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TRAFFIC SIGNS DETECTION AND RECOGNITION USING THE ANT BEE COLONY OPTIMIZED ARTIFICIAL IMMUNE SYSTEM

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Abstract: Now-a-days transportation system needs to be monitored and maintain for avoiding the accidents which was done by using the traffic panel system. The traffic panel system contains the different signs that help to manage the rules in the transportation. The displayed traffic panel sign has been recognized in the correct way with minimum time and high accuracy is one of the important issues in this system. So, in this paper enhance the traffic panel sign detection system using the ant bee colony optimized artificial immune system. Initially the sign images are captured and the colour transformation has been performed. After wards the image is divided into different sub image, the structure of the image is obtained using the Active Appearance Model (AAM). From the generated appearance model, various edges and descriptor is derived with the help of the Lpboost fuzzy clustering approach. Then the derived descriptors and frames are recognized with the help of the proposed classifier. Finally, the performance of the system is analysed with the help of the precision, recall and accuracy metrics.

Keywords: Traffic panels, grey scale image, Active Appearance Model, Lpboost fuzzy clustering approach, ant bee colony optimized artificial immune system, precision, recall and accuracy metrics

1. Introduction

Now a day's transportation system places a vital role for providing the inventive services in terms of using the traffic management system. The traffic management system includes the mobility management process, vehicles and infrastructure for establishing the effective transport mode [1]. The implemented traffic management system needs to maintain the driver's safety as well as influence their coordination plans, actions, funds for creating the intelligent transport system. The efficiency of the transport system is improved by utilizing the traffic signs and panels. The traffic signs are created with the help of the board which are placed either side of the road that providing the lot of information for drivers. This traffic sign related transportation system has been developed since 1930's in which the pictorial representation of the signs are used to understanding the traffic rules for reducing the accident in the road gradually [2]. The traffic signs are in different types such as messages, symbol representations, marking in road surface, traffic lights and rumble strips and so on. According to the various types of traffic panel sign, some of the traffic signs are shown in the following figure 1.

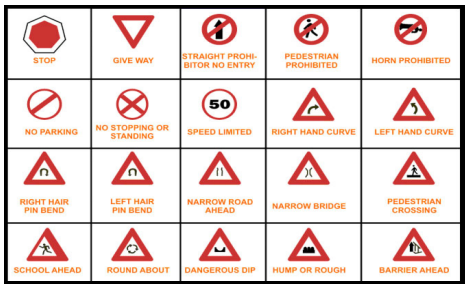

Figure 1. Traffic Signs

The above figure 1 depicted that some of the traffic signs utilized in the Indian traffic system that includes, warning, school information, hospital, barrier, hump, narrow and curve information. Even though the traffic sign consists lot of information regarding the transportation process due to the shooting angles, partial occlusions [3], geometrical distortions of the symbols are fail to recognize the driver from the long distance. So, various automatic traffic sign detection system has been created for classifying the signs from long distance by reducing the issues present in the normal transportation system. Different researchers use the image processing techniques such as median filter

removal, Gaussian filtering process, edge detection techniques, corner subtraction and sign segmentation process, and classifier [4] for recognizing the traffic signs with effective manner. The research author introduces methods are further improved using the optimized techniques for recognizing the traffic signs with minimum time when compared to the other methods. So, in this paper introduces the active appearance model (AAM) [5] for segmenting the captured images with sub images and the signs are classified with the help of the ant bee colony optimized artificial immune system. This method identifying the traffic signs with minimum time because of utilizing the optimized segmentation and classification techniques. At last the efficiency of the system is evaluated with the help of the experimental results.

Then the rest of the section is organized as follows, section 2 discussing the different researcher opinions regarding the traffic sign detection process. Section 3 analyzing the proposed ant bee colony optimized artificial immune system based traffic detection system. Section 4 evaluates with performance of the proposed traffic sign detection system and concludes with section 5.

