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Hybrid Soft Computing Approach for Hydro power Energy Prophecy

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Abstract

The prophecy of electricity station output power is taken into account as an associate degree vigorous way to increase the water energy capability and improve the protection and economy of the ability system. The electricity power plants output energy depends upon numerous factors like the rate of water or volume of flow of water and height or head of water etc. that is troublesome to be delineated by some mathematical expression. This paper introduces a technique of hydropower energy prophecy for an electricity station of Niagara Falls on historical information of rate of water or volume of flow of water and height or head of water. Water energy is free, natural resources, and non-polluting. This paper includes the coupling of the ant colony optimization (ACO), particle swarm optimization (PSO) and Adaline Neural Network (ANN) to foretell the hourly hydropower energy.

Keywords: Ant colony optimization; Particle swarm optimization; Adaline neural network; hybrid.

1. INTRODUCTION

Hydropower energy is that the most promising energy within the present day world. The assimilation of hydropower energy has become a contention within the trendy grid. The uncontrolled nature of the hydropower energy could be a confrontation with

the power system [2]. Hydropower energy prophecy depends upon varied factors like the flow of water or volume of flow of water and height or head of water etc. Hydropower model estimates the relative contributions of water from completely different elements of a landscape; giving insight into however changes in land use patterns affects annual surface water yield and hydropower production. First, it determines the number of water running off every pixel because of the precipitation less the fraction of the water that undergoes evapotranspiration. Hydropower energy model doesn't differentiate between surface, undersea and base flow, however, assumes that each one water yield from a pixel reaches the purpose of interest via one amongst these pathways, then sums and averages water yield to the sub-watershed level [1]. The pixel-scale calculations permit us to represent the no uniformity of key driving factors in water yield like soil kind, precipitation, vegetation kind, etc. therefore the ways of Hydropower energy prophecy are often divided into completely different categories that's basing upon the prophecy time, the ways of energy prophecy are classified into semi-permanent prophecy methodology, mid-term prophecy methodology, short prophecy methodology and super short prophecy methodology [3-5]. Basing on parameters, the ways are classified into water speed-based prophecy methodology and output power-based prophecy methodology. Basing on prophecy models, the ways of energy prophecy are classified into physical prophecy methodology, data point prophecy methodology, and learning methodology. Applied mathematics approaches use historical information to foresee the water flow speed on Associate in nursing hour basis. On the opposite hand, short-term prophecy and learning approaches rely on meteorological information. The neural network could be a common learning approach for hydro power foretelling. Alvisi et al. [13] studied 3 data-driven water level foretelling models. The One that's supported the unreal neural networks approach, whereas the remainder of two models is supported the Mamdani and therefore the Takagi-Sugeno symbolic logic approaches, severally. All of them are parameterized with respect to flood events alone, wherever water levels are above a specific threshold. An equivalent input and output variables are used for the analysis of the three models. However, so as to judge their capability and to influence completely different levels of data, two completely different input sets are deliberated. The previous is characterized by vital time and abstraction collective data of downfall, whereas the latter considers data associated with downfall that's a lot of distributed in area and time. The feature teams comprising information of Reservoir water levels, downfall within the structure, evaporation, discharges from rivers Malewa and Gilgil and one combine of your time harmonics were accustomed develop neural network models by Ondimu and Murase [13] and it had been more accustomed forecast water levels for Lake Naivasha in Republic of Kenya. Every feature cluster includes of six components. Some feature teams were compacted victimization the Karhunen–Loeve Techniques (KLT) to cut back their magnitudes. The neural network models developed that were able to forecast the reservoir levels terribly effectively for the lake for consecutive four months when a given month and given information for consecutive six months before the month. It had been found that the flexibility of neural network to forecast the reservoir level accurately will increase with the rise within the variety of feature teams. Information compression typically

reduced the dimensions and computation time of the models. Okoye & Igboanugo [14] states that Poor electricity generation in African country could be a terribly dangerous drawback. Correct prediction of water levels in dams is incredibly vital in power designing. Ex gratia power designing helps in making the certain steady offer of electrical power to the shoppers. This paper uses a hybrid technique that takes the advantage of each swarm intelligence and neural network to prophesy the hydropower energy. This paper incorporates the sexual union of the ant colony optimization (ACO) that is employed for locating the native optimum worth from the search area, Particle swarm optimization (PSO) is employed for locating the world optimum worth from the search area [6].

