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Investigation of the Spatial and Temporal Variations of Weather Conditions in a Mesoscale Vineyard

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Abstract

Climatological conditions and weather variability have a momentous impact on viticulture and vineyard management and can be detrimental for grapevine growth and its yield. Humid weather conditions contribute to the spread of fungal pathogens and diseases, which afterwards degrade the quality of the grapevine and risk the longevity of orchards and vineyards in the tropical and subtropical regions. Therefore, it is critical to monitor the spatial and temporal variations of weather conditions in the vineyards. Despite numerous sensor systems developed in academia and industry to address this problem, a scalable and dense sensor system that guarantees low maintenance, fast and reliable data acquisition is still lacking. Thus, in this study, a low-cost wireless networked system was developed for real-time monitoring of weather parameters namely, temperature, relative humidity and dew point temperature. A capacitive-type sensor SHT31 integrated into an STM32L0 microcontroller was employed as a measuring unit. Data transmittance was empowered via a functional radio network. The sensor housings were designed and manufactured in-house via a 3D printer. The accuracy of data readings was validated by a climatic test chamber CTS-20/1000 under a wide-ranging set of temperatures and relative humidities. As an evasive experimental site, a mesoscale 30-ha vineyard located in Hessigheim, Germany was used to test the monitoring system. A number of 30 sensors were installed irregularly in this area. For the graphical analysis, data collected during the summer and winter periods were compared. From the results, substantial differences in temperature were observed between vineyard sites at $p \leq 0.05$. The spatial temperature gradients altered up to 8°C, which was mainly attributed to the heterogeneous and steeply sloping terrain of the vineyard. These gradients increased over the summer and decreased during the winter. This behaviour was accredited to the diurnal solar orientation, shaded conditions as well as wind direction imposed by a bend in the river. Likewise, significant differences were observed for dew point and relative humidity. In conclusion, the developed network system demonstrated a high capability to track the variability of weather conditions and should be used as a tool for the prediction of infection hotpots in vineyards.

Keywords: Low-cost, mesoscale, monitoring, real-time, sensor, vineyard, wireless

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