VEHICLE IMPACT DETECTION SYSTEM

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ABSTRACT

Object detection is widely used to extract data from images for further computation. It is a technology related to computer vision and image processing that deals with detecting instances of semantic objects of a certain class (such as animals, tables, or cars) in digital images and videos and has applications in many areas of computer vision, including image retrieval, part identification, part inspection and video surveillance. An image classification or image recognition model simply detect the probability of an object in an image and this of pivotal importance in it's detection. In contrast to this, object localization refers to identifying the location of an object in the image. An object localization algorithm will output the coordinates of the location of an object with respect to the image. In computer vision, the most popular way to localize an object in an image is to represent its location with the help of bounding boxes. By applying object detection, you'll not only be able to determine what is in an image, but also where *a given object resides. Constructing an object detection dataset will cost more time, yet it will result most likely in a better model. The above method can be used for image processing, background subtraction or for video processing and aids in it's assistance. This paper puts forth the idea of using said processed images for detecting vehicles in front of the camera in order to detect the possibility of a collision and warn the user accordingly using techniques like Histogram of Oriented Gradients (HoG), Machine Learning algorithms such as SVM, MLP, XGB and distance measure (Chi - squared).*

KEYWORD :- *Object Detection, Support Vector Machines, Multilayer Perceptron , XGBoost , Histogram Of Gradient , chi-squared, Scala, Hadoop*

1.INTRODUCTION

A camera captures images of the vehicles that are present in front of the car and images of them are captures. Histogram of Oriented Gradients is used to represent the images as feature descriptors and process them using Machine Learning techniques. The histogram of oriented gradients (HOG) is a feature descriptor used in computer vision and image processing for the purpose of object detection. The technique counts occurrences of gradient orientation in localized portions of an image. This method is similar to that of edge orientation histograms, scale-invariant feature transform descriptors, and shape contexts, but differs in that it is computed on a dense grid of uniformly spaced cells and uses overlapping local contrast normalization for improved accuracy. HoG was found to be affected by background noise. Hence further image processing was applied to increase the effectiveness of the system. Thus foreground was focused on by application of object detection algorithms. HoG descriptors were computed for this foreground object.

1.1 SUPPORT VECTOR MACHINES

Support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a nonprobabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting).

1.2 MULTILAYER PERCEPTRON

A multilayer perceptron (MLP) is a class of feedforward artificial neural network. An MLP consists of at least three layers of nodes. Except for the input nodes, each node is a neuron that uses a nonlinear activation function. MLP utilizes a supervised learning technique called backpropagation for training.

1.3 XGB AND CANNY DETECTION

XGBoost(XGB) is an implementation of gradient boosted decision trees designed for speed and performance. The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images.

2. EXISTING SYSTEM

Research was done and existing systems show independent of object detection and CBIR systems to retrieve relevant images of cars. A paper presented an approach for learning to detect objects in still gray images, that is based on a sparse, part-based representation of objects. A vocabulary of information-rich object parts is automatically constructed from a set of sample images of the object class of interest. Images are then represented using parts from this vocabulary, along with spatial relations observed among them. Based on this representation, a feature-efficient learning algorithm is used to learn to detect instances of the object class. The framework developed can be applied to any object with distinguishable parts in a relatively fixed spatial configuration. We report experiments on images of side views of cars. Our experiments show that the method achieves high detection accuracy on a difficult test set of real-world images, and is highly robust to partial occlusion and background variation. Another system was presented as a framework for combining object detection techniques with a content based image retrieval (CBIR) system. As an example, a special CBIR system which focuses on human faces as foreground and decides the similarity of images based on background features is presented. This system may be useful in automatically generating albums from consumer photos.

3. HISTOGRAM OF ORIENTED GRADIENTS

The essential thought behind the histogram of oriented gradients descriptor is that local object appearance and shape within an image can be described by the distribution of intensity gradients or edge directions. The image is divided into small connected regions called cells, and for the pixels within each cell, a histogram of gradient directions is compiled. The descriptor is the concatenation of these histograms. For improved accuracy, the local histograms can be contrast-normalized by calculating a measure of the intensity across a larger region of the image, called a block, and then using this value to normalize all cells within the block. This normalization results in better invariance to changes in illumination and shadowing. The Algorithm is implemented in four steps, Gradient computation, Orientation binning, Descriptor blocks, Block normalization, Object recognition.

4.MACHINE LEARNING ALGORITHMS

More formally, a support vector machine(SVM) constructs a hyperplane or set of hyperplanes in a high- or infinite-dimensional space, which can be used for classification, regression, or other tasks like outliers detection. Intuitively, a good separation is achieved by the hyperplane that has the largest distance to the nearest training-data point of any class (so-called functional margin), since in general the larger the margin the lower the generalization error of the classifier.

