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An Overview on Various Techniques used for Correct Interpretation of Roadway Symbols

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ABSTRACT: *In this research paper, a comparative analysis of various image enhancement in the spatial domain techniques is performed which is based on the numerical values of three image quality metrics that are the Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR) and the Structural Similarity for measuring the Image Quality (SSIM) in order to find the best technique among them so that the process of enhancing an image in the spatial domain can be done. The criteria for choosing the best technique are that it should have the minimum numerical value of Mean Squared Error (MSE) and maximum numerical value of Peak Signal to Noise Ratio (PSNR) and Structural Similarity for measuring the Image Quality (SSIM).*

KEYWORDS: traffic sign recognition, image denoising, image enhancement in the spatial domain, image filtering, pixel, noise

INTRODUCTION

Vehicle manufacturing companies boom due to an increase in autonomous vehicle production and growth in its use. It adds to a rise in competitors and also promotes increasing number of companies. It will facilitate the process of envisaging some novel methods employing roadway symbol identification. It helps in providing a secure driving environment [1-5]. The velocity of a moving vehicle can be limited by using maximum speed limit roadway symbols. Its speed can also be regulated by using them. They find use comprising localities employing enormous journey. A majority of roadway symbols comprises these localities [6-10]. During the course of driving a vehicle, the driver tends to ignore the speed limit sign boards. This conveys a message to limit the speed of car. The chances of having a crash can be minimized thus ensuring safety of person who is driving a vehicle. Now, the time has come to design an architecture which automatically identifies the Speed Limit symbols. It also issues a warning signal thereby telling him to stop the vehicle [11-15]. Speed Limit symbol identification is carried through following experiments. The potential candidates titled Regions of Interest are detected in the symbols. A symbol is categorized through identifying the Regions of Interest [16-20]. Colorful and regular symbols can be identified in order to fulfill the motive [21-25].

Sign's interpretation methods

The original problem was being decomposed into a class of problem which is the complement of the former having two classes encoded in ECOC matrix. The classifiers were being shared across the original categories with the use of these methods. Taking into account the research work found in [26-30], the color version subjected to discretization of the viewed symbol was

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compared with other symbols. The sets of discriminative local regions belonging to various categories were taken into account. By making use of standard templates of roadway symbols, they were subjected to learning through offline mode thereby employing the principal of one versus all dissimilarity maximization [1-5]. A color distance transform was employed to compare the true color roadway symbol which was being discretized thereby having the property of robustness thus laying a foundation to define the degree of dissimilarity [6-10]. The measurement of actual performance is very much difficult in this case [11-15]. The evaluation of performance of numerous machine learning techniques is not feasible due to lack of ideal database or technique [16-20]. Several attempts have been made to identify roadway symbols in spite of being included in the manuscripts [21-25]. A fast growth is observed in the research work pertaining to the domain employing identification of roadway symbols [26-30]. The research performed on this platform considering past few decades clearly signifies the concepts. Different types of new ideas and numerous techniques are implemented [1-5]. The potential regions of traffic signs are generally exploited by the detection module [6-10]. The recognizing module assigns different classes as well as indicates the class of a given roadway symbol [11-15].

LITERATURE SURVEY

It becomes a challenging task when it comes to the method of comparison of the actual performance since there is no such kind of ideal database or procedure for performance evaluation of several machine learning approaches that try to find a solution to the problem of recognizing traffic signs, even though they are present in the literature part [16-20].There has been a rapid growth in research and development sector especially in the area of detecting and recognizing traffic sign board images over the last few decades. Several novel ideas and effective methods have been proposed [21-25]. Usually, the detection part hunts potential regions of traffic signs whereas the category to which a traffic sign belongs is determined by the recognition part. The traditional methods which are used for the purpose of detecting sign boards can be grouped into three main classes, viz., color-based methods, shape-based methods and the sliding window-based methods. One may consider the process of recognizing a particular sign board image amongst all other members, a Herculean task when it comes to recognizing sign board image from a group of other sign boards. It is found that a variety of techniques are available in the arena of classifying known sign board images ranging from ordinary methods like the matching of templates to sophisticated machine learning techniques. One of the very significant and most important algorithms which are employed to perform the task of classifying multiple sign board images can be attributed to well-known Support Vector Machine (SVM) algorithm. If the transcripts authored by [26-30] are taken into account, one can find the significance attached to automatically detecting and recognizing sign board images taking help of Support Vector Machines (SVMs) in combination with Gaussian kernels. However, the system was required to classify candidate blobs into a shape class before recognition. As a sequence, only the pixels that were part of the sign were used to construct the feature vector. In [1-5], different methods other than those which are currently available in the context of detecting and recognizing sign boards in an automatic fashion were brought to the notice of people. It can be very well understood from this study that a comparatively greater emphasis was laid in enhancing the accuracy of existing methodologies prevalent in detecting and recognizing sign boards in an automatic fashion thereby resulting in the reduction of multiple vectored inputs which prove to be more useful in the task for supplementing above parameters that may be required during executing complete process leading to a sudden fall in the usage which demands capacity and duration for testing latest specimens [6-10].An SVM segmentation approach for traffic sign recognition was given in [11-15] while in [16-20] an effective strategy helping in the process of recognizing slanted speed limit signs by extracting the rotation invariant features with the help of Fourier based wavelet descriptor was introduced. The different categories of sign board images were classified with the help of Support Vector Machines (SVMs) consisting of binary tree architecture. In [21-25], a shape-based classification was developed using an SVM. In order to represent the features, two types of features including a thresholded frame as well as moment generation that was proposed by some scientists. One can conclude that carrying out an extensive experimental procedure satisfy our main objective that involves some processes which consists of recognition of roadway symbols falling in distinct classes consisting of numerous geometrical patterns arranged in regular fashion as well as roadway symbol frames that depict the property of controlling velocity of moving vehicles in a safe and healthy environment. One may consider the process of recognizing a particular sign board image amongst all other members, a Herculean task when it comes to recognizing sign board image from a group of other sign boards. It is found that a variety of techniques are available in the arena of classifying known sign board images ranging from ordinary methods like the matching of templates to sophisticated machine learning techniques. One of the very significant and most important algorithms which are employed to perform the task of classifying multiple sign board images can be attributed to well-known Support Vector Machine (SVM) algorithm. If the transcripts authored by [26-30] are taken into account, one can find the significance attached to automatically detecting and recognizing sign board images taking help of Support Vector Machines (SVMs) in combination with Gaussian kernels. However, the system was required to classify candidate blobs into a shape class before recognition. As a sequence, only the pixels that were part of the sign were used to construct the feature vector. 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Driver Fatigue and Driver Mental Workload

