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Neural Network with Improved Gradient Amplitude (NN-IGA) for Detecting and Diagnosing the Cerebral Palsy (CP)

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Abstract: Cerebral palsy (CP) is set of disorders that can affect the human ability to progress and preserve challenge and posture. This is basic disability that can occur in childhood. Based on the ability of the brain this can damage the eye of the human. Children between ages 3-11 years can effect with this disorder. This can capture by observing the movement of the eyes of the children. The effected children will have the mild motor-impairment and also we have analyzed the performance of CP children periodically. To decrease the risk of this disease, there is a need of developing the automated learning algorithm to detect the cerebral palsy (CP) in kids very effectively. In this paper, Neural Network with Improved Gradient Amplitude (NN-IGA) is developed to overcome the various issues in detecting the abnormalities in CP for kids and the performance is improved with more accuracy. To get the more accuracy the canny edge detection is used to overcome the issues in finding the edge detection. The comparative results shown among random forest (RF), neural network with canny and NN-IGA. The proposed system NN-IGA shows the more accuracy when compare with existing approaches.

Keywords: Cerebral palsy (CP), Eye disease, automated learning, Neural Network with Improved Gradient Amplitude (NN-IGA), canny edge detection.

Introduction

Cerebral palsy (CP) is one of the most common disorders that can be seen in children with a affect of 2.6 to 3.7 cases per 1000 live births [1]. Physical activities which are deficient have the significant problem that affects the status of health, functional mobility and well-being of children with CP [2, 3]. Physical activities that are very low level may contribute the development of weaken the other conditions such as obesity, chronic pain, fatigue, and osteoporosis [4, 5]. Based on this analysis, several techniques and challenges for rehabilitation services have moved to focused on developing the automated skills to interference to increase the method mobility and persistent physical activity (PA) [2, 3, 6]. To analyze the improvements of such interferences, developers, researchers, experts

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and doctors have based on the reports of PA. From the self reports these are very low-cost and better to complete, and this to consider that the social desirability and recall bias, and therefore may not be sufficiently valid or reliable for evaluation of sensibly important changes in PA [7].

The diagnosis of CP starting with an analysis of risk where, premature children, at the time of birth the weight is approximately less than 1500 grams which is high risk. Several early symptoms are defined such as abnormal muscle tone, epilepsy, gastro-esophageal reflux and feeling difficulty for taking food. Many default techniques are present for CP that includes prenatal stroke, hypoxic ischemic encephalopathy (HIE), infection, and birth asphyxia [8]. The author [9] defined that one of the most common lesion in kids with CP leads to the per ventricular white matter (19% to 45% of cases), and grey matter injuries including the basal ganglia, thalamus (21%) and cortical infarcts (10%). With some of the scanning techniques such as cranial ultrasound and brain magnetic resonance imaging (MRI) can be used to predict the CP with sensitivity (87% to 100%) and specificity (90% to 98%) shows the high risk in kids [10]. In [11], the author explained that 18% of kids effecting with CP may fails to detect abnormalalities in imaging.

Literature Survey

The author [12] introduced the 3-layer CNN which is integrated with the back propagation (BP) stochastic gradient decent (SGD) algorithm. The CNN is used to generate the required regions within the frame that reaches the huge points region which is selected as items location. The SGD algorithm is used for the training data with the temporal element. The performance of this algorithm is shown as 84.12% accuracy when compare with existing algorithms with the accuracy of 75%.

In [13], CNN is considered as basic object tracking. The architecture, VGG-16 is used as training for ImageNet database which is evaluated to find the relationship between the information which is represented at the receiver variable (inputs) and variables that are activated at every layer of the CNN. The author [14] analyzed (I) about the feature maps that are activated by the sparse and confine compared to the receiver field. (II) All these feature maps are very noisy which do not distinguish a target from its background. (3) Lower layers are distinguish among object classes and higher layers encode the overall technique and its background.