To boost the convergence rate and process speed, Associate in Nursing Adaline Neural Network rule (ANN) has been used. The proposed technique is applied to historical information of flow of water or volume of flow of water and height or head of water that is collected from an electricity station of Niagara Falls for prophesying the hydropower energy. This paper has 3 sections; section 2 contains the literature review of hydropower energy prophecy. Section 3 contains the define of Particle swarm optimization, ant colony optimization, Adaline neural network, and section 4 comprehends the projected hybrid model and therefore the result analysis of the model.

2. LITERATURE REVIEW

2.1. Hybrid technique of ant colony and particle swarm optimization

This hybrid technique entails of two meta-heuristic techniques of swarm intelligence called ant colony optimization (ACO) and particle swarm optimization (PSO) [6]. The mating of the two algorithms is employed to optimize the parameters of the model for locating a higher result. in this paper, the ant colony optimization (ACO) and particle swarm optimization (PSO) techniques area unit wont to forecast the water flow rate output of electricity power station of Niagara Falls. The hybrid technique is applied on the historical weather info that consists of water flow speed and height of water for twelve months. In this hybrid model, the secretion trails are updated for every ant for locating solutions by using the ACO technique [7]. PSO offers freedom to the particles for flying within the answer area. Therefore, PSO offers the broader portion of the answer area at every iteration, whereas ACO has the flexibility to seek out a higher answer round the search area [5]. Therefore the hybrid technique of each ACO and PSO can offer the benefits of each algorithm. As a result, the most effective answer is obtained for each the algorithms and therefore the MAPE of the projected model is 3.32%. during this hybrid technique, PSO finds its answer from the world search area however it slows its convergence speed towards the answer and takes a lot of iteration for locating the minimum error.

2.2. Hybrid Evolutionary Adaptive approach to foretell electricity prices and hydro power

The HEA approach is applied over the historical information of the wind from the year 2007 to 2008 in Portugal. This paper provides a replacement hybrid evolutionary adaptation approach (HEA) for hydropower and electricity market costs prophecy. The HEA approach is that the pairing of Mutual info, wavelet remodel, evolutionary particle swarm improvement and ANFIS techniques. During this paper Mutual info is employed for avoiding the randomness throughout the choice of the input file from the information set, wavelet remodel is employed for moldering the input file for the higher result, ANFIS network is employed for predicting the decomposed information [8]. Evolutionary particle swarm improvement is employed for optimizing the parameters of ANFIS network and determined mean absolute proportion error is 3.73%.

2.3. Recent method and progresses in forecasting of Hydropower generation

The principal found out of fuzzy-logic controller expend to the mark of accommodative genetic algorithms is to use out there measurable performances of the genetic algorithms as a result of the input of the controller, in conjunction with the algorithm parameters [11].This model consists of Genetic algorithm (GA), Particle Swarm optimization (PSO) and ant Colony optimization that involves a lower place evolutionary procedure algorithm for prognostication the speed of flow of water. Throughout this model fuzzy is applied on a dataset, then for a neural network, fuzzified knowledge is taken as input. The neural network particle swarm optimization (PSO) is used to elevate the parameters .and jointly the everyday mean absolute share error is 4.91%

3. OVERVIEW OF TECHNICAL SURVEY

3.1. Ant Colony Optimization

Ant Colony optimization was first introduced by Dorigo and Gambardella in the year 1997. Ant Colony optimization uses artificial stigmergy. This system is employed for finding drawbacks the issues like finding smart ways through graphs like traveling salesman problem [9]. In this technique the ant tries to seek out the shortest path between its nest and also the food supply that is understood because of the destination. Initially, the ants are moving indiscriminately by going some secretion path on the way. If food supply is found, then the ant returns to its nest by parturition down secretion path [7]. If the secretion is found in additional amounts, then the opposite ants follow the identical path. The secretion could be a volatile substance; therefore it's volatilized over time. Hence, the probabilities are a lot of for the presence of secretion path within the shortest path and then the ants try and notice the shortest potential path. The ACO technique relies on changing the secretion path which provides an honest resolution.