Driver fatigue is a major causal factor in road accidents [21-25]. Fatigue is also a construct that links factors such as time of day, time since waking, task duration and monotony, with safety-related outcomes [26-30]. Fatigue can result from sleepiness (drowsiness), boredom, and mental or physical exhaustion. From these causal factors, drowsiness is considered the most relevant aspect of fatigue when applied in the driving context. Driver drowsiness has been implicated in road accidents both within professional [1-5] and general driving populations [6-10]. Accidents caused by driver drowsiness can have a similar fatality rate to alcohol-related crashes [11-15]. Multiple factors contribute to drowsiness, such as long working hours [16-20], lack of sleep [21-25] and medical conditions [26-30]. Lack of sleep is more prevalent in some populations, including junior doctors [1-5], submariners at sea [6-10] and 'fly-in fly-out' mining workers [11-15]. Chronic sleep restriction is a known risk factor in driving [16-20]. It is also well established that the 24 h circadian rhythm is marked with peaks and troughs in alertness levels as evidence by studies incorporating both subjective and objective sleepiness measures [21-25]. Task-related factors also contribute to driver drowsiness [26-30]. These factors may include driving duration [1-5] and monotony [6-10] such as that experienced in highway driving [11-15]. The effects of drowsiness manifest in a reduced capacity to maintain vigilance [16-20]. In the driving context this leads to observable changes in driver performance such as reduced capacity to maintain speed, distance between vehicles and lane keeping [21-25] all of which increase the risk of road accidents [26-30]. With mounting evidence linking driver drowsiness to road accident risk, industry has responded with investment in driver monitoring tools aimed at mitigating this risk [1-5].

Tools and Techniques to Monitor Driver Fatigue

These tools employ a range of methods including those based on (a) continuous driving time, (b) specific driver performance (e.g., steering) or (c) physiological response (e.g., eye metrics). Among the latter, eye and eyelid characteristics have been used to infer levels of drowsiness [6-10]. One of these tools, the Optalert Alertness Monitoring System (OAMS) [11-15] utilizes infra-red (IR) reflectance oculography to monitor eyelid movements. The system uses an IR emitter and sensor mounted on a spectacle frame to continuously measure eye blink velocity, from which levels of drowsiness are derived. The OAMS has been used for detection and monitoring of driver drowsiness in the mining [16-20] and road transport industries [21-25] as well as for pilot drowsiness detection in aviation [26-30]. OAMS has been used in commercial settings predominantly through the provision of drowsiness data to a central monitoring area. When a driver's drowsiness reaches a predetermined risk level, interventions (e.g., taking a mandatory break) can be implemented. Applications of this type come with a significant overhead in terms of monitoring and implementation cost. In addition, such interventions rely on fatigue detection rather than prevention. The current study explores the utility of real-time drowsiness feedback to drivers for fatigue prevention [1-5] has reported preliminary observational data indicating a reduction in an across-the worksite average driver drowsiness associated with the provision of driver feedback during the staged rollout of OAMS across a number of mining sites [6-10]. These data suggest that, at a group difference level, direct real-time driver feedback may reduce their drowsiness, compared to monitoring-only operation of OAMS. They do not; however, offer an insight into how individual drivers would respond to such feedback. Our study is focused on this individual response and developing an understanding of the utility of real-time feedback to individual drivers potentially leading to a low-cost strategy to improve driving outcomes for at-risk individuals. It also aims to examine the effectiveness of OAMS in improving driver functional state. It focuses on the Australian Army Reserve personnel. For the majority of participants, an Army training weekend is normally preceded by a full-time working week and often a lengthy drive to the location of Army Reserve duty. In addition, members often report for duty on a weekday night, again involving the commute to and from the duty location.

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Software Tools used

MATLAB R 2019a is employed to process input traffic sign boards in the training and testing image database. MATLAB (an abbreviation of "MATrix LABoratory") is a proprietary multi-paradigm programming language and numeric computing environment developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages. Although MATLAB is intended primarily for numeric computing, an optional toolbox uses the MuPAD symbolic engine allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems. As of 2020, MATLAB has more than 4 million users worldwide. MATLAB users come from various backgrounds of engineering, science, and economics.

History

Origins:

MATLAB was invented by mathematician and computer programmer Cleve Moler.The idea for MATLAB was based on his 1960s PhD thesis. Moler became a math professor at the University of New Mexico and started developing MATLAB for his students as a hobby.
He developed MATLAB's initial linear algebra programming in 1967 with his one-time thesis advisor, George Forsythe. This was followed by Fortran code for linear equations in 1971.In the beginning (before version 1.0) MATLAB "was not a programming language; it was a simple interactive matrix calculator. There were no programs, no toolboxes, no graphics. And no ODEs or FFTs". The first early version of MATLAB was completed in the late 1970s.The software was disclosed to the public for the first time in February 1979 at the Naval Postgraduate School in California. Early versions of MATLAB were simple matrix calculators with 71 pre-built functions. At the time, MATLAB was distributed for free to universities. Moler would leave copies at universities he visited and the software developed a strong following in the math departments of university campuses. In the 1980s, Cleve Moler met John N. Little. They decided to reprogram MATLAB in C and market it for the IBM desktops that were replacing mainframe computers at the time. John Little and programmer Steve Bangert re-programmed MATLAB in C, created the MATLAB programming language, and developed features for toolboxes.

Commercial development:

MATLAB was first released as a commercial product in 1984 at the Automatic Control Conference in Las Vegas.MathWorks, Inc. was founded to develop the software and the MATLAB programming language was released. The first MATLAB sale was the following year, when Nick Trefethen from the Massachusetts Institute of Technology bought ten copies. By the end of the 1980s, several hundred copies of MATLAB had been sold to universities for student use. The software was popularized largely thanks to toolboxes created by experts in various fields for performing specialized mathematical tasks. Many of the toolboxes were developed as a result of Stanford students that used MATLAB in academia, then brought the software with them to the private sector. Over time, MATLAB was re-written for early operating systems created by Digital Equipment Corporation, VAX, Sun Microsystems, and for Unix PCs.Version 3 was released in 1987.The first MATLAB compiler was developed by

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Stephen C. Johnson in the 1990s.In 2000, MathWorks added a Fortran-based library for linear algebra in MATLAB 6, replacing the software's original LINPACK and EISPACK subroutines that were in C.MATLAB's Parallel Computing Toolbox was released at the 2004 Supercomputing Conference and support for graphics processing units (GPUs) was added to it in 2010.

Recent history:
Some especially large changes to the software were made with version 8 in 2012.The user interface was reworked and Simulink's functionality was expanded. By 2016, MATLAB had introduced several technical and user interface improvements, including the MATLAB Live Editor notebook, and other feature.

