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CELLULAR PARTICLE SWARM OPTIMIZATION BASED ON OPTIMIZED CANNY TECHNIQUE FOR EDGE DETECTION IN SIGN LANGUAGE DIGITAL IMAGES

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ABSTRACT

Sign Language act as a medium in exchange of message, knowledge and transfer ideas from deaf to common people. The understand and responses to the pattern or gesture is called as sign. In this technological era, we proposed and design a system that can understand the sign language and act as an interpreter to recognize the sign image. The technique is designed as a real time system for the recognition of sign. The objective of the paper is to proposed an effective and optimized algorithm to tested with real time American Sign Language (ASL) dataset which is collected from 10 different signers with single handed images. The objective method includes Pre-processing, Segmentation and Edge detection. The existing Edge Detection algorithms are not recognizing the boundaries in Edge detection and noise removal. The objective of the Canny Edge Detection method with Particle Swarm Optimization (PSO) and Cellular Particle Swarm Optimization (C-PSO) is to overcome the edge detection. The performance of this method shows that higher accuracy than the existing Edge Detection algorithms in terms of PCC, SI, SNR, MSE with standard metrics and alone with this few more metrics are used for finding the edge detection rate that is True positive rate (TP), False Positive rate (FP), True Negative rate (TN), False Negative rate (FN) and Accuracy.

KEYWORDS: Sign Language Recognition, edge detection, PSO, C-PSO, Canny, accuracy rate.

INTRODUCTION

Human communicates with each other by conveying their ideas, thoughts, and experiences to the people around them. There are numerous ways to communicate among all human is the gift of "Speech".[1] A language is structured as a system for communication with normal people. Every language expresses its own features differently. Whereas English speakers often signals the question by using a particular tone of voice, the users do so by raising the eyebrows and widening their eyes.[4] Sometimes users may ask question by tilting their bodies forward while signaling with their eyes and eyebrows. Just like other languages, there is some specific ways to express their ideas in American Sign Language and is vary from users. ASL users may choose terms from synonyms to express its common words.[3] It also changes county-wide like English words are differently spoken in different parts of the country. Culture, age, and gender are the factors that impact the ASL usage. After a long research and practice user can improve their fluency in ASL which is used in America. English language is completely separate from ASL and it contains essential features and functions on its own rules for grammar, punctuation, and sentence order. In general, spoken language are having different sounds which is created by words and tones of human voice (intonation). They are the most important tool which is used to communicates with human,[12] This paper concentrates on ASL which is used for special people. The only means of communication for deaf and dumb people is the Signed Language. A sign may use one hand or both the hands. Each sign in ASL is composed of a number of unique components and are called parameters. In sign languages, all signs can be described using five parameters namely handshape, movement, palm orientation, location and non-manual markers. Sign language is visual-manual modality deaf communities can communicate and receive information from other normal human. Signer uses hand shape, position, hand and body movements, gestures, facial expressions and other visual cues to form the words.[14]

The related works implies that the wide variety of researches are already existed in the field of Sign Language recognition system. In this paper, major research module optimal boundary detection technique has been proposed. Initially, the real time Static images of the palm side of right-hand digital image is resized into 256 x256 and converted into grayscale image. The operations on image performs preprocessing, tuning, noise removal, enhancement,

foreground and background segmentation and edge detection. The edge detection method performs three different steps namely Noise smoothing, Edge enhancement and Edge localization. The Canny Edge detection method fails in thin edge detection and errors in boundary detection and noise removal. The proposed method is to integrate with novel PSO and optimized CPSO to enhance canny edge detection technique.

PSO is a continuous evolutionary algorithm and initialized with a population. Random particles are searched by optimal value and then updates the population based on generations. Each particle is confirmed by its solution, fitness value, velocity and pbest in the particle. Each particle seeks in the search space with a velocity and is dynamically adjusted according to their own memory and the threshold value. Thus, particles evolve towards better search space. The velocity of a particle is predictable by:

$$v^{t+1} = wv^t + \varphi_1\left(x_b^t - x^t\right) + \varphi_2\left(x_g^t - x^t\right) \quad \text{Eq: 1}$$

And the solution is updated by

$$x^{t+1} = x^t + v^{t+1}, \quad \text{Eq: 2}$$

Where w is the inertia weight which is uniformly distributed among random numbers that determine the weight between attraction to the particle pbest which is the best particle position and gbest which is the overall best particle. It is based on the iteration that the edges are detected in digital image and their performance metrics are evaluated.

