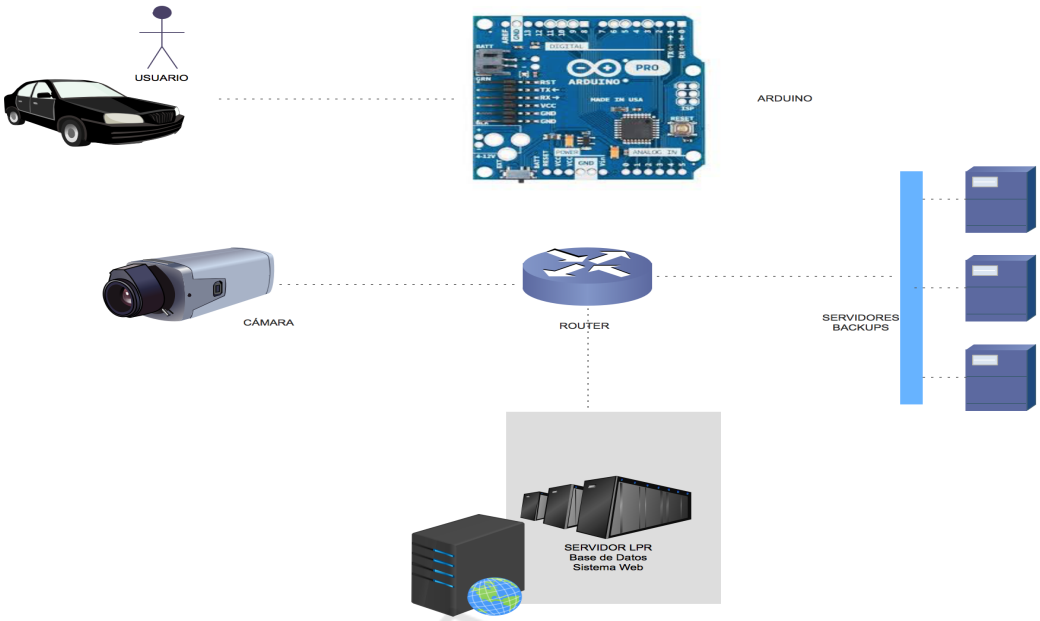

Figure 3: Diagram of the application.

```
OFSET_MIN_AREA = 2.1    # %
OFSET_MAX_AREA = 5.9    # %
OFSET_MIN_WIDTH = 12.0  # %
OFSET_MAX_WIDTH = 14.0  # %
OFSET_MIN_HEIGHT = 60   # %
OFSET_MAX_HEIGHT = 55   # %
OFSET_MIN_Y0 = 20.5

OFSET_X0_WORD_1 = 81.7  # %
OFSET_X0_WORD_2 = 67.7  # %
OFSET_X0_WORD_3 = 53.4  # %
OFSET_X0_NUM_1 = 33.5   # %
OFSET_X0_NUM_2 = 19.5   # %
OFSET_X0_NUM_3 = 5  # %

OFSET_X0 = [OFSET_X0_WORD_1, OFSET_X0_WORD_2, OFSET_X0_WORD_3, OFSET_X0_NUM_1, OFSET_X0_NUM_2,
```

Figure 4: Values of the positioning of the letters in the image.

4.3 Software Development

For the development of the system it was decided to use the good practice SCRUM for this the following roles are defined:

- Scrum master: person who leads the team to comply with the rules and processes of the selected methodology.
- The representative of the client who will use the software. It focuses on the business side. Transfers the vision of the project to the team, formalizes the benefits in stories to be incorporated in the Product Backlog and reprioritizes them on a regular basis.
- Team: consisting of two people with the necessary technical knowledge and who developed the system along with the stories of each sprint.

```
def detect(c):
    ar = 0.0
    shape = "unidentified";
    perim = cv2.arcLength(c, True)
    approx = cv2.approxPolyDP(c, 0.04 * perim, True)

    if len(approx) == 4:
        (x,y,w,h)=cv2.boundingRect(approx)
        ar = float(w)/float(h)

    shape = "square" if ar >= 0.95 and ar <= 1 else "rectangle"
    return shape
```