6.Proposed Research Methodology to be employed:
The block diagram of our proposed research methodology to be employed is shown in the figure (Figure 1) below:

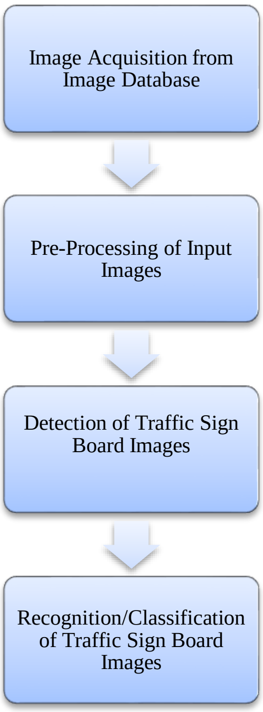

Figure 1 Block Diagram of our Proposed Traffic Sign Recognition (TSR) System

In our experiments, a traffic sign image database is prepared which consists of different types of traffic signs of different colors, shapes, sizes and variations in the lighting conditions according to the surrounding weather conditions like sunny, cloudy, rainy, foggy, snowy, smoky and hazy weather etc. After the traffic sign images are acquired from the traffic sign image database which is done with the help of external moving camera placed on the top of the car or in some cases may be mounted in the body of the car itself and in some cases, the driver who is driving the vehicle may wear a camera which is attached by a string with its two ends tightly fitted to the two ends of the camera and the assembly is worn by the driver. The process consists of five modules, viz., image acquisition from the image database, pre-processing of

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the input images, detecting the traffic sign which is followed by the process of recognizing the sign board which is followed subsequently by the process of traffic sign recognition which is then classified accordingly. The input image is acquired from the image database and subjected to some pre-processing operations such as noise removal as well as enhancing the image in the spatial domain. The images were detected by taking the aid of some methods that are used for segmenting an image. The input images were then subjected to the process of segmentation in which the complete image is partitioned into multiple images or a group of similar images by using an appropriate segmentation procedure. After the process of segmentation, the images were subjected to the process of feature extraction in which a set of suitable features was extracted from an image by using some feature extraction techniques. The images were then classified with the help of some appropriate classification algorithm that is most commonly used in the domain of applications pertaining to the engineering discipline where a correct and accurate interpretation of sign boards is required for ensuring safety of the driver who is driving the vehicle for the purpose of classifying the images.

EXPERIMENTAL RESULTS AND DISCUSSION

In this experiment, a traffic sign image database was prepared comprising various roadway symbol images belonging to numerous categories of different colors, shapes, sizes and variations in the lighting conditions according to the surrounding weather conditions like sunny, cloudy, rainy, foggy, snowy, smoky and hazy weather etc. There are a total number of 679 traffic sign board images in the training image database belonging to 18 different categories of traffic sign board images as well as there are a total number of 48 traffic sign board images which are present in the testing image database. The training image database was divided into two main categories, viz., the non-textual information traffic sign images which contain only the color, shape and there is no textual information present on it and the textual information traffic sign images which contain the color, shape as well as textual information present on it. The examples of different traffic sign images which are present in our Testing and Training image databases are included (Figures 2 and 3) in this paper.

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Figure 2 Examples of Textual and Non-Textual Traffic Sign Board images from Testing image database

Figure 3 Examples of Textual and Non-Textual Traffic Sign Board images from Training image database

The techniques of filtering the images with the help of Arithmetic Mean Filter, Circular Averaging Filter (Pillbox), Harmonic Mean Filter, Box Filter, Gaussian Filter were implemented as well as various parameters which give a clear idea about the quality of the

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image under consideration were also being calculated. There are a number of parameters which decide the quality of the given input image out of which we thrust upon the Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR) and Structural Similarity for measuring Image Quality (SSIM). A tabulated format consisting of numerical values of the above parameters (Table 1) will be quite helpful in deciding which algorithm is the best for implementation, for example, the values of PSNR and SSIM should be maximum whereas the value of MSE should be minimum for a given algorithm. The algorithm which fulfills the above criteria will be adopted for the research work in this project. The main thrust of this work is to focus on the comparison task involving various noise removal techniques from digital images by using standardized performance indices enabling the researcher to select and use the best algorithm for future work. The processes involving enhancing digital images, segmenting the images by using suitable techniques, extracting useful features from the images followed by the task of classifying the images by employing an appropriate classifier algorithm are reserved for future work. The techniques which are incorporated for carrying out these specific tasks will also undergo comparison process which is highlighted in the above section of this paper. The techniques which are chosen for carrying out the proposed work will be derived from these comparison tasks thereby employing the best technique having mean accuracy of nearly 100% and the ultimate goal will be to achieve best results as compared to other techniques found in the literature part ensuring maximum reliability, efficiency and robustness to noise which is present in two dimensional images. The different types of algorithms that are used in the above experiment are discussed in this paper.

Various Image Enhancement in the spatial domain techniques:

Fast Local Laplacian Filtering (FLLF) Type 1:

The technique of Fast Local Laplacian Filtering (FLLF) Type 1 is used for the purpose of enhancing a given input color image by increasing the local contrast of the color image. In this technique, a given input image is first of all imported into the workspace by setting the parameters of the filter in order to increase the details which are smaller than 0.4. Then, the technique of Fast Local Laplacian Filtering (FLLF) is applied to the resultant image to obtain the output image. The results which are obtained after carrying out the process of Fast Local Laplacian Filtering (FLLF) Type 1 are depicted as shown in the figure (Figures 4 and 5) below:

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Figure 4 Testing image database Color image Fast Local Laplacian Filtering (FLLF) Type 1 Results