2. Related Works

This section discussing the various researches thoughts regarding the traffic panel detection system. Tomislav Fištrek et al., [6] detecting the traffic sign symbol using the artificial neural network and circular hough transform method. Initially the images are captured and the edges are segmented with the help of the colour histogram and threshold value. After segmenting the edges from the image region, the effective regions have to be selected using the artificial neural network which detects the related features in terms of using the lighting condition of the image. The selected features are classified using the circular Hough transform that uses the radius metrics for detecting the sign from the traffic panel. The efficiency of the system is evaluated with the help of the traffic image database which ensures the high accuracy while detecting the traffic signs.

Yanjun Fan et al.,[7] discussing issues present in the traffic sign recognition system using the advanced driver assistance system (ADAS). The ADAS system uses the detection and recognition step for analyzing the traffic sign image. Initially the image has been taken and the candidate region is segmented from the image. From the segmented image, the effective features are derived which is recognized using the feedforward neural network with random weights approach. The network trains the derived features which effectively recognize the traffic signs. Then the efficiency of the system is evaluated in terms of experimental results and the author introduced ADAS system recognizes the traffic signs with 91% accuracy with 40ms time.

Duo Liu et al., [8] proposing the k-means clustering with Gaussian mixture model for detecting the anomalies present in the traffic system. Initially the images are captured and the edges present in the traffic sign has been segmented with help of the Gaussian mixture model. From the segmented edges, the natural and statistical features are extracted, based on the features clustering has been done by using the k-means clustering approach which successfully divides the normal and abnormal traffic anomalies with effective manner. The efficiency of the system is analyzed using the training and testing dataset which ensures the high accuracy when compared to traditional traffic anomalies detection methods.

Xiaoguang HU et al., [9] recognizing the traffic sign from the intelligent traffic system using the scale invariant feature transform with support vector machine. First the images are divided into different sub images according to the distance, vehicle view angle, and actual weather of the transport. Then the sift features are derived from the sub images which estimates the key points of the image with eliminating the illumination and other noises. After that the traffic sign has been recognized using the support vector machine which ensures the highest accuracy when compared to the traditional traffic sign detection method. Efficiency of the system is evaluated with the help of the experimental results and discussions. According to the few author opinions, in this paper is implementing the automatic traffic sign recognition system using the ant bee colony based optimization techniques which are explained in very detail as following section.

3. Proposed Ant Bee Colony Optimized Artificial Immune System based traffic Direction System

In this section analyzing the ant bee colony optimized artificial immune system based traffic detection system. Then the structure of the traffic sign detection system is shown in the figure 2.

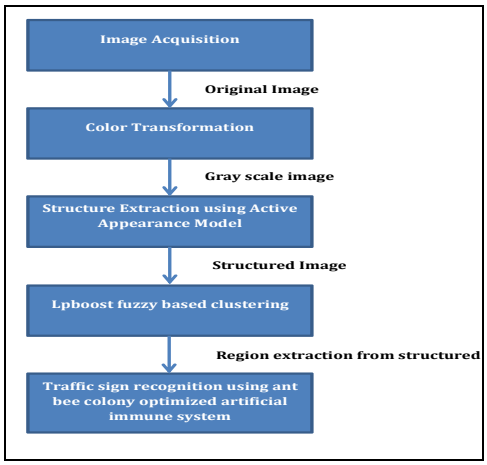

Figure 2. Proposed Traffic Sign Recognition System

Above figure 2 explains that proposed traffic sign recognition system architecture which includes several stages such as colour transformation, edge related structure derivation, region extraction and sign recognition process. Each stage uses the different algorithm for processing the captured images which explained in the following section.

