

Study of Applications of Artificial Intelligence Algorithm for Analysis and Investigation of Hybrid Energy Systems to give Optimum Power Generation

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Abstract. Philosophy, psychology and Computer Science together contribute to Artificial Intelligence (AI). AI helps and play prime role for prediction, modelling and analysing of performance of renewable energy. It also plays vital role for study and control of various parameters for the said system. Complex rules which are the outcome of very strong mathematical equations and routines are rigid methods or approaches. On the other hand, AI based approaches are the flexible adaptive ways to learn key information patterns within information domain which is heaving multiple objective optimization algorithmic requirement. Further, hybrid energy systems are investigated which is formed by creating constructive superposition of advantages of the solar, wind and hydro energy systems. Study of simulation results is supporting the application of AI based techniques for hybrid energy resources based power generations.

1. Introduction

Artificial intelligent based techniques cover various algorithms from machine intelligence to expert systems. Basic fundamental thing is, machine is empowered with the ability to think. Researchers are proceeding in the area to make machine think intelligently in an adaptive way. Earlier methods with fixed coefficient values and rigid parameters are giving very much limited output. To excel in the output optimisations so that multiple objectives which are have tread off can be optimized and maximum output can be achieved. To compensate earlier problems, AI based techniques are emerging as very strong candidate. AI based approaches find applications in prediction and modelling of radiations from solar system and performance control and designing of hybrid system based photo voltaic systems.

The term hybrid energy systems basically points towards multiple energy conversion devices combined to aid to the energy supply system. They are best alternative to more conventional systems. The renewable energy resources like wind solar, water, and even ocean waves are combined either all together or minimum two of them finds huge contribution toward energy and power generation and can improve the performance tremendously[1][2][3][4].

Hybrid systems are having number of advantages as compared to the system based on single sources like

- Reliability is very high
- Life cycle cost is minimized
- Efficiency is enhanced



- Electricity generation is achieved for maximum hours.

The Paper is organised as follows: section 2 gives the brief discussions on AI based techniques. Section three discusses about the energy sources. Sections four discusses the conclusions and study some simulation results. Last section, fifth, lists the references.

2. AI based Algorithms

There are various AI based techniques like Genetic algorithms and advancement like real coded genetic algorithm, artificial Neural network (ANN) and advancement likes convolutional Neural Networks, R-CNN and Faster R-CNN.

2.1. Artificial Neural Networks

Methods proposed earlier were based on handcrafted features and a classifier combination. These which were basically dependent on human ingenuity for feature design. Old methods required manual analysis of real data and suitable feature representation was defined, were not robust and do not meet the challenges of analysis and control of the parameter of the energy systems. Hence, recent years see the future in several deep learning based algorithmic frameworks such as Convolutional Neural Networks(CNNs) capable of learning good features automatically from the most complex representation of the hybrid energy system. This makes the detection task robust and faster in contrast to the methods which used a combination of mechanically engineered features and classifier within a sliding window approach. However, RCNNs were slow in the sense that they calculated convolutional features for each candidate region separately. Fast RCNN and Faster RCNN methods which use Object Proposal Methods (OPMs) to propose candidate regions to the classifier are among the top performers for object detection on common benchmark datasets-ANN and Faster R-ANN can also be explored for the same as they have much more advanced properties.

2.2 Genetic Algorithms

A Search algorithm is a algorithm which is designed to find out some parameters. But its result sometimes may not be to the point. Presently for many solutions heuristic algorithms are used, as they never give wrong results and are never slow. Always its results are near to optimum. There are various heuristic algorithms whose description is there in the literature. To put in nut shell, Genetic Algorithms are different from other normal optimization methods in four ways:-

* GAs handles a coding of the parameter set, and not individual the parameters themselves.

" GAs search from a huge population of points and not a single point.

* GAs use objective function information.

* GAs use probabilistic transition rules for execution and not deterministic rules.

The binary coded Genetic Algorithm works successfully in discrete search spaces and the performance largely it depends on the coding used to represent the problem variables. For solving of optimization problems having continuous search space, binary-coded Genetic Algorithms discretise the search space by coding the problem variables as binary strings. Anyhow the coding of real variables into finite length bit strings always leads to the inability to reach the solution with arbitrary precision. The problem of optimization in continuous search space is dealt with a number of Real coded Genetic algorithms whose crossover operators are found to have inadequate search power[5].

