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RESEARCH ARTICLE

"SIC" - INTELLIGENT SYSTEM TO CONTROL THE ENTRY AND EXIT OF VEHICLES USING COMPUTER VISION AT FAMETRO UNIVERSITY CENTER

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Abstract

The security of physical and logical information are vital to any institution, which has to ensure availability, confidentiality and integrity of all types of information, be it logical or mainly property. The investments in the physical access control adopted must be directly linked to the importance of the assets to be protected, as in the parking of vehicles. And through the computer vision that covers several areas, specifically character identification, in this project the use of this technology aims to identify vehicle license plates, which can be used to authorize the entrance of vehicles. The main objective of this project is to intelligently automate the control of vehicles and increase the security of the internal environment, both for the patrimony and for the users themselves, making sure that only students and collaborators will use them. The developed system will add to the institution, having control over daily tasks, bringing security and statistical control through complete reports.

Introduction:-

According to Batista (2013, p.20), "in the business world it is remarkable the constant evolution that occurs from the small to the large company, and both need a good management for their expansion, so that this management can be done in a more efficient way if it is necessary to adapt to new realities and needs. And technology has a lot to add in supplying such needs."

In an institution, be it private or public, small or large, are composed of the activities-mean, such as security, maintenance, logistics and assets, are essential activities to maintain the quality of services. It will rarely be able to maintain its objective and level of quality without giving the necessary attention to all the points mentioned above. The idea of parking management came from the need to offer personalized, quality service to employees, collaborators, and customers using automation and the university's modernization process in parking.

Information security goes far beyond the computational factor and, therefore, logical controls, when used alone, become useless. True protection depends on a balance between logical access control and physical access control. The implementation of physical and environmental security measures are aimed at the physical protection of equipment, the facility, areas, equipment, and sensitive information assets(Marcondes, 2017).

Aiming mainly at the security of Fametro's parking lots, we analyzed how the control and monitoring of the entry and exit of vehicles is done, we found that it is possible to develop a prototype to allow only authorized vehicles to

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enjoy such benefit until then free of charge, speeding up and facilitating the flow of vehicles, regardless of the hours of operation.

We then decided to implement a prototype to manage the parking lot, where the characteristics of the "SIC" (In Portuguese "Sistema Inteligente de Controle") will be presented, gathering the necessary information to understand the business and the functionalities of the system.

When delving into the problem, we saw that in parking lots the biggest difficulty is the ability to know the number of available spaces, which could help in management, logistics and time, this usually occurs when the arrival of vehicles is massive causing delays in the entrance. Furthermore, if the number of vehicles leaving the institution is less than the number of vehicles arriving, it will cause a long queue causing the drivers to wait for the next parking space, which is exactly what happens, because the institution makes the space available for parking vehicles without any prior control of consultation and/or verification if the vehicle has a direct or indirect connection with the institution to use the parking space, free of charge until then.

Today there is equipment for automating the entry and exit of vehicles already consolidated in the market, but the cost is a factor to be considered. One of the differentials of this project is the search for simplicity in all areas, including programming, thus reducing the human participation in the control and having a low implementation cost in the vehicle identification.

Our recent research shows that real-time parking information management reduces the search time for parking spaces. We have noticed that when the parking lot is full, drivers waiting in line need to wait for other vehicles to leave, and this is a variable because without "SIC" we cannot know the average time it will take for a space to become available and where it will be.

In this context, we can verify the need for studies aimed at increasing security, control and optimization of vehicle entries in parking lots. Making available an application that, with agility and ease, can provide the employees with a solution that meets their needs and the necessary standards to provide a good experience in the use of the prototype.

Theoretical Framework

The main objective of "SIC" is to optimize the daily demands of vehicles that exist in a parking facility and to assist in administrative management. It can automate many daily processes such as the beginning and ending of a parking space, as well as storing all the data that occurs on a daily basis and using this data to bring you complete reports about the status and condition of the facility. And bringing some of this information about how many spaces are available in a parking lot "A" to the parking lot user via a mobile application.

Intelligent System

The intelligent systems applied to the processes allow their adequacy and updating to the demands in real time and, thus, properly allocate the available resources to ensure efficiency and quality to the processes (BARBOSA, 2016).

Intelligent systems aims the research, development and application of computational systems capable of solving problems that require intelligence. The objective is to apply the concepts, techniques and tools of artificial intelligence to help solve conceptual and practical problems in computing and other areas of knowledge, while researching and developing the latest technologies in artificial intelligence with the goal of practical application in industrial and agro-industrial processes. This line includes systems that evolve and adapt (evolutionary systems), distributed intelligent systems (multi-agent systems), and systems that can learn from experience (machine learning).