Cellular Particle Swarm Optimization (CPSO) is developed from Novel PSO. CPSO improve their positions using a scheme similar to cellular automata. The concept of cellular automata was first proposed by Von Neumann and Ulam.[18] The operation of a cellular automaton raises from homogeneously interconnected cells evolving synchronously at discrete time steps obeying one common transition function. Thus, a large array of simple elements can generate complex behaviors interacting locally with its neighbors. Likewise, Particles in swarm (or smart-cells) are communicate with cells that are present outside the swarm to improve their fitness value. The best value is compared with neighborhood and selected as the new particles (smart-cell). The neighborhood concept is used in optimized algorithm which is proposed to detect the continues edges of segmented image. The performance of this method shows that higher accuracy in standard metrics.

LITERATURE REVIEW

The research idea is justified by some of the methods on sign language and best classification methods are explained below

Suhaila N. Mohammed, Huda M. Rada explains about the sign language recognition system which is used for numbers. It is segmentated using the threshold saturation band combination with PSO and DBN. The recognition rate equal to 99.58%.

Alhussain Akoum, Nour Al Mawla describes hand gesture recognition system in ASL. The system effective replace for speech and enhancing the individual ability to express and intermingle with society in form of sign. The implemented and overall matching result shows 85%- 90% for recognition the words and letters.

Suharjito, Meita Chandra Ariesta, Fanny Wiryana and Gede Putra Kusuma explained about the sign language recognition focuses only on the right hand which is assumed to be the dominant hand of the signer. In this paper, CNN is for hfeature extractor and HMM as classification. The experimental results showed that the Hybrid CNN-HMM outperformed and focuses best method then other classification techniques.

Sakshi Goyal, Ishita Sharma, Shanu Sharma demonstrates that the real time digital images are captured and stored in directory. The feature is extracted to identify the Indian Sign Language and has been articulated by the user through SIFT (scale invariance Fourier transform) algorithm. The algorithm outperforms better and sign are recognized.

Mingguang Liu, Xiangshun Li,Chuyue Lou andJin Jiang explained CPSO-KICA algorithm and is proposed to solve the problem in selection the kernel parameters. CPSO is compared with PSO-KICA with collected data set. The proposed algorithm is independent and efficient in fault detection applications. The analysis of its components results are higher detection rates and lower the latency rate.

Ali B. Hashemi, M. R. Meybodi demonstrated differently in dynamic environment. The new approach based on local interactions in cellular automata and split the population of particles into different groups across the cellular automata. Each group tries to find an optimum locally which results in finding the global optima. Experimental results shows that Cellular PSO outperforms better than PSO.

Proposed Work

In the proposed method, the 5 fingers are converted into 26 Alphabet in English. The palm side of right-handed is converted into ASL. The real time dataset has been collected from 10 different signers and are given in Figure 1.

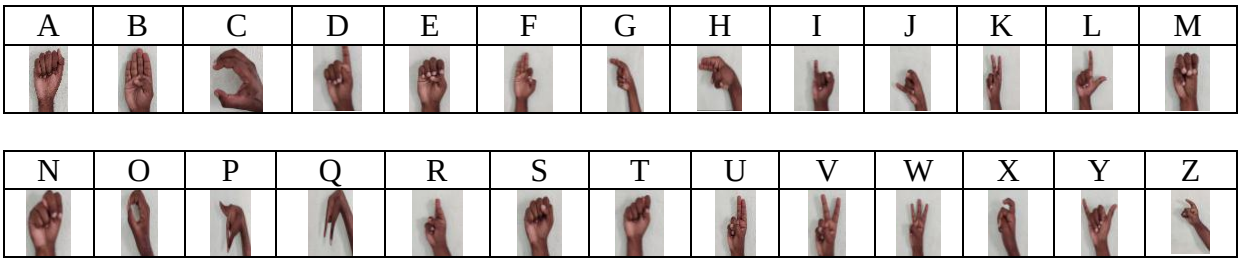

Fig. 1: Input Dataset.

The pre-processed and segmented image is taken forward for edge detection.[20] The processed image is taken as input in Sobel, Prewit, Robert and Canny method. The canny method performs much better than other methods, based on the results canny is processed with PSO-Canny and CPSO-Canny for edge detection.