3.2. Particle swarm optimization (PSO)

Particle swarm optimization (PSO) is one in every of the meta- heuristic optimization techniques of swarm intelligence [6]. It had been 1st introduced by Kennedy and Eberhart (1995). it had been first meant for social behavior of the flocking and schooling of birds and fishes. In PSO, every particle could be a candidate resolution to the matter. Every particle in PSO makes its call supported its own expertise in conjunction with different particles experiences. Particles approach the optimum resolution through its gift rate, previous expertise and also the best expertise of its neighbors [15]. Compared to different biological process computation techniques, PSO will solve the issues quickly with top quality resolution and stable convergence characteristic, whereas it's simply enforced. In PSO, every particle flies within the multidimensional search area and adjusts its position in each step till it reaches an optimum resolution. In particle swarm optimization every particle has some fastened distance from the food supply which distance is thought of as fitness worth of every particle. From that fitness worth the particle best (P_{best}) worth is calculated. Then all the particles move within the direction of P_{best} particle by dynamical their rate and calculate the P_{best} worth for every particle. The rate and also the location of the particles are updated once each iteration. From that particle best (p_{best}) and also the world best (g_{best}) values are determined.

Algorithm of PSO

Step 1: Initialize the swarm particle within the search house indiscriminately.

Step 2: Calculate the fitness worth by exploitation objective operate and contemplate it as P_{best}.

Step 3: Update the speed and also the location for every Particle.

Velocity of every particle is updated by exploitation the equation

$$V_t = (w * V_{t-1}) + (c_1*r_1*(gb_{t-1} - P_{t-1})) + (c_2*r_2*(p_{bt-1}^{k} - P_{t-1}^{k})) \quad (1)$$

Location of every particle is updated by exploitation the equation

$$P_t = P_{t-1} + V_t \quad (2)$$

Step 4: Update the P_{best} and g_{best}.

Step 5: Stop if max iteration is reached otherwise repeat from step 2.

The velocity of particle i at iteration k should belong the range:

$$V_{tmin} \leq V_t^{k} \leq V_{tmax}$$

The parameter V_{tmax} determines the resolution or fitness, with those regions are to be searched between this position and also the target position [16]. If V_{tmax} is just too high, the PSO facilitates a world search and particles might fly past smart solutions. Conversely, if V_{tmax} is just too little, the PSO facilitates a neighborhood search and particles might not explore sufficiently on the far side domestically smart solutions. In

several experiences with PSO, V_{tmax} was usually set at 10-20% of the dynamic vary on every dimension.

3.3. Adaline Neural Network (ANN)

In computational intelligence Neural networks are the weighted directed graph wherever the nodes are the neurons and edges are connected in between two neurons within the network [10]. Different types of neural networks are there. Adaline network could be an easy two-layer neural network with solely input and output layer, having one output neuron. The amount of input layer neurons equals a number of inputs.