Vehicle entry and exit Control

Access control is any system, mechanism or equipment that limits access to an environment or information, ensuring the security of data, goods and people. According to Chiavenato (2014), a system is a set of interdependent elements, whose result is greater than the sum of the results that these elements would have if they operated in isolation.

First you automate, then you optimize, this is a premise used in the area of industrial automation, since the initial investment is for the implementation of the operational control platform, aiming at the planned production (VENTURELLI, 2014). Prevent unauthorized access to environments, as they are considered the main asset of

organizations, information has a major challenge, to make the human sector aware of its importance (FERREIRA and ARAUJO, 2014).

In the development of this prototype we seek to control the entry and exit of vehicles through registrations made both online and in person so we will have the control of vehicles that enter the Fametro university.

Computer Vision
Computer vision is a set of mixed systems of cameras, computers and artificial intelligence, where the images captured by cameras are interpreted in a way that allows the extraction, analysis and interpretation of relevant information from images and videos so that decisions can be taken, being used in several areas such as public and private security in the identification of people and objects.

For Dawson (2014), the term computer vision is attributed to the ability of computers to automatically analyze images and videos, with the focus on obtaining information. Computer vision consists of extracting information from operations or transformations done on data, such as digital images, videos or any multidimensional data structure from the real world (GARCÍA et al, 2015).

In this context, this project will present the development of a prototype, which identifies the letters and numbers of license plates through recognition of geometric shapes in real time runtime of the camera and show this information and make the business rule of the system. Making it possible to identify the car and the user in which the car is registered.

Image Capture
According to the CameraNeon blog (2014). "Image can be defined as a visual representation of something, whether real or not, such as a painting, a drawing, a sketch. Some artists create paintings of fantastic landscapes, non-existent places, while others faithfully depict a person's face. Whether scenes or objects are real or unreal, they can all be called images."

With the application of the OpenCv library, capturing images becomes a very simple task. We understand that a video is a succession of images that give us the impression of motion. To each image we give the name frames. With this we use the function VideoCapture which is called to save frames from a video. In this case the reading of the environment in real time.

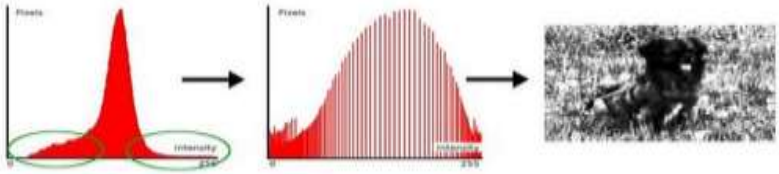
Digital Image Processing
These are techniques for manipulating an image, where it can be defined as a function (x,y), where “x” and “y” are coordinates of a plane. In this way, a digital image can be described as a matrix with rows and columns.

From this concept, we can say that image preprocessing consists of correcting and improving the quality of the digital image by reducing filters and noise, changing the contrast and brightness levels.

Histogram Equalization
It is a method that unifies and improves the contrast or gray level intensity in the processed image, making it possible to improve the contrast of the image. It is done by calculating the distribution of pixels to increase contrast. The objective is to more evenly distribute the pixel intensities over the image.

The picture 1 shows an example of a histogram where it is possible to identify the uniformity of intensity levels by mapping each intensity.

Imagine equalization



Source: OpenCV (2019).

Image Binarization
Binary images are described as binary intensity images that have only 1 bit per pixel and can assume only binary values, i.e., only '0' or '1' and are displayed by only two colors, black or white.

The binarization process is done by an operation that transforms the intensity of a pixel into 1 or white, when it indicates the presence of an element, or, when the intensity of this pixel is greater than a given limit, it is transformed into 0 or black, making it explicit that there is an element in that position. As we can see in picture 2 the example of binarization.

Python

;**Source:** OpenCv (2019).

Plate Segmentation
It consists in locating and isolating the license plate from the entire digital image, performing a series of pre-processing to perform license plate detection. The purpose is to divide the image into parts for analysis, resulting in a binary image in black and white to verify the location of the license plate, since the white pixels represent elements. At this stage regions of interest are delimited, so it is considered the most critical moment, if there are distortions present that were not eliminated the processing result will be unsatisfactory.