3. Energy Resources

Energy as it is known today is of broadly two types namely, Renewable energy resources and Non-Renewable Energy resources[6]. Non-Renewable Energy Resources are those when spent take a lot of time (Millions of years) to replenish and are made up of mostly decomposed biological wastes. Non-Renewable energy resources include coal, oil, natural gas, fossil fuels and nuclear energy. Renewable energy resources on the other hand are those which can be generated without depleting its source or causing any harm to the environment. These Resources include Sun, Water Bodies, Heat within the Earth taking form of different types of energies like Solar, Hydro and Geo-thermal[7][8][9].

3.1 Solar Energy

Solar Energy is a form of energy which comes under the category of renewable energy. Energy which comes to the Earth from the Sun in the form of Light energy when converted to Electrical Energy is known as Solar Power. This conversion is accomplished using two approaches, one is direct and the other is indirect. Direct approach is done by using Photovoltaic's (PV) while, the Indirect approach utilizes Concentrated Solar Power (CSP). Solar energy is very beneficial to for many good reasons. It is comparatively better to generate, it is pollution free and maintenance and wear costs are almost negligible. However, there are some short-comings to it too. Installation of the solar panels requires a lot of space. There's also an efficiency that is not 100% and one of the major disadvantages of the entire system is its dependence on weather. If it is very cloudy or it is night, there will be less to none production of solar energy.

3.2. Wind Energy

Wind when flows, contains a lot of kinetic energy in it. The energy generated by the conversion of this potential energy in wind into Electrical energy with the help of turbines is known as Wind Energy. The rotor blades of the turbines are made up of Glass fibre or Reinforced carbon-fibre plastics. Wind energy is very helpful in a lot of ways. Windmill uses the flow of wind to run its turbine and hence making it an evergreen and technically an unlimited resource. There are no harmful residues left by the generator and therefore causing no harm to the environment. Naturally, there are short-comings to this type of energy generation too. It is a very erratic form of energy because it solely depends on the regularity and direction of the wind. Also, there are cases in which many birds have flown into the turbines and died.

3.3. Hydro Energy

When water is stored in place of higher land it possesses potential energy, this potential energy and make the water fall on the blades of the turbine, the turbines start moving rapidly. These fast-moving turbines are used to generate electricity and the generated energy is called as Hydro energy. Hydro energy is a very clean and green fuel. It causes almost no pollution, the hydro plants run for a very long economic span and the maintenance costs are very cheap. The short-comings for Hydro energy are the risks that come up with putting up a plant. There are always chances for the wall-bursts, destabilization of natural flora and fauna also, sediment is retained on the other side of the dam (or the plant), causing soil erosion.

4. Hybrid Energy

The energy generated by the combination of two or more than two energy generation devices is known as Hybrid Energy. Combining of these devices is done to overcome barriers for the individual devices. Currently hybrid energy systems are gaining popularity on the global level. There are many benefits to the Hybrid systems which make it a more desirable system than the individual ones.

4.1. Hybrid Solar and Wind Energy

Hybrid solar and wind energy is the energy we generate by making a system of the combination solar panels and wind turbines. These kinds of systems tackle the problems faced by the individual systems. For example as demonstrated in Figure 1,2 and 3.