3.1 Traffic Sign Colour Transformation

Colour Transformation is the first step of the traffic sign detection step in which the capture traffic signs are transferred into the grey scale image [10]. So, the captured colour images are transferred into grey image for because it processes better than the colour image. The converted grey scale image consists of several range pixels such as black pixel whose pixel range is (0,0,0), white pixels (255,255,255) and grey pixel value (127,127,127). For getting this pixel value related grey scale image, the weighted average of the red, green, blue value has been computed. So, the weighted average value of the image is estimated as follows.

$$GS = 0.2989 * Intensity\,(r) + 0.58701 * Intensity\,(g) + 0.1140 * Intensity\,(b) \quad (1)$$

According to the above equation 1 the colour images are transferred into grey scale image and the noise present in the image has been eliminated with the help of the median filter. The median filter analyze the entire pixel present in the image. If the pixel is corrupted by the noise, which is eliminated with the help of the median value of the neighboring pixel value. The median value is calculated by arranging all pixels in the ascending order and the median value is chosen for replacing the corrupted pixel value. This process is repeated for eliminating the noise present in the converted grey scale image. After eliminating the noise in the image, the structure of the image is obtained by using the active appearance model algorithm which is explained as follows.

3.2 Structure Image Derivation Using Active Appearance Model

The next step is structure image extraction from the pre-processed image which analyze the shape of the image using the active appearance model [11] approach. The method effectively locates the objects from the long distance with effective manner by creating the statistical appearance model. The structure of the image is created by using the appearance model which is generated using the following parameter m, controlling texture g, shape x

$$x - \bar{x} + Q_s m \quad (2)$$

$$g = \bar{g} + Q_g m \quad (3)$$

where $\bar{x}$ is mean shape, $\bar{g}$ is mean texture, Q_s is modes of variation in shape and Q_g is modes of variation in texture from the training set. The position of the model points in the image frame X, is defined by the shape transformation parameter s, and the appearance model parameter m. The region of model points in traffic panel are selected in the image frame is I_{im} and the texture model I_s(image patch sampled on the traffic sign, which is warped to the mean shape), which is yield by projecting I_{im} in the texture model frame is given by the equation 4

$$I_s = T_v^{-1}(I_{im}) \quad (4)$$

where v is the vector of transformation parameter s.

$$I_m = \bar{I} + Q_g m \quad (5)$$

Where I_m is the current texture model in the traffic sign, During each search step,the current difference between the texture model I_s and image I_m is

$$r(p) = I_s - I_m \quad (6)$$

Where p is the parameter of model,

$$p^T = (m^T | s^T | v^T) \quad (7)$$

The sum of square error (pixel error) minimization is the main aim of AAM search procedure

$$E(p) - r^t r \quad (8)$$

The Image I_s is non linear due to the image is wrapped, so to make it linear the first order taylor expansion is

used by following the Gauss-Newton optimization method to approximates the equation 6

$$r(p+\delta p) = r(p) + \frac{\partial r}{\partial p}\delta p \quad (9)$$

Where $\frac{dr_i}{dp_j}$ is the *ij*th element of matrix $\frac{\partial r}{\partial p}$

Setting P to 0 in equation 9 to choose δp to minimize $|r(p+\delta p)|^2$ during matching the current residual(r) gives

$$\partial p = Rr(p) \text{ where } R = \left(\frac{\partial r}{\partial p}^T \quad \frac{\partial r}{\partial p}\right)^{-1} \frac{\partial r}{\partial p}^T \quad (10)$$

During training $\frac{\partial r}{\partial p}$ is calculated once using numeric differentiation and for h steps each parameter is displaced from its optimal value from -1 to +1 standard deviations and a weighted average of the resulting difference between next image and the current image over the training set is built.

$$\frac{dr_i}{dp_j} = \sum_h \omega(\delta p_{jh}) \frac{(r_i(p+\delta p_{jh}) - r_i(p))}{\delta p_{jh}} \quad (11)$$

This process is repeated in the iterative process for obtaining the significant image structuring with effective manner. After deriving the image structure, the region of interest should be segmented from the image which is explained as follows.

