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# Zebra Crossing Detection Using Concatenation of SIFT-Gabor Features

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***Abstract: Zebra-crossing recognition is a challenging activity for visually impaired navigating safely. This paper proposes a zebra-crossing scene recognition model-based fusion of texture features and geometrical features. The Gabor features for 8 orientations are extracted for different orientations Zebra Crossing lines. The SIFT is employed for keypoint detection and description. The final features vector is obtained by concatenating Gabor and SIFT features. The feature vector is optimized using K-means clustering and Principle Component Analysis (PCA). The optimized feature vectors were classified using five Classifiers, SVM, Random Forest, Decision Tree, Naïve Bayes Classifiers. The proposed model successfully recognizes the crosswalks with 89% accuracy. The different classifier models are evaluated for Precision, Accuracy, F1 Score, Recall, and RoC. This paper specifies the classification of two class positive which is zebra-crossing and negative which is no zebra-crossing. The designed system will classify either the crosswalk is detected or not on the basis of percentage specified for each class. This can be done by matching the features of the trained dataset. Those features are matched with the real videos or images to recognize the motion and classify into specific class. More specific crosswalk detection in real time can be executed to get more specific type of positive and negative class and classification.***
***Keywords: crosswalk, feature, classification, traffic.***

## I. INTRODUCTION

The zebra crossing detection method is extensively researched in several disciplines. The method is used in the advanced driver assistance system to locate where the zebra crossing is. The methods assist the blind in crossing the street on their own. An important traffic signal that indicates a secure crossing of the street is the zebra crossing. For safe travel, the visually impaired should have access to the zebra crossing's accessible area. Also, the visually handicapped request the zebra crossing's direction in order to change their course of movement. The crossing photos are classified as crosswalks using multiple methods and the matching of features extracted is followed using the ORB algorithm [1]. In order to create an image-based tool that would enable blind people to recognize important information on their own for safely navigating a crossing. According to figures from the World Health Organization, there are about 40 million blind persons in the world. It is quite challenging for blind persons to carry out any kind of action on their own. Zebra crossing is one of the most important elements of the road system and of driving safety. Zebra crossings exist to safeguard both vehicles and pedestrians. But for those who are blind, it becomes tough. Discovering crosswalks, figuring out when the walk interval begins, keeping a straight line while crossing, and finishing crossings before the start of opposing traffic are all challenges for blind persons. Also, according to the current situation, many people continue to pass away while crossing the road. There are many challenges that blind individuals face while crossing the street, and the importance of zebra crossings in ensuring their safety. To address this issue, a computer vision-based approach is proposed for zebra crossing detection. The system uses a dataset of zebra crossing images for training and a camera module for collecting real-time data as the test dataset. Various feature extraction and matching algorithms are used to classify the zebra crossings, and machine learning algorithms like SVM, Random Forest, Decision Tree, and Naïve Bayes are used for the classification. This approach can enable blind individuals to navigate zebra crossings safely and independently, improving their quality of life.

A blind person needs information regarding the position of the crossing, or if it is in his frontal area, as well as an estimate of its length and the status of traffic lights to cross a road safely. Typically, blind individuals utilize a white travel aid: a cane. A cane has a relatively limited range for detecting unique patterns or impediments. When it is safe to cross the road, certain traffic signals contain beepers that signal the blind person to do so. However, such technology is not always present at crossings. Perhaps it would take too much time to install and maintain such equipment at each crossing [2].

Blind people cannot see, but they can hear. New opportunities to create an intelligent navigation system for blind people have opened up with the introduction of quick and inexpensive digital portable laptop computers with multimedia computing to transform audio-video streams in real-time. The paper represents a computer vision-based approach for zebra crossing detection [3]. The system captures real-time data for the detection process. The dataset is divided into train and test training datasets consisting of zebra crossing images using the camera module will collect the real-time data which is used as a test dataset. Then features are matched by using the algorithms like SIFT, ORB, etc. After matching, classification is done by using SVM, Random Forest, Decision Tree, and Naïve Bayes to finally detect the crosswalk.