Canny edge detection using proposed method

The Canny edge detection method was developed by John F. Canny in 1986.[21] This edge detection operator uses multi-stage algorithm to detect the edges in digital images.

Algorithm for the Canny is given as

Step 1: Apply Gaussian filter to smooth image in order to remove the noise in the image.

Step 2: Find the intensity gradients present in the image

Step 3: Apply gradient magnitude thresholding or lower bound cut-off suppression to find the edge detection

Step 4: Apply double threshold technique to determine potential edges of the sign

Step 5: Track the edges by hysteresis

Step 6: Detect the edges by suppressing the weak edges which is not connected to strong edges.

The main objective of the proposed method is to choose the optimal threshold values in CPSO which is also compared with novel PSO based canny edge detection.[7] The implementation of double threshold hysteresis method is viewed as a non-linear complex problem. The work is based on the appropriate threshold values and is chosen in canny edge detection method where the edge details are preserved more in sign images (2).

Particle Swarm Optimization (PSO)

Particle Swarm Optimization (PSO) is the lifetime inspired optimization technique proposed by Kennedy and Eberhart (1995). The objective is to find optimal solution for segmentation of ASL based on threshold value.[8] The procedure of novel PSO optimized canny edge detection method is to perform edge detection.

Algorithm for the PSO is given as

Step 1: Initialize population randomly (position and velocity of each particle)

Step 2: Evaluate the fitness value of the particles

Step 3: Repeat step 1&2 until attain fitness function

Step 4: Calculate particle velocity and based on it update particle position

Step 5: Until maximum iterations exceeded or minimum error criteria attained,[15]

Step 6: Best particle in the populations is selected and are the best solution.[11]

Cellular Particle Swarm Optimization (CPSO)

Cellular Particle Swarm Optimization algorithm is implemented to find the optimal solutions based on both the threshold value (low L and High H) that can be applied for segmentation of the regional sign language images. The ranges of thresholds are estimated through histogram analysis of the sign language dataset. The procedure of CPSO optimized canny method is to perform edge detection and is described below in algorithm. In this proposed work image segmentation of the regional sign languages threshold vales are estimated through histogram analysis. The procedure of CPSO optimized canny method is to perform edge detection.

Algorithm for the C-PSO is given as

Step 1: Initialize the particles

Step 2: Compute velocity of every particle and its new position

Step 3: Repeat step 1&2 until attain fitness function

Step 4: Compare the fitness value of each particle with the value of individual best of Pbest

Step 5: If the current value of a particle is better than Pbest, then the value is set to Pbest and update position in the problem space

Step 6: Identify the neighborhood best (Gbest) particle in the population

Step 7: If the current value of a particle is better than Gbest, then the value is set to Gbest. The index value of a current particle is updated

Procedure

Step 1: Input the segmented American Sign Language image I (u,v) for classification process.[13]

Step 2: The image selected from dataset is analyze and extract the edge detection.

Step 3: The canny edge detection provides average accuracy of image. Here, the weight selection process is viewed as a non-linear complex problem (10). It is formulized as an optimization problem in which the value of connection weights are falls within a threshold value range from 0 to 1. C-PSO algorithm is applied to choose optimal weight and to improves the edge detection of canny.

Procedure: To find optimal threshold values (Low L and High H) for CPSO

Step 1: Initialization of particle swarm and its parameters based on the threshold value the particles p and size m are assign between the range (0.0<=n<=1.0) are calculated its random position and velocity.

Step 2: Fitness evaluation of each particle is evaluated by threshold range.

Step 3: Find the pbest particle by evaluating the fitness function and neighborhood best gbest from each iteration.

Step 4: Compare the previous value of the particle with the current value.

If (gbest-1< gbest)

Set Gbest = gbest;

Else

Set Gbest= gbest-1;

Step 5: Find the gbest particle by identify the neighbourhood particle and assign value to the index variable g.

Step 6: Velocity and position is depending on three factors:

R1, R2 = random numbers between 0 and 1

Pbest= Personal (individual) best

Gbest = Neighbourhood (social) particle best

Step 7: Repeat the steps for maximum number of iterations

Step 8: Cellular Particle Swarm Optimization (CPSO) algorithm contains Gbest (low and high threshold values) after the fitness execution of 1000 iterations.

Step 9: Threshold value (high and low) is assigned while detecting the edges in ASL digital images from dataset by using hysteresis thresholding method.

