Prediction for icing incidents in cold regions using an IoT-based device

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Abstract

An IoT-based device is introduced, designed to enhance safety and operational efficiency in environments prone to icing incidents. This device is equipped with a suite of sensors monitoring and analyzing crucial meteorological data in real-time to predict the onset of icing conditions. It can track variables such as air temperature, wind speed, and seawater temperature in real time, establishing the fundamental groundwork for precise icing predictions. Notably, this device has a distinctive capability - the ability to detect the presence and amount of liquid water, an essential layer of analysis, given that not all sub-freezing conditions inevitably culminate in ice formation. The algorithm is designed with a threshold-based approach, which integrates defined values for each monitored parameter, promptly activating predictive capabilities upon meeting these thresholds. Furthermore, the device's trajectory includes incorporating neural networks to refine the algorithm to improve its predictive abilities continually. Practical applications include infrastructure protection for marine installations like offshore platforms, aquaculture facilities, and wind turbines. Its early warning system can play a role in mitigating ice-related damages and improving anti-icing systems, such as optimizing heating control. Additionally, it may contribute to environmental research by providing data on climate patterns and weather-related trends. Currently, in the construction phase, the device undergoes testing in a controlled cold room environment to assess feasibility and enhance algorithm performance for practical deployment.

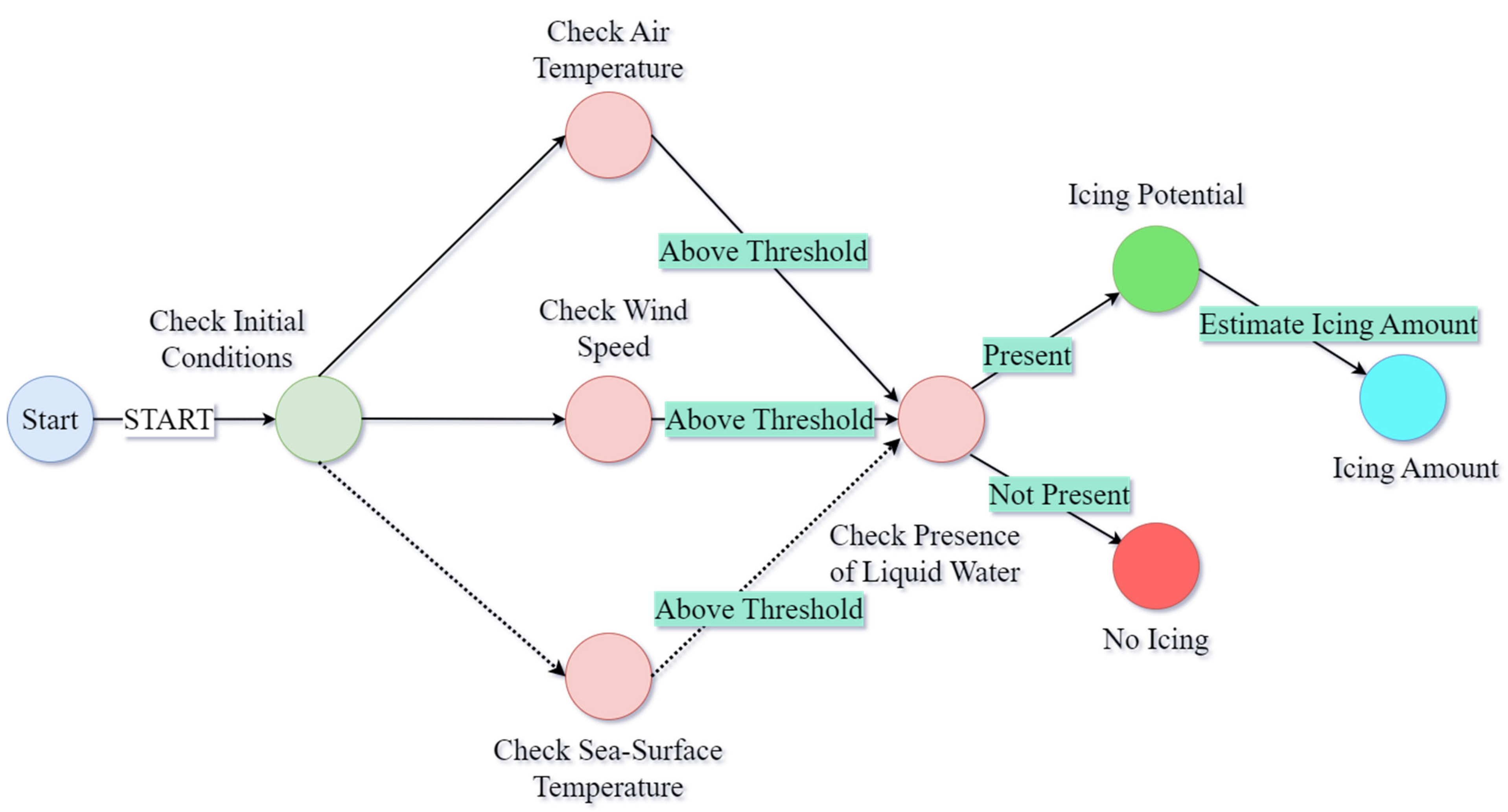

Fig.1. IoT- device's Icing Estimation Algorithm

Fig.2. IoT-Device

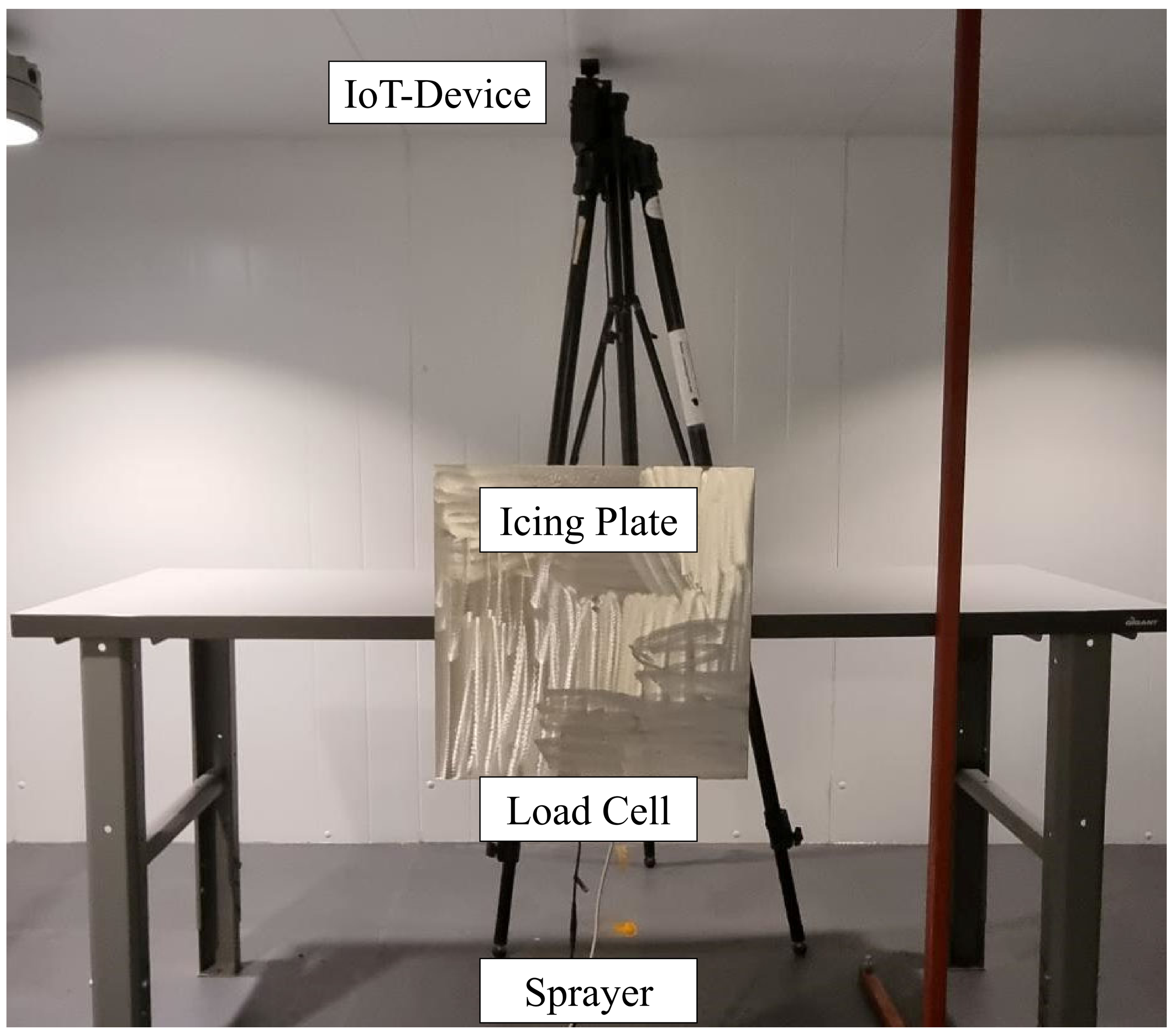

Fig.3. Experimental setup

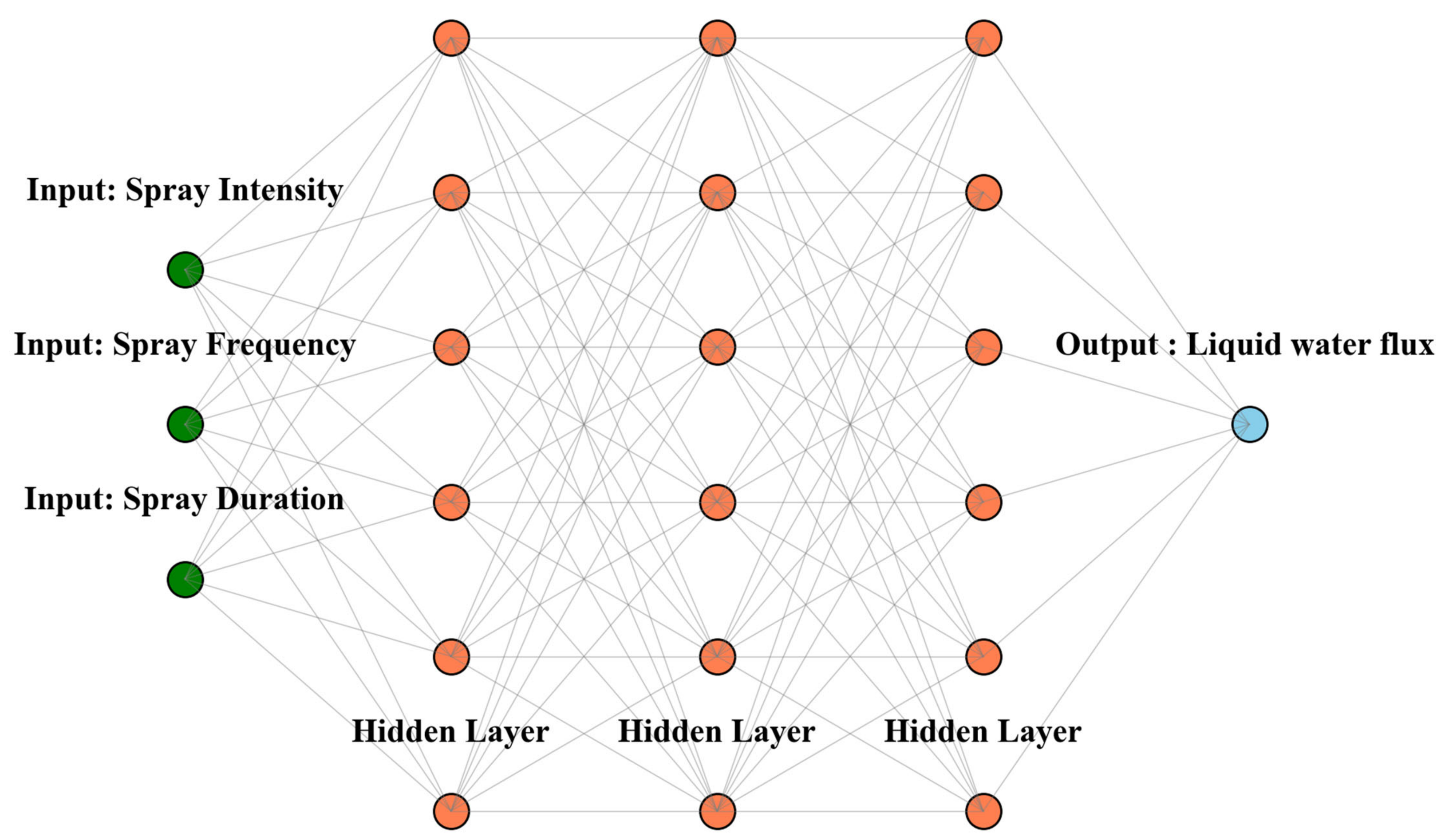

Fig. 4. Illustrates the application of a Neural Network for estimating spray flux.

