Development of Smart Cloud-based Irrigation Controller:
Real-time Evapotranspiration Monitoring in Tomato Greenhouse

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1 MOTIVATION
Background & problem identification

Smart Irrigation Controllers optimizes water use by monitoring and utilizing environmental information, and applying the right amount of water. Smart Controller is “smart” due to the feedback from the irrigated system, and then it used to adjust irrigation volume. Here are generally two types of smart controllers: climatologically based (ET0: Evapotranspiration) and soil moisture-based (SMST) controller [1]. Our final goal is developing a hybrid controller which attempting to take the advantages of both ET0 and SMST in term of water saving and irrigation automation.

2 MATERIALS & METHOD
Experimental setup & system configuration

The objective of this study is to present the development of a real-time evapotranspiration monitoring in the application of smart cloud-based irrigation controller. The hourly step real-time ET0 was estimated using the FAO-56 Penman-Monteith model based on environmental data.

![Fig. 1: System architecture of smart cloud-based irrigation controller [2] and hardware/software specification. The experiment was conducted in Tomato (Solanum lycopersicum) greenhouse at the Kyushu University (33.628151, 130.426660) on June 2015.](image)

### a. Estimation of reference evapotranspiration (ET0)

Evapotranspiration is the process of transpiration combined with evaporation from plant and soil surfaces. Reference evapotranspiration (ET0) can be estimated using FAO-56 Pen model:

\[
ET0 = \frac{0.408 \Delta R_n - G + \gamma \frac{37}{(T_s + 273.16)U_{10}V_{PD}}}{\Delta + \gamma(1 + 0.34U_{10})}
\]

ET0 is the reference evapotranspiration (mm hour⁻¹), \( \Delta \) the slope of saturation vapor pressure curve (°C⁻¹), \( R_n \) net radiation at the surface (MJ m⁻² h⁻¹), \( G \) the soil heat flux density (MJ m⁻² h⁻¹), \( T_s \) mean of hourly air temperature (°C), \( U_{10} \) is average hourly wind speed (m s⁻¹), \( V_{PD} \) the vapor pressure deficit (kPa), \( \gamma \) the psychrometric constant (kPa °C⁻¹).

### b. Real-time computation of hourly step evapotranspiration

The developed real-time evapotranspiration monitoring could estimate the hourly step reference evapotranspiration (ET0) from the environmental data.

The real-time computation performed in a function that executable at certain time interval implementing time-shifting with \( w \) time interval.

However, in order to verify the estimation value, direct measurement of ET0 might help the improvement of the system accuracy.

Investigation on relation between soil moisture ET0 for potential input for hybrid controller and development of the smart controller are our future works.

3 RESULTS & DISCUSSION
Current result and system evaluation

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4 CONCLUSION & FUTURE WORKS
Current conclusion and challenges

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Cited documents and further information

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