Application based on Machine Learning to obtain information on monuments and tourist areas (P-Search)

Aplicación basada en Machine Learning para obtención de información de monumentos y zonas turísticas (P-Search)

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Abstract

Guanajuato seeks to boost the tourism sector, increasing the level of satisfaction in the experiences of visitors to the state, encouraging the use of technology and promoting its accessibility (Government of the state of Guanajuato, 2021). As a result of the use of new technologies, mainly through mobile devices, users want to obtain more information about their environment with the least possible effort. In this context, the P-Search application emerges, with the aim of improving the tourist experience by obtaining information about the monuments and places that the user visits, without the need for a tourist guide. By taking a photograph of the monument and / or place, the application will do the image recognition process and the user will be able to view the corresponding information. The application uses a Machine Learning algorithm and a data repository to perform image classification and maintain a history with the preferred categories for the user. The first version of the application continues to update the classification process, expanding the number and variety of images used for training and knowledge of the database, using optimization tools.

Machine Learning, KNN Algorithm, Tourism Sector

Resumen

Guanajuato busca impulsar el sector turístico, incrementando el nivel de satisfacción en las experiencias de los visitantes al estado, propiciando el uso de la tecnología y el fomento a su accesibilidad (Gobierno del Estado de Guanajuato, 2021). Derivado del uso de nuevas tecnologías, principalmente a través de dispositivos móviles, los usuarios desean obtener mayor información de su entorno con el menor esfuerzo posible. En este contexto surge la aplicación P-Search, con el objetivo de mejorar la experiencia turística al obtener información sobre los monumentos y lugares que el usuario visite, sin necesidad de un guía de turistas. Con tomar una fotografía al monumento y/o lugar, la aplicación hará el proceso de reconocimiento de imagen y el usuario podrá visualizar la información correspondiente. La aplicación utiliza un algoritmo de Machine Learning y un repositorio de datos para realizar la clasificación de imágenes y mantener un historial con las categorías preferentes para el usuario. La primera versión de la aplicación sigue actualizando el proceso de clasificación, ampliando el número y variedad de imágenes usadas para el entrenamiento y el conocimiento de la base de datos, utilizando herramientas de optimización.

Aprendizaje automático, Algoritmo KNN, Sector turismo

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Introduction

The tourism sector is constantly seeking new proposals to improve tourist experiences, and the use of technology plays a decisive role. According to data from the State Tourism Observatory (OTEG), Guanajuato recorded the arrival of more than 18,700,000 visitors in 2021 (Carranza, 2022).

When traveling, tourists achieve a better experience when they know the detailed information of the places they visit, without the need of a tour guide.

According to the results generated by the project "The tourist's gaze: imaginary and perception of tourists visiting the city of Guanajuato" (Reales Angulo, Frías Guerrero, Ramírez Morales, Ospino De La Rosa, & Pabuena Domínguez, 2019), the attraction that most captures the attention of tourists is the architecture of a city, followed by the history of the place.

Tourism apps are of great use, not only when buying airline tickets and booking hotel accommodations, but also when receiving relevant information about tourist sites and historical monuments of interest.

Problem statement

Derived from the need expressed by the Ministry of Tourism (SECTUR) of the state of Guanajuato and the Institute of Innovation, Science and Entrepreneurship for Competitiveness (IDEA), to increase the level of satisfaction in the experiences of visitors to the state of Guanajuato, favoring the use of technology and promoting its accessibility (Government of the State of Guanajuato, 2021), the creation of an application that facilitates access to relevant information of the different monuments and/or tourist areas of the city of Guanajuato is proposed.

The problem is addressed with the following question:

How to promote and strengthen the identity of the tourist areas of Guanajuato, using Information Technologies?

Objective

Improve the user experience, obtaining information about the tourist sites of the city of Guanajuato in a simple way, through the design and implementation of a web application based on artificial intelligence.

Justification

Research and interest in the history and culture of an area or historical monument is increasingly lost because it is often perceived as a boring and tedious process. That is why, the purpose is to provide a simple and easy to use means "...the experience can be improved if some changes are achieved in the teaching of history by proposing to make it more illustrated, that is, through different technological tools useful to promote motivation, dispel doubts, arouse curiosity and share ideas that are generated at the time." (Valencia Díaz, 2018).

P-Search contributes in improving the user experience by providing information about historical monuments and tourist sites, through a photograph.

