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Analytical Study of ANN Modelling Based Estimation of Solar Radiation

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Abstract: *Energy provided by the sun is solar energy which is in the form of solar radiation. It is advantageous because it is renewable and sustainable source of energy which never runs out since it is a natural power source[1].Solar energy system's potential is beyond imagination with limitless advantages and minor negative impacts as there is nothing completely risk free [1]. A rough calculation that is the estimation of solar technology is done. Number of expressions, estimation models are used for proper monitoring ,utilization and and record of solar radiation data[2]. ANN are the excellent and one of the main tools used in machine learning. Artificial intelligence is the emerging trend that is basically a intelligent machine that performs and behaves like humans. ANN based models have been successfully trained to have different solar radiation variables, so as to improve the existing empirical and statistical approaches.*

Keywords: *Artificial Neural Network (ANN), Machine Learning, Solar Radiation Estimation.*

I. Introduction

Solar energy potential is beyond imagination. The earth surface receives 120,000TW of sunlight in the form of solar radiation which is 20,000 times exceeding power than what the enter world needs. Energy provided by the sun is solar energy which is in the form of solar radiation. It is advantageous because it is renewable and sustainable source of energy which never runs out since it is a natural power source. The Solar energy system uses Photovoltaic cell for the conversion of sunlight into electricity. The produced DC electricity converted to AC by an inverter for the use of the home or other appliances. Combining ANN with solar technology will raise the technology efficiency, it will upgrade the present and will predict the future. Along with so many applications, ANN can also be used for the prediction of solar energy. So this study covers the beyond imagination potential of solar system ,its major positive impacts ,minor negative impacts and impact assessments. It also covers the estimation and artificial intelligence inclusions. This paper deals the study of various models for the prediction of solar energy estimation.

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II. Environmental Impact Of Solar Energy Technology

There is nothing that is either perfect 0% of error or 100% accurate in the energy world. Nothing can be classified as perfect 100% scheme , So Solar power is not without its downside, especially when trying to generate enough energy to sustain a reasonable quality of life. To analyze both the positive and negative impacts of solar power and have the impact assessments, solar panel is important to realize. It is known that while solar power system is certainly less polluting in comparison to fossil fuels but still some problems do exist. "The manufacturing processes are associated with green house gas emissions" Nitrogen trifloride and sulfur hexafluoride has been taken and assumed back to the production of solar panels . Nitrogen trifloride and sulphur hexafluoride are the the most potent gases causing green house effect and have greater impact of about 1000 times on global warming. For the environmental damage, Silicon is the main component of most photovoltaic modules, manufacturing process involves toxic chemicals and these need to be carefully controlled and regulated to prevent damage to environment.Manufacturers and distributors are working on PV cycle scheme , PV cycle scheme aims to reach 80% of recycling rate by year 2015 and 85% by 2020.

III. Solar Energy And Solar Radiation

The constraining of heat and light from the sun using various technology such as photovoltaic, solar heating, artificial photosynthesis, solar thermal energy. This radiant heat and light is converted into electrical energy and is called as solar energy. The earth surface receives 120,000TW of solar radiation, this radiation is inconsistent since at different places and in different times ,the light availability differs. For example, areas near the equator experiences more satellite in comparison to areas at poles. Solar radiation is the energy in the form of radiation that we get from the sun solar radiation can also be called as short wave radiation. These radiations comes in different forms like as X-rays, visible light, radio waves, UV rays, heat. Therefore solar radiation is basically all the emitted radiant energy by the sun.

IV. Estimation Of Solar Radiation

Sun rays falls on the earth parallel in the same wayas rainfalls on the earth, so therefore the sun rays hitting the earth surface or say hitting the solar panelsis proportional to the width of its projection along that direction. Solar radiation provides 99.97% of heat energy approximately, hence it is the primary source of earth's energy [5]. Estimation is a rough calculation of the values , numbers, quantity or extent of something. Solar radiation has many useful applications inmany areas like agriculture etc. with the advancement and development in solar technology, it wil minimize the country's overreliance on wood, fuel consumption, electricity power supply consumption.Number of expressions have been used for estimation of global solar radiation. These expressions include different models with different techniques namely linear and linear logarithms models ,quadratic functions,power relationship, power trigonometric equation. Complete and accurate estimation of solar radiation data is immensely essential for development of irrigation system, for regional crop growth and combinedly we can say that it is important for efficient utilization of solar energy resources.

Meanwhile because of increasing growth in the demand of global energy, the role of reliable solar radiation comes into demand. There must be some measuring instrument installation for solar radiation data estimation for their proper monitoring ,utilization and testimony. This estimation depends upon various variables such as sunshine hours, allied humidity and it has greater dependency on correlation between estimated and measured variables.

V. Solar Radiation Prediction Importance And Need

Because of growing and strong increase of solar power generation. The prediction of solar power radiation is acquiring utmost importance nowadays. Solar radiation is an important parameter in solar energy application due to generation from photovoltaic (PV) is directly related to this parameter . Atmospheric events has greater impact on solar radiation, radiations vary nonlinearly due to atmospheric variations. These atmospheric variations include cloudy weather , humidity, rainfall, windstorm and many others .Therefore estimation and prediction of solar radiation is an utmost importance gaining and thus an attractive issue in solar energy field .