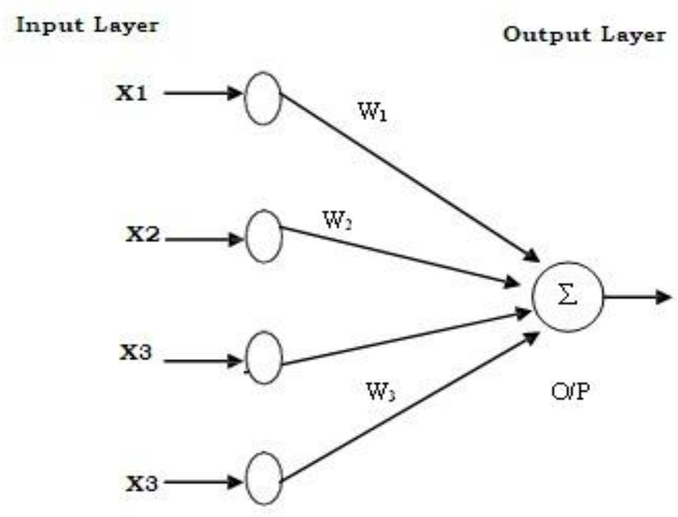

Figure 1: Represents the Adaline Neural Network

The figure 1. Represents the Adaline neural network in which the output neuron receives input from all input neurons. The above diagram consists of four neurons that are X1, X2, X3, X4 in the input layer and the output layer consists of only one neuron.

The output of the input layer is X1, X2, X3, X4 multiplied with four weights that are W1,W2,W3,W4 which is taken as input to the output neurons .

$$\sum_{i=0}^{n}(Xi * Wi) \quad \text{……………………………………..…(3)}$$

Error of the Adaline network will be calculated by using the equation

$$E = (d - o)^2 \quad \text{……………………….................. (4)}$$

3.4. Hybrid Model

This paper projected the hybridizing model for hydropower energy estimation that relies on ant colony optimization (ACO), Adaline Neural Network (ANN) and Particle Swarm optimization (PSO). In this model, ant colony optimization is

employed for determining the native optimum price from the search area. PSO is employed for determining the worldwide optimum price from the search area. To boost the convergence rate associate degreed process speed an Adaline Neural Network algorithm has been used. Particle swarm optimization approach is combined with the Adaline rule to cut back the error. The hybrid model is applied to historical information of rate of flow of water information that is gathered from the electricity power station of Niagara Falls for twelve months from November 2015 to October 2016.

The peak of water head, the most speed of water flow, minimum speed and low is taken as input for a hybrid model for estimating the energy. Within the projected hybrid methodology the hydropower information set is normalized by the equation.

$$Y'=(Y-Y_{min})/ (Y_{max}- Y_{min})\text{.....} \quad (5)$$

A variety of swarm particles used is ten. The acceleration coefficients c_1 and c_2 are thought of as a constant that's a pair of and therefore the inertia weight issue has taken as a constant price to influence the velocity of the particle. The constant represents what proportion a particle has the assured that is nearest to the food supply. In PSO approach, four parameters area unit chosen like a, b, c and d. confirm fitness price of every swarm mistreatment the parameters. From the fitness price, confirm particle best (P_b) price supported the subsequent equation.

$$\text{If}(x)>P_b(x)$$
$$P_b(x)=f(x)$$
$$\text{else } P_b(x) =\text{swarm}(x)\text{.....} \quad (6)$$

Wherever f(x) is that the fitness price of each particle and swarm(x) is that the current or previous fitness price. Then update a number of iteration parameters and from that the utmost fitness price is allotted because of the world best (gb) price of PSO technique. The inertia weight issue is taken into account for calculative the speed of particles by mistreatment equation (1) .The parameters of the PSO are used as weights for the Adaline network.

3.4. Flow chart

The flow chart of proposed hybrid mode is shown in figure.