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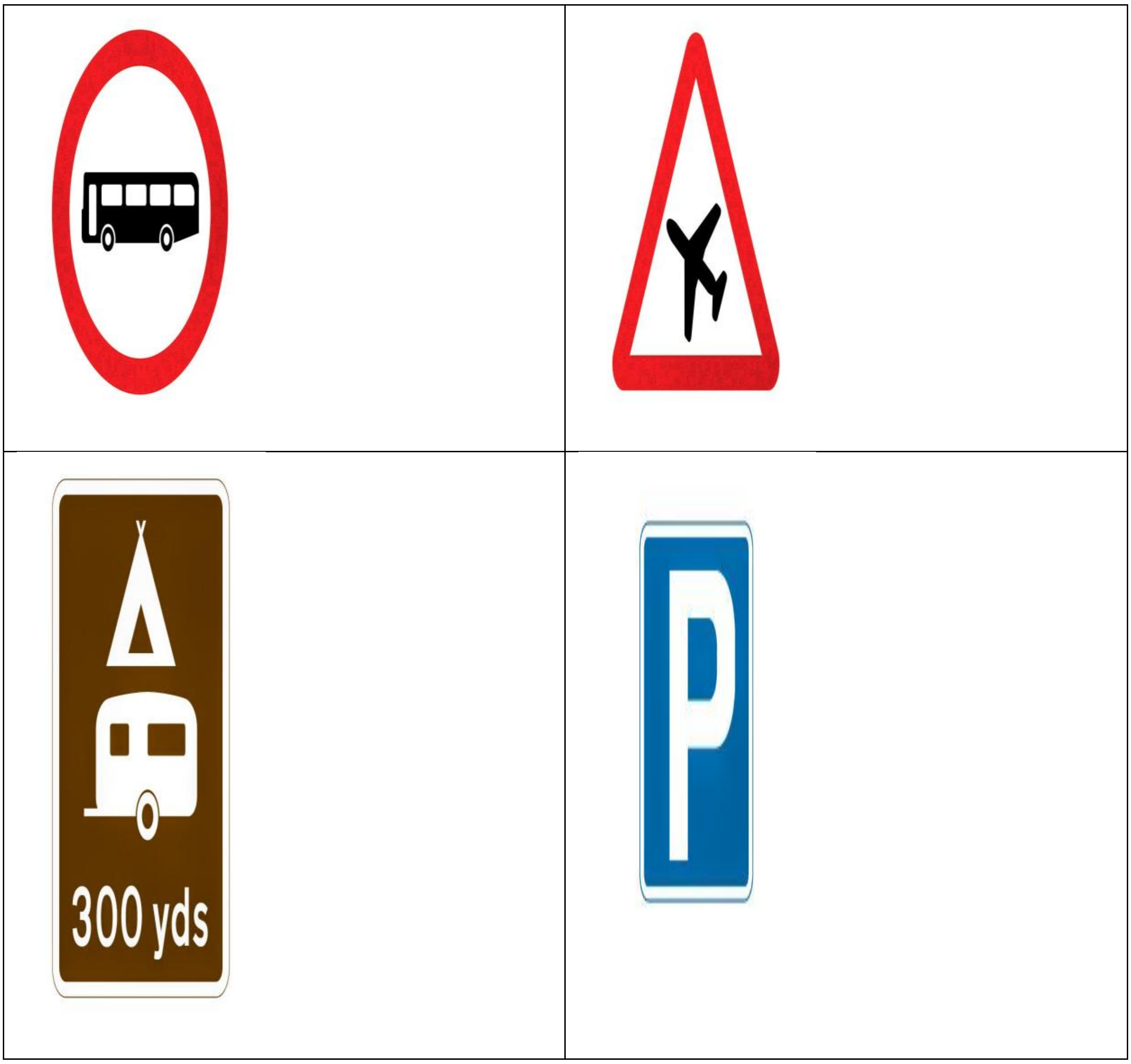

Figure 5 Training image database Color image Fast Local Laplacian Filtering (FLLF) Type 1 Results

Fast Local Laplacian Filtering (FLLF) Type 2:
The total number of computations which are required for the purpose of processing a digital image are very much greater in the case of Fast Local Laplacian Filtering (FLLF) Type 2 as compared to different algorithms which are used to enhance a given input color image. The process of approximation of the algorithm is carried out with the help of NumIntensityLevels parameter which discretizes the range of intensity of the pixels which are present in the input color image into a number of samples. The speed of operation as well as the quality of the given input color image is balanced by making use of this parameter. In this technique, a true color given input image is first of all imported into the workspace and displayed. The details which are present inside the given image are processed by making use of the sigma value parameter and the contrast is increased by making use of the alpha value parameter which also effectively enhance the local contrast of the input color image. The speed of execution can be increased

by making use of small number of samples but it also tends to produce artifacts which are clearly visible by the naked eye particularly in the areas which are having a flat contrast. The function can be timed by making use of only 20 intensity levels. The resultant image is subjected to processing and displayed as the final output. The results which are obtained after carrying out the process of Fast Local Laplacian Filtering (FLLF) Type 2 are depicted as shown in the figure (Figures 6 and 7) below:

Figure 6 Testing image database Color image Fast Local Laplacian Filtering (FLLF) Type 2 Results

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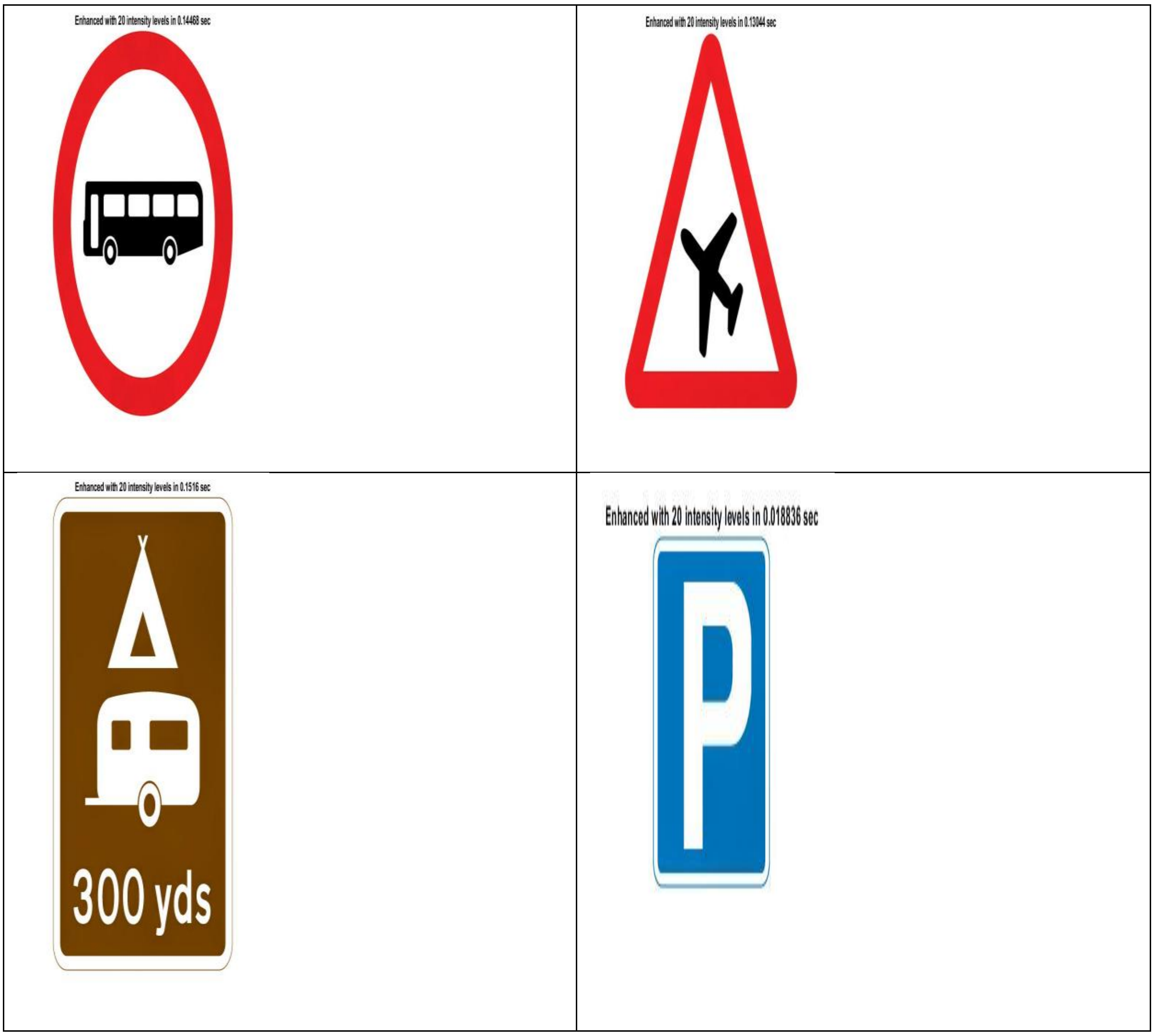

