APPLYING ARTIFICIAL INTELLIGENCE TO IMPROVE SAFETY AND THE MICROGRID CONTROLLING SYSTEM

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ABSTRACT

Microgrids, a newer form of power grid architecture, are gaining popularity among researchers and enterprises. The ability to integrate renewable generation, electric vehicles (EV), energy storage, and distributed energy resources into the power grid and connect them with effective communication links gives a potential to increase power grid efficiency.

Keywords: microgrid, artificial intelligence, control systems, energy resilience, predictive analysis, machine learning, adaptive control, real-time monitoring.

Espionage is a type of soft cyber-attack in which an attacking country uses phishing attacks or botnets to monitor and steal important information. Sabotage assaults, often known as cyber sabotage, are purposeful attempts to destroy key infrastructure by introducing a flaw into the system. [1] These assaults are typically detected when a software update flaw is introduced. A denial-of-service attack is described as flooding the communication channel with repeated requests, leading the channel to become unresponsive to genuine users. This attack is serious because it creates communication delays or pauses, harming military and scientific organizations. The most dangerous and damaging phenomenon is cyber-attacks on power grids. They can impede information sharing, impair key services, and result in massive economic losses.

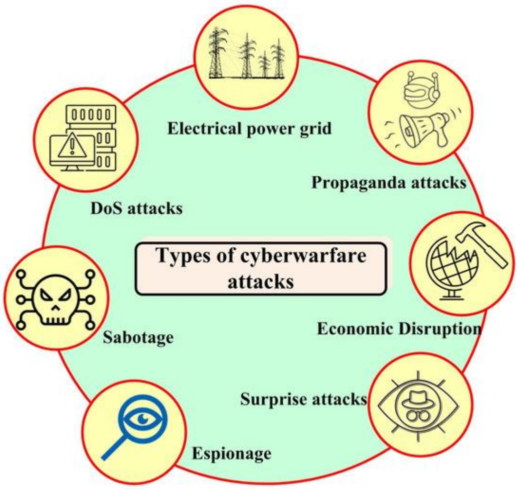

Figure 1. Different attack methodologies used for cyber warfare.

Role of AI in Microgrid Control and Safety. Microgrid systems, as an application of cyber-physical systems, are more sophisticated and critical in their operation than traditional CPS. Microgrids have properties such as energy management, demand-side management, generation, load scheduling, and interoperability. Industrial IoT is utilized to attain these traits, as are network frameworks such as GOOSE, DNP3, and IEC 61850. Figure 4 depicts the applications of artificial intelligence in DC microgrid systems. [5] The energy management system is critical in the control and operation of DC microgrid systems. Because the microgrid system contains several distributed generations and a range of loads, energy management is critical to achieving optimized power consumption.

Because EMS is so important, it becomes a target for opponents who try to disrupt its operations. EMS essentially collects input from variable sensors and sends it to various meta-heuristic methods, math heuristic methods, and state estimate methods for optimization. One of the most effective energy management strategies for microgrid systems is state estimation. The estimated state variables are utilized to monitor and control the microgrid's many characteristics, such as load forecasting, stability analysis, contingency analysis, bad data detection, and optimal power dispatch. Voltage control is one of the goals of a microgrid system; voltage control in microgrids is accomplished through distribution generators controlled by power electronic devices. In such circumstances, attackers attempt to enter the control layers and adjust sensor variables, producing a change in the microgrid's reference voltage levels.

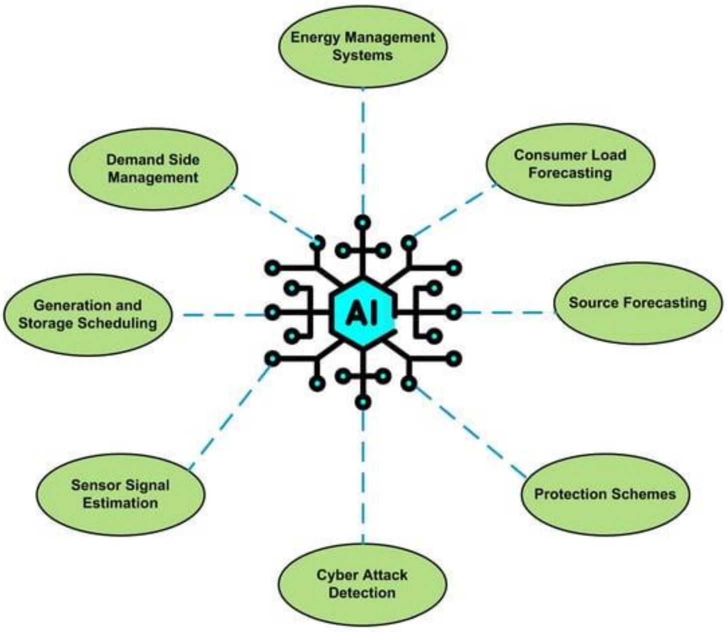

Figure 2. Applications of AI in DC microgrid systems.

Figure 3 depicts the distributed control DC microgrid's control architecture. This design is made up of four nodes that communicate with one another. The primary control layer and the secondary control layer are the two control layers. The secondary control layer transfers sensor value information from neighboring converters to the specific converter. The received information is processed and transferred through the control algorithm, after which the control outputs are provided to the plant via the primary layer connection. Control and optimization are critical in microgrid systems due to the presence of diverse sources and loads. In the literature, many microgrid control and optimization strategies are presented. Distributed algorithms are used in the optimization and analysis of microgrid operations; the initialization-free approach focuses on generation cost optimization in economic dispatch problems. [8]

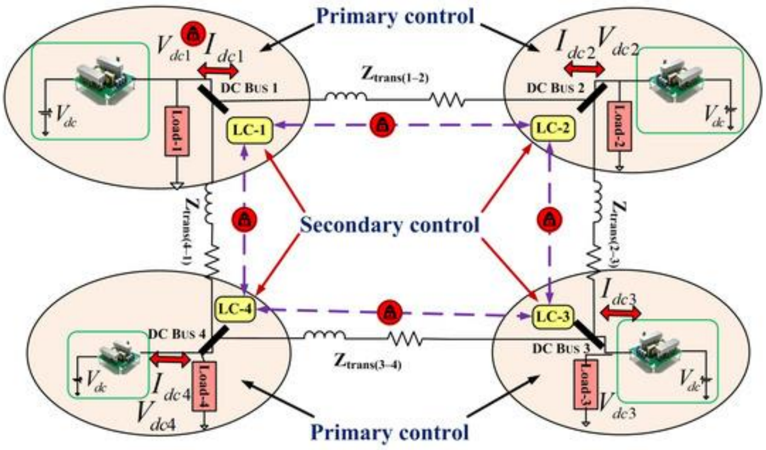

Figure 3. Control architecture of a distributed DC microgrid.

The current literature includes several model-dependent control and optimisation approaches. AI integration in microgrid control can boost system efficiency. The AI and DL approaches' estimation and adaptive capabilities should be used as much as possible.

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