3.3 Extracting Region of Interest

The next important step is region extraction [12] which is done with the help of the Lpboost fuzzy clustering algorithm. During the image segmentation process, the cluster center has been identified using the worm swarm optimization algorithm and each pixel is evaluated using the Lpboost algorithm. First the cluster center is analyzed using the luciferin level, worm movement and neighboring pixel range. So, the cluster center is chosen by updating the luciferin level according to the fitness function which is defined as follows

$$l^i(t) - (1-\rho)l^i(t-1) + \gamma^j\left(x^i(t)\right) \quad (12)$$

Where,
l is the Luciferin Level,
i= position of glow warm,
ρ= luciferin decay constant,
γ = luciferin enhancement constant,
t=time, ($x^i(t)$) = search space.
After choosing the cluster center, cluster center valued is compared to the next neighbourhood value by using the distance and brightness condition in which the distance between i^{th} value and j^{th} value must be shorter and then the brightness value should be high. If the neighbourhood value is satisfying that condition, the neighbourhood value is updated by using the following equation.

$$r^i(t+1) = min\{r_s, max[0, r^i(t) + \beta(n_d - |n^i(t)|)]\} \quad (13)$$

Where
$r^i(t+1) = neighborhood\ range$,
$r_s =$ sensor range,
$n_d = number\ of neighborhood$,
$|n^i(t)| = number\ of\ neighbors\ in\ glowwarm\ i$
$\beta = modulated\ constant$.

During the cluster center estimation process, each pixel in the image is boosted by using the Lpboost techniques which helps to segment the effective region. The boosting algorithm maximizes the margin between the pixels while analysing the cluster center. The boosting process is done by as follows,

$$f(x) = \sum_{j=1}^{J} \alpha_j h_j(x) \quad (14)$$

Where,
α_j *is the nonnegative weighting for week pixel*
h_j *is indiuidual pixels present in the image*
Based on the above equation (14), each pixel is boosted while analyzing the cluster center. After estimating the cluster center, fuzzy clustering [13] process forms the cluster using the following equation.

$$J_m = \sum_{j=1}^{c}\sum_{i=1}^{n} \mu_{ij}{}^m d_{ij} \quad (15)$$

Where,
$J_m = fuzzy\ cluster$,
$\mu_{ij} = fuzzy\ membership\ value\ of\ ij$
$d_{ij} =$ *distance between ij*
c=cluster,
n=number of objects in workspace,

The above process is repeated to segment region from the structured image. From the segmented image, signs are recognized using the ant bee colony optimized artificial immune system which is explained as follows.

3.4 Traffic Sign Recognition

The last phase is traffic sign recognition which is done with the help of the ant bee colony optimized artificial immune system[14] which recognizes the signs by effective training and competition process. Initially the affinity value of each pixel present in the segmented region must be estimated as follows,

$$affinity = \left(\frac{distane}{maximum\ distance}\right) \quad (16)$$

In which the distance is calculated using the Euclidean distance measure and the maximum distance measure is estimated as follows,

$$Maximum\ distance = \sqrt{\sum_{i=1}^{n} r_i^2} \quad (17)$$

Where,
r is the data range of the attribute *i.*

After calculating the affinity value, the pixel present in the region is trained using the ant bee colony approach which train the feature according to the transition probability which is defined as follows

$$P_i^k(t) = \begin{cases} \frac{|\tau_i(t)|^{\alpha}|n_i|^{\beta}}{\sum_{u}|\tau_i(t)|^{\alpha}|n_i|^{\beta}} & if\ i\ \epsilon j^k \end{cases} \quad (18)$$

Where,
j^k is the set of feasible features t
n is the pheromone values
α, β is the heuristic information.

Then the training is repeated according to the probability value, which helps to recognize the traffic sign from the segmented region with effective manner. The recognition is done by conducting the competition between the features. Thus, the proposed ant bee colony based artificial immune system successfully recognizes traffic sign. Then the efficiency of the system is evaluated with the help of the experimental results and discussions.