Scope

The project is aimed in the first instance at tourists in the city of Guanajuato who wish to obtain quick and simple information about the area and/or historical monument they are visiting, through a photograph. Subsequently, tourist areas and moments in other municipalities of the state will be included

Frame of reference

Artificial Intelligence (AI) and Machine Learning

AI is the intelligence carried out by machines and is developed through different disciplines, including: computer vision, natural language processing, neural networks and machine learning. Machine learning is a branch of artificial intelligence that is applied in a wide variety of fields. Its aim is to find patterns in data and develop techniques that allow machines to learn, i.e., as they are exposed to new data, they generate new learning. The different machine learning algorithms are grouped into (Embarec Riadi, 2020):

- Supervised learning. Algorithms that work with data grouped into known variables; given the input variables, the answers are known and the output labels are assigned.

- Unsupervised learning. The modelling process is performed on a set of examples formed by inputs to the system, without having information on the categories of those examples.

- Reinforcement learning. The input information is feedback from the outside, i.e., the system learns by trial and error.

The KNN algorithm

The KNN (K-Nearest Neighbour) or k-NN algorithm is a non-parametric supervised learning model that uses proximity to make classifications or predictions about the clustering of an individual data point. The k stands for the number of neighbouring points that are close to the point of interest, in order to classify it into one of the initially labelled groups (output variables).

It is generally used as a classification algorithm, based on the assumption that similar points can be found by proximity, learned in the training stage and making guesses for new points based on that classification (IBM, 2022).

The KNN calculates the distance of the new element to each of the existing ones, and ranks these distances from smallest to largest to select the group to which it belongs. From an initial dataset, its goal is to correctly classify all new instances; therefore, learning occurs at the same time as the test data is evaluated (MERKLE, 2020).

The steps to run the KNN algorithm are (Mirjalili & Raschka, 2019):

1. Choose the number of k and a distance measure.

2. Find the k-nearest neighbours of the sample to be classified.

3. Assign the class label by majority vote.

Graphic 1 shows the assignment of a new data element (?) to the class label triangle by majority vote among its five nearest neighbours.
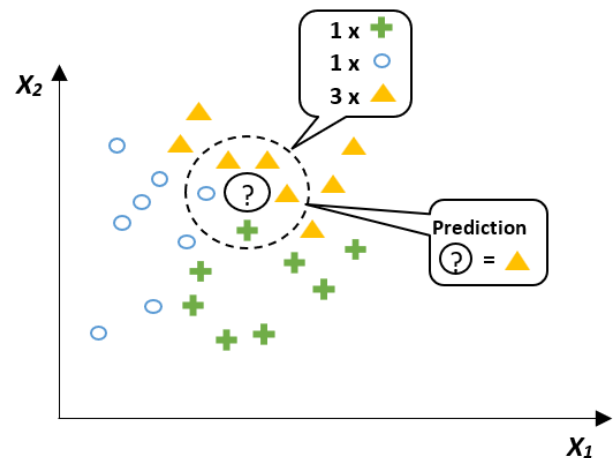
Graphic 1 Working example of the KNN algorithm
Source: Mirjalili & Raschka, 2019

Artificial intelligence (AI) and the tourism industry

The Secretary of Tourism of the state of Guanajuato, highlights that the most innovative trends towards which the tourism sector is tending can be divided into three blocks: tourism intelligence, robotisation and artificial intelligence and augmented reality (Olvera Novoa, 2022).

According to data from the study conducted by the company SmartTravel: "AI travel agents, the future?", 64% of travellers between 30 and 40 years old want to get to know a certain destination through an Augmented Reality (AR) view before making a trip; while 50% feel encouraged to book a trip with technologies that help them personalise destination suggestions (CIO Mexico, 2021).

In this regard, Gustavo Parés, CEO of NDS Cognitive Labs, a Mexican Artificial Intelligence (AI) services company, mentions that "AI is very useful for both companies and travellers, as a pleasant travel experience is key in the tourism sector" (Hernández Villegas, 2021).

According to NDS Cognitive Labs, AI enhances the travel experience by offering personalised options that fit the tourist's wants and needs (CIO Mexico, 2021).

For the development of this project, applications, platforms and available tools were reviewed, aimed at facilitating the search for information on tourist areas, among which the following stand out:

- *Google Lens* is an application that has several processing functions based on image analysis. It compares objects in photos with other images, which it classifies by their degree of similarity and relevance to the objects in the original photos. It can also copy or translate text, identify plants and animals, explore places or menus, discover products and find visually similar images (Google, 2022).