The term "multilayer perceptron"(MLP) does not refer to a single perceptron that has multiple layers. Rather, it contains many perceptrons that are organized into layers. An alternative is "multilayer perceptron network". Moreover, MLP "perceptrons" are not perceptrons in the strictest possible sense. True perceptrons are formally a special case of artificial neurons that use a threshold activation function such as the Heaviside step function. MLP perceptrons can employ arbitrary activation functions. A true perceptron performs binary classification (either this or that), an MLP neuron is free to either perform classification or regression, depending upon its activation function. The term "multilayer perceptron" later was applied without respect to nature of the nodes/layers, which can be composed of arbitrarily defined artificial neurons, and not perceptrons specifically. This interpretation avoids the loosening of the definition of "perceptron" to mean an artificial neuron in general.

XGBoost stands for eXtreme Gradient Boosting. XGBoost is a software library that you can download and install on a machine, then access from a variety of interfaces. Specifically, XGBoost supports the following main interfaces:

1. Command Line Interface (CLI).
2. C++ (the language in which the library is written).
3. Python interface as well as a model in scikitlearn.
4. R interface as well as a model in the caret package.
5. Julia.
6. Java and JVM languages like Scala and platforms like Hadoop.

5. DISTANCE MEASURE

Let training data be $(x_i, y_i\}^N_{i=1}$, where x_i is sampled from a probability simplex and let y = {1,2,...,n} be the associated class label; the symbol **1** denotes a dimensional column vector whose all components are one. The chi-squared distance between two samples $\mathbf{x_i}$ and $\mathbf{y_i}$ can be computed by

$$\chi^2 (x_i, y_i) = \frac{1}{2} \sum_{\square=1}^{\square} \frac{(\square\square - \square\square)^2}{\square\square + \square\square}$$

Where xl is the l^{th} element on the feature sample $\mathbf{x_i}$

6.DEVELOPMENT OF CANNY ALGORITHM

Canny edge detection is a technique to extract useful structural information from different vision objects and dramatically reduce the amount of data to be processed. It has been widely applied in various computer vision systems. Canny has found that the requirements for the application of edge detection on diverse vision systems are relatively similar. Thus, an edge detection solution to address these requirements can be implemented in a wide range of situations. The general criteria for edge detection include:

a. Detection of edge with low error rate, which means that the detection should accurately catch as many edges shown in the image as possible
b. The edge point detected from the operator should accurately localize on the center of the edge.
c. A given edge in the image should only be marked once, and where possible, image noise should not create false edges.
d. To satisfy these requirements Canny used the calculus of variations – a technique which finds the function which optimizes a given functional. The optimal function in Canny's detector is described by the sum of four exponential terms, but it can be approximated by the first derivative of a Gaussian.

Among the edge detection methods developed so far, Canny edge detection algorithm is one of the most strictly defined methods that provides good and reliable detection. Owing to its optimality to meet with the three criteria for edge detection and the simplicity of process for implementation, it became one of the most popular algorithms for edge detection.

7.DATASET

The data chosen was the cars dataset, which contained 1155 training data of photos of cars from the rear. Car dataset taken by Brad Philip and Paul Updike, California Institute of Technology. It was taken on the freeways of southern California. Resolution is constant at 320x240 pixels. This dataset allowed us to calculate the HoG descriptors for the cars and retrieve similar images.

8.METHODOLOGY

The dataset was taken and converted to HOG descriptors for processing by the Machine Learning algorithms. Python Notebook was used to run the whole processing by importing various libraries. The HoG descriptors of all the images was calculated using the inbuilt cv2 (OpenCV) library function HOG Descriptors(). This function provided the HoG features of the image with dimension 1024x1, which was stored in an array. The HoG descriptors of the images are fed as training and testing datasets to the three different machine learning algorithms(SVM, MLP, XGB), that train themselves to predict the presence of a vehicle in an image with different accuracies. Hence, they detect the presence of a vehicle from a given image by using the HoG features.

Post the detection of a vehicle in the image,in the event of the presence of a vehicle the distance between the camera and the image is calculated using a calibration image using which a morphological operator using rectangular structural element is used. Relative velocity between the car and the vehicle in front of it is calculated by taking images at different timing intervals and determine the distances at each time intervals. In the event of the relative velocity crossing a threshold value, the user is warned of the possibility of a collision so that the user shall be cautious and control the car accordingly.

In the event of a collision, the number plate of the vehicle in front of it is detected by blurring the image of the vehicle except its number plate and performing canny edge detectors to detect the characters in its licence plate and the contours.