4. Performance Analysis of Traffic Sign Recognition Process

In this section discussing the efficiency of the proposed ant bee colony based artificial immune system based traffic sign recognition process. Then the proposed system uses the Linkopin universe traffic data set while recognizing the traffic signs [15] with effective manner. The efficiency of the system is evaluated with the help of the mean square error rate, sensitivity, specificity and recognition accuracy. In this paper the error rate of the traffic sign recognition process is reduced by using the effective training algorithm. Then the obtained mean square error rate is shown in the figure table 1.

Table 1. Mean Square Error of Different Recognition Techniques

Classification Technique	Mean Square Error Value
Bag of visual Words for Text Geolocation and recognizing Symbols and Texts (BTG & ST)	0.79
Shape and Color	0.889
RBFN	0.924
BPNN	0.245
Proposed Method	0.0234

The above Table 2 clearly shows that the proposed ant bee colony based artificial immune system has the minimum mean square error which means it reduces the irrelevant feature from the image. The obtained mean square error rate is shown in the figure 2.

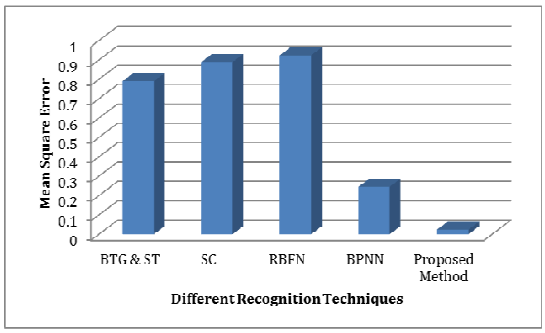

Figure 3. Mean Square Error

Then the proposed ant bee artificial immune recognition system effectively classifies traffic signs from the captured image with high sensitivity and specificity rate. The sensitivity and specificity value [16]] is calculated by using the following equation.

Sensitivity=TP/((TP+FN)) (19)

Specificity=TN/((TN+FP)) (20)

Where, TP = True Positive, TN = True Negative
FP = False Positive, FN = False Negative.

The following Figure 6 shows that the Sensitivity and Specificity value of the proposed system which is compared to the several traffic sign recognition methods.

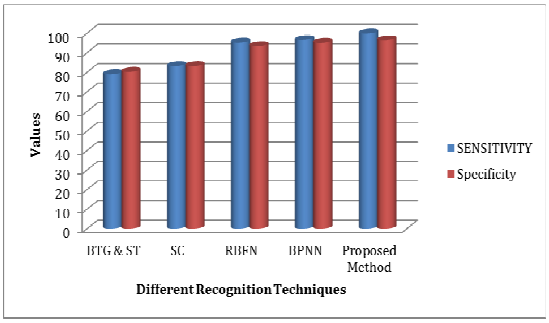

Figure 4. Sensitivity and Specificity

The above figures examine that the efficiency of the proposed traffic sign recognition system sensitivity and specificity value which indicates that the proposed system ensures the highest recognition rate [17] when compared to the traditional classifiers which is shown in the table 2.

Table 2: Classification Accuracy for Different Classification Techniques

Classification Techniques	Classification Accuracy (%)
Bag of visual Words for Text Geolocation and recognizing Symbols and Texts (BTG & ST)	72
Shape and Color	84.6
RBFN	87.2
BPNN	92.6
Proposed Method	99.3

Thus, the proposed system recognizes the traffic signs from the image with 99.3% accuracy when compared to the other methods because of its effective training and optimized region extraction process.

5. Conclusion

In this paper the traffic signs are recognized by using the Linkopin universe traffic data set. The data set consists of variety of the traffics signs information in terms of the image, numbers and words and so on. Initially the images are captured, transferred into grey scale image and the noise present in the image is removed by applying the median filter. Afterwards the structured of the image is derived by applying the active appearance model. From the structured image, the region has been extracted with the help of the Lpboost fuzzy clustering approach which evaluate each pixel in the image also boosting each pixel while analyzing the cluster center. According to the segmented region, the traffic signs are recognized with the help of the ant bee colony artificial immune system. Thus, the performance of the system is evaluated with the help of accuracy, sensitivity and specificity metrics.

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