Figure 5: Detect Function.

```
def retornaplaca(img_bin, img_resized, contours):
    mayor = 0;
    #se recorren los contornos para encotrar la de mayor area
    for h,cnt in enumerate(contours):
        mask = np.zeros(img_bin.shape,np.uint8)#mascara de negros
        cv2.drawContours(mask,[cnt],0,255,-1)
        area = cv2.contourArea(cnt)
        if area>mayor:
            mayor=area
    #recorren de nuevo todos los contornos entontrados en cada imagen
    #buscando la de mayor area,  y que cumpla proporcion geometrica de los rectangulos
    for h,cnt in enumerate(contours):
        mask = np.zeros(img_bin.shape,np.uint8)#mascara de negros
        cv2.drawContours(mask,[cnt],0,255,-1)
        area = cv2.contourArea(cnt)
        # print area;
        #si limita el area a unos pixeles especificos
        #de los cuales se sabe puede ser el area de una placa
        #luego se compara si es el area mayor y ademas tiene forma rectangular
        if area > 7000 :
            if area < 150000:
                form = detect(cnt)
                if area == mayor and form == 'rectangle':
                    x,y,w,h = cv2.boundingRect(cnt)
                    box = img_resized[y:y+h,x:x+w]
                    return box
#se recorren todas las imagenes en la carpeta
```

Figure 6: Return the outline of the plate.

4.4 Criteria of Acceptance

The acceptance criteria are the basis for the application which will analyze the requirements, types of tools that will be used and how they will be developed, facilitating the functionality of the application, among them we have:

- Independence of the platform.
- Attractive and functional interface.
- Updated information.

```
file in files:
img = cv2.imread(folder+"\\"+file)
img_resized = img[800:2050, 1100:2200]
img_lab = cv2.cvtColor(img_resized, cv2.COLOR_BGR2LAB)
img_red = img_lab[:, :, 2]
_,img_bin = cv2.threshold(img_red.copy(),140,255,cv2.THRESH_BINARY)

S,contours, hierarchy = cv2.findContours(img_bin,cv2.RETR_TREE,cv2.CHAIN_APPROX_SIMPLE)

box = retornaplaca(img_bin, img_resized, contours)

img = box
```

Figure 7: Go through the images on the plates.

5 RESULTS

The system:

- Allows us to capture the plate through the camera and send it to the system.
- Performs the segmentation of characters by means of the algorithm.
- Recognizes the characters and very that the displayed plate has access.
- Can store the license plate of all the vehicles that have entered.
- Can store people who have tried to enter without being part of the university.

6 CONCLUSIONS

- It seeks to automate the access of the staff of the institution for control of Paris street without problems and in a faster way minimizing effort and maximizing its performance.
- Avoid entry to people who are not in the database of the University.
- Achieve a record of the people who are authorized to enter the university on Paris Street.

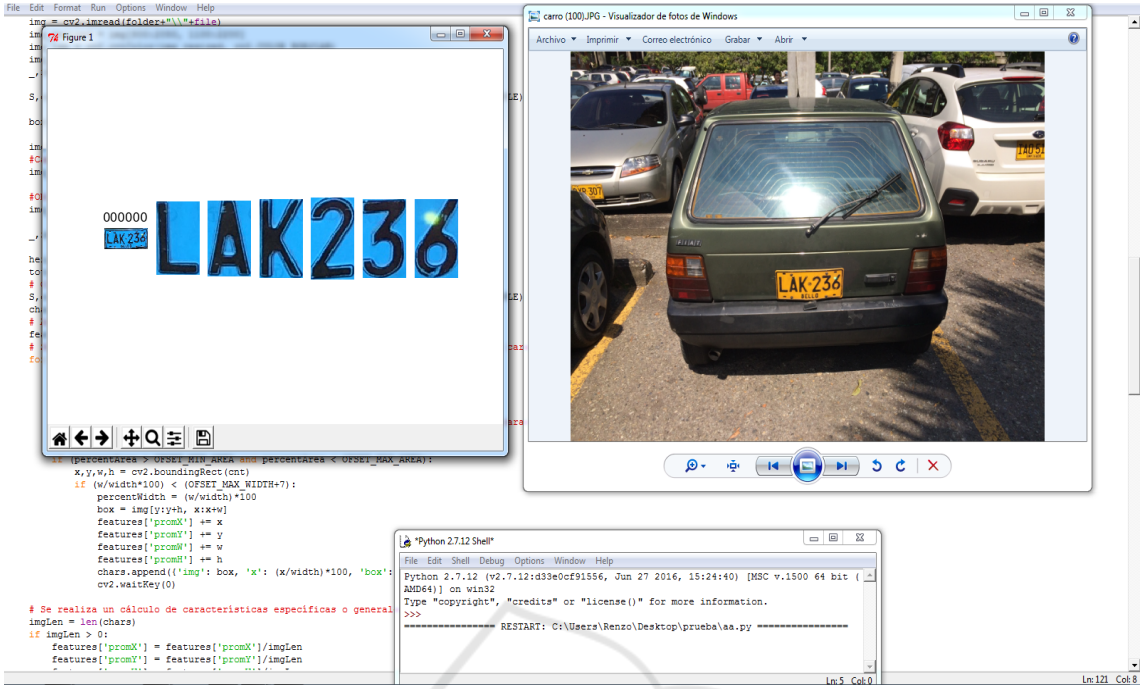

Figure 8: Extraction of the number the plate.