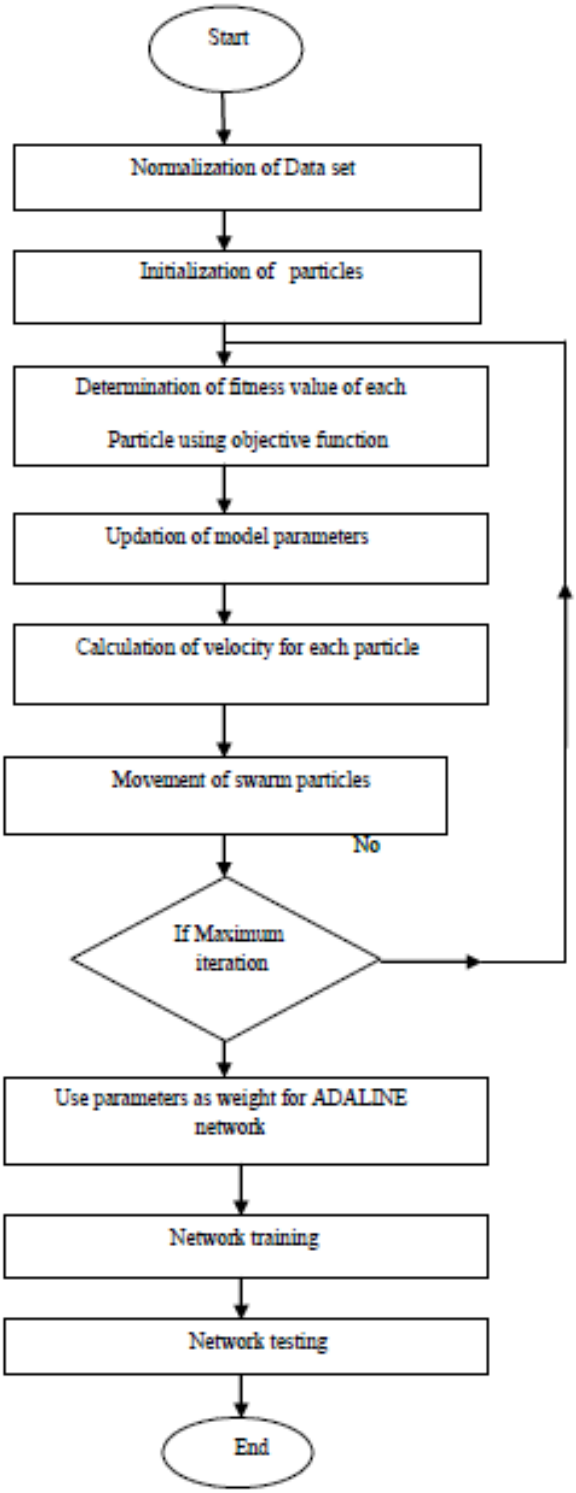

Figure 2. Flowchart of Hybrid Model

3.5. Proposed Algorithm

Step 1: Normalisation of Dataset.

Step 2: Initialize ten numbers of particles.

Step 3: Verify the fitness price of every particle exploitation an objective function.

Step 4: Notice the particle best price from the fitness price.

Step 5: Update the model parameters.

Step 6: Calculation of speed for every particle.

Step 7: Movement of swarm particles.

Step 8: If max iteration then step 8 else step 3

Step 9: Use parameters as weight for ADALINE network

Step 10: Verify the output of the network and calculate the mean error.

4. RESULT ANALYSIS

The hydropower energy is prophesied by victimization the hybrid of PSO, ANN and ACO and the hybrid technique is applied to the historical data of electricity powerhouse of Niagara Falls for twelve months and the Mean square error is obtained 0.0307 and MAPE is obtained 3.07%. The Mean Absolute percentage error is calculated by applying the hybrid model over Hydropower data set. Figure 3 represents the mean error obtained for the whole year. Figure 4 represents the error from the month of December to March, Figure 5 represents the error from the month of Apr to July and Figure 6 represents the error from the month of August to November. The graph for the desired vs. obtained values of the dataset are shown in Figure 7 where the blue line represents the obtained output and the line represents the specified value. In Figure 8 the blue line represents the mean error obtained by victimization PSO technique and the mean error is set as 0.0324. In Figure 9 the blue line represents the mean square error obtained in the Adaline network.

Table 1 represents Hourly Error for Hydropower energy prophecy throughout the year, Table 2 represents Iteration comparison result for Hydropower energy prophecy and Table 3 represents the comparative Mean absolute percentage error result for hydropower energy prophecy.