## II. LITERATURE REVIEW

Zebra-crossings are detected by looking for groups of concurrent lines [1] where three methods are used for color detection and segmentation which includes RGB images being converted into IHLS color space and these methods are tested on outdoor images [2] and many other threshold image techniques such as Gaussian filter, Canny edge detection Contour, and Fit Ellipse [3][4] are used for traffic sign recognition with Kalman filter [5] which also includes Block-based Hough proposed by Yu-Quin Bao [6] and transform and directional variance techniques [7], a novel approach to detect and locate the zebra-crossings and the system is found out to be feasible for use on public roads around the world [8] to obtain 13,40 high-quality photo-realistic images from the video from 13 classes of various objects [9]. The design of a low-power, low-latency electronic mobility assistance for blind persons revealed that decision trees, random forests, and KNNs may all be used to recognise objects [10]. The pedestrian walk detection system is adopted by HOG and LBPH methods worked together with the SVM algorithm [11] where which uses segmentation according to the color of the pixel, classifies shape using linear SVM performs form content recognition using Gaussian-kernel SVMs [12] and to model the video they use GMM [13] which depends on YOLOv3 real-time data and applied kinematic based filter [14] for vehicle detection and to obtain high accuracy for vehicle speed SVM and HOG [15] methods are used [16]. Many application based model have been developed one of those is, An Electronic Travel Aid for Navigation of Visually Impaired Persons [17], a means through which a blind person can autonomously navigate a new environment.

Lane detection is another factor that can be detected using ROC and DET for accurate canny edge detection, Flood Fill canny edge detector [18], and Sobel operators [19] where local image orientations and line segments are calculated [20] and Gabor filter is sometimes used to reduce noise [21]. Motion detection [22] used by Zhang along with HOG for edge detection is another important factor that uses the Gaussian Mixture Model (GMM) where data is processed through HCC with an accuracy of 91.5% at a resolution of 720p [23]. CNN algorithm can be used which gives good accuracy if the image resolution is good and the white paintings on the crossing are fine as well as there is no vehicle obstruction [24].

LDA grayscale algorithm to process images and the use of the EDLines algorithm for edge straight line detection [25] will help to achieve more accuracy of 90.3%. Real-time traffic sign recognition can be applied using CNN algorithms [26] and the RNN method to help design a unified framework for classifying images [27]. ZebraRecognizer software was also demonstrated by Mascetti et al such that it computes the crossing position precisely with accurate and efficient results [28]. Several other algorithms can work for this detection like the zebra crossing detection CBR module [29] proposed by Z Qujiang Lei, the K-means clustering approach [30] to classify the image, and the accuracy of this method is good along with the RDP algorithm and shape-arc algorithm [31] used for pre-processed image identification. Viola-Jones method [32] to segment road signs based on HSV color space and fuzzy logic [33] which describes how this cascaded classifier works and how integral images are used [34].The Adda boost method is used here on a bird-eye view image called inverse perspective mapping image for zebra crossing detection [35]. A workable camera using an auto-calibration technique suggested by Zhang et al [36] is used for traffic scene surveillance in this research which also provides a practical method for traffic scene surveillance camera auto-calibration in this study can also be considered as further implementation with Fourier transformation [37] and convolutional neural networks [38] can play a vital role while creating our dataset which can be used for zebra crossing detection [39]. Another most unique called Gaussian process dynamical models and probabilistic hierarchical trajectory matching techniques can present a study on pedestrian path prediction. Another step in the progress of implementing this process can be a monocular visual odometry (VO) system called UnDeepVO by focusing on Gaussian process dynamical models (GPDMs) for nonlinear time series analysis [40].

## III. METHODOLOGY

This system follows a procedure right from taking the input dataset and performing feature matching of crosswalk then further proceeding with image pre-processing. In pre-processing we, have performed image resizing and augmentation. Further, we, have performed feature extraction using Gabor Filter and SIFT algorithm. Later matching of features if performed as a classifier is taken here into consideration. Individual accuracy for each classifier is predicted.

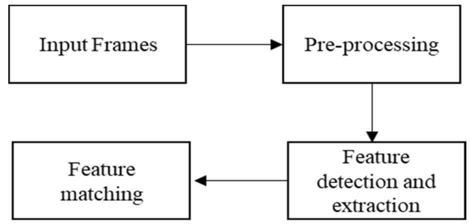


Fig.1 Block Diagram of system architecture

Fig. 1 specifies the real-time image taken from the camera module as the real-time image taken by the camera module which is made up of multiple frames, which are basically the collection of images created for both the test and the training sets. The frame is then pre-processed into the relevant size for each image which will be easier to use for further processing of frames. Our next step is to detect features on each frame and extract those features for each test file, which are then mapped to the detected features from a random video in the training dataset.

