An Artificial intelligence Application Use in Solar Energy System

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Abstract.The energy that is generated from natural source as the sun, the wind, the geothermal etc. More renewable energy will be use which will decrease the expense and demand for fossil products. The first purpose of solar photovoltaic energy is development of electricity and heat for a variety of applications. Renewable energy source generate electricity with minimum contributions of CO_2 and other gases. The use of Artificial intelligence in the energy system is becoming more prevalent to ensure an effective energy demand .The use of Artificial in solar PV system for highlighting the challenges and effective utilization in the renewable energy system. The proposed system implementation will bring down the cost of electricity. The increasing in the impacts of global warming, climate change and a rise in world temperature can be linked to CO_2 emission. [1,2]

Keywords : *Smart technology, a solar –powered, Artificial intelligence system, Internet applications, solar PV system, learning machine.*

1. Introduction

The non-renewable global energy use has significantly raised the demand for fossil fuel resources by different sectors of the economy, resulting in a constant CO2 emission from these sectors with the energy sector contributing substantially to this emission. The increase in the impacts of global warming, climate change challenges, and a rise in world temperatures, can be linked to CO_2 emissions, which pose a prolific threat to the sustainability of the ecosystem. Because of the contaminant emissions created by nonrenewable energy resources, it is projected that the world average temperature would rise by approximately 2°C by 2050 to tackle these issues, timely and productive efforts must be taken to reduce adverse ecological effects while also exploring efficient and cost- effective renewable energy sources. These techniques have been the interest of numerous studies over last few decades with the goal of enhancing process performance. According to a study carried out by the International Renewable Energy Agency in 2018.The cost of electricity generated by renewable energy sources has decreased gradually over last few years. Many nations throughout the world have benefited from this cost reduction by incorporating renewable energy sources into their national power systems. The application of renewable energy sources to generate electricity has become increasing popular as the world's energy consumption continues to rise as a result of the expansion of global industry and urbanization. [2]

Overall the annual use of energy increases predictably. If the rate of global population increase continues at its current pace, the yearly utilization of oil and natural gas employed for electricity generation will increase to quadruple by 2050, as projected by the International Energy Agency. As well as these benefits, there are a variety of other reasons to shift away from petroleum toward renewable energy sources including a reduction in the costs of energy synthesis from renewable sources, a decrease in carbon emissions, a competitive market, and the consistency of RES. The application of solar and wind energies has resulted in a rise in the production of sustainable energy, with about 77 % of additional output added in 2017. Based on the International Energy Agency report, solar PV energy cost dropped by three-quarters between 2010 and 2017. Prices of wind turbines have decreased by around half in a comparable period, resulting in lower-cost wind energy. [1]

2. Overview Solar Energy System and Artificial Intelligence (AI) Technology

The increased attention to the application of optimization technologies for solar PV system deployment is spreading worldwide, thanks to research journals published in both developed nations including the United States and Europe, and developing nations including China and India, which demonstrate how the technologies can be applied. Increased effectiveness and reduced human involvement, and, consequently, a manual techniques make use of offline operations, the PV module or PV string is isolated from the facility in order to diagnose and correct problem conditions. The semi-automatic and automatic techniques are executed immediately over the internet. Automatic techniques can also be divided into two major categories. The first technique seeks to build a basic algorithm to discern, recognize, and maybe localize problems based on mathematical studies, to reduce the number of steps in the process. Using artificial intelligence (AI) approaches in a more sophisticated way, the second strategy can be used to actively respond to errors, self-heal, and schedule upkeep. However, to diagnose, categories, and pinpoint problems, a big dataset (recorded currents, voltages, pictures, and solar irrinfrared or electro-luminance images) is used in conjunction with advanced algorithms. AI approaches have been used in solar PV farms for over two decades to enhance the modeling, control optimization, and output power prediction efficiency of large datasets, and they continue to be used today. Other AI techniques including learning machine (ML) and deep learning (DL), are applied to manage big datasets and speed up management and decision-making. The internet of things facilitates interaction and data distribution among a diverse range of facilities and services. It is becoming increasingly important. In recent years, Internet Things techniques have also been explored in the field of PV facility surveillance and remote sensing to meet industry demand for improved fault diagnosis and prognostics. These researches have demonstrated that deploying the internet of things in the field has several advantages, including decrease in expenses, among others. [1]

3. Classification of Solar Energy Technologies (SET)

SET to a larger extent, provides sustainability to anthropological actions. A huge reduction in greenhouse gas emissions is one of the most significant environmental benefits of the SET. In this section, two major classifications are discussed: concentrating solar- thermal power and solar PV energy.

