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Automated Vehicle Entry Monitoring System Using YOLOv5

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Abstract

This project showcases an innovative You Only Look Once (YOLO) object detection model-based Automated Vehicle Entry Monitoring System for community gates. By using YOLO, the system transforms conventional access control paradigms by accurately and in real-time detecting vehicles that are seeking to gain entry. Unlike traditional approaches, the project leverages YOLO's effectiveness in vehicle recognition, classification and Number Plate Detection to improve residential security. By providing communities with a cutting-edge tool for gate access management, this project advances the field of intelligent security solutions as urban living dynamics change. The deployment of YOLO offers a state-of-the-art framework for effectively fortifying community gates, meeting contemporary security needs in a constantly shifting urban environment. The emergence of computerised systems for vehicle entry surveillance has been made possible by the quick expansion of urban infrastructure and the need for intelligent security solutions. The use of the YOLOv5 (You Only Look Once version 5) deep learning model to the development of dependable and effective car entrance monitoring systems is examined in this study. Because of its well-known real-time object identification features, YOLOv5 is a good option for these kinds of applications. The architecture, training techniques, performance indicators, and difficulties related to YOLOv5-based car monitoring systems are covered in this study.

Keywords: YOLOv5, tesseract, easy OCR, image preprocessing, OpenCV, number plate detection, darknet, object detection

INTRODUCTION

This study presents a synthesis of technical innovation and security enhancement by investigating the deployment and effects of an automated vehicle entry monitoring system at community gates. Unlike conventional manual verification techniques, the system provides a dynamic response to modern urban living problems. The goal of the study is to create an adaptive access control framework by examining the essential elements of the suggested system. Furthermore, the possibility for improving community security through the integration of surveillance systems like CCTV cameras and optional facial recognition is further examined [1–4]. The study also assesses user-friendliness, scalability, and the possible drawbacks and advantages of implementing such systems in various home contexts. This research intends to help communities in efficiently protecting their gates by

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offering insights into cutting-edge security methods that intelligently respond to the needs of modern living. Three distinct entry control strategies were employed by gated communities: (1) unrestricted access; (2) physical identification; and (3) electronic identification. "Free access" meant that anybody may enter a gated community without restriction, but in practice, some people might still be hesitant to do so even in the absence of security personnel as shown in Figure 1. When using "physical identification", guests must sign a registration log and provide identification at a gate manned by security personnel in order to gain access to the community [5]. To enter a gated community, one must register in the log prior if the gates have "electronic identification". To access the gated neighbourhood, guests who are not registered must be escorted by a resident. To prevent uninvited trespassing, every electronic identification facility is additionally guarded or monitored.

METHODOLOGY

Image Labelling and Annotation

In the labelling section, we use the "train" and "annotation" tools. The photographs in the "train" section are properly labelled using our annotation tool. This application speeds up the process by creating the necessary file formats, such as CSV files, for annotation purposes. These annotations are then saved in a format that works smoothly with our workflow, assuring compatibility and convenience of usage.

Training and Model Configuration

To ensure that the YOLO model is representative of the diversity of vehicles in the community, compile a varied collection of car photos and videos for training and testing. Using the dataset gathered, train the YOLO object identification model, adjusting the parameters to maximize performance for vehicle recognition. During the training phase, we take the critical step of training our deep learning model to effectively learn from data [6–8]. This phase begins with data preprocessing, which involves refining and preparing the dataset for training. Using the skills taught in earlier rounds, we alter and manipulate the data to ensure its acceptability for model training. For data preprocessing, we use several crucial Python libraries, including NumPy, Pandas, and CV2. These libraries provide strong tools for data manipulation, array operations, and picture processing. In addition, we use the train-test-split function from the sklearn.model_selection module to divide the dataset into training and testing subsets, which allows for more robust model evaluation. Furthermore, we use functions from TensorFlow-Keras to load and convert photos.

Moving on to the selection of deep learning models, we look at the pre-trained models accessible in the TensorFlow Keras application framework. MobileNetV2, InceptionV3, and InceptionResNetV2 are among these models, each with its own set of architectural properties that make it suited for a variety of workloads and dataset types. We also include key layers such as Dropout, Flatten, and Input layers to improve model performance and adaptability.

Figure 1. Entrance of vehicle in sensor range.