REFERENCES

Python Software Foundation (2017). Python. url:https://www.python.org/.

Badamasi, Y. A. (2014). The working principle of an arduino. In *2014 11th International Conference on Electronics, Computer and Computation (ICECCO)*, pages 1–4.

C. Sanchez, V. Sandonis. (2017). Reconocimiento Óptico de Caracteres . url:http://www.it.uc3m.es/jvillena/irc/practicas/08-09/09.pdf.

Draghici, S. (1997). A neural network based artificial vision system for licence plate recognition. *Signal & Image Processing*, 8(1):113–126.

E. Caballero. (2017). *Aplicacion Practica De La Vision Artificial Para El Reconocimiento De Rostros En Una Imagen, Utilizando Redes Neuronales Y Algoritmos De Reconocimiento De Objetos De La Biblioteca OpenCv.*

Enciso-Quispe, L., Barba-Guaman, L., Sanchez, J., and Quezada-Sarmiento, P. A. (2018). Simulation of people counter for public service buses of loja with iot concept applying the viola-jones algorithm. In *2018 13th Iberian Conference on Information Systems and Technologies (CISTI)*, pages 1–6.

Enciso-Quispe, L., Delgado, J., Vivanco, H., Zelaya-Policarpo, E., and Quezada-Sarmiento, P. A. (2017a). Internet of things based on android technology for people with disabilities. In *2017 12th Iberian Conference on Information Systems and Technologies (CISTI)*, pages 1–6.

Enciso-Quispe, L., Quichimbo, J., Luzón, F., Zelaya-Policarpo, E., and Quezada-Sarmiento, P. A. (2017b). Rest architecture in the implementation of a web and mobile application for vehicular tariff rotating parking. In *2017 12th Iberian Conference on Information Systems and Technologies (CISTI)*, pages 1–6.

García., A. (2015). *Reconocimiento De Objetos Inmersos En Imágenes Estáticas Mediante El Algoritmo Hog Y Rna-Mlp.* Universidad Tecnológica de la Mixteca, México (2015).

H. Vega, A. Cortez, A. M. Huayna, L. Alarcón, P. Romero. (2017). Reconocimiento de patrones mediante redes neuronales artificiales . url:http://sisbib.unmsm.edu.pe/BibVirtual/Publicaciones/risi/2009_n2/v6n2/a03v6n2.pdf.

I. Ortiz (2016). Google Visión Api. url:https://elandroidelibre.elespanol.com/2016/02/google-vision-api-reconocimiento-de-fotos.html.

J. Cano, J. C. P. C. (2003). Vehicle license plate segmentation in natural images. *Pattern recognition and image analysis*, pages 142–149.

Lanzarini, L. and Giusti., A. D. (2014). *Aplicacion De Redes Neuronales Al Reconocimiento De Patrones En Imagenes Medicas.* Universidad Nacional de la Plata, Argentina (2014).

Nilsson, N. (2001). *Inteligencia Artificial:Una Nueva Síntesis.* Mcgraw-Hill Grupo Editor, España (2001).

OpenCv Team (2017). OpenCv . url:https://opencv.org/.

P. García. (2013). *Reconocimiento De Imágenes Utilizando Redes Neuronales Artificiales.* .

Pajares, G. and de la Cruz, J. (2008). *Visión Por Computa-*

dor: Imágenes Digitales Y Aplicaciones. Alfaomega Grupo Editor, México (2008).

Paucar, L. and Tasiguano, C. (2016). Desarrollo de algoritmos para el reconocimiento de placas de vehículos.

Peralta, A. (2009). Reconocimiento de imagenes a traves de su contenido. *Universidad Pontificia Comillas*, 8(1):202.

R.Radha, C. (2012). A novel approach to extract text from license plate of vehicles. *Signal & Image Processing*, 3(4):181–192.

Serrano, A. G. (2013). *Inteligencia Artificial: Fundamentos, práctica y aplicaciones.* Alfaomega Grupo Editor, México (2013).