### *A. Dataset*

| Sr. No. | Type of Class | No. of images |
|---|---|---|
| 1. | Positive | 500 |
| 2 | Negative | 500 |
| 3 | Total | 1000 |

Fig.2 Dataset description

Fig.2 Fig. shows some images of the training dataset. The dataset is split into train and test. The training dataset further has two classes' positive class and negative class. Zebra crossing images can be found in the positive class, whilst random images can be found in the negative class. For the test dataset, the system records real-time photographs. After data splitting pre-processing is done. In pre-processing, images are resized with the size of 135x135

Fig. 3a

Fig. 3b

Negative class

Fig. 3c

Fig. 3d

Positive class

Fig. 3 Dataset classes

Fig 3. shows some images of the training dataset. The dataset is split into train and test. The training dataset further has two classes' a positive class and a negative class. Zebra crossing images can be found in the positive class, whilst random images can be found in the negative class. For the test dataset, the system records real-time photographs. After data splitting pre-processing is done. In pre-processing, images are resized with the size of 135x135.

### *B. Feature Detection*

Numerous algorithms are capable of carrying out feature detection; in this case, we have implemented Gabor Filter and SIFT among other feature detection algorithms. This feature can be further processed to match the feature, identify the similarities of actions taken by training data, and detect the actual probability of a specific class of actions taken and classify in line with that probability.

**Algorithm 1.** Preprocessing and Dimensionality Reduction of Data:-

```
Input: Directory of images
Output: Dataframe of training data
N = Dataframe
for all, I in D begin
Ig = grayscale(I)
N = N + SIFT(Ig)
end for
Z = Dataframe
for all, I in D begin
    Ig = grayscale(I)
    q  =  SI(Ig)
    Z = Z + k.predict(q).bins()
    Return matched features with count
```

### *C. Feature Matching*

The matching is carried out by the detected features of each image in the train and test set. Here the matching is done on each image from train to test images. The test frames are matched with the features of the training set for every image. It firstly displays the probability of each class predicted based on matched features from the training dataset and finally decides how many features have matched and the class showing the highest percentage of prediction is considered as the classified final class for the defined image.

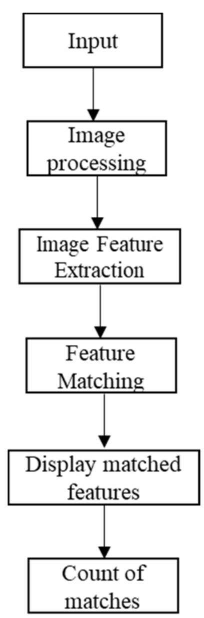


Fig. 4. System-level block diagram

The above figure describes the system block diagram which explains the overall workflow of the system. Working right from taking input data to processing the image while converting it into greyscale and adjusting the pixel value of each image in the dataset. Further, feature extraction is performed which is an important step to process before classification, feature extraction is performed using ORB and SIFT algorithms. The number of matched features with each image is displayed on the screen. Here we take a real-time image using the video capture function and that image is tested on the trained dataset, train set contains all zebra crossing images, we have we perform feature extraction and further followed by feature matching on the test image matching with every test image. The count of matched features is also visible on the console screen. We later perform classification using multiple algorithms.

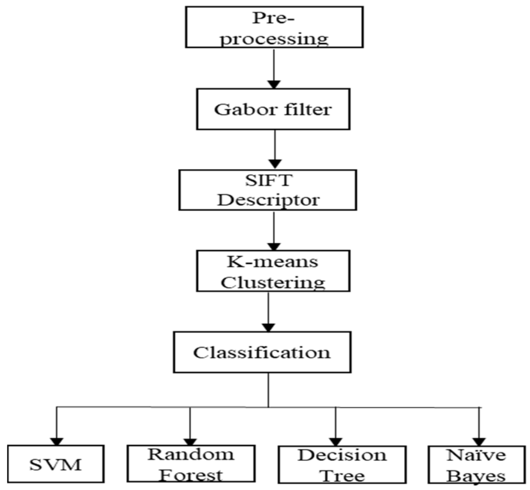


Fig. 5

Fig. 5 demonstrates the model's general functioning process. Working begins with pre-processing. The preprocessing process begins with both the positive and negative datasets. The data is subsequently used in the Gabor filter. To detect edges, a gabor filter is employed. Then the SIFT descriptor is applied to the output of the Gabor filter. After that, k-means clustering is used. In essence, k-Means is the process of clustering that locates cluster centres and arranges input samples around the clusters. Following that, classification is carried out with the help of four classifiers: SVM, Random Forest, Decision Tree, and naive bayes. SVM provides the highest accuracy among these classifiers.