The author [14] introduced the two new deep learning (DL) algorithms such as AlexNet and GooLeNet these are CNN networks, the architecture of the layer is considered as different. The training is applied on audio recording with networks, with the duration of 1 second, kids who is suffering with asphyxia at the time of birth and also kids with normal birth. The training data is 2:1 ratio for the normal and abnormal, this is compared with the birth of asphyxia of 0.86 per 1000 [15]. The accuracy of 95.10% is obtained for GooLeNet when compare with AlexNet with 93.12%.

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The author [16] conducted several experiments by applying 3 age groups such as 0-6 years, 6-12 years and above 12 years. SVM is the classifier which is used to train the test set with 1201 normal and 1201 are abnormal samples, the training is uplifted with normal and abnormal ratio. The SVM is applied on testing and training which is against experts; by the observation it is represented as classifier by performing at human level[12,13,14,15].

IGA Canny Edge Detection

Canny edge detection algorithm is most widely used to detect the edges of the any input image. Generally, this algorithm utilizes the Gaussian filtering, this makes the edges clearly seems blurry. To overcome this issue, media filter is adopted to remove the noise within the image. In the image processing [10] Euclidean distance is used to filter the enhanced edges of the given input. Based on the Euclidean distance the filters are developed. This filters are in the direction of horizontal and vertical axis with 45^0, 135^0 and also the called as direction and central pixel value. This is very close to the central pixel, weight is greater and these shows affect on center pixel. This filter first specifies the size of the filter template. The 3x3 template is used and this is divided into horizontal and vertical axis direction and 450, 1350 direction. The filter is calculated as follows:

$$f(a,b) = \sqrt{f_{ab}^2(a,b) + f_{45^0 135^0}^2(a,b)}$$

$$f_{ab} = \begin{bmatrix} 0 & 2 & 0 \\ 2 & -1 & 2 \\ 0 & 2 & 0 \end{bmatrix} \quad f_{45^0 135^0} = \begin{bmatrix} 2 & 0 & 2 \\ 0 & 0 & 0 \\ 2 & 0 & 2 \end{bmatrix}$$

Where, filter can be divided into row and column filters as xy f it can be divided into 45 and 135 direction filters as 45 135 f 135.

Neural Network in Diagnosis of Cerebral Palsy Rehabilitation

To calculate the gradient amplitude, the Frei-Chen algorithm is utilized in this paper, this is more efficient when compare with the traditional gradient amplitude which is more deficiency. This calculation method shows from equation (1) to (4). With the integration of improved canny edge detection the efficiency of the detection of the edges of select CP input shows the better results.

$$A_a = \left(X_1 + \sqrt{2} \times X_2 + X_3 - X_4 - \sqrt{2} \times X_8 - X_9\right) \div 2\sqrt{2} \quad \text{Equation (1)}$$

$$A_b = \left(X_1 - X_3 + \sqrt{2} \times X_4 - \sqrt{2} \times X_6 + X_7 - X_9\right) \div 2\sqrt{2} \quad \text{Equation (2)}$$

$$A_{45^0} = \left(\sqrt{2} \times X_1 - X_2 - X_4 + X_6 + X_8 - \sqrt{2} \times X_9\right) \div 2\sqrt{2} \quad \text{Equation (3)}$$

$$A_{135^0} = \left(-X_2 + \sqrt{2} \times X_3 + X_4 - X_6 - \sqrt{2} \times X_7 + X_8\right) \div 2\sqrt{2} \quad \text{Equation (4)}$$

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$$A = \sqrt{A_x^2 + A_y^2 + A_{45^0}^2 + A_{135^0}^2}$$

Dataset Description

The dataset is collected from UCI repository which consists of 156 kids' eye images and suffering with Cerebral Palsy Rehabilitation. Among this 76 are affected with disease and 80 are normal images. The proposed system applied on this dataset[7,8,9,10,11,12].

Figure 1: dataset CP sample images

Experimental Results

The experimental results are conducted by using python programming language and Win python as IDE. The training and testing is conducted on various images that are belongs to CP effected images. The affected region is highlighted with the bounding box with red color. The green bounding Box is represented as normal image. The blue bounding box represented the severity of the affected region.