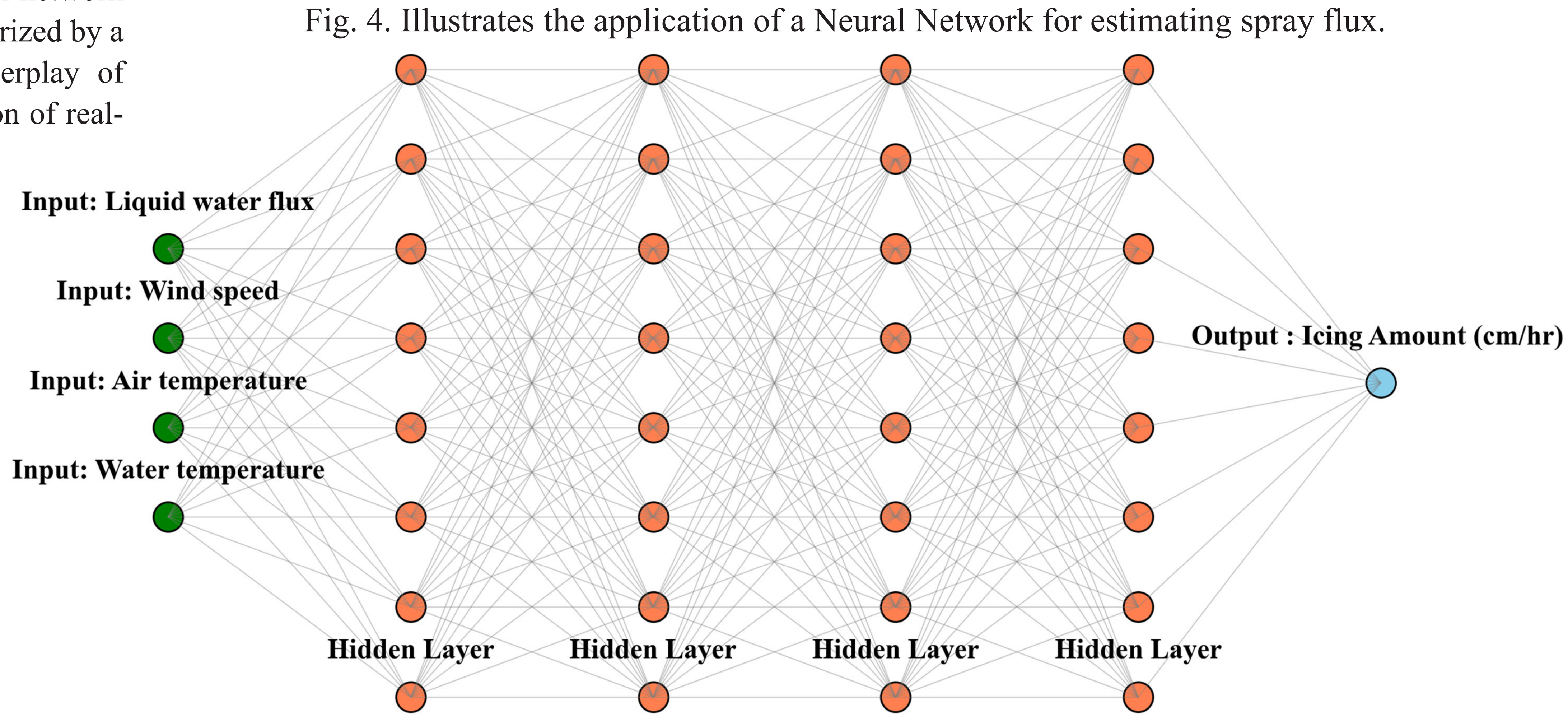

Fig. 5. Depicts the utilization of a Neural Network for estimating the amount of icing.

Conclusion

The ongoing development of the IoT-based device signifies progress toward enhancing safety and operational efficiency in environments prone to icing incidents. Progressing through the development phase involves crucial testing in a controlled cold room environment, contributing to the generation of diverse simulations. These simulations capture variations in wind speed, water temperature, and air temperature, alongside systematic applications of different spray amounts, facilitating the collection of extensive and nuanced icing data.

Essentially, the gathered data forms the backbone for refining the robust neural network icing estimation model, a pivotal component of the device. This model, characterized by a sophisticated algorithm, is intricately designed to analyze the complex interplay of meteorological variables and liquid water presence, thus enhancing the precision of real-time icing predictions.

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