3.1 Concentrated solar thermal power(CSP)

There are four categories of CSP technologies as these systems are either commercialized or on their way to being so .Parabolic troughs, solar towers, parabolic dishes, and linear Fresnel reflectors are examples of CSP systems. Based on the method of operation, these systems are further classified as linear focusing systems (focus solar radiations into parallel tube receivers arranged above a row of mirrors (optical concentrators) or point focusing systems (focus solar radiations reflected from optical concentrators around a central tower/point which functions as the receiver). Parabolic Troughs are a form of linear focusing system on which optical concentrators are designed in the shape of parabolic troughs making them capable of collecting parallel radiations as well as a single line focus. They gather and focus solar radiation onto parallel receivers situated at the parabola's focal line. Consequently, CSP technology has a minor environmental effect; compared to fossil fuels which supersede that of networks of power supplies. Temperature disparities occur from changes in the form of the technique.[1,2]

3.2 Solar photovoltaic energy

The global growth of solar PV energy can be broken into two parts. The increase of solar PV projects and research and the breakthroughs in solar PV R&D technology. the use of optimization technologies in solar PV facilities has expanded dramatically. In addition to the advancement of scientific articles, the number of PV installations has increased. According to a worldwide electricity market in 2018, solar PV, for example, surpassed all other renewable energy technologies to become the world's fastest-growing renewable energy technique. The increased attention to the application of optimization technologies for solar PV system deployment is spreading worldwide, thanks to research journals published in both developed nations including the United States and Europe, and developing nations including China and India, which demonstrate how the technologies can be applied.[3]

4. Artificial intelligence (AI)

Artificial Intelligence refers to data processing systems and technical resources linked or dependent on software mostly in the virtual world. However, to display human intelligent behavior and specified goals, AI-based systems can analysis their environment and take actions autonomously. Mores, AI can also use, train, and analysis data sets for decision-makers in database analysis, accounting, information retrieval, product design, medicine, food quality monitoring, biometrics, forensics, production planning and Distribution.

Figure 1 show that Deep learning is a subdivision of Machine learning, and thus both are Artificial Intelligence techniques. Theories like statistics, neural networks, and evolutionary learning are all used in these Artificial Intelligence techniques. The suitable approach for a given application depends on the nature of the issue, the accessibility of data, and the necessary accuracy and easiness. [1]

In environmental and renewable energy applications, Artificial Intelligence is gaining momentum because of its capacity to automate.

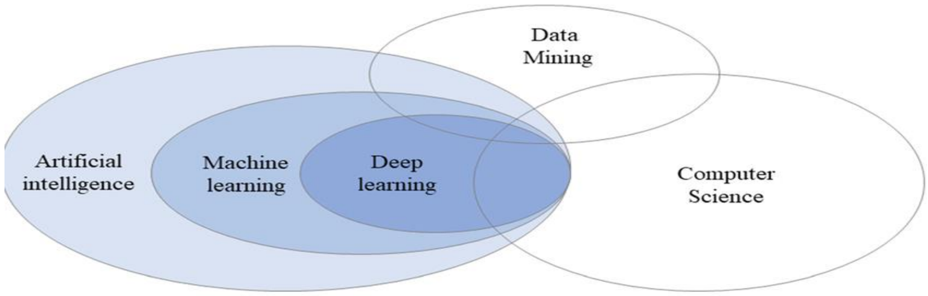

Figure 1. Venn graphic demonstrating the correlation between AI, ML, and DL, DM

4.1 Machine learning

Machine learning (ML) consists of strategies that allow systems to accomplish a task automatically from experience (data stored in a record) without human intervention. The ML implementation process starts with raw data, and progresses through feature extraction, training and evaluation, and model distribution. The process is often initiated by selecting time-series data (for example, stock and /or return data) as depicted in figure 2, and the relevant information over a given time to achieve a target. To handle complex problems, including medicinal, economic, ecological, advertising, security, and manufacturing applications. ML is commonly preferable over conventional techniques which fail or are unfavorable to multi-task. Given that there is no complex interplay between outputs and inputs, ML is the best choice for problems that have multi-parameters including the following [3]