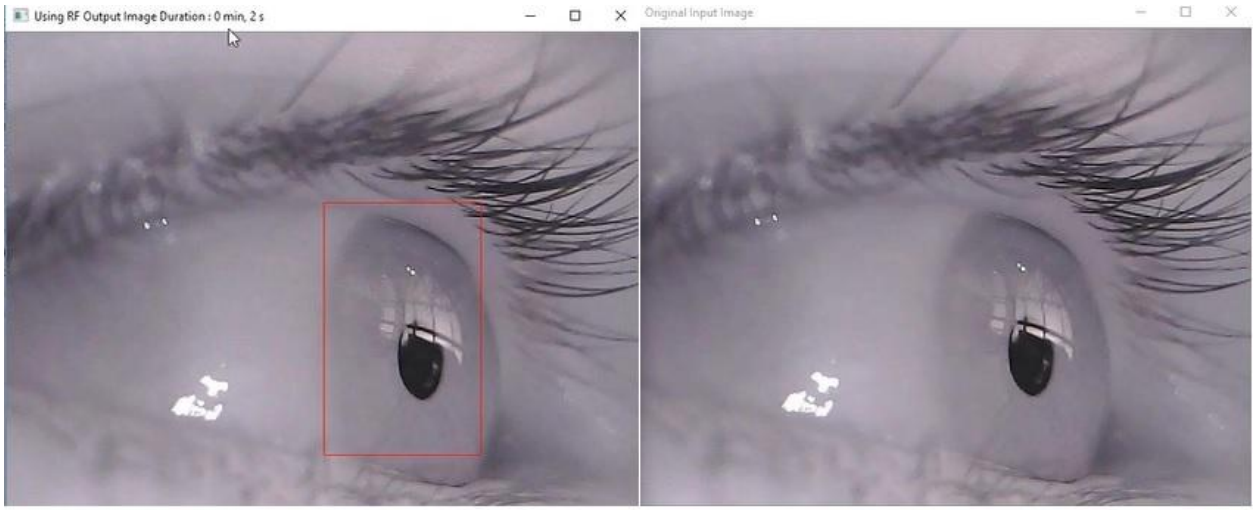

Figure 2: representing red bounding box which is affected area

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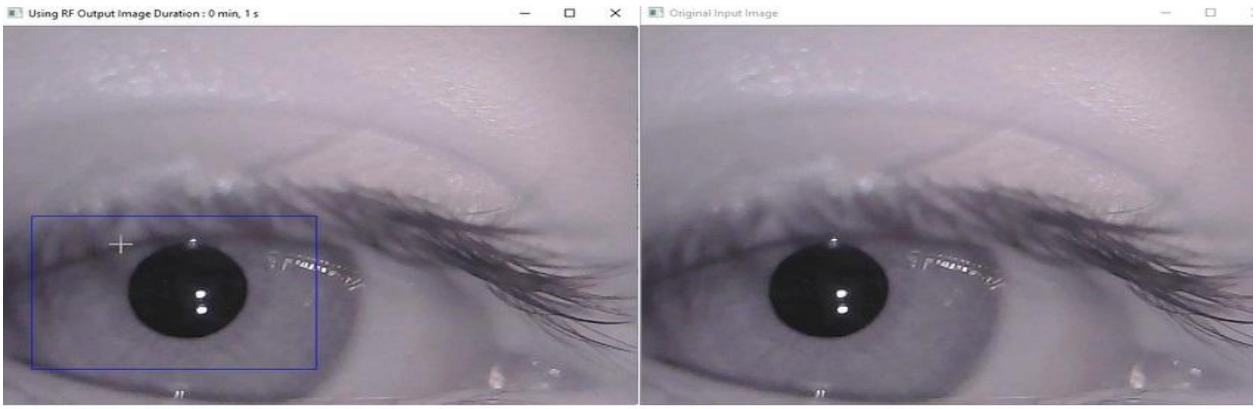

Figure 3: representing the blue bounding box with more abnormalities.