Figure 7 Training image database Color image Fast Local Laplacian Filtering (FLLF) Type 2 Results

Fast Local Laplacian Filtering (FLLF) Type 3:
In this technique, the given input original color image is subjected to processing with the help of Fast Local Laplacian Filtering (FLLF) Type 3 technique and it is timed by making the use of 100 intensity levels since the results which are obtained after carrying out the entire process are far more better as compared with the results obtained during the course of performing experiments on the given input image thereby making use of a large number of samples even though the time which is required for processing an image is considerably more. The resultant image is subjected to processing with 100 intensity levels and displayed. The results which are obtained after carrying out the process of Fast Local Laplacian Filtering (FLLF) Type 3 are depicted as shown in the figure (Figures 8 and 9) below:

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Figure 8 Testing image database Color image Fast Local Laplacian Filtering (FLLF) Type 3 Results

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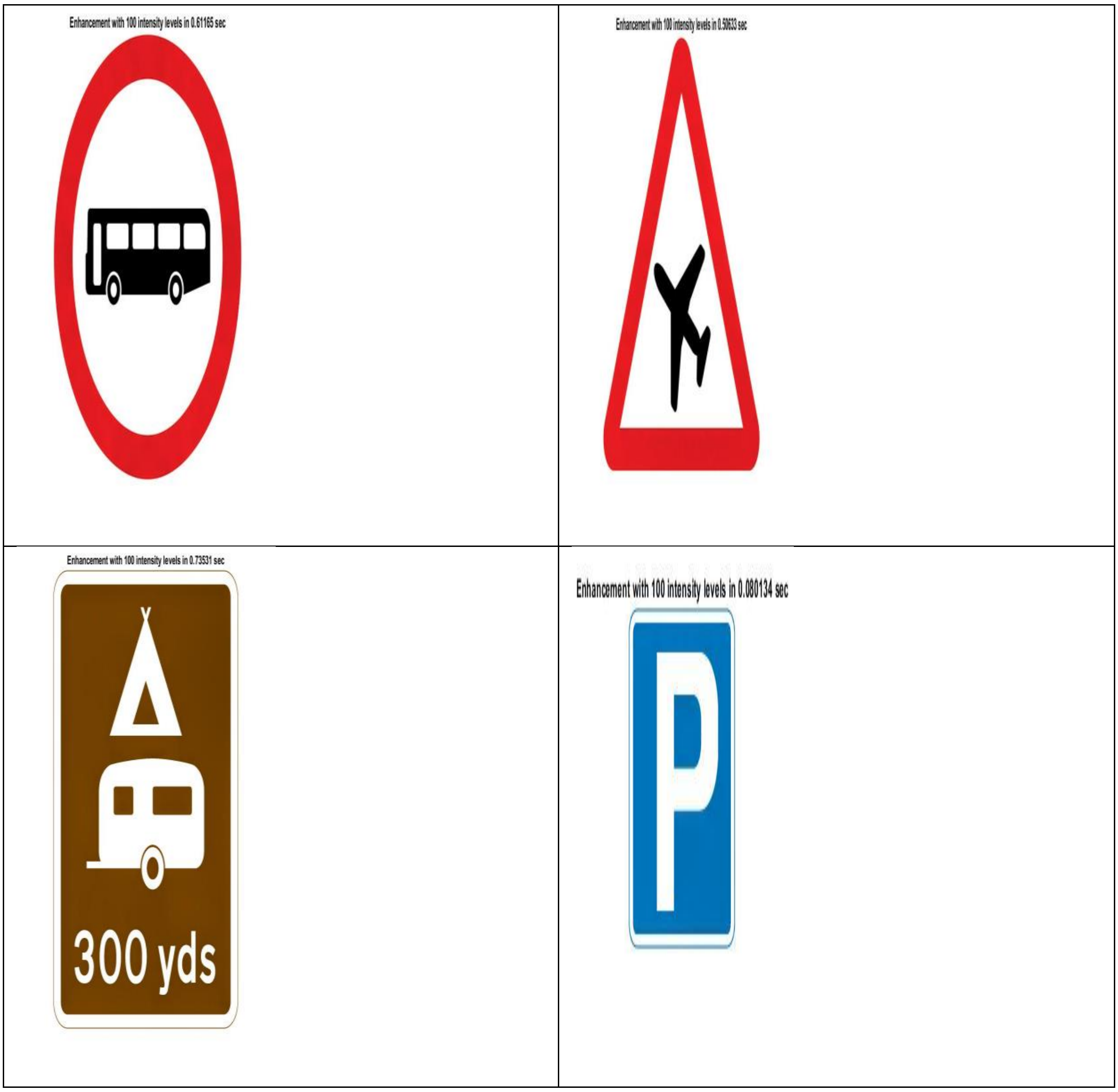

Figure 9 Training image database Color image Fast Local Laplacian Filtering (FLLF) Type 3 Results

Fast Local Laplacian Filtering (FLLF) Type 4:

In this technique of Fast Local Laplacian Filtering (FLLF) Type 4, the local color contrast of the given input color image is boosted by making use of the color mode parameter. First of all, the given input image is imported into the workspace with the original size of the image being reduced and displayed. The parameters of the filter are adjusted in such a fashion so that the details which are smaller than 0.3 out of a normalized range of 0 to 1 can be dramatically increased. In this technique, the given input color image is boosted by enhancing the local luminance contrast. The results which are obtained after carrying out the process of Fast Local Laplacian Filtering (FLLF) Type 4 are depicted as shown in the figure (Figures 10 and 11) below:

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Figure 10 Testing image database Color image Fast Local Laplacian Filtering (FLLF) Type 4 Results


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Figure 11 Training image database Color image Fast Local Laplacian Filtering (FLLF) Type 4 Results

Fast Local Laplacian Filtering (FLLF) Type 5:
In this technique of Fast Local Laplacian Filtering (FLLF) Type 5, the given input color image is enhanced by boosting the local color contrast. The colors are more saturated when the Color Mode is set to separate instead of luminance in spite of the fact that an equal amount of contrast is being applied to each image during the course of carrying out the experimental procedures on the input images. The results which are obtained after carrying out the process of Fast Local Laplacian Filtering (FLLF) Type 5 are depicted as shown in the figure (Figures 12 and 13) below:

	

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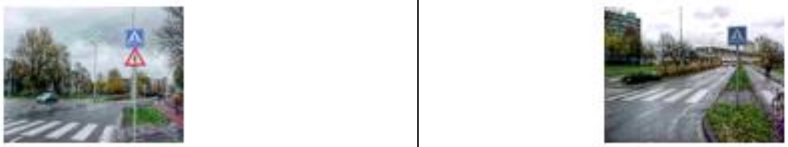