- *Photo Sherlock*, aimed at searching for people by photo. The application provides search by image taken from the camera or gallery, using Google, Yandex, Bing search engines. It can be used to search for information about a photo on the Internet, for example, to detect the real owner of the photo in a social network (Prysjazhnjuk, 2022).

- *Blippar AR*, an augmented reality application that uses computer vision and can identify different historical monuments around the world through a photo or scan of the monument (Blippar, 2022).

Development methodology

The methodology used in the development of this project is an iterative model in which five phases were defined, which are shown in Figure 2 and described below:

1. Detection of needs. 100 surveys were carried out with people between the ages of 20 and 50, with the following main results:

    - 68% of the people surveyed like to take photos when they travel; and 50% search the internet related to the tourist areas they are visiting.

    - 98% have a mobile device when travelling; and 82% would like to have an application that allows them to have information about the historical monuments and tourist areas they visit, through a photograph.

    - Finally, 80% of respondents suggested that the application should also allow them to keep a history of places visited and give their opinions so that other users can see their impressions.

2. Desk research. Exploratory research was carried out, the state of the art was reviewed and the requirements to be met by the application were determined.

3. Definition of the project. The I.T.-based proposal is presented, defining the proposal with objectives, scope and expected results.

4. Project planning. A chronogram of activities is generated, considering times and people in charge; and the architecture of the application is detailed, defining the automatic learning algorithm to be used, as well as the most suitable development tools.

5. Development and implementation. The data repository is modelled, the interfaces are designed, coded and the various preliminary tests are carried out.

The application has been built using an evolutionary development model (Figure 1), which consists of developing an initial prototype and gradually refining it through different versions that are presented to a sample of end users. This model allows the application of a technique or exploratory development that involves working with the client, starting the development of the proposal with the requirements that are most understood, and then adding new proposed attributes until the final version is reached (Sommerville, 2005).

It focuses on the gradual construction of the product, requiring constant reviews and evaluations of the different versions of the prototype, detecting timely changes in the requirements, allowing realistic results in a shorter period of time (Ramos, Noriega, Laínez, & Durango, 2017; Sommerville, 2005).
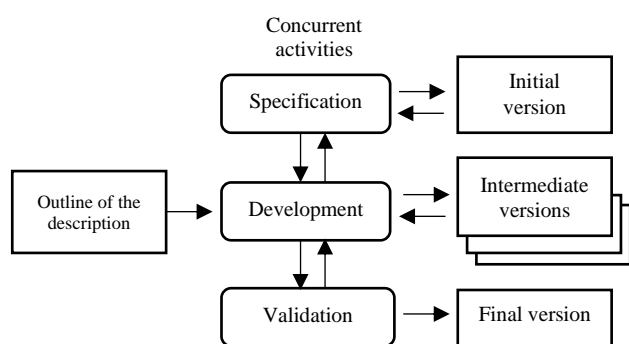
Figure 1 Evolutionary development model
Source: Sommerville, 2005

6. Testing and results. A pilot group is selected, in order to validate the software prototype, implementing changes for continuous improvement of the functionality and guaranteeing the expected results.
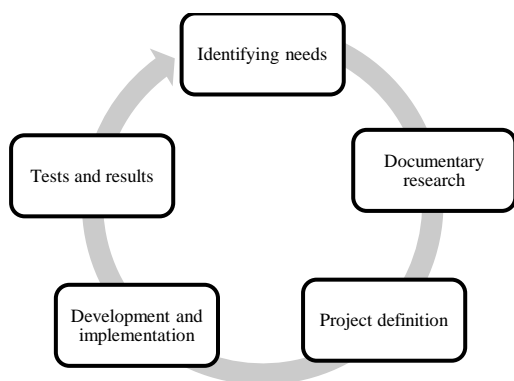

Figure 2 Project development methodology
Source: Own elaboration

Project development

P-Search is based on client-server architecture, with PHP programming language using the Model View Controller (MVC), which allows a better structure and organisation of development. The interfaces were designed implementing the *CodeIgniter framework*, being necessary the use of *HTML5*, *CSS3*, *JavaScript*, *AJAX*, *JQuery* and the ML5.js library to facilitate the use of the automatic learning algorithm. The database driver used is *MySQL*. A sample of the main interfaces is presented below.

