Short-time Prediction of Solar Power Output Changes with Omnidirectional Camera

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Introduction

Stable operation of photovoltaic generation requires control based on output forecasting. In solar PV output prediction, satellite cloud observation data are used. This system enables large-scale solar PV forecasting for mega solar. However, in recent years, with the spread of solar PV, more accurate and localized energy management has become more important(Fig.1,Fig.2). From such background, FURUNO has developed a prototype for predicting change in local solar radiation using omnidirectional camera(Fig.3).

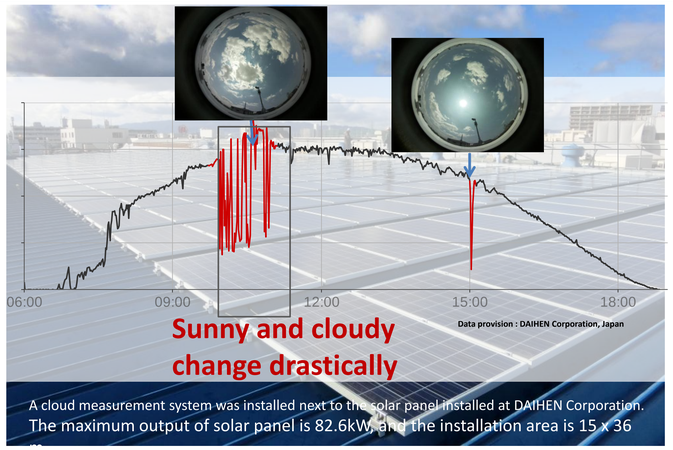


Fig.1:Solar power generation output

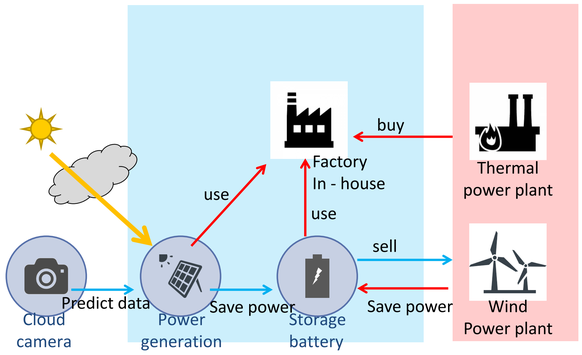


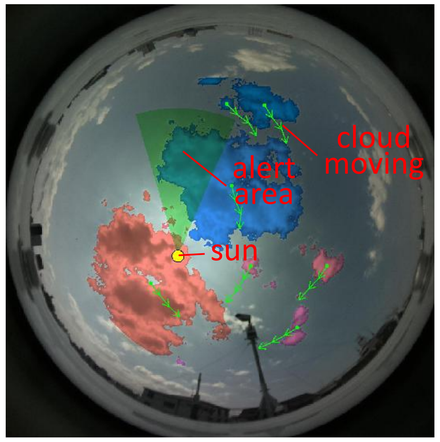
Fig.2: Energy management system

Fig.3: Identify cloud/sky by image processing

Details

Even if the clouds that mask the sun are very small, but this causes a sharp drop in power generation. Therefore, it is necessary to capture the detailed advection of clouds in order to predict rapid changes of power generation.

In this case, the cloud advection is estimated from the image at multiple times(Fig.4). Then, it predicts the rate at which clouds mask the sun at a given time (referred to as "sun forecast index" in this presentation)(Fig.5). If this value is low, it indicates that there is a high possibility of clouding or rain, and if the value is large, it indicates that the possibility of sunny is high.



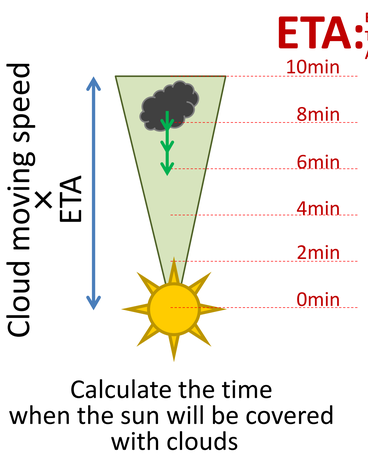
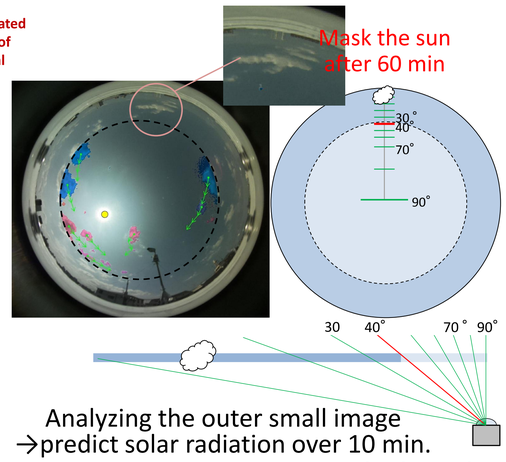