- Immense data intellect: This is a data-based and information-based AI approach for Data management.
- Cross-media sensing and computation: Asynchronous sensing and cognition engines that outperform humans.
- Swarm intelligence: processing information related to group behavior.
- Hybrid and improved intelligence: Integrated application of human and AI.
- Autonomous coordination and control Operating machines and stems.

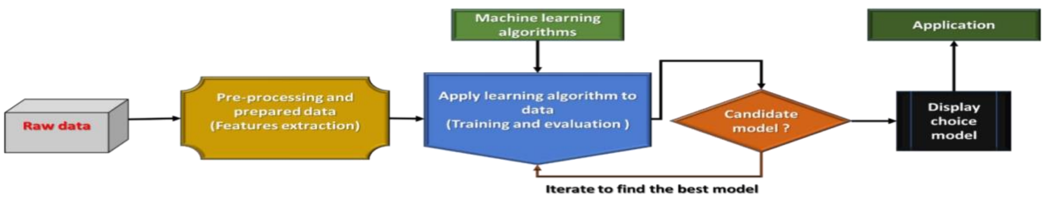

Figure 2. Machine learning workflow

4.2 Deep learning

Deep learning, also known as structured or hierarchical learning, has gained momentum in ML research since 2006. Herein, recent DL research has improved many aspects of signal and information processing, including ML and AI. On other hand, DL is an emblematic neural network-based approach, in that it can over fit and reduce gradient. This approach can extract features from massive data sets, allowing for modeling flexibility in network designs and model parameters. In general, DL algorithms combine and train a set of classifiers, and then aggregate their predictions into a single prediction/decision. Models of DL are made up of multiple levels or stages of non linear processing information, such as supervised or unsupervised learning of feature extraction at progressively improved levels with increasingly arbitrary layers. In addition, DL is an interdisciplinary field integrating studies of neural networks, AI, pattern recognition, signal processing, graphical modeling and optimization. The rising processing capacity of chips (such as general- purpose graphics processing units - GPGPUs), the expanding number of training data, and current breakthroughs in ML and signal/information processing research are all important areas of DL that are currently gaining promise.[1,4]

4.3 Convolution neural networks (CNNs)

The CNNs are a type of DL with a topology that looks like a grid. These are NNs that replace matrix multiplication with convolution in at least one of their layers. As shown in, software like Python is commonly used to make machine DL CNN applications for large PV facilities or farms, as well as utility grids. It comprises input and output layers with several concealed layers. Figure 3 illustrates a complex CNN structure, including convolution and pooling layers in most networks. A CNN convolves the entire image as well as the intermediate layers prior to the output layer using various kernels in the convolution layers. Image representation and network parameter sizes are language-independent. Furthermore, CNN involves two training techniques namely (i) forward stage and (ii) backward stage. The forward stage represents the input image with the existing parameters (weights and bias) whereas the backward step computes each parameter's gradient using chain rules. The gradients update all parameters, preparing them for the next forward computation. The network learning can be stopped after enough forward and backward iteration. [1,3]