Model Storage

After preparing the data, the model is assembled and stored for further use. In order to facilitate further analysis, deployment, or training, this step guarantees that the processed data, along with the corresponding model setup and weights, are stored and easily accessible. Preprocessed model data should be saved since it simplifies processes and makes them more repeatable, allowing the project to continue without interruption in the future.

OCR

To reliably extract and decipher license plate numbers from car photos or video frames, integrate OCR algorithms with LPR. To transform the text on license plates into machine-readable data for additional processing and verification, use optical character recognition (OCR). Use optical character recognition (OCR) to process text from identity documents that are shown at visitor registration. By employing OCR technology to automatically extract and validate information from visitor IDs, you may increase the registration process's efficiency. Use optical character recognition (OCR) to retrieve pertinent data from access cards or electronic identification documents to authenticate registered residents or allowed vehicles. For thorough monitoring and auditing of entrance and exit actions at the community gates, log the data that was extracted using OCR.

Number plate detection and text extraction

Introduction to YOLOv5

You Only Look Once version 5 (YOLOv5), is well-known for its high-performance and real-time features. The most recent version of the series, YOLOv5, was created by Ultralytics and offers notable enhancements in terms of speed, accuracy, and usability. YOLOv5 uses an anchor-based detection approach with a deep neural network architecture. The architecture is made up of a detecting head, neck, and backbone network (CSPDarknet53). Incorporate the YOLO model into the gate entrance monitoring system's system architecture. Define a component that is only used to process YOLO-model images or video frames from the gate cameras. In images or video frames, this model can identify automobiles. It gives bounding box coordinates and class predictions, which enable precise vehicle identification and location by the system. After recognizing the vehicles, it tries to detect the number plates of the vehicles.

Data Preparation

Before training, the labelled dataset is prepared by annotating each image with bounding box coordinates delineating the location of number plates. These annotations serve as ground truth labels for training the model. The dataset is then split into training, validation, and test sets to facilitate model evaluation and validation.

Training Procedure

The YOLOv5 model must be fine-tuned using an annotated dataset in order to be trained for number plate detection. Utilizing the training set, optimize the YOLO model's parameters for license plate and vehicle recognition. The objective is to train the model to accurately detect the vehicle and its number plate that enters into the gated community. During training, the model iteratively adjusts its parameters to minimize the discrepancy between predicted bounding boxes and ground truth annotations.

Text Extraction

EasyOCR is a Python library designed to make OCR accessible and straightforward for developers. It extracts text from photos by using deep learning models that have already been trained. It lets users choose the language models for text recognition and supports a number of languages. The user can specify one or more languages for the OCR process during initialization. The first step in extracting text from an image is importing it into an image processing library, like OpenCV. The OCR process uses the image as its input [9, 10]. The readtext method is the fundamental feature of EasyOCR. This function accepts a loaded image as input and outputs a list of results, each of which contains the recognized text, and bounding box coordinates and the confidence probability of the recognition. The rectangle that surrounds the image's identified text is represented by the bounding box. The four coordinates that define it are top-left, top-right, bottom-right, and bottom-left. The outcomes of the OCR procedure are usually shown in the picture. A bounding box is superimposed on top of each identified text to provide an image of the retrieved data.

RESULTS

Accurate identification of various vehicle types is ensured by the YOLO-based vehicle recognition technology. When used in conjunction with EasyOCR to extract license plates, the technology offers accurate data for security and monitoring needs.

Figure 2 is the input taken from the gate cameras while the car is entering the community.

The image in Figure 3 is the result of Number plate detection and Text extraction. The red outlined bounding boxes are drawn around the detected number plates, which helps in getting the information of the vehicles entered the gated community.

Figure 2. Input.

Figure 3. Output.

CONCLUSION

The process for getting in is more streamlined and convenient for residents. Technology integration shortens gate wait times, improving community members' overall convenience and satisfaction. The modular architecture of the project facilitates easy scalability and customization. The system can be enhanced with new features or modifications to accommodate changing community requirements and technology breakthroughs. With its powerful vehicle and license plate recognition capabilities, the sophisticated gate access system reduces the possibility of unwanted entry. Unauthorized cars are less likely to sneak into the neighbourhood. The technology links precise license plate information to each vehicle input, so improving accountability. Accountability is important for community management and security investigations. Effective execution guarantees smooth integration with the community's current gate control systems. In addition to minimizing disruptions, this maximizes the utilization of already-built infrastructure.

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