9.PLOTS

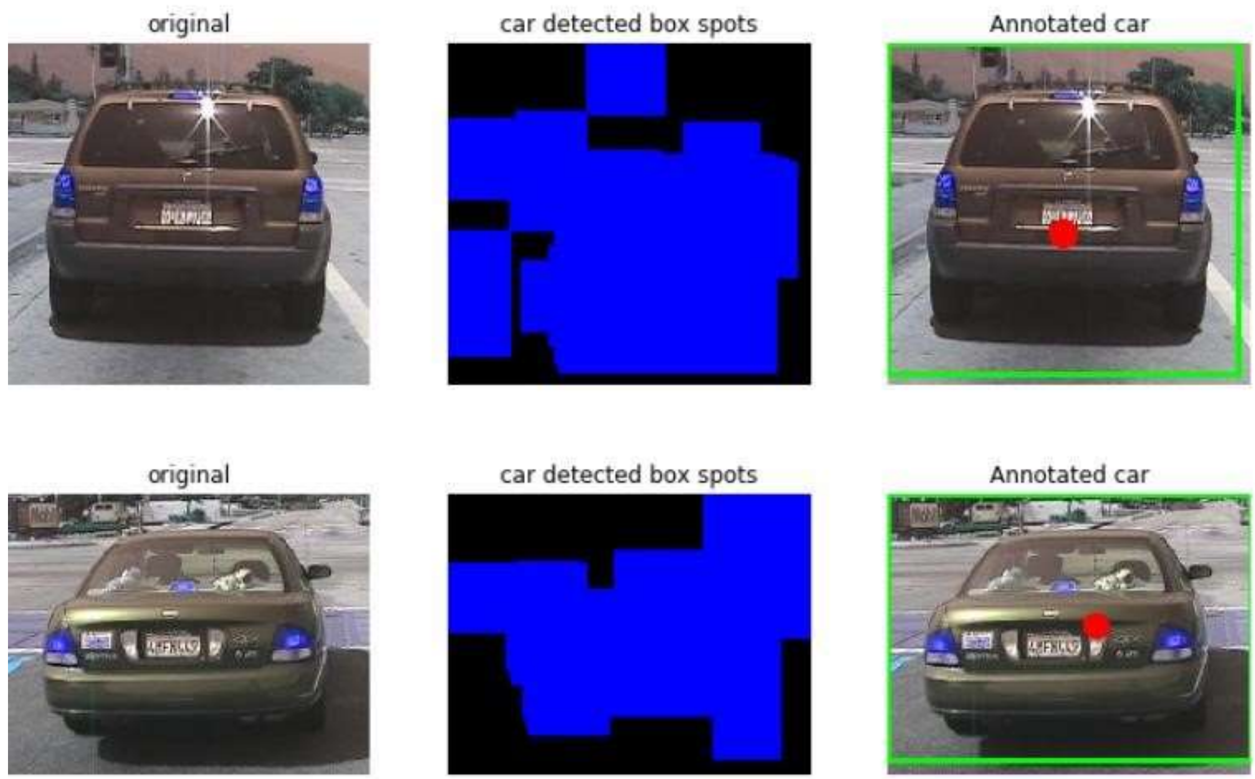

FIG 1. OBJECT DETECTION USED ON CARS

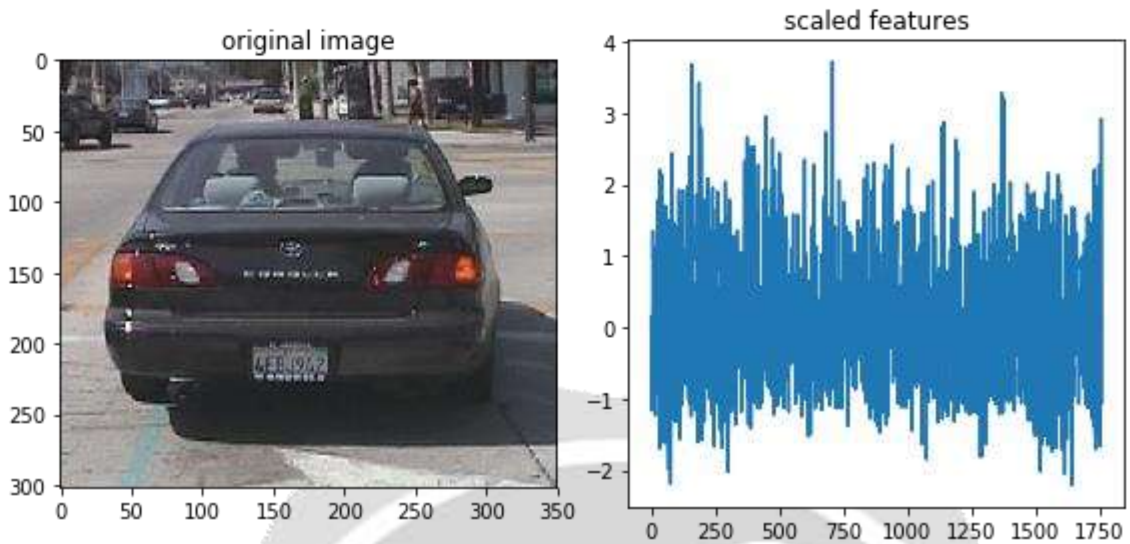

FIG 2. IMAGE FEATURES OF THE VEHICLE

10. CONCLUSIONS

The conclusions were noted. The algorithm was programmed to be trained from the given dataset by three different Machine Learning algorithms from the HoG of the images and the accuracies are listed below.

Algorithm	SVC	XGB	MLP
Accuracy(%)	100	99.51	100

The images of the detected vehicles are shown in Fig.1. The distances of the vehicles in the six images from the camera were calculated using the calibration image. And the values were 68.24ft,127.57ft,80.00ft,92.55ft,104.12ft and 123.13ft respectively.

The features of the image are displayed in Fig.2.

11.REFERENCES

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