Figure 12 Testing image database Color image Fast Local Laplacian Filtering (FLLF) Type 5 Results

Figure 13 Training image database Color image Fast Local Laplacian Filtering (FLLF) Type 5 Results

Fast Local Laplacian Filtering (FLLF) Type 6:

In this technique of Fast Local Laplacian Filtering (FLLF) Type 6, the input color image is first of all imported into the workspace and displayed. It is being converted into the floating-point image format for the purpose of external noise addition in a easier fashion. The Gaussian noise which is having a zero mean and variance as 0.001 is added to the input image externally. The amplitude of the details is being set to smooth followed by setting of the amount of smoothing for the purpose of application. Then, the Edge aware filter is being applied to the input given color image. There is a remarkable improvement in the Peak Signal to Noise Ratio (PSNR) of the given image. It is also being observed that the details are smoothed and there is no change in the sharp intensity variations along the edges of the input color image. The results which are obtained after carrying out the process of Fast Local Laplacian Filtering (FLLF) Type 6 are depicted as shown in the figure (Figures 14 and 15) below:

Figure 14 Testing image database Color image Fast Local Laplacian Filtering (FLLF) Type 6 Results

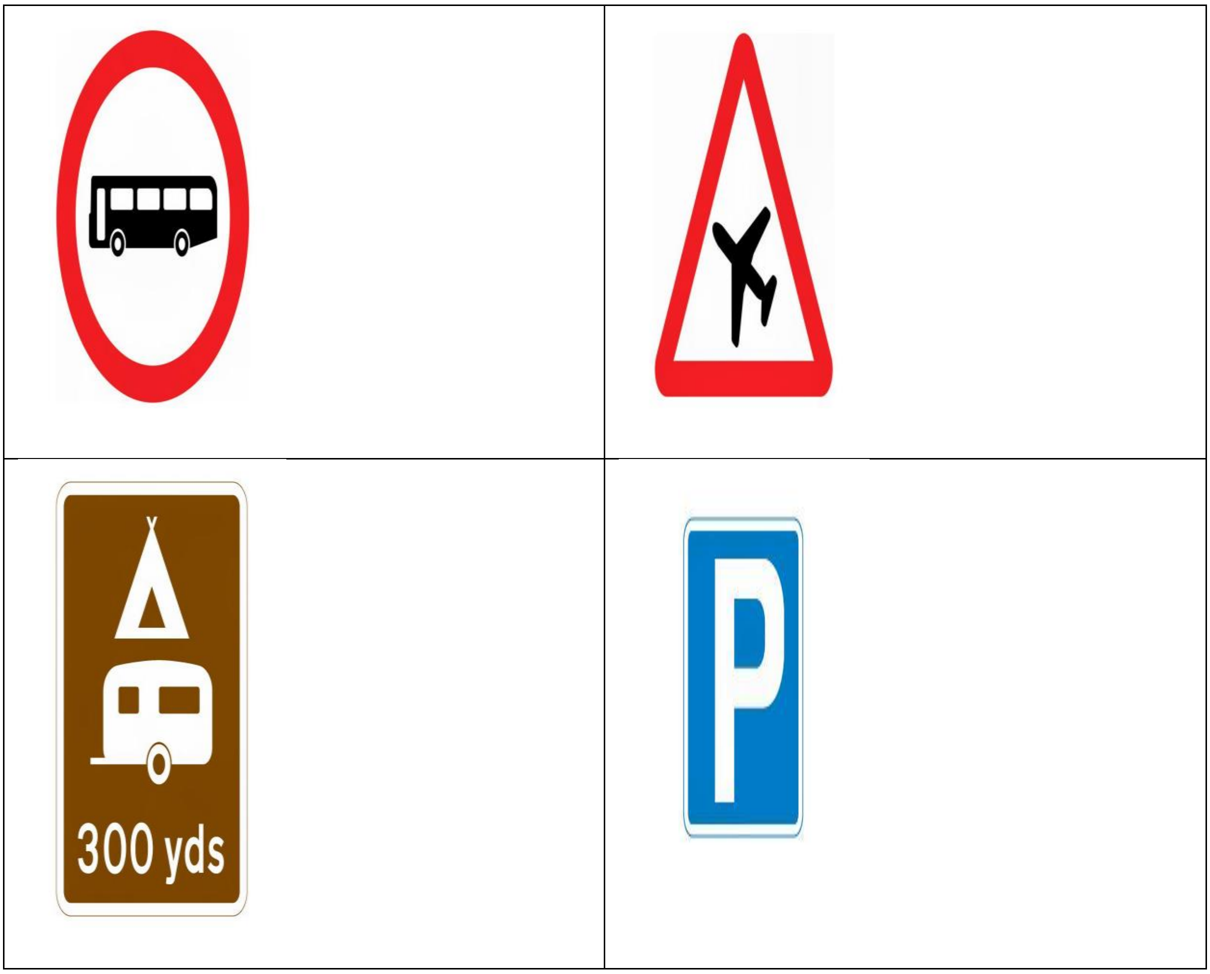

Figure 15 Training image database Color image Fast Local Laplacian Filtering (FLLF) Type 6 Results

Fast Local Laplacian Filtering (FLLF) Type 7:
In this technique of Fast Local Laplacian Filtering (FLLF) Type 7, the details which are naturally present inside a given image are being smoothed without affecting the sharpness of the edges which are present in the image. First of all, the input color image is being imported into the workspace and displayed. The amplitude of the details is set to smooth and the amount of smoothing is also set to a higher value for the purpose of application. It is generally observed that the filter produces results which are having a very good quality with a smaller number of intensity levels when the numerical value of the parameter alpha is greater than 1. The number of intensity levels are being set to a smaller value to ensure that the input image is processed at a faster rate. Then, the filter is also being applied. The output image is displayed after the complete process of filtering the image is carried out at the end of the experimental procedure. The results which are obtained after carrying out the process of Fast Local Laplacian Filtering (FLLF) Type 7 are depicted as shown in the figure (Figures 16 and 17) below:

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Figure 16 Testing image database Color image Fast Local Laplacian Filtering (FLLF) Type 7 Results

	

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Figure 17 Training image database Color image Fast Local Laplacian Filtering (FLLF) Type 7 Results

Table 1 Comparison of various image enhancement in the spatial domain techniques of traffic sign images present in our Testing image database based on various image quality metrics like MSE, PSNR and SSIM numerical values for Testing image database

Sr. No.	Years	Techniques used	Mean Squared Error (MSE)	Peak Signal to Noise Ratio (PSNR)	Structural Similarity for measuring image quality (SSIM)
1	2016	Fast Local Laplacian Filtering (FLLF) Type 1	298.540	23.409	0.811
2	2016	Fast Local Laplacian Filtering (FLLF) Type 2	133.472	26.911	0.878
3	2016	Fast Local Laplacian Filtering (FLLF) Type 3	156.974	26.212	0.868
4	2016	Fast Local Laplacian Filtering	841.632	18.920	0.644