1. Login interface. Two login profiles are considered, administrator and standard user (Figure 3).
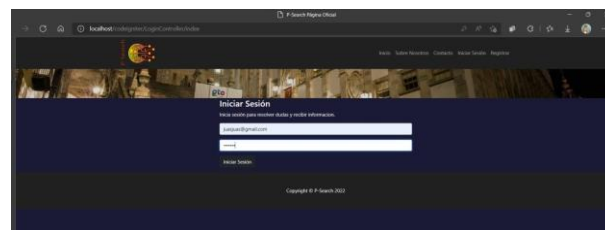
Figure 3 Login interface
Source: Own elaboration

2. Main interface. Both profiles have access to the learning module of the algorithm; the administrator profile also allows the registration of monuments and tourist areas (Figure 4).
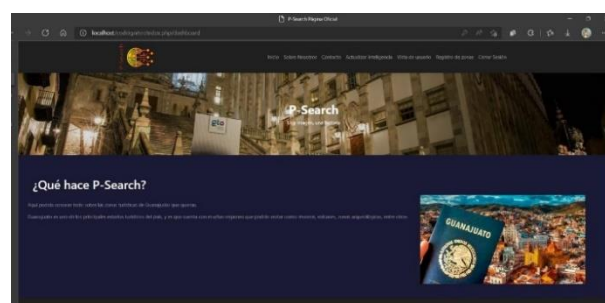

Figure 4 Main interface, administrator view.
Source: Own elaboration

3. User view interface, access to the recognition of images of monuments and tourist areas (Figure 5).
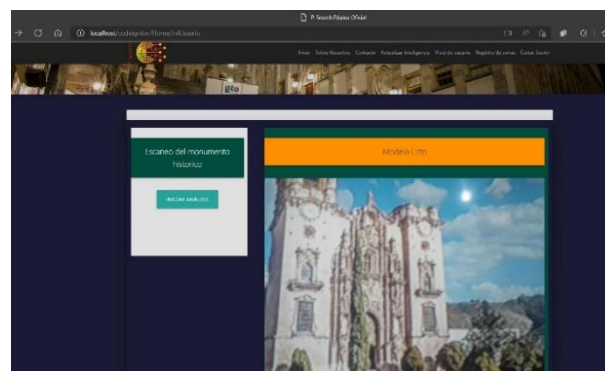

Figure 5 KNN model execution interface, user view.
Source: Own elaboration

4. Tourist zone control interface. In this section, monuments and tourist zones are registered, updated and deleted (Figure 6).
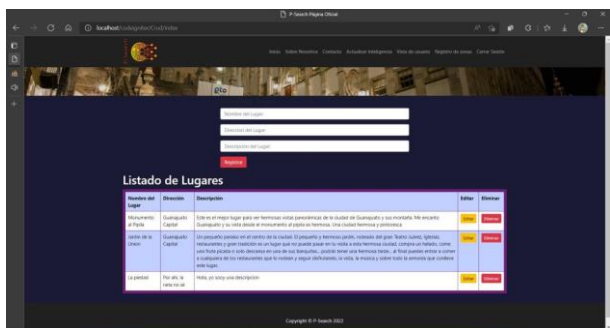
Figure 6 Tourist zone control interface.
Source: Own elaboration

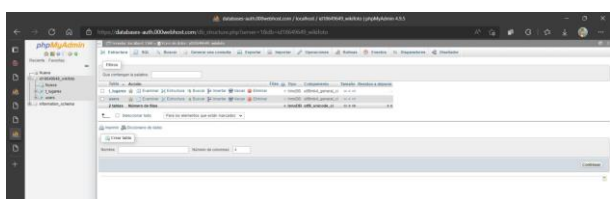The database is managed in PHPMyAdmin (Figure 7).

Figure 7 Database in PHPMyAdmin
Source: Own elaboration

Results and impact

P-Search is an application that displays information about tourist sites and historical monuments by means of automatic learning and image recognition through a mobile device; when a photograph is taken, the application identifies the place or monument and redirects to a customised interface that displays relevant information about it.

