Deep Reinforcement Learning Control for Maximum Power Point Tracking With Real-Time Experiments

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To ensure the efficient operation of photovoltaic systems, the maximum power point (MPP) must be found under different environmental conditions using a maximum power point tracking (MPPT) algorithm. Conventional methods such as the perturb and observe (P&O) algorithm tend get stuck at local MPP, not being able to find the global MPP. In this research, we focus on the integration of deep reinforcement learning (DRL) to tackle the MPP problematic in real-time experiments. The main contributions are a real-time comparison between the deep-q-network (DQN) agent against the P&O algorithm for MPPT under uniform and partial shading conditions, and a pipeline for testing DRL models, trained with MATLAB/Simulink, in real-time with the use of a Raspberry Pi and TensorFlow Lite. A diagram showing the experimental set-up can be seen in Fig 1. To summarize, the DQN agent was able to outperform the P&O algorithm in simulations, while in the real test benches, it did not happen every time. However, when the P&O algorithm got stuck in a local MPP in partial shading scenarios, the DQN algorithm was able to extract up to 63.5% more power than the P&O algorithm as shown in Fig 2. Future research should be focused on testing different DRL agents in real test scenarios. Furthermore, to the proposed pipeline, a final step that allows the DRL models to be deployed into an embedded system using TinyML or EdgeIA is needed.

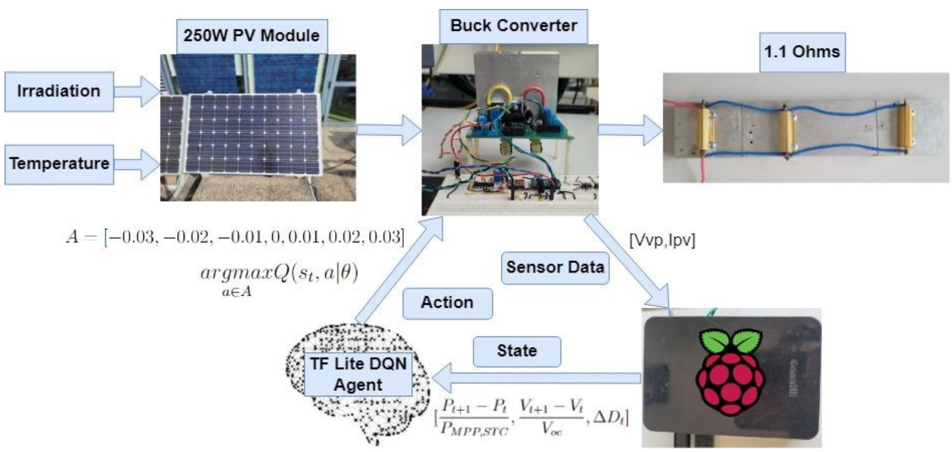

Figure 1 Experimental Set-Up Diagram.

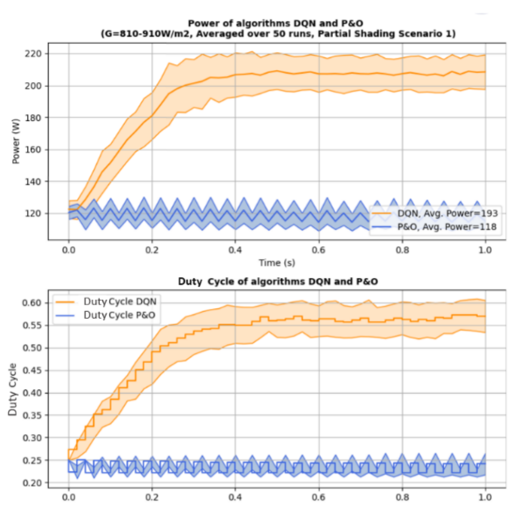

Figure 2 DQN and P&O results under partial shading scenario 1 with fixed initial duty cycle averaged over 50 runs.