Fig.4:Predict the course that covers the sun



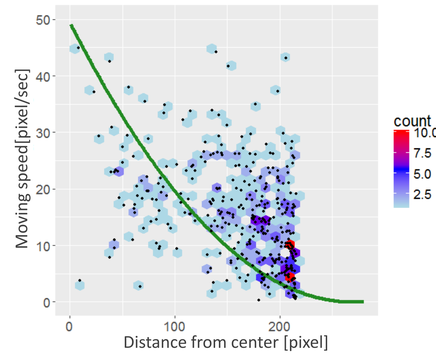
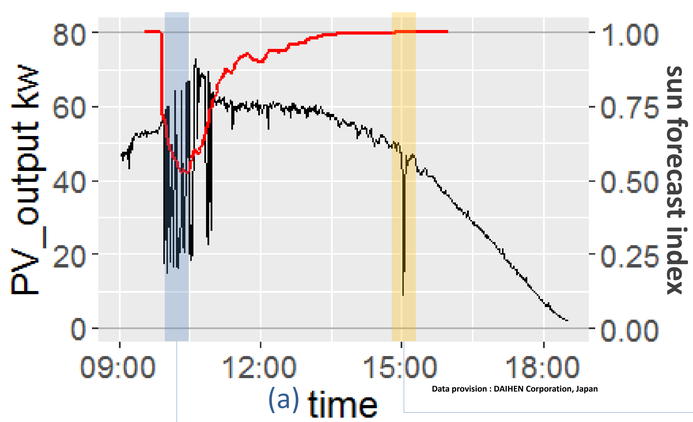


Fig.5: calculate cloud moving speed

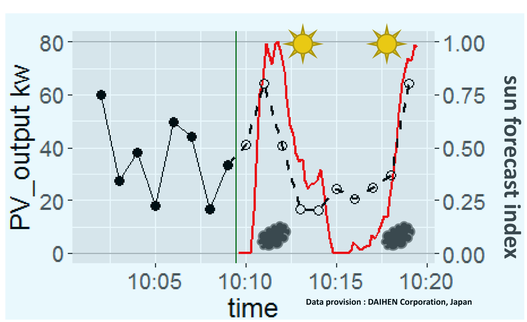
Results

In this result, sun forecast index was predicted at the same point where solar PV, and compared it. Here, the solar prediction index is calculated using only past information for prediction, and solar PV amount itself is not predicted. Fig.6(a) shows the prediction result of time series. The graph shows the predict result after 60 min. Red shows the predicted, and black shows the solar PV. Fig.6(b) shows the prediction result of time series. The vertical green line at represents the predicted start time, the graph solid black line represents the past solar PV output, and the dotted line represents the actual solar PV amount after the prediction. In Fig.(b)(c) the actual power generation output (black dotted line) are compared, it can be seen that the tendency is matched well. Depends on the weather conditions, the forecast accuracy of sunny or cloudy after 10 minutes was 65–85%. This result suggests that cloud cameras can be used to predict changes in solar radiation.

60 min trend prediction



10 min detailed prediction



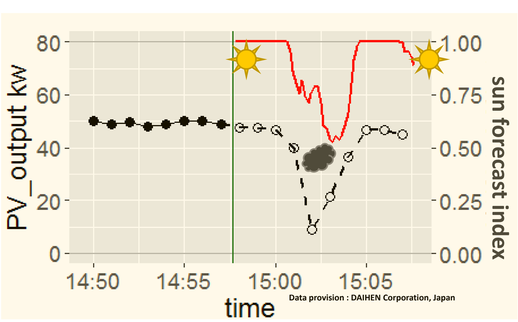


Fig.6:Result of solar radiation prediction (a)predict 60 min later, (b)predict 10min later at 10:09,(c)predict 10 min later at 14:57

Conclusions

This presentation reported the prediction of solar PV in a short time using a cloud camera system. The cloud advection was estimated from the image at multiple times and it predicts the rate at which clouds mask the sun at a given time. As a result, it was shown that the tendency of the output change of the solar PV after 60 minutes was predicted by analyzing the image of the omnidirectional camera.

Especially, after 10 minutes detailed solar prediction index matched well with PV output. This result suggests that cloud cameras can be used to predict changes in solar radiation.