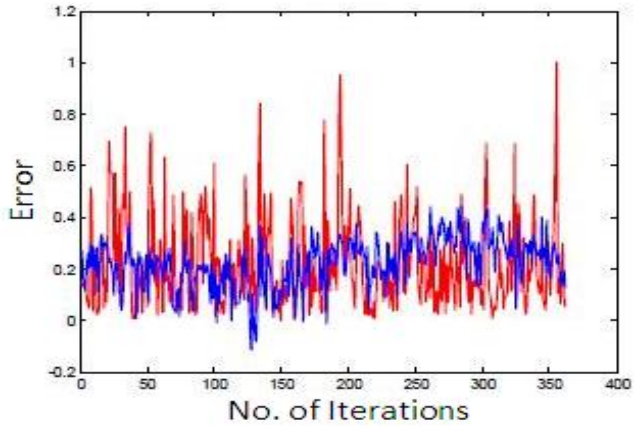

Figure 3: Represents the mean error obtained for the entire year (365 days)

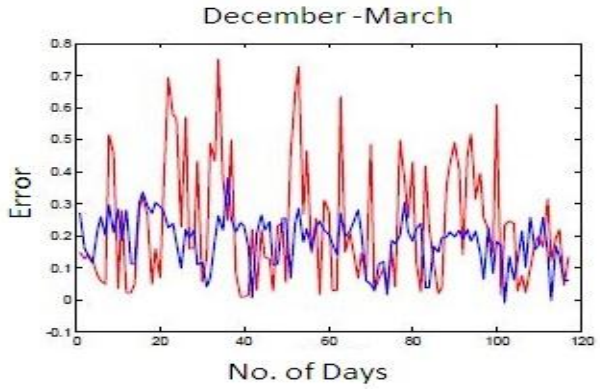

Figure 4: Represents Error from the month of December to March

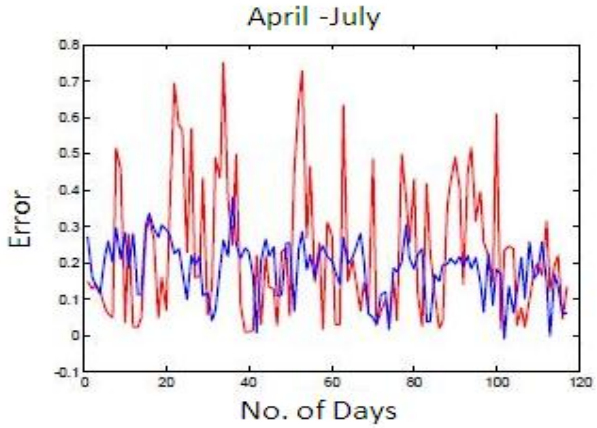

Figure 5: Represents Error from the month of April to July

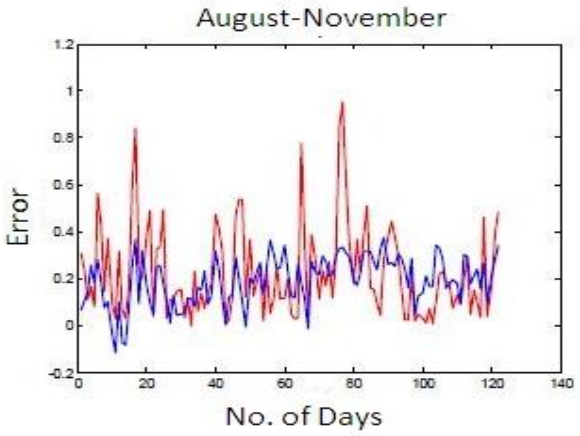

Figure 6: Represents Error from the month of August to November

Table 1: Represents Hourly Error for Hydropower energy prophecy

Month	**Mean error**
December-March	.0009
April-July	.0086
August-November	.0079
Average	.0058