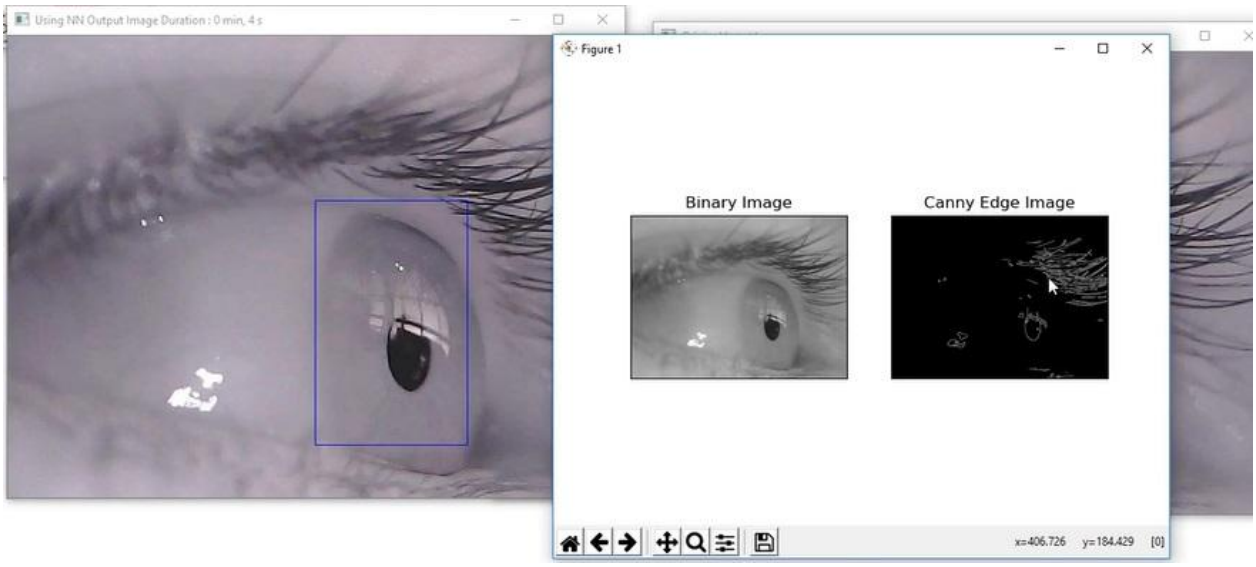

Figure 4: Finding the edges of the given sample by using the traditional canny edge detection

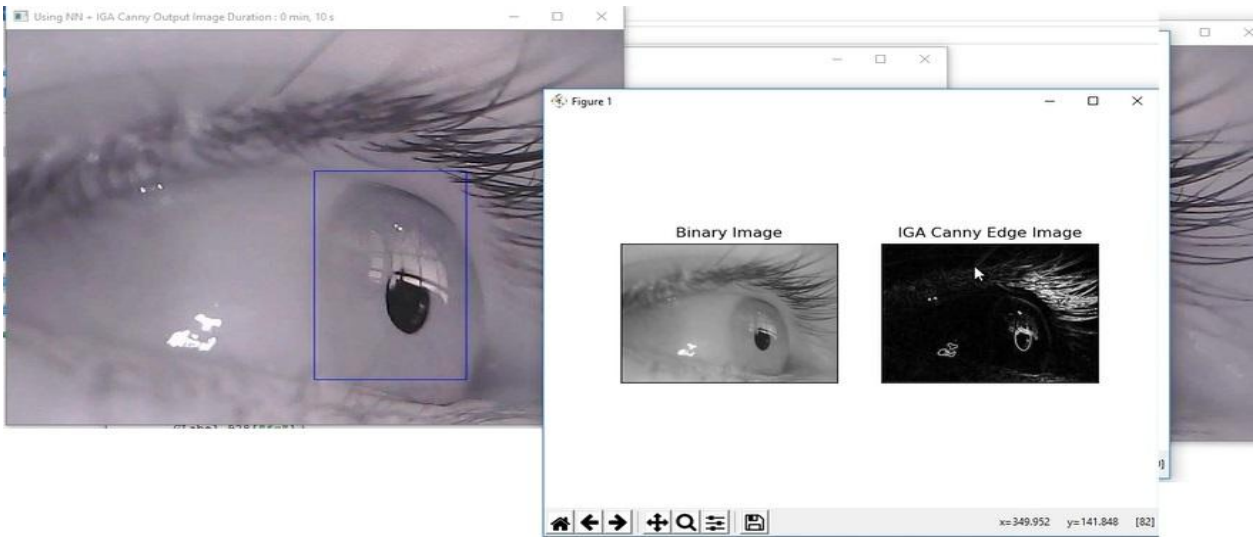

Figure 4: Finding the edges of the given sample by using the improved gradient amplitude canny edge detection

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Performance Metrics: Performance of the results are evaluated by using these parameters.