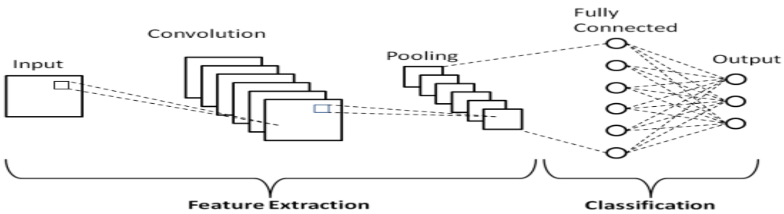

Figure 3 Convolution Neural Networks (CNN) structure

5. Application of Artificial Intelligence in solar photo voltaic system

Most research developments on solar energy optimization have been conducted recently. Due to the uncertain aspects of solar photo voltaic materials, there are difficulties with the stability of the overall system. Previous studies have presented more suitable optimization strategies than conventional types. In terms of sizing, load demand and power generation, the optimization algorithms have shown great results in solar photo voltaic applications. Furthermore, the optimizations aid in lowering operational costs and power losses, as well as improving peak power incorporation and how best the process could be controlled.

5.1 Monitoring of PV systems

The surveillance system for PV plants collects and analyzes a variety of parameters the reliability and stability of any PV facility the monitoring system also maintains track of various electrical generating indicators and faults. Existing Monitoring systems. Different components of PV surveillance systems have been documented in literature over the last decade. This covers a thorough examination of all of the primary PV Monitoring evaluation methodologies and their relative performance. Sensors and their operating guidelines, and controllers utilized in data collection, transmission, storage and analysis mechanisms are all major parts of PV monitoring systems. All these factors need to be understood in order to design viable, cost-effective, and efficient PV monitoring systems for small and medium sized PV systems without sacrificing required efficiency. PV monitoring systems are designed to ensure data availability on the energy harvesting operating temperature analysis, and energy loss connected with various defects that may occur. As a result, lots of efforts have gone into designing efficient PV monitoring systems. The monitoring system would include various commercial goods that have been integrated into it. With the increased proliferation of commercial products based on numerous concepts, it is critical to study each one's functioning and characteristics. For a viable PV monitoring system, selecting the right product for a specific climatic situation is critical. Various elements of PV monitoring systems have been reported throughout the last decade. Figure 4 depicts a general block structure of a PV monitoring system classification. Owing to the lack of sensors, space-based systems may be cost-effective in this regard. The drawback of space-based systems is their poor precision, which is heavily influenced by weather situations, which is undesired. As a result, the extent of this analysis of PV monitoring systems is limited to ground-dependent systems.

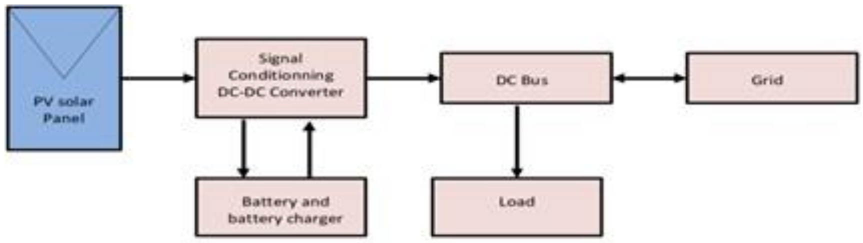

Figure 4. A block representation of the PV systems classification

5.2 PV fault detection and diagnosis (FDD) methods

If issues in parts (modules, interconnectors, converters or inverters) of solar photo voltaic systems (hybrid PV, stand-alone, or grid-connected systems) are not quickly identified and rectified, they can have a substantial effect on the performance and energy output of a solar photo voltaic system. Moreover, some faults (e.g. arc, ground and line faults) can aggravate the threat of fire- outbreak. The FDD systems are critical for solar photo voltaic system stability, performance and security. When a PVM fails, the problem is typically linked to the system warranty. PVS flaws result in unanticipated safety concerns, lower performance, power accessibility, system reliability, and safety many researchers have identified and investigated PVM faults of various forms. Some of these problems are discoloration, cracking, degradation of the anti-reflective coating, blistering, staining, oxidation and corrosion of the bus bars, split encapsulations over cells and joints and loss of backside adhesion. Encapsulation, module corrosion cell cracking and PV inverter are some of the failure modes that are commonly occurring. In general, PVM defects can be divided into two categories permanent and temporary. Permanent flaws include yellowing of cells, scrapes, delaminating, charred cells and bubbles. So, by simply replacing the damaged modules, such defects can be avoided. [3,4]