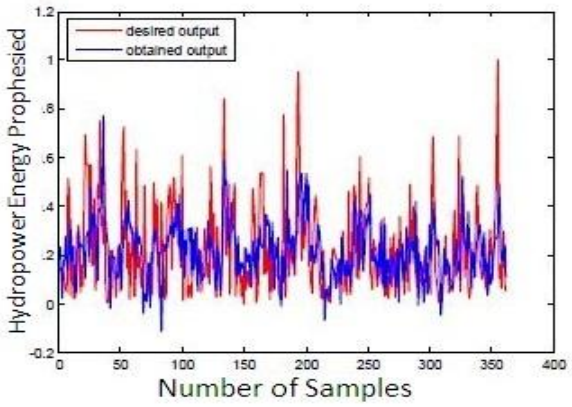

Figure 7: Represents Mean Absolute Percentage error is calculated by applying the hybrid model over Hydropower energy data set

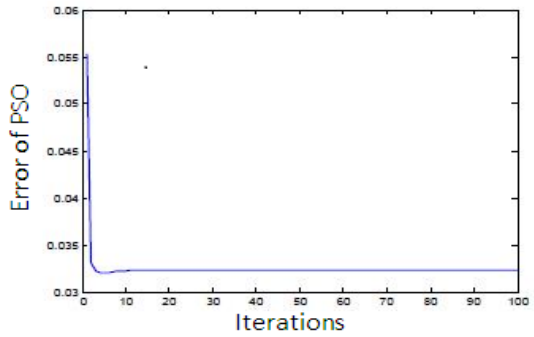

Figure 8: Represents Mean error obtained by using PSO technique

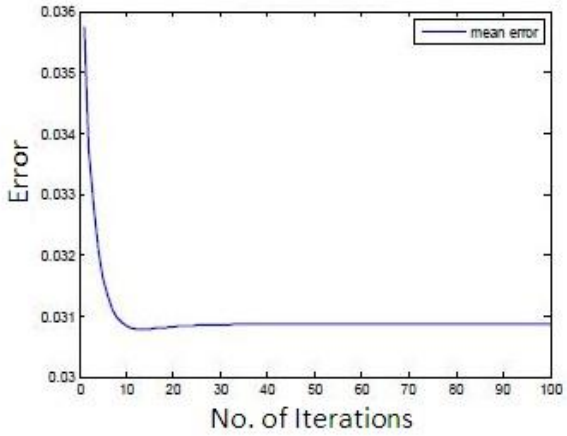

Figure 9: Represents the Mean square error obtained in the Adaline network

Table 2: Iteration comparison result for Hydropower energy prophecy

Models	**No. of Iterations**		
	50	**75**	**100**
PSO	0.326	0.325	0.325
ACO-PSO-ANN	0.0308	0.0307	0.0307
Dec-March	0.0009	0.0009	0.0009
April-July	0.0086	0.0086	0.0086
Aug-Nov	0.0079	0.0079	0.0079

Table 3: Represents Comparative MAPE result for Hydropower energy prophecy

Models	**Mean Error**	**MAPE**
Persistence	0.902	90.2%
NN	0.907	90.7%
NNWT	0.534	53.4%
HEA	0.0412	4.12%
ACO-PSO	0.03321	3.321%
ANN-PSO	0.0491	4.91%
PSO	0.0324	3.24%
ACO-PSO-Adaline	0.0307	3.07%

5. CONCLUSION

The proposed hybrid approach of ACO-PSO-ANN is used for hydropower energy prophecy. The proposed algorithm in this study, has directed to a higher quality of result with a faster convergence profile. For the comparison purpose, PSO and ANN algorithms are also applied to the same model and the results obtained are tabulated based on the mean average percent error. The empirical hourly hydropower energy for 365 days is used to train and test the prepared model. The empirical results indicate that the proposed technique can predict the hourly energy of hydropower with an MAPE of 3.07% which is completely acceptable, and better than other model. This approach is working with MATLABR10 c on a laptop with 1.86GHZ processor and 2 GB RAM.

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