Smart farm – ICT&AI agriculture based on monitoring and modeling of plants

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Abstract

Conventional research and technology of cultivation management and environment control have already become matured and saturated. At present the most important issues in greenhouse horticulture are succession of farm expert technology and reduction of labor management. As for large-scale commercial greenhouses, development of labor management to reduce labor cost, mechanization and installation of robots receive more attention. Application of information and communication technology (ICT) and artificial intelligence (AI) is one of possible methods for documentation and quantifying of the technology. Variety of noteworthy research and development using image-sensing based on AI technology are in progress in Japan. In this study, technologies for ICT/AI-based monitoring and modeling of plants are reviewed.

Keywords

Computer simulation, fruit, growth and development, growth model, image analysis, plant canopy

Category	Measured item	Instrument	ICT/AI based method	M[2]	Automation
Plant canopy and leaf	Canopy structure	3D Camera, Lidar	Image analysis	N	○
	Leaf area index	3D Camera, Lidar	Image analysis	N	○
	Leaf color	VIS camera		N	△
	Chlorophyll conc.	SPAD meter		N	△
	Leaf thermal temperature	IR camera		N	○
	Spectral characteristics	VIS/IR camera		D/N	△
Growth	Growth rate	VIS camera	Image analysis, Weather data	N	○
	Predicted growth rate	VIS camera	Image analysis, Weather data, Computer simulation, Growth model	N	○
	Leaf area	VIS camera	Image analysis	N	○
	Fruit, Seed	VIS camera	Image analysis	N	○
	Leaf photosynthesis	LI-6400/ I-6800		D	×
	Whole plant photosynthesis	3D camera	Image analysis, Computer simulation, Ray tracing method	N	○
	Leaf transpiration	LI-6400/I-6800		D	×
	Whole plant transpiration	Electric balance		D/N	×
	SPAC[1]	Sap flow		D/N	×
		Stem diameter		D/N	△
	Chlorophyll fluorescence	VIS camera	Image analysis	N	○
Fruit	Number of fruits, Size	VIS camera	Image analysis	N	○
	Maturity, Quality	VIS camera	Image analysis, Machine learning	N	○
	Predicted maturity and quality	VIS camera	Image analysis, Machine learning, Growth data, Weather data	N	○
Disease	Species	VIS camera	Image analysis, Weather data, Machine learning	N	○
	Damage	VIS camera	Image analysis, Machine learning	N	○

[1]SPAC: Soil-Plant -Atmospheric continuum. [2]M column: D is destructive. N is nondestructive.