Character Segmentation
It is the intermediary step of the process, after the previous step is performed the extraction of the identified element, it is necessary so that each character can be recognized individually, with the extraction of the isolation of the digital image already performed can make the recognition and interpretation of the characters.

Character Reading
Character reading is the classification and contextualization obtained from the previous steps, and is the last series of the identifier system. After the plate has been located and the position of the characters found, separate images of the characters are obtained. Using an alphanumeric classifier.

Security
To have an effective access control system, it is necessary to determine a security strategy in a management, so we will use a monitoring system (SM, in Portuguese “Sistema de Monitoramento), developed to assist in the management and decision making of a system (OLIVEIRA, M, 2017).

In order to be able to apply the monitoring system, it is necessary to choose a technology and this work has the objective of collaborating with the application and implementation of the system, regarding the research of the technologies used in the monitoring of vehicles that enter the Fametro university, making it possible, after the research, to compare them, and finally propose the best technology, for the proposal of monitoring of the parking lot access control.

The security control is a way to identify the authorized people and avoid that there is improper access, thus avoiding robberies, thefts and other situations that can put at risk the security of people. However, we can easily find flaws in the current security controls, causing many of the known systems to lose their credibility.

Tools used
For the software development, the following tools were used:

Bootstrap
Through this framework, the system design was developed with a focus on providing a user-friendly experience. It provides default settings for the pages. One of its goals is that developers who do not have solid knowledge in design techniques or for a short period of time can develop beautiful pages, without difficulty and in a short period of time.

"Bootstrap is a front-end framework that provides CSS structures for creating responsive websites and applications quickly and easily. Moreover, it can handle desktop websites and mobile device pages in the same way." (Alura,2022).

This tool was used with the main goal of making the web system responsive. Providing CSS frameworks for creating applications simply and quickly, and saving lines of code due to its extensive library.

Xampp
Xampp is a server package for storing files and information, where you can run projects locally and test them before putting them on the online hosting server.

"XAMPP is an open source solution that is used as a local server, simulating a real web server on a home machine. It is a widely used solution for students who need to test their code and for development professionals who do not yet have the budget to rent a remote testing environment." (ValueHost, 2022)

It was used for the development of the system, both in the code part, using the Apache server, and in the Database Management System (SGBD, in Portuguese "Sistema Gerenciador de Banco de Dados), using the MySQL server, and for its due tests in the local network.

OpenCv
OpenCv (Open Source Computer Vision) consists of a platform that has a set of code libraries for developing computer vision and machine learning software for real-time applications.

"The OpenCv library has over 2,500 optimized algorithms, which include a comprehensive set of classical and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, object tracking, and in motion." (OpenCv, 2020).

"Scrum" agile development methodology
"Scrum" is an agile method for developing more complex projects and its main goal is to finish project development faster by focusing the team's work on divided parts of the project.

"Scrum is a lightweight, simple, and objective framework that helps people, teams, and organizations complete projects by generating value through flexible and adaptive solutions to complex problems, which you can employ a variety of processes, tools, and techniques." (Marcondes, 2022)

It was used for the entire development of the system because it optimizes the work by dividing the project into parts, that is, in sprint that are delivered in cycles defined for example as weekly, biweekly or monthly. It represents a set of tasks executed and finished in a short period of time.

Programming language
According to Kriger (2022), programming languages play a fundamental role both in the development of websites and software, and in more complex areas such as data science, artificial intelligence, etc.

Programming languages are a set of words composed of their proper usage rules that constitute the software's source code. This algorithm after being translated and compiled is read by the machine and transformed into a computer program that only then will work according to what was written.

PHP
"PHP" is a programming language for server-side web development, it can do anything like read form data, send and receive data, it is widely used because it is easy to integrate with HTML files. Also, because it is server-side the user can't see the source code lines, so will never really know what the content is in its entirety.

"The best thing about using PHP is that it is extremely simple for a beginner, but offers many advanced features for a professional programmer." (PHP, 2022)