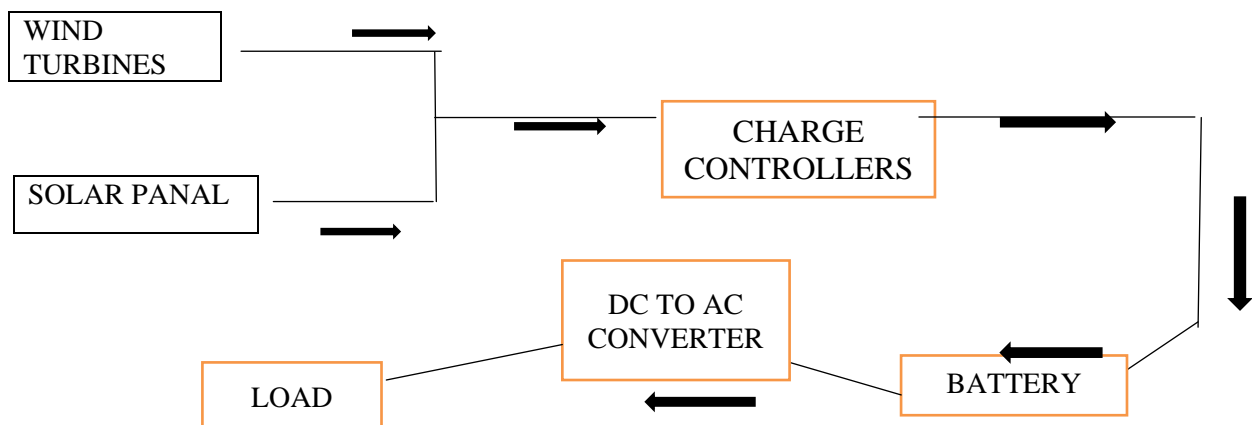


Figure 1: Hybrid wind and solar system

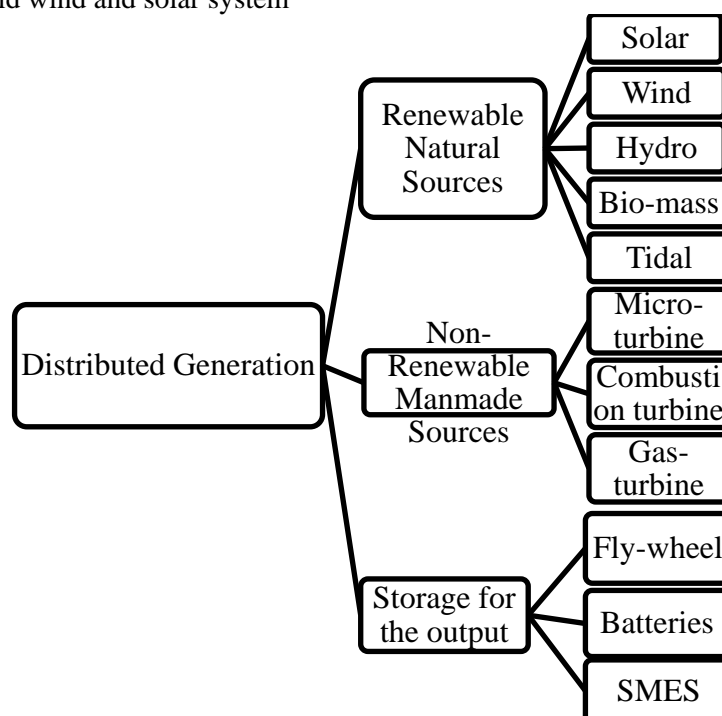


Figure 2 generation of energy and ways to distribute.