5.3 Modeling of a solar PV generator

Solar PV power facilities that are connected to the grid are becoming more widespread in India. The majority of these have power outputs ranging from a few hundred kilowatts to tens of megawatts.. Small grid-connected solar power plants of 1 or 2 KWs are not being deployed in India, like in many other countries. The ability of solar PV power plants to generate electricity has increased dramatically during the previous several years from a universally installed output of 7 GW reported in 2006 to 70 GW in 2011 with a ten-fold growth in five years. So far, six countries have now added more than 1 GW of capacity this year. For solar PV power generation, this being the most frequently used mode of operation was regarded as the only mode of operation for PV systems till a few decades ago. The power plant served as an electric power generator for local loads in this case. Because solar power generation is restricted by the amount of sunshine available, energy storage technologies in battery form are commonly used. [1]

6. Challenges of effective AI application in solar PV system

6.1 Solar energy optimization

Solar energy is among the commonly used RES, and it leads the market for renewable energy. However, despite the significant progress that has occurred in recent years, solar energy is confronted with significant challenges that could stifle this growth. These drawbacks related to techniques, administration, finance, and reliability. In contrast, optimization helps to mitigate the downsides of solar energy systems while also increasing their dependability. Consequently, improved solar energy optimization can contribute to alleviating the unpredictability associated with energy generation. A significant amount of money is being invested in photovoltaic power technology sector to increase performance. The downsides of photovoltaic cells include the fact that they stop producing power when there is no solar radiation shining on them and that their effectiveness is low compared to other forms of energy generation. This could result in a failure to meet the capital investment necessary to make the technology. Subsequently, solar energy storage devices have been suggested among the options for overcoming the lack of light and flattening the electricity production and demand curves. This technique depends on batteries, which are sometimes big, enormous, and heavy, occupying a significant amount of space, and need constant upkeep or even substitution now and then. When compared to the past decades, the majority of these systems' components are now available at reasonable cost due to continued technological advancements such as greater PV conversion efficiency of solar-electricity-generating solar panels. The PV system optimization procedures necessitate the use of following critical inputs [1,4]

- To achieve a preferred optimization, it is critical to obtain correct data for the primary characteristics of the solar system, which include wind speed, ambient temperature, dust, humidity, and sunshine. However, the hourly or daily collection of these data remains one of the most difficult tasks in optimization, despite the existence of prediction techniques such as ANN.

- Load predicting is necessary to have access to the outline of a maximum loading requirement over one year to determine the optimal PV device size

- Validity of models when optimizing, it is critical to have a model that is as precise as possible. To be accurate, the model must take into account all of the important aspects that influence system effectiveness and performance.

- Accessibility and application of the offered techniques: Optimization should produce lucid and exact outcomes. This can be accomplished by merging two methodologies, such as analytical techniques and artificial intelligence technology.

6.2 PV-dependent hybrid facility optimization

One of the most significant drawbacks linked with the usage of REs is their unpredictable character and failure to function effectively as a result of inconsistent and unaccepted fluctuating nature, which frequently results in over-sizing and a rise in capital expenses. These challenges have lately been addressed by the hybrid method's structures, which have renewable energy system include lowering the overall expenditure of the facility, minimizing the energy storage capacity, improving performance and increase dependence while maintaining or improving stability. Many studies have focused on the application of conventional optimization method and more recent heuristic methods to tackle challenges connected to design and operation procedures. Biological or physical intelligence mechanisms or animal colonial behaviors are the foundations of the vast majority of optimization strategies developed. Though data- driven optimization techniques are limited by sophisticated computation and intensive training periods, current development in advanced computer techniques, large storage volumes and incredibly fast computing capabilities have alleviated the computational sophistication difficulties. For instance depending on multiple mixes of independent producing systems one of the optimization models employed in hybrid systems estimates the ideal design of HRES. Using this model, the optimal configuration of

HRES has been determined. A further study by the authors on the optimization of system size revealed that off-grid hybrid facilities, which include biomass and solar PV systems may give a practicable option. Khakis and colleagues developed an approach to assist in complementing predictions amid solar power and small hydro power systems. An optimization algorithm that linked hydrology with solar irradiance data was used to build the methodology. The programmed then advised feasible adjustments in the system design that may boost their competency in the field. [3,5]