False Positive Rate (FPR)	$FPR = \frac{FP}{FP + TN}$	True Positive (TP),	False Positive (FP)
False Negative Rate (FNR)	$FNR = \frac{FN}{FN + TN}$	True Negative (TN),	False Negative (FN)
$Sesitivity = \frac{No.\ of\ TP}{No.\ of\ TP + No.\ of\ TN}$	$Specificity = \frac{No.\ of\ TN}{No.\ of\ TN + No.\ of\ FP}$	$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$	

Algorithm	Specificity	Sensitivity	Precision	F1-Score	Duration
Random Forest (RF)	0.91	0.74	0.74	0.74	1.95
Neural Networks (NN)	0.94	0.94	0.94	0.93	3.77
NN-AGI	0.97	0.97	0.93	0.91	1.41

Table 1 shows the comparative results of existing and proposed methodologies

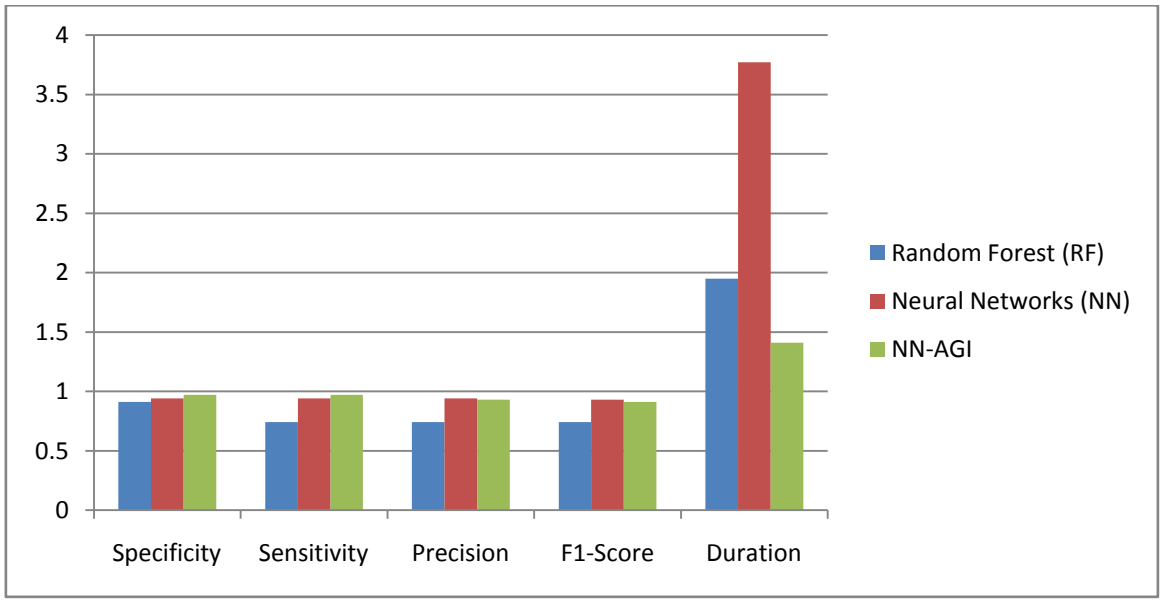

Figure 6: performance graph

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Conclusion

In this paper, an improved algorithm is introduced to overcome the various issues in detecting and Diagnosis of Cerebral Palsy Rehabilitation. The proposed algorithm is integrated with neural network and Improved Gradient Amplitude (NN-IGA). This will improve the performance in terms of parameters such as sensitivity, specificity, precision, f1-score and duration. This can show the improvement in the performance and NN-IGA work very efficiently. This is done by using improved canny edge detection to the NN-IGA model.

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