VI. Modelling And Prediction Methods

This solar radiation modeling includes Markov Processes. It is named after a Russian mathematician 'Andreivich Markov, he invented markov analysis hence called as Markov processes. Markov processes are the process under which we cannot predict exactly the next or future behavior/output with the help of previous/past behavior/output, which is not the case in current behavior so therefore markov processes has arbitrary chances. Some of examples of markov includes traffic flow, business area etc. Hence markov is a random process and can also be called as stochastic process. Markov processes are extensively used in many areas such as speech modeling, traffic flow etc.

There are some considerations in the experimental work including:

- For observation of the model, mean of ambient temperature measured hourly is considered.
- Hidden events consideration includes mean of solar radiation values (taken hourly measurements)

These considerations constitutes to the proposed mathematical model outcome.

VII. Various Models For Solar Radiation Predictions

Models for solar energy predictions are essential generally due to the fact that determination of necessary variability is difficult in most of the chances. And due to which, even by using the solar radiation measuring station and density number also, its determination is difficult. Estimation of solar radiation and its modeling is of vital importance as of acquiring the accurate idea of solar radiation distribution for a specific and particular geographical location [3]. So therefore for efficient utilization of solar technology and its estimation we require new models.

Models are of two types that is available in the literature [4]:

1. Parametric models
2. Decomposition models

Parametric models include iqbal model, gueymard model and ashrae models, these models require detailed form information of conditions of atmosphere and factors affecting. It is quite possible to have developed correlation models that will make predictions to beam/sky radiation, based on measurement of other solar radiations.

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On the other hand decomposition models predicts the beam and sky components , generally rely on global radiation information so as to have the predictions in same. Decomposition models are used for hourly estimations ,generally have radiation based diffusion on horizontal surface.

Sunshine duration parameters is the most commonly used parameters for global solar radiation estimation. This most commonly used parameter is easy and reliable in the sense that it has easy measurements with its wide availability at the weather stations. The below are the few imperial models used for solar radiation estimation:

- **Angstrom Prescott**: The first theoretical model for estimating global solar radiation based on sunshine duration, model is used for predicting solar radiation. This model was able to foresee the fluctuation in monthly mean daily solar radiation[6]
- **Kasten and young model:** kastel and young model have developed an empirical relation that is meant for direct terrestrial solar radiation.This model is specified in terms of m: which is mass of air and integrated Rayleigh scattering atmospheric thickness and link turbidity factor.
- **Singh and Tiwari model**: They have done modifications to the kasten and young model for the composite climate of New Delhi with the additional component of cloudiness factor and an atmospheric transmittances for diffusion radiation.

VIII. Combining Artificial Intelligence And Solar Energy Technology

Artificial intelligence (AI) is a machine mimicking of human brain. It is the creation of intelligent machines that performs and acknowledges like humans. AI includes learning, problem solving, planning. AI is taking a compelling turn on its journey to grow into metamorphic transformational technology. The following points explain how AI is able to change the solar industry:

- AI improves accessibility and will raise the efficiency (in the sense to track and ameliorate) across the renewable energy stratum, like solar industries for planning, inspections, decision making.
- It will change the future of energy.
- AI can be used in interpretation of part , for upgrading the present and predicting the future.
- It can also be applied for complex system control and for optimized prediction.
- The use of solar technology has increased to its triple rate since 2010 and it is estimated that by 2050, it is going to become world's biggest energy source.
- With AI the machine can peruse and remodel to different scenarios, machine gets smarter and advanced with time and counters disparately to achieve surpassing results.

There are only three bars to building successful AI systems including:

1. Data availability
2. Computing power
3. Imagination

Having knowledge of data availability and computing power is easier in comparison to having the exact idea of the 3rd component imagination.AI has revolutionary results and effects in most areas including the energy world. The solar energy world depends on optimization and predictions which involves the energy production information, the radiation measurements. AI endeavours a unique solutions to these challenges of predictions and optimization and because of its "capacity to evolve and learn and the impact of its revolutionary results it wil undoubtedly become a critical component of energy industry. AI has potential of remitting/distributing the next level of performance for the future platform. It is a new approach fundamentally that has solutions to every problem and that can be applied to any field of interest. The decisions of considering this fundamental approach and implementing it will be made by those thinkers who want more improved and advancements in the world who believe in attaining utmost success and growth thus expanding the frontiers. The relevance of all forms of AI to the solar technology industry is no barring.

IX. Conclusion

Solar energy potential is beyond imagination, it is going to be world's biggest energy source. It has limitless advantages. It is environment friendly , harnessing it causes no pollution. There is noway it can be overconsumed, hence it is sustainable. It is easily available all over the world. By becoming solar users, electricity expenses can be reduced. Like everything has both upsides and downsides, solar power is also not meeting the scale of perfect 0 negatives, but by viewing its utmost importance and overall impact, it has more positive environmental impact and it provides excellent long term outcomes. The energy that is being used today in solar panel creation will be regained after 3 to 4 years. By overviewing the processing stages and manufacturing stages that are present in solar system , The emissions produced from solar system are lesser in same amount than the fossil fuels energy by 3 to 10 times. The negative impacts are minor and can be minimized by favourable alleviation measures. Overall solar system technology provides a net positive impact

with limitless advantages. Certain expressions have been used for estimation of solar radiation. This estimation is done for proper utilization, monitoring and record of solar radiation data. The renewable energy sector especially solar industry is merging economic force, Artificial intelligence is the emerging trend and is integrated across many sectors including solar industry increasing the accessibility and efficiency.

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