In the user view, access to the device's camera is automatic, but the intelligence does not start image recognition until the user presses the "Start Analysis" button (Figure 8).
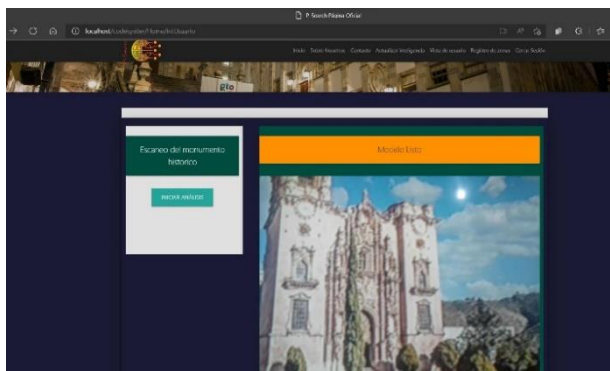

Figure 8 Standard user view
Source: Own elaboration

The supervised learning algorithm starts the image recognition process, looking for colour and shape matches, making a comparison with the images preloaded in the application. It then visualises the image with the highest percentage of coincidence (Figure 9).
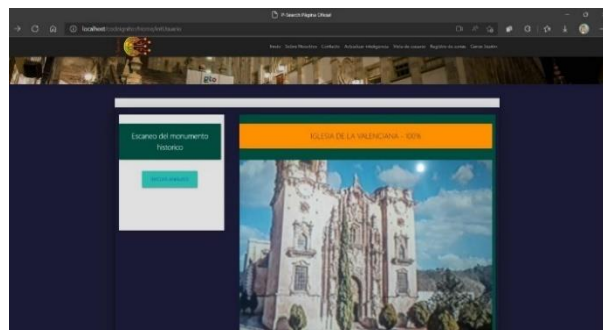

Figure 9 Image detection with supervised learning
Source: Own elaboration

To train the KNN algorithm, the button corresponding to the monument or tourist area to be added must be pressed until the coincidence is 100% (Figures 10 and 11).
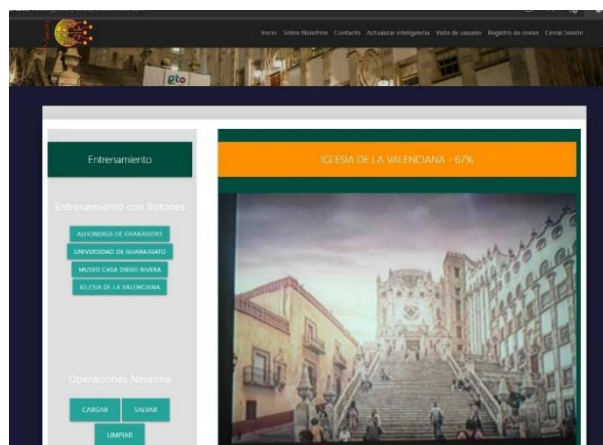

Figure 10 Demonstration of training of the KNN algorithm, at 67%.
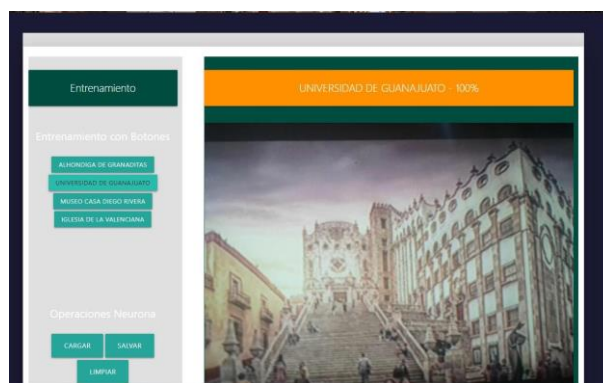*Source: Own elaboration*

Figure 11 Training demonstration of the KNN algorithm, at 100%.
Source: Own elaboration

The administrator has the "Save" button to download the file containing the new knowledge.

When the KNN algorithm identifies the place three times in a row and with the same percentage, it displays the information of the identified monument or tourist area (Figure 12).

Figure 12 Tourist area information.
Source: Own elaboration

The application is currently hosted on a cloud server and can be accessed from any browser and device with a camera and internet access.

Conclusions

P-Search is an application that displays information about monuments or tourist sites by means of automatic learning and image recognition, through a mobile device. It is trained to recognise images of the following monuments and tourist areas in the city of Guanajuato: Alhóndiga de Granaditas, University of Guanajuato, Diego Rivera's house and the Valenciana Church.

When a photograph is taken, the application is able to identify the area or monument with a 100% match and display the most relevant information about the monument or tourist area; if it does not recognise the image, the application currently tries to relate it and displays suggestions.

For the development of the project, open source web technology is used, so the cost is accessible, as well as being intuitive and easy to use.

This application is intended to be a technological tool that benefits the tourism sector by improving the tourist's experience when visiting the historical sites of the city of Guanajuato, providing information about the place they are visiting without the need for a tourist guide.

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