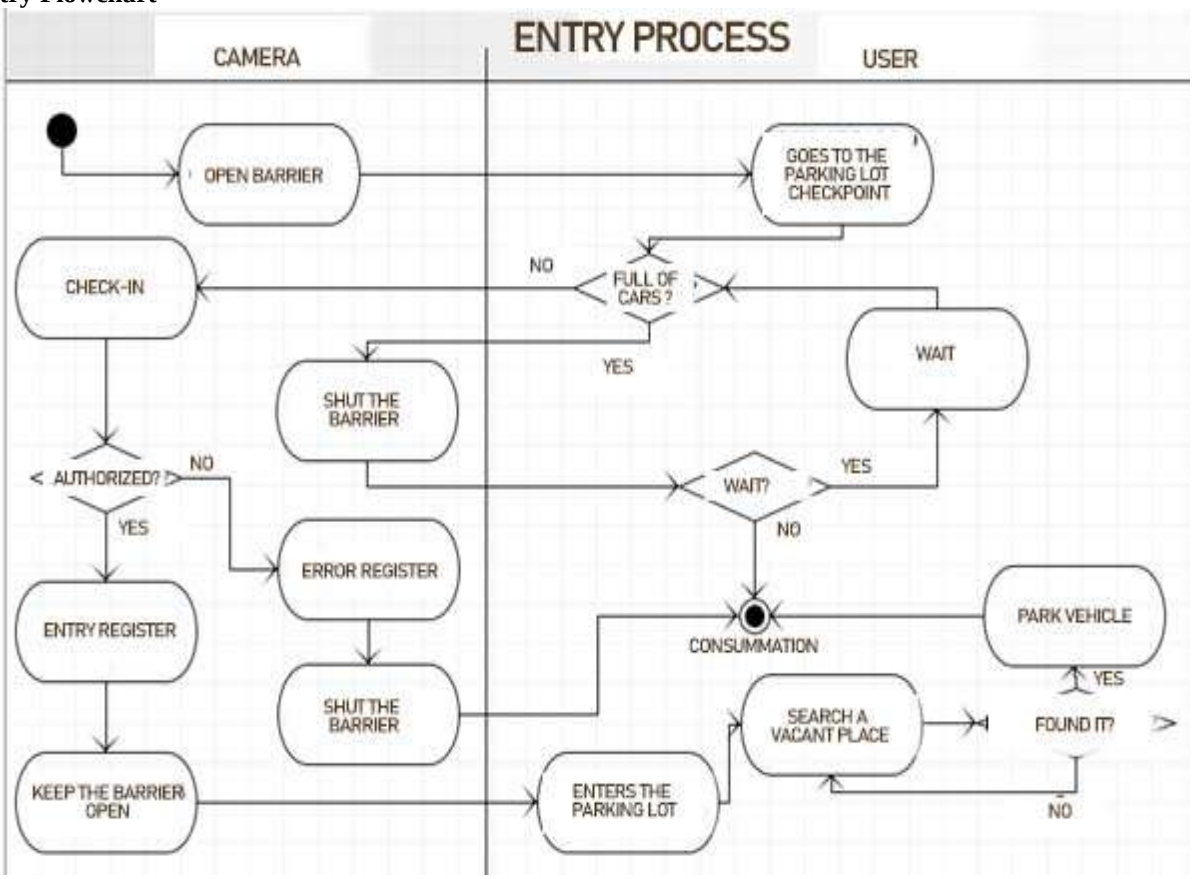
Python
It is a simple programming language and at the same time robust and versatile, it is multiplatform and used in the most diverse areas from automation to data analysis, we decided to use it in the control station system because it has

several libraries and one of them is OpenCv which enables the use of computer vision used for example to identify objects.

"Python is a dynamic, interpreted, modular, cross-platform, object-oriented, High Level Language - a specific way of organizing software where, roughly speaking, procedures are submitted to classes, which allows for greater control and stability of code for large projects." (Kriger, 2022)