*D. Classification*

Once the feature matching is performed the test image will apply various classifiers including, KNN, Random Forest, SVM, and Decision Tree to classify the actions. Here the classification is performed in such a way where the matched features display the percentage of features matched with the train set and display the match percentage of each class and the one with the highest matching features is the detected class for the given test image.

**Algorithm 2.** Classification of features

Input: Extracted Features
Output: Classification into classes

1. Divide into train and test datasets.
2. dataset_split
3. Training the model
4. Predicting the data
5. Match the features with the test
6. Percentage of each class
7. Final classification
8. Return classified class

## IV. RESULT AND DISCUSSION

Table. 1. Performance accuracy

| Classifier | Accuracy |
|---|---|
| SVM | 93% |
| Random Forest | 75% |
| Decision Tree | 50% |
| Naïve Bayes Classifier | 50% |

Table 1 specifies the accuracy of classification for each classifier implemented in this system to classify numerous actions into classes. The results clearly display the best accuracy for the SVM classifier.

Fig. 6a

The above-mentioned figure displays the features matched and the count of features matched for each training image with the real-time test image.

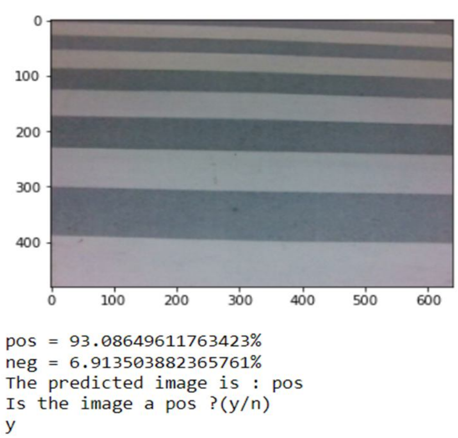


Fig. 6b

Fig. 6. Output Result

The above-mentioned images specify the output of percentage description for each class and finally predict the final class of action.

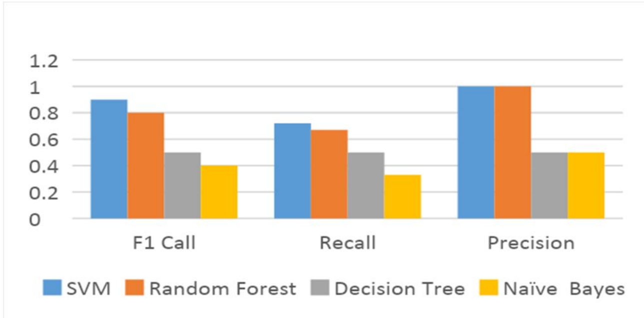


Fig. 7. Graphical representation of parameters

Some important results are calculated using the following formulas:
Precision = TruePositives / (TruePositives + FalsePositives)
F-Measure = (2 * Precision * Recall) / (Precision + Recall)
Recall = TruePositives / (TruePositives + FalseNegatives)
Fig. 6 displays different factors for each classifier which will help to define the better option for the classifier algorithm to classify the positive (zebra-crossing) and negative (no zebra-crossing).

## V. CONCLUSION

The paper successfully represents a machine learning and computer vision-based approach for zebra crossing detection. Positive and negative are the main classes that are being classified where positive denotes a zebra-crossing class and negative specifies a no zebra-crossing class Multiple algorithms have been used like SVM, Random Forest, Decision Tree, Naive Bayes, which gives the accuracies of 93.00%, 75.00%, 50.00%, 50.00%, respectively.
The dataset consists of 200, 135*135 images that are further split into training and testing of crosswalk images. For feature extraction, SIFT algorithms have been utilized, then test images are matched with training features, further, the count of feature matched with each of the train images with real-time test image is displayed and accordingly match percentages for each class is displayed to display the final class of action. The best accuracy is shown by the SVM classifier which clearly shows the best classifier for the system to detect the particular class. We have customized a dataset for training and testing images are real-time images. The system was trained on two different feature extraction techniques SIFT and then we have done feature matching with the same techniques to detect crosswalks. The number of lines that match training and testing images i.e. real-time images tells about accuracy. After performing it was found that SIFT is better for matching.