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		(FLLF) Type 4			
5	**2016**	**Fast Local Laplacian Filtering (FLLF) Type 5**	**809.782**	**19.089**	**0.649**
6	**2016**	**Fast Local Laplacian Filtering (FLLF) Type 6**	**141.266**	**26.654**	**0.887**
7	**2016**	**Fast Local Laplacian Filtering (FLLF) Type 7**	**0.0002**	**35.445**	**0.972**
8	**2006**	**Entropy Filtering**	**18.16306875**	**-12.562758333333**	**-0.00484375**
9	**2006**	**Standard Deviation Filtering**	**335.46449375**	**-24.801495833333**	**-0.00370625**
10	**-**	**Pretrained Neural Network based Image Denoising**	**1.25E-5**	**47.180**	**0.998**

Table 2 Comparison of various image enhancement in the spatial domain techniques of traffic sign images present in our Training image database based on various image quality metrics like MSE, PSNR and SSIM numerical values for Training image database

Sr. No.	**Years**	**Techniques used**	**Mean Squared Error (MSE)**	**Peak Signal to Noise Ratio (PSNR)**	**Structural Similarity for measuring image quality (SSIM)**
1	**2016**	**Fast Local Laplacian Filtering (FLLF) Type 1**	**187.175**	**29.346**	**0.974**
2	**2016**	**Fast Local Laplacian Filtering (FLLF) Type 2**	**47.086**	**35.563**	**0.991**

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3	**2016**	**Fast Local Laplacian Filtering (FLLF) Type 3**	**57.260**	**34.558**	**0.990**
4	**2016**	**Fast Local Laplacian Filtering (FLLF) Type 4**	**544.488**	**24.926**	**0.927**
5	**2016**	**Fast Local Laplacian Filtering (FLLF) Type 5**	**268.785**	**26.816**	**0.942**
6	**2016**	**Fast Local Laplacian Filtering (FLLF) Type 6**	**8.0354505169867E -5**	**41.936**	**0.998**
7	**2016**	**Fast Local Laplacian Filtering (FLLF) Type 7**	**127.231**	**29.446**	**0.989**
8	**2006**	**Entropy Filtering**	**1.6744496307238**	**- 1.818430235988 2**	**0.03375480059084 2**
9	**2006**	**Standard Deviation Filtering**	**1.6744496307238**	**- 1.821116248153 6**	**0.03375480059084 2**
10	**-**	**Pretrained Neural Network based Image Denoising**	**1.373E-5**	**49.074**	**0.998**

Uniqueness of the Research Work:
The main objective of our proposed research work is to identify the best technique which helps in removing the noise which is naturally present in an image among various noise removal techniques based on different image quality metrics like Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR) and the Structural Similarity for measuring Image Quality (SSIM).The best technique is identified from its counterparts by assuming that it is having the least numerical value of Mean Squared Error (MSE) as well as it is also having the greatest numerical value of Peak Signal to Noise Ratio (PSNR) and Structural Similarity for measuring

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Image Quality (SSIM).After the process of calculating the numerical values of Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR) and the Structural Similarity for measuring the Image Quality (SSIM) was completed, it was observed that the Mean Squared Error (MSE) value was found out to be 0.0000 and the Peak Signal to Noise Ratio (PSNR) and the Structural Similarity for measuring the Image Quality (SSIM) values were found out to be Infinity and 1.0000 respectively for both the Testing and the Training image databases wen a combination of two techniques,namely,Pretrained Neural Network based Image Denoising and Fast Local Laplacian Filtering (FLLF) Type 7 were applied to the input traffic sign board images. The results which are obtained after combining the techniques of Pretrained Neural Network based Image Denoising and Fast Local Laplacian Filtering (FLLF) Type 7 for the input traffic sign board images which are present in our Testing image database are shown as below:




Figure 18 Testing image database Color image Results

The comparison of these image quality parameter numerical values for different combinations of Entropy Filtering and Standard Deviation Filtering techniques which are employed for removal of noise present in the Testing and the Training image database is given in the tabulated fashion shown (Table 3 and Table 4) as below:

Table 3 Comparison of various image enhancement in the spatial domain techniques of traffic sign images present in our Testing image database against our proposed technique

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based on various image quality metrics like MSE, PSNR and SSIM numerical values for Testing image database

1	**2006**	**Pretrained Neural Network based Image Denoising**	**1.25E-5**	**47.180**	**0.998**
2	**2006**	**Fast Local Laplacian Filtering (FLLF) Type 7**	**0.0002**	**35.445**	**0.972**
3	**Our Proposed Technique**	**Pretrained Neural Network based Image Denoising + Fast Local Laplacian Filtering (FLLF) Type 7**	**0.0000**	**55.413725**	**0.99952916666667**

CONCLUSION AND FUTURE SCOPE

In this research paper, a comparison of various image enhancement in the spatial domain techniques was done in order to choose the best technique among different techniques based on calculating different parameters which decide the quality of input roadway symbols like Mean Squared Error (MSE),Peak Signal to Noise Ratio (PSNR) as well as Structural Similarity for measuring Image Quality (SSIM) and after a thorough comparison, it was concluded that if the techniques of Pretrained Neural Network based Image Denoising and Fast Local Laplacian Filtering (FLLF) Type 7 are combined in a successful fashion, they have the maximum Peak Signal to Noise Ratio (PSNR) as well as Structural Similarity for measuring Image Quality (SSIM) numerical values which were found out to be Infinity as well as 1.0000 respectively and a minimum Mean Squared Error (MSE) value of 0.0000 as compared to other techniques for the Testing image database. A combination of these two techniques which are mentioned in the above section of our research paper will be used for Image Enhancement of the original input images present in Testing as well as Training traffic sign board image database in future research work.

References

[1] Huaping Liu, Yulong Liu, Fuchun Sun, “Traffic sign recognition using group sparse coding”, Elsevier- Information Sciences, Volume 266, January 2014, pp. 75-89.
[2] Zhan-Li Sun, Han Wang, Wai-Shing Lau, Gerald Seet, Danwei Wang, “Application of BW-ELM model on traffic sign recognition”, Elsevier- Neurocomputing, Volume 128, October 2014, pp. 153-159.
[3] Fatin Zaklouta, Bogdan Stanciulescu, “Real-time traffic sign recognition in three stages”, Elsevier- Robotics and Autonomous Systems, Volume 62, August 2012, pp. 16-24.
[4] Shuihua Wang, Hangrong Pan, Chenyang Zhang, Yingli Tian, “RGB-D image-based detection of stairs, pedestrian crosswalks and traffic Signs”, Elsevier- Journal of Visual Communication and Image Retrieval, Volume 25, November 2014, pp. 263-272.
[5] Jonathan J. Kay, Peter T. Savolainen, Timothy J. Gates, Tapan K. Datta, “Driver behaviour during bicycle passing manoeuvres in response to aShare the Road sign treatment”, Elsevier- Accident Analysis and Prevention, Volume 70, April 2014, pp. 92-99.