Materials and Methods:-

Entry Flowchart



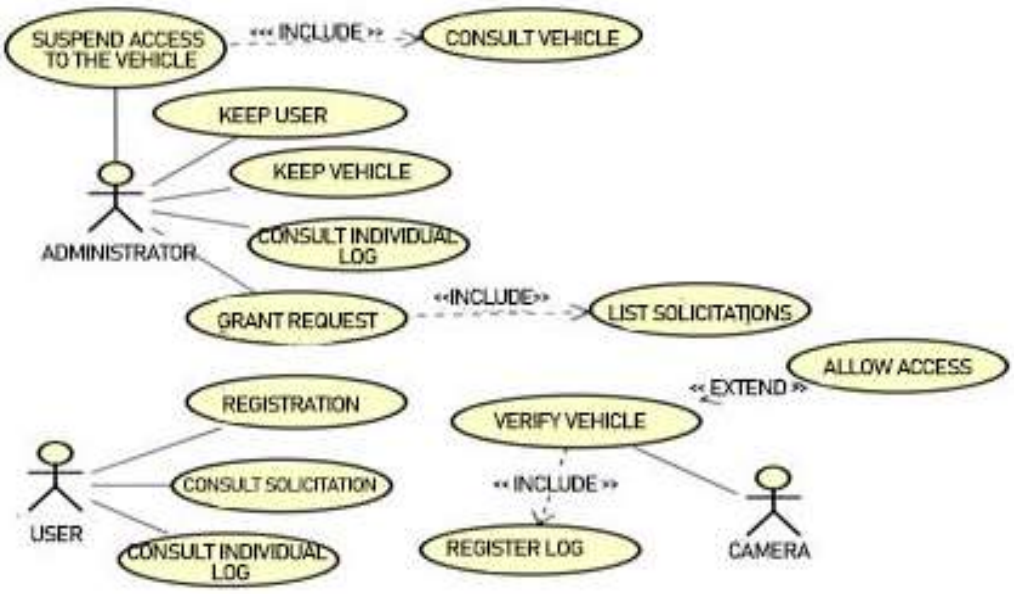
Source: Authors,2022

In the picture above the input flow that occurs between the actors user and camera is detailed, explaining from the beginning to the end of the entire process of entry and exit of the vehicle, where the vehicle when approaching the checkpoint that will already have the gate open will read the license plate and soon after the query of the vehicle in the database checking whether it is authorized to enter or not. If yes, the gate will remain open in the waiting for the next one, if not it will close immediately not allowing the passage

Diagramming

Use Case Diagram

A use case is intended to describe how the functionality will be used and how it will interact with the actors in the system.



Source: Authors,2022

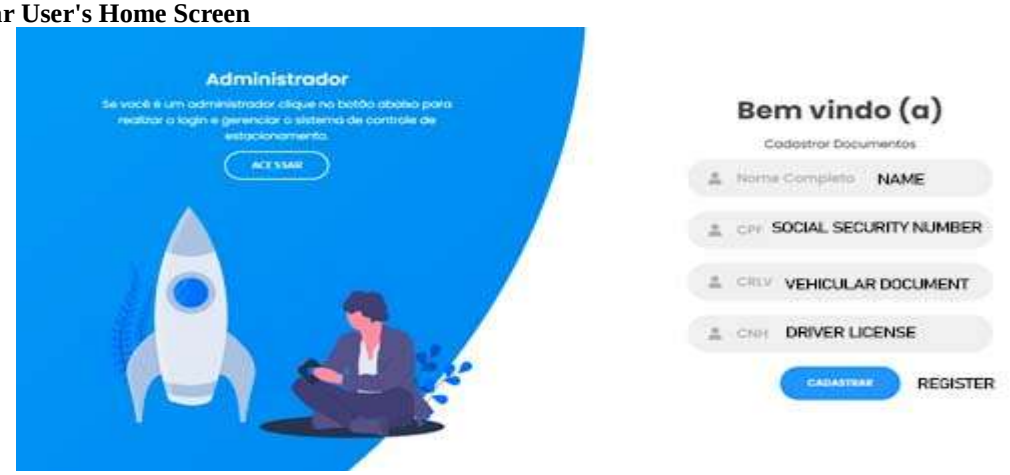
The use case diagram represents how the use cases interact with each other in the system and with the users, that is, how the functionalities will relate to each other and how they will be used by the user during use. (VENTURA, 2021)

In this use case we show the functionalities that the actors: user, administrator and camera will have in the system. The administrator will be able to access everything and all the information from the approval of the requests, user blocking and viewing all the recorded logs. The user, on the other hand, will only be able to register his data to send the request and consult his log in and out of the parking lot. Finally, the camera that will remain at the control station will play the system's primordial role, which is to identify and release the vehicle by reading its license plate.

System Screens

Below are some screenshots of the prototype system.

Regular User's Home Screen



Source: Authors, 2022.

The user, when entering the web system, will have to register information such as: Full Name, Social Security Number, Driver License and Vehicular Document. After filling in all the fields, the user will click on register and the system will create a request for the administrator to approve or not.

Prototype

Source: Authors,2022

The control pole camera will search for the license plate and when it finds it, it will isolate it by making the rectangle on the element.

Source: Authors, 2022

After the above step, the system will read and recognize the characters and then show you the elements it was able to read.

Source: Authors,2022

Once the characters are properly identified, the system will query the database to check whether the vehicle is authorized or not to pass through the gate; if authorized, the gate will remain open; if not, it will close, not preventing the vehicle from passing through.

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