ABSTRACT

Solar energy has become one of the most promising renewable energy sources to support global energy demands. To optimally harness this potential, intelligent devices are needed to accurately measure and predict solar irradiance. This study developed an Intelligence Solar Power Meter with the addition of Machine Learning features for daily solar irradiance prediction and enhanced remote monitoring capabilities. The system uses a light sensor as the main input to record solar irradiance data in units of W/m², with time features (hour and minute) as additional variables. A Random Forest Regressor model was integrated into the device to perform daily solar irradiance prediction. The model results show a coefficient of determination value of R of 88,77%, which indicates quite good predictive ability. The results show that the system is capable of measuring solar irradiance with an error of 7.01% compared to a standardized reference instrument. In addition, the system is equipped with connectivity features that allow real-time data transmission and monitoring via an internet-based platform. It supports reliable data transmission up to 1500 meters under Near Line of Sight (nLoS) conditions and up to 500 meters under Non Line of Sight (NLoS) conditions. This approach not only improves solar irradiance measurement but also enhances the integration of monitoring systems in various solar energy applications in a more adaptive and efficient manner.

Keywords—solar terrestrial measurements, solar irradiance, machine learning, IoT