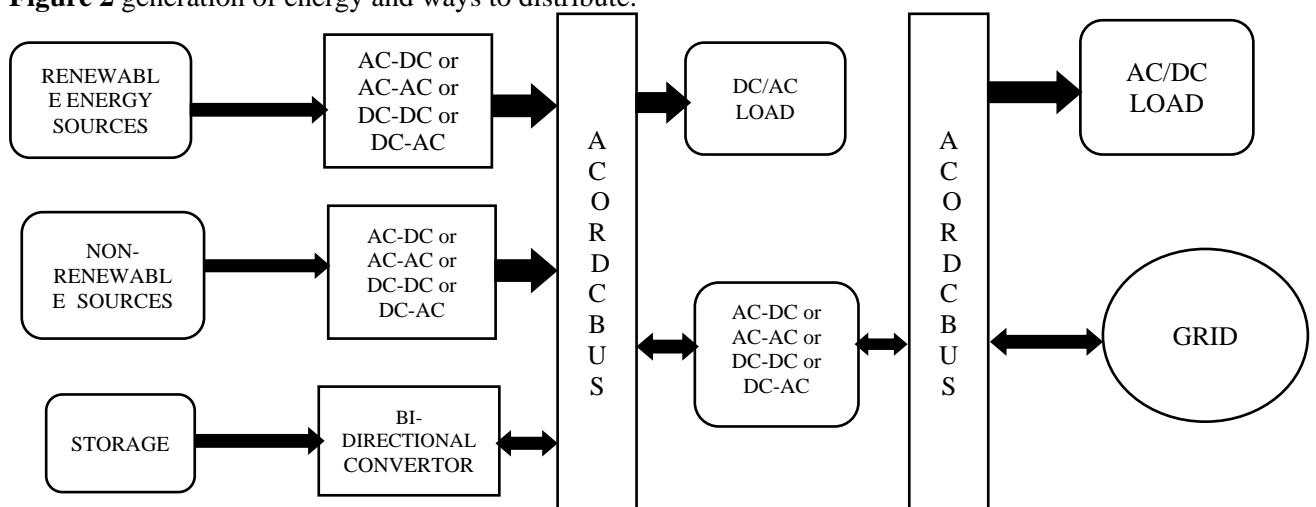


Figure 3 Basic components of hybrid system

The adjustment for the constant value can be achieved by following analysis

if $V_{dc} \geq V_{dc.ref}$ then $k = 1$;

if $V_{dc} < V_{dc.ref}$ then $k = -1$;

$i_{ac.ref}(n+1) = i_{ac.ref}(n) + (k)\Delta i$

where V_{dc} is the measured dc bus voltage;

$V_{dc.ref}$ is the reference value of the dc bus voltage;

$i_{ac.ref}(n)$ is amplitude of current command for the present 60 Hz cycle;

k is the constant value which is proportional to value of injected ac current and

Δi is the current command adjustment.

5. Discussions and Conclusions

Findings of Literature Survey:

1. So broadly, as per the above study, Hybrid Energy architecture comprises of two parts: an ancient algorithm to generate candidate regions as input to the conventional systems, and the second part is using hybrid system accompanied by semantic algorithms.
2. Therefore, in a nutshell, from the thorough study of the literature, it can be concluded that to get in place high power and energy generation at the output, robust and AI based system, are needed so that improvements are made both at the coefficient generation method level and adaptive algorithmic level.
3. As per the study, hybrid energy based power generation proposal methods are way better than conventional approach, which unnecessarily increases the number of steps to be processed in the input space, thus increasing computational time.
4. Out of the proposal methods, Genetic algorithm based methods are the best available method based on deep learning based framework which gives superior performance with little adaptation.
5. On the other hand, Faster RCNN is the best detector on common benchmark datasets, but does not gives superior performance on hybrid systems computational complexity.
6. Although the resolution of handcrafted features based methods is higher, but deep learning based methods are computationally very fast.
7. So, it is desirable to achieve good detection performance, without compromising the speed.
8. After extensive literature survey, the remedy proposed for this, could be using an object detection system comprising of RPN and boosted classifiers as proposed in for pedestrian detection.
9. The challenge of missing small instances could be solved by pooling features of (Real Coded Genetic Algorithms) RCGA.

References

- [1] T. Gonzalez, "Clustering to minimize the maximum intercluster distance," Theoretical Computer Science, vol. 38, pp. 293-306, 1985.
- [2] T.H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, Introduction to Algorithms, MIT Press, 2001.
- [3] S. Shmuel and O. Schwartz, "On the complexity of approximating TSP with neighborhoods and related problems," Computational Complexity, 2006.
- [4] A. Dumitrescu and J. Mitchell, "Approximation algorithms for TSP with neighborhoods in the plane," ACM Symp. Discrete Algorithms, 2001. V. Smil, Energy in World History. Boulder (USA): Westview Press, 1994.
- [5] Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall, 1995. M. Srinivas and L. Patnaik, "Genetic algorithms: A survey", IEEE Computers, Vol. 27, No. 6, pp. 17-26, July 1994.
- [6] J. Perlin, Let it Shine: The 6,000-year Story of Solar Energy. San Francisco (USA): New World Library, 2013.
- [7] G.N. Tiwari, S. Dubey, Fundamentals of Photovoltaic Modules and Their Applications. Cambridge (UK): Royal Society of Chemistry, 2010.

- [8] Hybrid Renewable Energy System: A Review International Journal of Electronic and Electrical Engineering. ISSN 0974-2174, Volume 7, Number 5(2014), pp. 535-542
- [9] A review on hybrid renewable energy systems K. Shivarama Krishna, K. Sathish Kumar School of Electrical Engineering, VIT University, Vellore-632014, Tamilnadu, India <http://dx.doi.org/10.1016/j.rser.2015.07.187> 1364-0321/ & 2015 Elsevier Ltd.