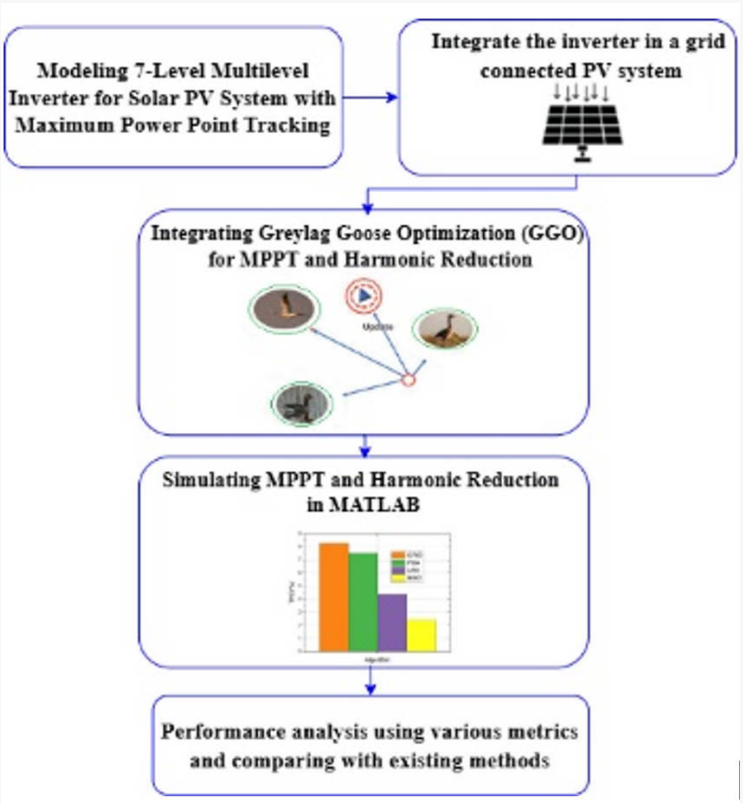
Greylag goose optimization: a game-changer for renewable energy systems

GA, UNITED STATES, March 12, 2025 /EINPresswire.com/ -- A recent study has unveiled a novel strategy to boost the efficiency of solar photovoltaic (PV) systems in agriculture, offering a solution to longstanding challenges. By integrating the Greylag Goose Optimization (GGO) algorithm with a seven-level inverter, the research team has achieved impressive advancements in maximum power point tracking (MPPT) and significantly reduced total harmonic distortion (THD). This innovation ensures more reliable and stable power for agricultural machinery, while also cutting operational costs and extending the lifespan of equipment.



Integrating GGO-based Optimization for Solar PV System Performance.

The agricultural sector's increasing demand for efficient and reliable energy solutions has underscored the limitations of traditional solar photovoltaic (PV) systems. Conventional maximum power point tracking (MPPT) methods often struggle to maintain optimal power extraction under fluctuating environmental conditions, leading to wasted energy. Furthermore, standard inverters often produce AC output with high total harmonic distortion (THD), which can harm sensitive agricultural equipment. These issues highlight the urgent need for more sophisticated optimization techniques and inverter designs that can adapt to dynamic environmental factors, ensuring the delivery of high-quality power. Addressing these challenges is crucial to developing more robust and efficient renewable energy systems for agricultural use.

A team of researchers from Annamalai University, published their findings (DOI: 10.1016/j.enss.2024.12.002) on January 16, 2025, in Energy Storage and Saving. The study introduces a unique approach by combining the Greylag Goose Optimization (GGO) algorithm with a seven-level inverter, enhancing solar PV system performance. By optimizing the inverter's

switching angles, the team achieved a dramatic reduction in THD, ensuring a smoother, more stable power output. This innovative method not only improves energy extraction but also significantly boosts the overall efficiency of renewable energy systems, particularly within agricultural environments.

The study's breakthrough lies in the use of the bio-inspired GGO algorithm, which mimics the migratory patterns of greylag geese to optimize the MPPT process. This dynamic algorithm continuously adjusts the PV array's operating point to ensure maximum energy extraction, even in the face of changing environmental conditions. Meanwhile, the seven-level inverter produces a staircase waveform with fewer switches, effectively minimizing THD and delivering cleaner AC power. Simulation results showed the GGO algorithm achieved a THD as low as 1.95%, far outperforming alternative optimization techniques, such as salp swarm optimization (6.14%) and genetic algorithms (10.84%). The system also demonstrated excellent adaptability, seamlessly switching between grid-connected and off-grid modes, further enhancing its real-world application in agriculture. This integration reduces energy losses, making the system a cost-effective solution for farmers.

"This study marks a pivotal advancement in renewable energy for agriculture," said Dr. K. Rajaram, lead researcher. "By combining the GGO algorithm with a seven-level inverter, we've created a system that not only maximizes energy extraction but also guarantees a stable and high-quality power supply, essential for the smooth operation of agricultural machinery."

The implications of this research are profound for the agricultural sector, where efficient and reliable energy is crucial. The reduction in THD and enhancement of power quality ensure that critical equipment like irrigation pumps and machinery run smoothly. With increased energy efficiency and reduced operational costs, this technology offers a sustainable and economical solution for farmers. The successful marriage of bio-inspired optimization techniques with advanced inverter designs paves the way for widespread adoption of renewable energy in agriculture, contributing to global sustainability efforts and reducing dependence on fossil fuels.

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