RESULT

The experimental observation is demonstrated to indicate how the new variant algorithm outperforms the Classical PSO on all evaluated metrics. The experimental parameters set were the same for both PSO and CPSO. The particle size was set to 101 and the inertia weight was set to 0.729. The execution of both PSO and CPSO were terminated with 10000 fitness evaluation iterations.

This effort has ultimately improved the temperament of PSO algorithm to yield high quality results in sign images. The subjective evaluation result of canny method, PSO based canny and CPSO based canny are given in Figure 2.

The proposed work is implemented in MATLAB and Java and it is tested in manually generated.

Tamil Sign Language (TSL) datasets with limitation of single handed signs and black background images.

Each sign is captured with ten different signers. It is seen that cellular PSO has found better average solutions than traditional PSO based on similarity index and pearson correlation coefficient metrics for which the eqn (16) and (17) which are given below and the comparison of the results is shown in Table 1.

The proposed algorithm outperforms the CPSO on all evaluated metrics. The parameters are same for both the novel PSO and optimized CPSO. The size and weight of the particles were set to 100 for PSO and 1000 for CPSO based on fitness evaluation function and its iterations. The result of canny edge detection method, PSO based canny and CPSO based canny are given in Figure-2. The proposed work is implemented in MATLAB and real time American Sign Language datasets has been collected from signers with limitation of single-handed palm side right-handed signs with white background. Each sign is captured with ten different signers. In this CPSO canny has found better than PSO canny and canny edge detection based on Pearson Correlation Coefficient (PCC), Similarity Index (SI), Signal to Noise Ratio (SNR) and Mean Square Error (MSE), True positive rate (TP), False Positive rate (FP), True Negative rate (TN), False Negative rate (FN) and Accuracy. The performance metrics are evaluated and computed result are shown in Figure 3.

LETTER	ORIGINAL IMAGE	CANNY	PSO CANNY	C-PSO CANNY
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				
U				
V				
W				
X				
Y				
Z				

Table 1: Edge detection on Canny, PSO and CPSO for ASL

Fig. 3: performance metric comparison for PCC(A), SNR(B), SI(C) and MSE (D) for three methods.

True positive rate (TP) is distinct as the proportion of positive cases that are correctly identifies, which is calculated using the following equation: TP=d/(c+d).

False Positive rate (FP) is defined as the proportion of negatives cases that are incorrectly classified as positive. It is measured using the following equation: FP=b/(a+b).

True Negative rate (TN) is defined the proportion of negative cases that are correctly classified as positive, which is calculated using the following equation: TN=a/(a+b).

False Negative rate (FN) is defined as the proportion of positives cases that are incorrectly classified as negative. It is determined by using the equation:FN= c/c+d

Table 2: Performance metrics for edge detection.

Metrics	Canny	PSO Canny	CPSO Canny
Accuracy	81.9	90.1	93.7
TP	82.3	87.6	94.9
FP	25	36.8	19.3
TN	75	63.4	80.5
FN	17.9	12.4	5.2

CONCLUSION

Edge detection is the main segmentation process carried out in finding the boundary of the objects within the images. Canny edge detection is considered to the best edge detection method and it seems to produce false detection in noisy environment. An objective is proposed to develop an optimized edge detector that increases the localization accuracy of edge detection, especially in real time digital images. The goal of improved canny edges is achieved by introducing a hybrid optimization technique to find optimal threshold values which is a combination of PSO with cellular organism inspired from fibroblast. The proposed approach has improved the canny detector to connect the short edge contours into longer contours, and the experimental results validate its potentiality with different metrics. The results obtained will lead to higher accuracy of the classification method, adopted for the development of Tamil sign language recognition system.

Edge detection method comes under segmentation process carried out in finding the boundary of the objects within the images. Compare to other edge detection method Canny edge detection is considered to be the best method and its edges are weak and not connected to strong edges in noisy environment. In this proposed method an optimized edge detector is

proposed to increase the localization accuracy of the image through edge detection, especially in real time digital images. The goal is to improved canny edge detection method and is achieved by introducing a hybrid optimization technique to find optimal threshold values which is a combination of novel PSO with cellular organism inspired from fibroblast. The proposed approach has improved the canny edge detector in order to connect the short edge contours into longer contours. The experimental results validate its potentiality with different metrics. The results obtained from this method leads to higher accuracy of the classification method and it adopts for the development of American sign language recognition system.

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