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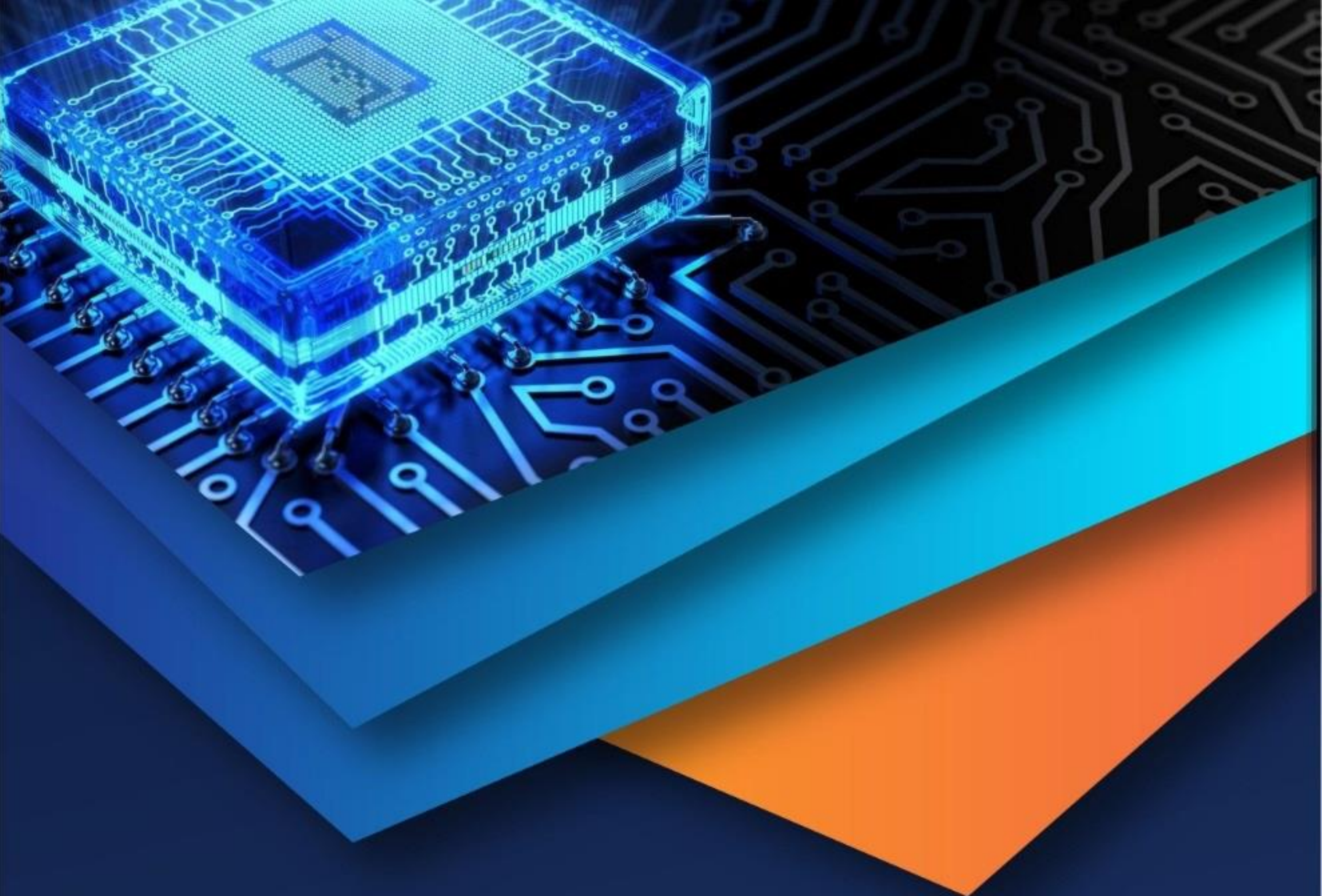

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