7. Future work consideration

The implementation of AI in smart energy systems has different types of bottleneck challenges, which include poor data standard, unavailability of data, tuning AI network factors, technological facility issues, very limited skilled professionals, risk management and regulatory compliance issues. The detection and identification of faults in developing energy systems are among some complex challenges. Herein, some studies have concluded that data security and information scarcity are two of the most significant drawbacks confronting the energy sector today. Mores, substandard sensors, and reduce the system's dependability and efficiency. The power grid's time-consuming connections and robust integration, as well as its high data dimensionality, pose significant difficulties in the energy market. Using Al to incorporate RES effective supercomputers. Also, quantum techniques facilitate AI-based machine learning procedures and improve system processing capacity. ML and DL can improve fault identification, categorization, and positioning of surveillance systems. The most efficient strategy to avoid and reduce solar plant failures is to incorporate a fixed fault identification system based on a smart tool. [3,4]

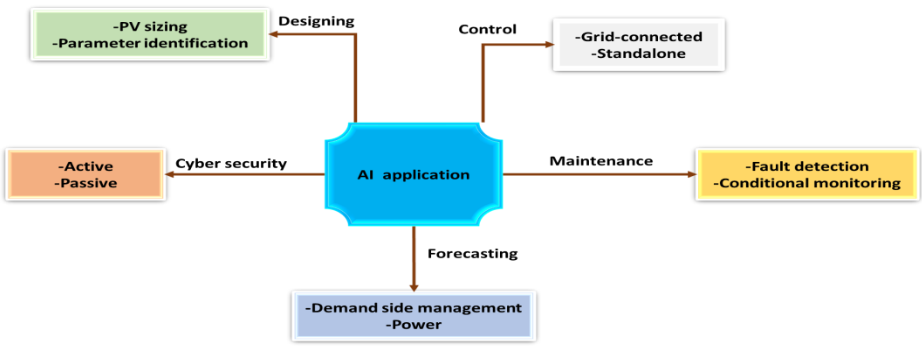

Figure 5.Schematic diagram of artificial intelligence (AI) applications in power systems

Infrared and fuzzy logic image based fault detection/identification, localization and categorization are costly to implement. Using IoT, a data acquisition circuit and Wi-Fi module can send data to cloud. The present condition of the PV system can be put on a website, with the information provided on the fault type and the faulty module or string . Moreover operators are alerted via SMS if a problem arises. In addition, the application of AI in the digital transformation of power systems has been cited as having substantial potential for enhancing power system network stability and facilitating crucial changes. As shown in Figure 5. AI is being used to implement the design, forecasting, control, optimization, maintenance and cyber security components of the power system. This suggests that the effective development of AI is a promising sustainable strategy to mitigate crab on footprint as direct rebound affects energy production.

8. Conclusion

Artificial intelligence approaches Deep learning and machine learning, have lately acquired prominence in this subject, attracting several researchers who are working to design and apply new defect detection and diagnostic techniques. In light of the availability of vast quantities of data and the accessibility of supercomputers, it is reasonable to predict rapid progress in the employment of Deep learning and machine learning techniques in this field in the not-to-distant future. As a result, developing intelligent problem diagnostic systems that are dependent on AI and IoT are hoped to become increasingly important. DL is a subset of ML, and it is becoming increasingly. Machine learning makes use of mathematical algorithms to understand on their own, and algorithms can learn from data by extracting insights from the data. Deep learning applies neural networks and can learn from new data without feature extraction which is the primary distinction between ML and DL. Deep learning is also more expensive than machine learning. Finally, readers are presented with comprehensive difficulties, recommendations, and perspectives to provide a vivid insight into future developments in the field, such as areas that require improvement and further study. A clear understanding of the precise implementation of ML, DL, and IoT approaches, as well as the discrete challenges encountered in this extremely notable and prospective field of research, can be gained from this study, which can benefit researchers in both academic institutions and industrial sectors.

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