[6] Jesmin Khan, Sharif Bhuiyan, Reza Adhami, "Hierarchical clustering of EMD based interest points for road sign detection", Elsevier- Optics & Laser Technology, Volume 57, October 2014, pp. 271-283.
[7] Zong-Yao Chen, Wei-Chao Lin, Shih-Wen Ke, Chih-Fong Tsai, "Evolutionary feature and instance selection for traffic sign recognition", Elsevier- Computers in Industry, Volume 74, September 2015, pp. 201-211.
[8] Samuele Salti, Alioscia Petrelli, Federico Tombari, Nicola Fioraio, Luigi Di Stefano, "Traffic sign detection via interest region extraction", Elsevier- Pattern Recognition, Volume 48, June 2014, pp. 1039-1049.
[9] J.M. Lillo-Castellano, I. Mora-Jiménez, C. Figuera-Pozuelo, J.L. Rojo-Álvarez, "Traffic sign segmentation and classification using statistical learning methods", Elsevier- Neurocomputing, Volume 153, November 2015, pp. 286-299.
[10] Haojie Li, Fuming Sun, Lijuan Liu, Ling Wang, "A novel traffic sign detection method via colour segmentation and robust shape matching", Elsevier- Neurocomputing, Volume 169, May 2015, pp. 77-88.
[11] Zhenyu An, Zhenwei Shi, Ying Wu, Changshui Zhang, "A novel unsupervised approach to discovering regions of interest in traffic images", Elsevier- Pattern Recognition, Volume 48, February 2015, pp. 2581-2591.
[12] Yingying Zhu, Chengquan Zhang, Duoyou Zhou, Xinggang Wang, Xiang Bai, Wenyu Liu, "Traffic sign detection and recognition using fully convolutional Network guided proposals", Elsevier- Neurocomputing, Volume 214, July 2016, pp. 758-766.
[13] Ayoub Ellahyani, Mohamed El Ansari, Ilyas El Jaafari, "Traffic sign detection and recognition based on random forests", Elsevier- Applied Soft Computing, Volume 46, February 2016, pp. 805-815.
[14] Selcan Kaplan Berkaya, Huseyin Gunduz, Ozgur Ozsen, Cuneyt Akinlar, Serkan Gunal, "On circular traffic sign detection and recognition", Elsevier- Expert Systems with Applications, Volume 48, 2016, pp. 67-75.
[15] Yongtao Yu, Jonathan Li, Chenglu Wen, Haiyan Guan, HuanLuo, Cheng Wang, "Bag-of-visual-phrases and hierarchical deep models for traffic sign detection and recognition in mobile laser scanning data", Elsevier- ISPRS Journal of Photogrammetry and Remote Sensing, Volume 113, January 2016, pp. 106-123.
[16] Hamed Habibi Aghdam, Elnaz Jahani Heravi, Domenec Puig, "A practical approach for detection and classification of traffic signs using Convolutional Neural Networks", Elsevier- Robotics and Autonomous Systems, Volume 84, July 2016, pp. 97-112.
[17] Mario Soilán, Belen Riveiro, Joaquin Martinez-Sanchez, Pedro Arias, "Traffic sign detection in MLS acquired point clouds for geometric and image-based semantic inventory", Elsevier- ISPRS Journal of Photogrammetry and Remote Sensing, Volume 114, February 2016, pp. 92-101.
[18] Y. Ouerhani, A. Alfalou, M. Desthieux, C. Brosseau, "Advanced driver assistance system: Road sign identification using VIAPIX system and a correlation technique", Elsevier- Optics and Lasers in Engineering, Volume 89, May 2016, pp. 184-194.
[19] Jack Greenhalgh and Majid Mirmehdi, "Recognizing Text-Based Traffic Signs", IEEE Transactions on Intelligent Transportation Systems, Vol. 16, No. 3, June 2015, pp. 1360-1369.
[20] Nadra Ben Romdhane, Hazar Mliki, Mohamed Hammami, "An Improved Traffic Signs Recognition and Tracking Method for Driver Assistance System", in the Proceedings of IEEE

International Conference on Information Security (ICIS'2016), June 26-29, 2016, Okayama, Japan.
[21] Ruben Laguna, Ruben Barrientos, L. Felipe Blazquez, Luis J. Miguel, "Traffic sign recognition application based on image processing techniques", in the Proceedings of the Elsevier- Proceedings of the 19th World Congress, The International Federation of Automatic Control, Cape Town, South Africa. August 24-29, 2014, pp. 104-109.
[22] X. Baro, S. Escalera, J. Vitria, O. Pujol, P. Radeva, "Traffic sign recognition using evolutionary adaboost detection and forest-ecoc classification", IEEE Transactions on Intelligent Transport Systems, Volume 10, Issue 1, 2009, pp. 113-126.
[23] S.M. Bascon, J.A. Rodriguez, S.L. Arroyo, A.F. Caballero, F. Lopez-Ferreras, "An optimization on pictogram identification for the road-sign recognition task using SVMs", Computer Vision Image Understanding, Volume 114, Issue 3, 2010, pp. 373-383.
[24] C.C. Chang, Y.P. Hsieh, "A fast VQ codebook search with initialization and search order", Information Sciences, Volume 183, Issue 1, 2012, pp. 132-139.
[25] Ciresan, U. Meier, J. Mascim, J. Schmidhuber, "A committee of neural networks for traffic signs classification", in Proceedings of International Joint Conference on Neural Networks (IJCNN), July 2011, pp. 1918-1921.
[26] S. Escalera, O. Pujol, P. Radeva, "Traffic sign recognition system with b-correction", Elsevier- Machine Vision Applications, Volume 21, Issue 2, 2010, pp. 99-111.
[27] H. Gomez-Moreno, S. Maldonado-Bascon, P. Gil-Jimenez, S. Lafuente-Arroyo, "Goal evaluation of segmentation algorithms for traffic sign recognition", IEEE Transactions on Intelligent Transportation Systems, Volume 11, Issue 4, 2010, pp. 917-930.
[28] Y. Gu, T. Yendo, M.P. Tehrani, T. Fujii, M. Tanimoto, "Traffic sign detection in dual-focal active camera system", in the Proceedings of IEEE Intelligent Vehicles Symposium (IV), 2011, pp. 1054-1059.
[29] S. Gunal, R. Edizkan, "Subspace based feature selection for pattern recognition", Elsevier-Information Sciences, Volume 178, 2008, pp. 3716-3726.
[30] Y. Huang, K. Huang, Y. Yu, T. Tan, "Salient coding for image classification", in the Proceedings of Computer Vision and Pattern Recognition (CVPR), 2011, pp. 1753-1760.