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Implementation of a wireless distributed node-based system for monitoring, controlling and data logging of a Parabolic Trough Concentrator

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Solar thermal energy harnessing through a Parabolic Trough Concentrator (PTC) type plant is the most efficient and cheapest technique in the field of renewable energy harnessing. Near real time performance monitoring and frequent maintenance of such plants should be done in order to maintain a consistent thermal output from the system. Typically, the temperature of a well-focused Heat Collecting Element (HCE) of a PTC exceeds 300 ℃ during peak operation. It is necessary to have an unmanned data acquisition system due to physical limitations in accessing the HCE and measuring the HCE temperatures. This also reduces the downtime and increases the efficiency of the monitoring and management process. The objective of this study was to develop a wireless distributed node-based controlling and monitoring system to monitor the status of a medium scale PTC, based on Wi-Fi enabled IoT devices. The system was designed as distributed nodes and a custom firmware was developed in order to handle data transmission using Message Queuing Telemetry Transport (MQTT). For long-term storage and redundancy, the collected data was uploaded to a cloud storage. Automated error and status reporting features were also implemented. The system was built using five low power wireless nodes. The temperature node was specially designed to measure the temperature profile across the focal plane to optimize the performance of the PTC. Twenty K-type calibrated thermocouples were used as the sensor. The trough angle was also measured using a MPU 6050 accelerometer. The tracking node was developed to use the current trough angle to move the trough according to the calculated solar angle using the Sun Position Algorithm developed by the National Renewable Energy Laboratory, USA. Ambient temperature, relative humidity and solar irradiance measurement were logged along with the temperature measurements. The average response time of the temperature, weather and trough-angle nodes were observed to be 7.10s, 150ms and 30ms respectively. The slow response of the temperature monitoring node was due to the switching of 20 thermocouples. The average power consumption of a node was found to be 0.42 W during the data transmission and 0.14 W when the system is idling. This system can be upscaled and adapted to similar data acquisition tasks involving spatially distributed applications.

Keywords: IoT, Wireless, Energy harnessing, Node-based, Control systems

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